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Carbohydrate consumption by children of different age groups.(From 24 hour diet recall).

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Ms. Sonu Mishra is a student of Second year M.Sc. Clinical Nutrition and Dietetics at Dr. BMN College of Home Science at Matunga. The Research Proposal entitled **"Carbohydrate consumption by children of different age groups. (from 24-hour diet recall)."** under the guidance of **Dr. Rupali Sengupta** was presented before the Ethical Committee on 16th July,2016. The Research Proposal was approved and passed by the ethical committee members to continue her further research.

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ABSTRACT

Research during the last two decades has firmly established that diet is one of the major risk factors in the development of a spectrum of non-communicable diseases and the major part of the diet is comprised of carbohydrates. Carbohydrates are the single most important source of food energy in the world. Diet quality follows a socioeconomic gradient. Where higher-quality diets are often associated with greater affluence, energy-dense diets that are nutrient-poor are preferentially consumed by persons of lower socioeconomic status (SES) and of more limited economic mean. The aim of the present study is to assess the carbohydrate consumption of children of different age groups. Data was collected from 480 samples using a 24 hour dietary recall method. The samples were selected from Mumbai city. The samples were selected from three age groups 3-6 years, 10-12 years and 13-15 years. Statistical analysis was performed by using SPSS software. It was noted that children belonging to age group of 13-15 years of middle socioeconomic strata had the highest consumption of added simple carbohydrates whereas children belonging to age group 13-15 years of low socioeconomic strata had the highest

consumption of complex carbohydrates. Moreover it was observed that children's age has a significant influence on consumption of energy, carbohydrates and percentage energy obtained from carbohydrates. Results from the present study concluded that the mean carbohydrate intake was highest among 13-15 years children belonging to HSES and the least intake was observed in 6-9 years children of LSES which shows that diet quality follows a socioeconomic gradient.

Key words: carbohydrates, socioeconomic, energy, simple sugar

CHAPTER ONE

INTRODUCTION

India is facing a triple burden of malnutrition where presence of undernourished individuals, micronutrient deficiencies and excess intake of calories resulting in increasing prevalence of overweight and obesity coexists (www.wcd.nic.in). This increasing prevalence of overweight and obesity was seen not only in adults but also in children. Childhood obesity is seen to be one of the most serious public health challenges of the 21st century. It is seen that overweight children are more likely to develop insulin resistance, hyperinsulinemia, diabetes and cardiovascular diseases at a younger age than non-overweight children which in turn are associated with a higher chance of premature death and disability. (www.indiaenviornmentportal.org.in).

Stephen &Cummings, defined dietary carbohydrates as a diverse group of substances with a range of chemical, physical and physiological properties (Stephen & Cummings, 2007).

Further, statistics showed that the primary classification of dietary carbohydrates, according to their chemical structure as proposed at the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Consultation on Carbohydrates in human nutrition convened in Rome in 1997 (FAO, 1998), was based on molecular size, as determined by degree of polymerization (DP), the type of linkage (a or non-a) and character of individual monomers. According to these features the following are the major classes of carbohydrates:

Sugars(1-2)
Oligosaccharides (3–9)(short-chain carbohydrates)
Polysaccharides (≥10)

Hydrogenated carbohydrates (polyols)

(WHO/FAO Consultation, 1997)

At the global level, 40-80 percentage of human dietary energy comes from carbohydrates, the primary energy source for the human metabolic system (Ruottinen, 2011).

Dietary fibre is the edible parts of plants or analogues of carbohydrates which are primarily derived from plant material and is composed of complex, nonstarch carbohydrates and lignin that are resistant to digestion and absorption in the small intestine. Physiologically mammals do not produce enzymes capable of hydrolysing them into their constituent monomers. As a result, these compounds enter the colon in intact form, where they are available for partial or complete fermentation by the resident bacteria (Gray & Juliet, 2003).

A study was conducted by Keast on intake data of children 2 to 18 y (n = 7332) participating in the 2003–2006 NHANES to identify food sources of energy and 28 nutrients for children in the United States. Analysis of food sources were conducted using a single 24-hour recall collected from children. The results of the study showed that the major food sources were total carbohydrate—soft drinks/soda (10.5%) and yeast bread/rolls (9.1%); total sugars—soft drinks/soda (19.2%) and yeast breads and rolls (12.7%); added sugars—soft drinks/soda (29.7%) and candy/sugar/sugary foods (18.6%); dietary fibre—fruit (10.4%) and yeast bread/rolls (10.3%) (Keast, 2013).The study thus concluded, that many of the major sources of energy were low in nutrient which indicated that many children were unaware of dietary recommendations, and do not consume recommended amounts of nutrient-dense foods, such as whole grains, fruit, vegetables, low-fat milk, and lean meat because of which diets could be nutritionally inadequate.

The dietary intake of healthy school children 6 to 16 years of age by a 24 hours dietary recall method was done in Balochistan, Sindh, Punjab and Karachi by Aziz and Hosain in year 2014. Author's studied the percentage intake of carbohydrate (CHO), protein and fat. They further recommended that the intake for children should be 45% to 65% of their calories from carbohydrates, 25% to 40% from protein and 20% to 35% from fat. However the study concluded that the children were taking 60% to 74% of their calories from CHO, 10% to 12% from protein and 18% to 32% from fat, indicating a high percentage of CHO and low protein intake. Fat was near the normal requirement. Overall the study

indicated that the children were being given high, energy-dense (ED) food (mainly CHO) beyond RDA's. This might be due to poverty, and further, parents could not afford protein-rich foods like meat. Another reason for the imbalance in the CHO, protein and fat to be found was lack of awareness amongst parents about the food pyramid (Hosain, 2014).

According to the Finnish nutrition recommendations and the Nordic Nutrition Recommendations (NNR) (Nordic Council of Ministers 2004), the proportion of carbohydrates should represent 50-60% of the total energy intake from age three onwards. Both the 1997 FAO/WHO Expert Consultation and the 2002 WHO/FAO Expert Consultation recommended that total carbohydrate should provide 55–75% total energy, with <10% total energy for free sugars. The European Food Safety Authority panel has recently proposed 45–60% energy as the reference intake range for carbohydrates and <10% energy for sugars (EFSA,2010).

Keeping in view the importance of dietary carbohydrate in children's diet, the present study was undertaken to understand the dietary pattern of children with respect to carbohydrate intake in the diet.

CHAPTER TWO

REVIEW OF LITERATURE

The dietary carbohydrates are known as a diverse group of substances with a range of chemical, physical and physiological properties .Carbohydrates are based on the elements carbon, hydrogen, and oxygen. In general Carbohydrates can be classified in two ways-either according to their chemical structures or according to their physical effects (Gray & Juliet, 2003).

Structural classification of carbohydrates: The primary classification of dietary carbohydrates, as proposed at the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Consultation on Carbohydrates in human nutrition convened in Rome in 1997 (FAO, 1998), is based on molecular size, as determined by degree of polymerization (DP), the type of linkage (a or non-a) and character of individual monomers (Table 2.1).

CLASS(DP*)	SUBGROUP	PRINCIPAL COMPONENTS
Sugars(1-2)	Monosaccharide	Glucose, fructose, galactose
	Disaccharides	Sucrose, maltose, lactose, trehalose
Oligosaccharides (3–9) (short-chain carbohydrates)	Malto	Maltodextrins
	oligosaccharides (α-glucans)	Raffinose, stachyose, fructo and galactooligosaccharides, polydextrose,
	Non-α-glucan oligosaccharides	inulin
Polysaccharides (≥10)	Starch (a-glucans)	Amylose, amylopectin, modified starches
	Non-starch polysaccharides (NSPs)	Cellulose, hemicellulose, pectin, arabinoxylans, b-glucan, glucomannans, plant gums and mucilages, hydrocolloids
Hydrogenated carbohydrates(polyols)	Monosaccharide type	Sorbitol, mannitol, xylitol, erythritol
	Disaccharide type	Isomalt, lactitol, maltitol
	Oligosaccharide type	Maltitol syrups, hydrogenated starch hydrolysates
	Polysaccharide type	Polydextrose

Table 2.1-The major dietary carbohydrates

*Degree of polymerization or number of monomeric (single sugar) units. Based on Food and Agriculture Organization/World Health Organization 'Carbohydrates in Human Nutrition' report (1998), and Cummings et al. (1997); Carbohydrates: Nutritional And Health Aspects,

Physiological classification of carbohydrates

Classifying carbohydrates according to their physiological effects was carried out in many ways. The FAO/WHO Expert Consultation on Carbohydrates in Human Nutrition recommended adopting the concept of glycaemic carbohydrates, defined as "providing carbohydrate for metabolism", i.e. carbohydrates that are digested and absorbed in the small intestine, leading to a rise in blood glucose, whereas non-glycaemic carbohydrates were the one that escape hydrolysis (digestion) in the small intestine, not leading to a blood glucose response, and were loosely classified as dietary fibre. (Gray & Juliet, 2003) as shown in figure 2.1.

Glycaemic[a]	Glucose, fructose, galactose, sucrose, lactose, maltose, trehalose, maltodextrins, starch
Non-glycaemic	Polyols, oligosaccharides (non-α-glucan), resistant and modified starches, NSP
Increase stool output	Polyols (except erythritol), some starches, NSP, lactose (in some populations), fructose (if taken in large amounts)
No effect on stool weight	Glucose, galactose, sucrose, maltose, trehalose, maltodextrins, oligosaccharides, most starches

NSP, non-starch polysaccharide.

Figure 2.1- Physiological/health groupings of dietary carbohydrate (Stephen, 2007)

To define total carbohydrate, two principal approaches are used, first, is derived 'by difference' method and second method is the direct measurement of the individual components that are then combined to give a total value.

By difference method, the moisture, protein, fat, ash and alcohol content of a food are determined, subtracted from the total weight of the food and the remainder, or 'difference', is considered to be carbohydrate. This method was used since the early 20th century and was still in use worldwide. There were however, a number of problems with this approach thus the direct method of analysis of carbohydrate was identified to obtain a total carbohydrate value. The total figure obtained is called 'available carbohydrate' when it did not contain the plant cell wall polysaccharides (fibre), therefore differs from carbohydrate by difference (Stephen & Cummings, 2007).

Sugars are composed of monosaccharide's and disaccharides. The most common monosaccharides are glucose, fructose where fructose is known to be sweetest of all the carbohydrates. The most common disaccharides include sucrose made up of two monosaccharide-glucose and fructose, and the term "sugar" is generally used to describe purified sucrose. Lactose is known as milk sugar which is comprised of glucose and galactose. Total sugars is defined as the sum of naturally occurring sugar and added sugar in foods and beverages which includes all monosaccharide's and disaccharides other than polyols. It is found to be a most suitable way to describe measure and label sugars. Free sugars are referred to as any sugars which are free and not bound. In recent years, the use of the term 'free sugars' has changed, it refers to all 'monosaccharides and disaccharides added to foods by the manufacturer, cook and consumer, plus sugars naturally present in honey, syrups and fruit juices' and was the preferred term for the WHO/FAO Expert Consultation on 'Diet, Nutrition and the Prevention of Chronic Diseases'. In a study conducted in Australia by Baghurst and his co-workers, it was concluded discretionary sugars as all refined sugars that are added at the table (almost exclusively sucrose), and added refined sugars were defined as sugars added to food and drinks either in commercial or domestic food preparation. In a study of Australian children's sugar intake the term refined sugar referred to a combination of the terms discretionary sugars and added refined sugars during manufacture. (Ruottinen, 2011). Added sugars has been defined by the FDA as, "sugars and syrups that are added to foods during processing or preparation" excluding sugars that are naturally found in foods, such as fruits or dairy products.Extrinsic sugars are not located within cellular structure of a food. These are the sugars which are added to foods and beverages during processing or home preparation and fruit juice. Non milk extrinsic sugars are all extrinsic sugars which are not from milk.Intrinsic sugars are sugars forming an integral part of certain unprocessed foodstuffs enclosed in the cells, the most important being fruits and vegetables(Slavin, 2015).

Dietary fibre which principally had effects on glucose and lipid absorption from the small intestine were defined as soluble fibre and those which were slowly and incompletely fermented and had more pronounced effects on bowel habit as insoluble fibre. However, the separation of soluble and insoluble fractions is very pH dependent, making the link with specific

physiological properties less certain. The other way to differentiate these fibres is that most of the insoluble fibre is completely fermented and not all soluble fibre showed any effects on glucose and lipid absorption (Stephen & Cummings,2007).

According to Codex Alimentarius commission/European Commission, 2007: "Dietary fibre means carbohydrate polymers with a degree of polymerisation not lower than three, which are neither digested nor absorbed in the small intestine"(Ruottinen,2011).

"Non-starch polysaccharides (NSP) are the main constituents of dietary fibre and include a host of different polymers, highly variable in terms of molecular size and structure, as well as in monomeric composition. Main classes of non-starch polysaccharides are cellulose, hemicelluloses, pectins, and other hydrocolloids."(Ruottinen,2011).

As early as in 2003, Gray and Juliet classified Resistant Starch under four classes where it was categorically differentiated as RS1 (starch that is physically enclosed), RS2 (raw starch granules), RS3 (retrograded amylose in processed foods), RS4 (chemically modified starch). Subsequently, in 2007 Stephen and Cummings defined resistant starch as the sum of starch and products of starch digestion (such as maltose, maltotriose and a-limit dextrins) that are not absorbed in the small bowel (Stephen & Cummings, 2007) .

GI- The glycaemic index (GI) is a classification of the blood glucose raising potential of carbohydrate foods. It is defined as the incremental area under the blood glucose response curve elicited by a 50 g available carbohydrate portion of a food expressed as a percentage of that after 50 g carbohydrate from a reference food taken by the same subject (Wolever, 2003; Consultation, 1997).

Starchy foods with a low GI are digested and absorbed more slowly than foods with a high *GI*. Some factors that influence glycemic properties of foods were - amount of carbohydrate, nature of the monosaccharide components, nature of starch, cooking/ food processing, other food components such as fat and protein, dietary fibre, anti-nutrients (FAO/WHO Consultation, 1997).

GL- Glycaemic Load takes into account how much carbohydrate a serving of a food contains and may be determined by indirect and direct methods. The indirect method involves multiplying the GI of a

food by the amount of available carbohydrate in the portion of food consumed whereas Glycemic equivalence is a method of directly determining GL.

However, Glycaemic Index does not take into account the amount of carbohydrate consumed, an important determinant of glycaemic response. For example, watermelon has a high GI and may not be considered a good food selection as part of a low GI diet however actually, watermelon only contains 5g of carbohydrate per 100g, thus it would have a minimal glycaemic effect. Thus the concept of glycaemic load was identified (Green & Venn, 2007).

Dietary sources of carbohydrates in children

In the European Prospective Investigation into Cancer and Nutrition (EPIC) adult population sources of total carbohydrate were found to be bread, fruit, milk and milk products, sweet buns, cakes and pies, potato, sugar and jam, pasta and rice, vegetables and legumes, crisp bread, and fruit and vegetable juices of which bread contributed 26.6% of total carbohydrate. (Wirfalt and Taggart, 2002).

A study conducted by Aeberli*et al*. 2007 on children aged 1-3 years to identify the predominant source of total fructose, found that fruits and fruit products (38%) were the major contributors, and in the age range 4-6 years non-alcoholic beverages (34%) followed by fruits and fruit products (21%)were the major sources of fructose. Corresponding results were received from the study done in Switzerland to identify fructose sources in children , where fruits and fruit juices were the largest source of fructose (30%) at 2-5 years of age, while in older children aged 6-11 years sugar-sweetened beverages (31%) was the main source (Aeberli*et al*. 2007) subsequently, a study done on Swiss children aged 6-14 years, it was concluded that 50% of fructose intake came from fruit and vegetables and 32% from sweets and drinks. (Ruottinen,2011).

Carbohydrate intake in children

The dietary changes that characterize the ‘‘nutrition transition’’ include both quantitative and qualitative changes in the diet. The adverse dietary changes include shifts in the structure of the diet towards a higher energy density diet with a greater role for fat and added sugars in foods, greater saturated fat intake (mostly from animal sources), reduced intakes of complex carbohydrates and dietary fibre, and reduced fruit and vegetable intakes. These dietary changes are compounded by lifestyle changes that reflect reduced

physical activity at work and during leisure time. (WHO/FAO consultation, 2002).

In the same year, according to the US FITS (Feeding Infants and Toddlers Study) for toddlers aged 12-24 months, milk, yogurt and 'ice cream, frozen yogurt and pudding' contributed 18%, whereas juice contributed 12% and sweetened beverages contributed 9% to carbohydrate intake. Grain products made a substantial contribution, of at least 27% (Ziegler, 2006).

Further in 2007 Devaney and colleagues demonstrated the carbohydrate intake of 1-2 year old children. It was found that average carbohydrate intake of 1 to 2 year-olds was 165 g/day. The USDA Continuing Survey of Food Intakes by Individuals 1994-96, 1998 (CSFII) found that the average carbohydrate intakes of 1- to 2-year-olds and 3- to 5-year olds were 179 g/day and 227 g/day, respectively. (Baker,*et al.,* 2007).

Another survey was done on 488 British infants aged 6-12 months indicated that the major sources of carbohydrate were commercial infant foods (24%), cereal products (23%), milk and milk products (17%) and infant formula (13%). NMES provided 29% of total sugars intake for infants 6 to 9 months, and 41% for those 9 to 12 months, indicating that the majority of sugars intake in infants of 12 months is intrinsic in foods, the greatest sources being milk and milk products and infant formula. The greatest contributors of NMES in this age group were juice and other beverages, with increasing contributions from sweet grain foods and confectionery. (Stephen, *et al*., 2012).

In UK's recent data, it was found that 31% of toddlers between 1.5 to 3 years were consuming beverages. However out of total carbohydrate intake, 17% contribution was from fruit juice as compared to 12% from soft drinks. Further, data revealed that cereals and cereal products along with sugar preserve and confectionary made a substantial contribution of 23% and only 17% contribution was from dairy products. As early as in 1995, data showed that 40% of beverages were consumed, wherein maximum contribution was from soft drinks. (Gregory, *et al.*, 1995). Recent studies also revealed that the consumption pattern did not show much difference when compared with earlier survey. However the study showed that the impact of beverages might be a key factor in declining nutritional status amongst the subject. (Stephen, *et al*., 2012).

In a study done by Ervin, on trends in intake of energy and macronutrients in children and adolescents from 1999 to 2000 through 2009 to 2010, concluded that over the 12 years studied, the percentage of kilocalories from carbohydrate decreased from 55.6% to 54.6% for non-Hispanic white boys and from 54.6% to 53.1% for non-Hispanic black boys. The percentage of kilocalories from carbohydrate decreased from 56.3% to 54.3% for non-Hispanic white girls over this time period, but did not decrease for non-Hispanic black and Mexican-American girls (Figure 2.2). (Ervin & Ogden, 2013).

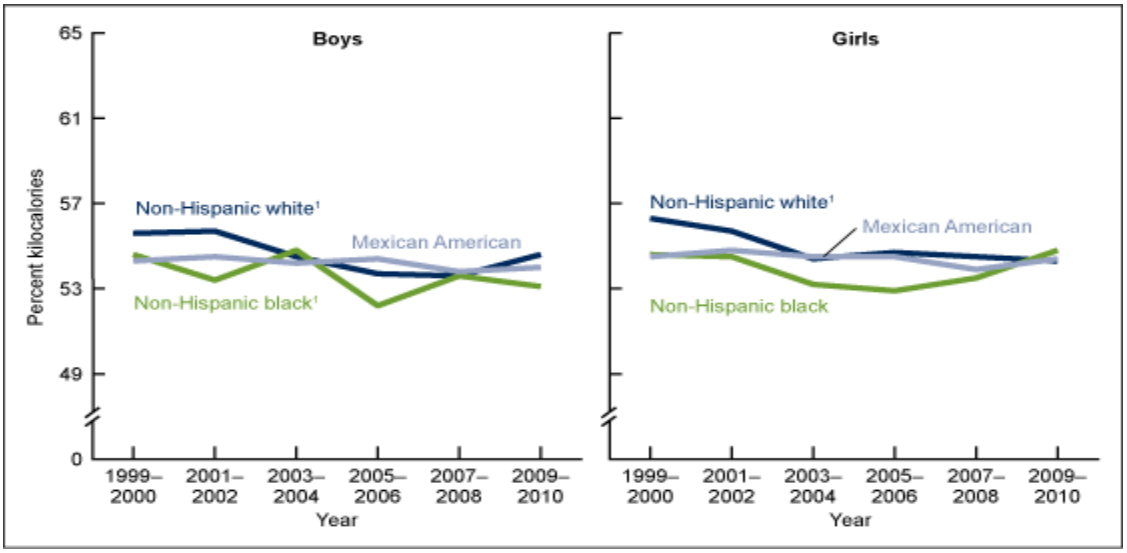

Figure 2.2. Mean carbohydrate intake for children and adolescents aged 2–19 years, by sex and race and ethnicity, 1999 to 2010, (Ervin & Ogden, 2013).

Sucrose and Fructose intake in children

A study was carried out by Erkkola, 2009 where sources of added and naturally occurring sucrose in the diets of 3-year-old children was reported. Juice drinks were by far the largest contributor to added sucrose (which was 85% of sucrose intake), at 27% of intake, with yogurt and cultured milks next at 13%, chocolate and confectionery at 12% and sweet bakery at 11%. For naturally occurring sucrose, fresh fruit and berries were the largest contributor at 38%, with fruit and berry juice at 23%. (Erkkola,*et al.,* 2009).

In another study carried in the United States, where fructose was used more often as a sweetener than in Europe, sources of total, added and naturally occurring fructose intake was reported by NHANES

from 1998 to 2004. For children aged 1-3 years, added fructose represented 65% of all fructose intakes, somewhat lower than for older age groups. The contributors to added fructose of 1-3 years were beverages (39%), grain products (26%), sugars and sweets (16%) and milk and milk products (14%). Naturally occurring fructose was largely from fruit and fruit products at 91% of intake. When expressed as a proportion of total fructose intake, fruit and fruit products were 38%, beverages 25%, sugars and sweets 10% and milk and milk products 9%. All these studies indicated that beverages (for example, fruit juices, juice drinks or soft drinks were the major) were the major contribution of 'added sugars' by young children, whether that be expressed as NMES, sucrose or fructose.(Stephen, *et al*., 2012).

Dietary fibre intake in children

The Feeding Infants and Toddlers study, found that average fibre intake of toddlers between the ages of 1 and 2 years was below the recommendation and was 8 g/day. In the USDA Continuing Survey of Food Intakes by Individuals 1994-96,1998 (CSFII),1 to 2 year-old children consumed 9 grams of fibre daily and 3 to 5 year-old children consumed 11 grams.(Baker, *et al*, 2007).

Average fibre intakes for U.S. children and adults were less than half of the recommended levels. Ruottinen, 2011 identified children's fibre intake at the age of 1-2 years which was approximately 9 g/ day, at 3-5 years 11 g/ day, and at 9 years 15 to 17g/ day.Fibre intakes by age and gender for children and adolescents in the US were identified by Sibylle Kranz, 2012. (Table 2.2)

Consumer gender and age	Fibre intake g/ day
Males	
2–5 y	11.3
6–11 y	13.7
12–19 y	14.9
Females	
2–5 y	10.5
6–11 y	12.0
12–19 y	13.3

Table 2.2- Fibre intakes by age and gender for children and adolescents in the US, (Sibylle Kranz, 2012)

Hoy and Goldman, conducted a study in the year 2014,to identify the mean dietary fibre intake of all individuals aged 2 years

and older, excluding breastfed children, concluded that 16 grams per day was the average intake of these children. Intakes of males and females were 18 and 15 grams per day, respectively. Further it was found that the top three WWEIA Food Categories that contributed to fibre intake were Vegetables, Fruits, and Breads, rolls, tortillas. (Hoy & Goldman, 2014).

Carbohydrates in Health and Disease.

Carbohydrates being an integral part of human diet throughout the world ,provides the majority of energy needs in the diets of most people. While the amount of carbohydrate required to avoid ketosis is very small (about 50 g/day),but still dietary carbohydrate was found to be important to maintain glycaemic homeostasis. (WHO/FAO Consultation, 1997) Carbohydrates provides easily available energy for oxidative metabolism in the form of glucose, also carbohydrate-containing foods are vehicles for important micronutrients and phytochemicals.

Carbohydrates and CVD

The World Health Organization was reported that CVDs are the major cause of death and disability in developed countries. High concentrations of total and LDL cholesterol, low concentration of HDL cholesterol, other dyslipidemias, hypertension, and smoking were well-established risk factors for CVD. (Ruottinen, 2011).Many genetic and lifestyle factors were involved in the etiology of coronary heart disease and influence both the atherosclerotic and thrombotic processes underlying the clinical manifestations of this disease. On one hand where obesity,particulary central obesity and high intake of saturated fatty acids appear to be strong promoters of coronary artery disease, the other hand showed increasing carbohydrate intake can assist in the reduction of saturated fat as many fruits and vegetables rich in carbohydrates are also rich in several antioxidants. Cereal foods rich in non-starch polysaccharides were found to be protective against coronary heart disease in a series of prospective studies. (WHO/FAO Consultation, 1997).

A study conducted by Gray and Juliet in 2003 reported that diets containing purified forms of starch or monosaccharide's induce the rise in triglycerides more readily than fibre-rich diets, in which the carbohydrate might be more slowly digested. (Gray & Juliet,2003).Similarly, Routinnen,linked high sugar intake with adverse changes in

lipoproteins. He reported that a diet high in sucrose associates with an elevation of plasma triglyceride concentration in children aged 6-19 years. It was also reported that sugar intake was inversely associated with total cholesterol in 3-year-old boys and decreased total, LDL and HDL cholesterol in the age range 6-19. HDL cholesterol is negatively associated with sugar in adults.(Ruottinen, 2011).Cut points for diagnosing dyslipidaemia and hypertension in children are provided in Table 2.3

Hypertension	**Guideline**
Prehypertension	Systolic or diastolic blood pressure >90th percentile for age and gender or 120/80 mm Hg, whichever is less
Stage 1 hypertension	Systolic or diastolic blood pressure >95th percentile for age and gender on 3 consecutive visits or 140/90 mm Hg, whichever is less
Stage 2 hypertension	Systolic or diastolic blood pressure >99th percentile + 5 mm Hg for age and gender or 160/110 mm Hg, whichever is less
Total cholesterol	
Borderline	≥170 mg/dL
Abnormal	≥200 mg/dL
LDL cholesterol	
Borderline	≥100 mg/dL
Abnormal	≥130 mg/dL

Hypertension	Guideline
HDL cholesterol	
Abnormal	<40 mg/dL

Table 2.3- Consensus Guidelines for Diagnosis of Hypertension and Dyslipidemia in Children, (Gidding, *et al*., 2005)

A very few studies were conducted to identify the relationship between fructose and lipoproteins. However a study done by Aeberli*et al* (2007) on 74 Swiss children aged 6-14 years regarding fructose intake and LDL particle size, it was found that high intake of fructose caused reduction in LDL particle size, a phenomenon regarded as atherogenic. However, there are only few studies on fructose intake and dyslipidaemia in children (Aeberli, *et al*., 2007).

Many studies suggested that replacing saturated fats with carbohydrates as a beneficial point in management of CVD. However, a study conducted by Tarino on relation of saturated fat, carbohydrates and cardiovascular disease ,reported that replacement of saturated fat with carbohydrate was not significantly associated with a reduced risk of CHD. Results showed that monounsaturated fat resulted in declined risk of CHD in patients with diabetes mellitus. (Tarino,*et al*, 2010)

Ruottinen, et al in 2011 reported that increased dietary fibre showed therapeutic benefits in lowering cholesterol values in childhood. It was reported that adding approximately 6g of soluble fibre (in psyllium-enriched cereal) to children's diets might lower LDL cholesterol by 6% more than a low-saturated fat, low cholesterol diet alone, and in adults also diets low in SFA and dietary cholesterol and very high intakes of foods rich in soluble fibre decrease total and LDL cholesterol. Soluble or viscous fibres affect serum total and LDL cholesterol values by binding bile acids in the small intestine and increasing their excretion in faeces. (Ruottinen, 2011)

Apolipoprotein E (apoE) gene is polymorphic, with three common alleles, designated apoE 2, apoE 3, and apoE 4. The apoE polymorphism may explain

approximately 10% of the interindividual variance in serum total cholesterol concentration. In 13-month-old children apoE phenotype explained 5% of the cholesterol concentration variation. It was well known that this apolipoprotein polymorphism was associated with serum cholesterol concentration already in childhood, where children with the carriers of the E2 allele had a lower total and LDL cholesterol concentration and in some studies, a higher HDL cholesterol concentration was found in these subjects than those children with E3 or E4. Triglyceride levels do not differ between the apoE phenotypes in children. In another study, it was also seen that individuals with the E2 allele had greater reduction in plasma LDL cholesterol after a high carbohydrate diet than E3 or E4 allele carriers. However, the apoE polymorphism might not play a major role in modifying the relation between diet and serum lipid concentrations (Ruottinen, 2011).

Carbohydrates and Obesity

The prevalence of overweight and obesity is rapidly increasing in western countries and among affluent people in developing countries. Studies indicated the role of carbohydrate in the prevalence of obesity, it is therefore important to understand how carbohydrates might influence body weight. To maintain stable body weight one requires to maintain a balance between the total amount of energy consumed and the total amount of energy expended. Increase in body weight, specifically in body fat, occurs when intake exceeds expenditure (Gray & Juliet,2003).

Alvina and Araya, in 2004 concluded that obese children consumed a higher energy intake when they were consuming a high carbohydrate meal with rapid carbohydrate digestion rate. Also meals with high glycaemic index induced higher energy intakes and higher fat deposition (Araya & Alvina, 2004).

In the same year, effects of fast-food consumption on energy intake and diet quality among children in a national household survey, reported that there was an increase in the consumption of fast foods along with higher amounts of sugar sweetened beverages. However a declining trend was observed where a study was conducted on intake of fruits and vegetables among children (Bowman,*et al*, 2004).

Overweight is associated with increased health problems in childhood as well as increased morbidity and mortality in

adulthood. Health problems associated with overweight in childhood are Cardiovascular- Hypercholesterolemia, Dyslipidaemia, Hypertension; Pulmonary- Asthma, Obstructive sleep apnea syndrome, Pickwickian syndrome; Endocrine- Hyperinsulinism, Insulin resistance, Impaired glucose tolerance, Type 2 diabetes; Orthopaedic- Genu verum, Slipped capital femoral epiphysis, Arthritis; Mental Health- Depression, Low self-esteem; Gastrointestinal/hepatic- Non-alcoholic steatohepatitis, Gall bladder disease(Baker, *et al*, 2007).

Davis *et al*. conducted a study to identify the relation between dietary fibre intake and visceral adiposity in overweight Latino youth. The study concluded that adolescents who increased total dietary fibre intake (3 g/1000 kcal) decreased their visceral adipose tissue (VAT), whereas adolescents on a reduced fibre intake diet increased VAT (Davis, 2009).

A study was conducted by Ambrosini, to identify dietary patterns (DPs) characterized by high sugar content, high fat content, or both and their longitudinal associations with adiposity during childhood and adolescence. It was observed that sugar and fat were key features of dietary pattern's that were linked to excess weight gain. It was also seen that a dietary pattern which was high in both fat and sugar was longitudinally associated with greater adiposity between the age group of 7 to 15 years in 6722 subjects. However in comparison with dietary pattern that was high in percentage energy from free sugars and low in percentage energy from fats was not associated with adiposity (Ambrosini,2016).

Role of Sugar Sweetened Beverages in Obesity

Sugar-sweetened beverages -SSBs includes the full spectrum of soft drinks, fruit drinks, and energy and vitamin water drinks containing added sugars. These beverages are sweetened by high fructose corn syrup (HFCS; the most common added sweetener in processed foods and beverages in the United States), sucrose or fruit juice concentrates. The HFCS that was commonly used in beverages contains 55% fructose and 45% glucose, while sucrose or table sugar consists of 50% fructose and 50% glucose. Consumption of SSBs had increased dramatically in the past several decades among both children and adults.

A school-based intervention targeting soda consumption carried out by Malik *et al*

where the independent role of the intake of sugar-sweetened beverages, particularly soda, in the promotion of weight gain and obesity in children and adolescents was studied. The study indicated that there was a decrease in the consumption of sugar-sweetened beverages such as soda and fruit drinks and intake of other beverages such as water, low-fat milk, and small quantities of fruit juice should be promoted (Malik,*et al.,* 2006).

Recent study conducted to identify role of sugar sweetened beverages in obesity. The study showed a positive association between SSB intake and long-term weight gain and obesity in children and adults. Dose–response relationship was also identified which concluded that, as SSB intake increases, the amount of weight gain increases in a dose–response manner (Hu, 2013).

Leermakers, *et al* conducted a population-based prospective cohort study on sugar-containing beverage intake at the age of 1 year and cardio metabolic health at the age of 6 years. It was observed that higher sugar containing beverages intake at 13 months of age was associated with a higher cardio metabolic risk factor score at 6 years of age. This observation was seen in boys only and not in girls (Leermakers, *et al.,*2015).

Carbohydrates and Gastrointestinal health

An adequate intake of fibre-rich carbohydrates is important to normal gut function. FAO/WHO expert consultation on carbohydrates in human nutrition, showed the importance of carbohydrate in the gastrointestinal health. It was seen that non starch polysaccharides from bran and other cereal sources and resistant starch are the most vital contributors to stool weight. Thus increase in consumption of these foods was found to be effective in treatment of constipation, haemorrhoids, anal fissure, and protective against diverticular disease and gallstones (WHO/FAO Consultation, 1997).

A study in 2003 on low fibre diet indicated that a low-fibre diet is a risk factor for chronic childhood constipation, and indicated that inadequate intake of dietary fibre was related to gastrointestinal disorders such as irritable bowel syndrome, diverticular disease, and colorectal cancer according to a commentary by the ESPGHAN Committee on nutrition (Aggett, 2003).

High intake of carbohydrate may also facilitate colonization of gut bacteria like bifidobacteria and lactobacilli and therefore reduce the risk of acute infective

gastrointestinal illnesses and also provides mechanisms which are effective in cancer prevention of the colon(Cummings & Elia, 2007).

A recent study was conducted by Chumpitazi ,*et al* on dietary carbohydrates and childhood functional abdominal pain. It was seen that Carbohydrate malabsorption might cause gastrointestinal symptoms (e.g., bloating) via the physiologic effects of both increased osmotic activity and increased gas production from bacterial fermentation. There was no strong evidence to prove that restriction of individual carbohydrates (e.g., lactose) for childhood functional gastrointestinal disorders would be benfecial. However evidences suggested that the restriction of fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAP) might be effective. Inclusion of soluble fibre supplementation in the diet of children suffering from functional gastrointestinal disorders was proven to be effective. (Shulman, 2016). Dietary fibre promotes gastrointestinal function by building up important microflora, and act as a prebiotic (substrate for beneficial microorganisms) . High fibre diets provide bulk, were more satiating, and were found to be linked with lower body weights (Maćkowiak, 2016).

Carbohydrates and Diabetes mellitus

History revealed that a high frequency intake of foods rich in carbohydrate seemed to increase the risk of insulin dependent diabetes mellitusn in childhood (Dahlquist, 1990).

A study was done in early 2000,reported that diabetic adults who consumed a diet with 50g of fiber for 6 weeks had significantly reduced their preprandial plasma glucose. (Chandalia, 2000). Further in 2006, Weickert,*et al* found that intake of 10g of β glucan by obese women resulted in significantly decreased glucose response after 30 minutes as well as a delayed glucose response. (Weickert, 2006). A recent study by Brauchla,*et al*, in 2012 reported a role of psyllium fiber as a method to decrease glucose levels in diabetic adults and has been suggested as an additional treatment to type 2 diabetics (Brauchla,*et al.*, 2012).

Thus intake of dietary fibre showed decrease in glucose levels in diabetic patients, whereas the intake of sugar-sweetened soda might increase the risk of type 2 diabetes. Although sugar-sweetened beverages on average have a moderate glycemic index , and they are

found with a high glycemic load (GL) of the overall diet by virtue of the large quantities consumed (Malik,2006).

Carbohydrates and Cancer

Most epidemiological studies revealed the role of carbohydrates in cancer mainly on dietary fibre and, to a much lesser extent, on monosaccharide's, disaccharides, and starches.(Gray & Juliet, 2003). Key, in his study suggested that high intake of sucrose might increase the risk for colorectal cancer and that high intakes of lactose might increase the risk for ovarian cancer, however to confirm anything the data present was limited and not sufficient to draw any conclusions (Key & Spencer, 2007)..

In 2007 Schairer*et al*, reported that the Breast Cancer Detection Demonstration Project (BCDDP) cohort did not show that diets high in carbohydrate, glycaemic index, or glycaemic load increased the risk of colorectal cancer (Schairer, *et al.,*2007).

Evidence of a significant inverse relation dose response association between dietary fibre intake and breast cancer risk was studied which concluded that10 g/d increment in dietary fibre was associated with a 7% risk reduction of the cancer (Dong, *et al*, 2011).

Carbohydrate and dental caries

For many years, the role of sugars, specifically sucrose, had been emphasised in the etiology of dental caries. The dental risk of dietary sugars was dependent on the frequency and amount of sugar intake, but the prevalence of caries is also modified by other dietary, social, genetic, and behavioural factor. Good oral hygiene and use of fluoride, together with a varied diet, are recommended for caries prevention (Gray & Juliet,2003).

Carbohydrate and sleep

It was seen that over the past 40 years, insufficient sleep duration among adolescents had markedly increased, whereby today only about 33% of teens were getting the recommended 9 hours of sleep. In a study carried out by Weiss *et al*, it was seen that shorter sleep duration was associated with a relative increase in calorie intake derived from fat and a decrease in calorie intake derived from carbohydrate (Weiss, *et al*, 2010).

Recommended intake of Carbohydrates

Estimated Average Requirement (EAR) is the average daily nutrient intake level estimated to meet the requirements of half the healthy individuals in a particular life stage and gender group. According to the

U.S. Food and Nutrition Board the EAR of carbohydrates is 100 g/d for children (IoM 2005), based mainly on data regarding glucose utilisation by the brain. Recommended Dietary Allowance (RDA) is the average daily dietary nutrient intake level sufficient to meet the nutrient requirements of nearly all (97% to 98%) healthy individuals in a particular life stage or gender group. The recommended intake for total carbohydrate by young children is 130 grams per day. Adequate Intake (AI) is the recommended average daily intake level based on observed or experimentally determined approximations of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate—used when an RDA cannot be determine. The RDA/AI for children 1-8 years is 130g/day. Acceptable Macronutrient Distribution Range (AMDR) is defined as ranges of macro nutrient intakes (as a percentage of calories) that are associated with reduced risk of chronic disease while providing recommended intakes of other essential nutrients. 45% to 65% of energy is AMDR for carbohydrates. Total carbohydrate recommendation for infants aged 6-11 months is 45-60 E% and for toddlers 12-23 months 50-55 E%. Exclusive breastfeeding is recommended for infants during the first 6 months and no recommendation for carbohydrate is given for that age (Gray & Juliet,2003).

Dietary fibre recommendations

According to the British Nutrition Foundation: "The recommended average daily intake for fibre was 18 g for adults although children need proportionally less. For preschool children, introduction of more fibre should be done gradually. Too much fibre might result in bulkiness in diet that they reach satiety level at early and might be low in total nutrient requirements by the body. RDA/AI for 1-3year old was approximately 19g per day and for 4-8 year old is approximately 25g per day.

The recommendation, based on various sources of evidence, stated that people of all ages should consume 14g of total fibre for every 1000 kcal total energy intake (Gray & Juliet,2003).

Sugar intake recommendations

In the WHO report (2003) the population goal for free sugars is < 10 E%. The report suggested that sugar-sweetened beverages should be limited for children to reduce chronic diseases. The Dietary reference intakes report in the United States suggests limiting added sugars to no more than 25% of total energy (Gray & Juliet,2003). According to the EFSA NDA Panel

(EFSA 2010) the available data were not sufficient to set an upper limit for sugar intake. According to the NNR (Nordic Council of Ministers 2004) the intake of refined sugars should not exceed 10 E% in infants over 6 months and in children. The AMDR for added sugar is that it should not be more than 25% of the energy (Ruottinen, 2011) while WHO recommends that added sugar intake should be less than 10% of total energy.

Research during the last two decades has firmly established that diet is one of the major risk factors in the development of a spectrum of non-communicable diseases and the major part of the diet is comprised of carbohydrates. Carbohydrates are the single most important source of food energy in the world. They comprise some 40 to 80 percentage of total food energy intakes, depending on locale, cultural considerations or economic status. In addition to providing easily available energy for oxidative metabolism, carbohydrate-containing foods are vehicles for important micronutrients and phytochemicals. Dietary carbohydrate is important to maintain glycaemic homeostasis and for gastrointestinal integrity and function. All the above reasons have made researcher to focus and study more on carbohydrate intake and its effect on health. Various studies have been carried in the western countries to identify the consumption pattern of carbohydrate among children and its potential effect on the health of the children as the prevalence of childhood obesity is increasing worldwide.

However, studies on carbohydrate consumption among children were lacking their origin in India. This study was done in the Mumbai urban city, which is one of the largest metropolises in the world, which has a heterogeneous population with diverse cultural, religious and economic backgrounds.

Mostly studies were done which focuses total carbohydrate intake and simple sugars intake. Very few studies focus on complex carbohydrate intake and percentage energy obtained from complex carbohydrate. Keeping in view all this, the present study encompasses intake of carbohydrate among children, and also focuses on consumption of added simple sugars, complex carbohydrate, total free sugars and percentage on energy obtained from them.

Moreover, childhood obesity is not only a public health problem but is also a major emerging health concerns for India. Since overweight and obese children are more

likely to develop non-communicable diseases (NCDs) during early adulthood, timely action must be initiated to combat the rising epidemic of childhood obesity. Keeping in view the importance of dietary carbohydrate in children's diet, the present study was undertaken with the following objectives:

The objectives of the present study is to describe the role of dietary carbohydrates in children's diet,

1. To examine whether intakes of carbohydrates foods differ among different socio-economic strata.
2. To identify the % simple carbohydrate energy and % complex carbohydrate energy consumed in a day.
3. To determine the frequency, amount and variety of carbohydrate consumption among children of different age groups.

CHAPTER

THREE

METHODOLOGY

Survey on 'CARBOHYDRATE CONSUMPTION BY CHILDREN OF DIFFERENT AGE GROUPS' was undertaken by PROTEIN FOODS AND NUTRITION DEVELOPMENT ASSOCIATION OF INDIA under the main topic of 'Household food consumption with emphasis on processed foods'.

This study was undertaken with following objectives:

1. To examine whether intakes of carbohydrates foods differ among different socio-economic strata.
2. To identify the simple carbohydrate energy % and complex carbohydrate energy % from the total consumed energy in a day.
3. To determine the frequency, amount and variety of carbohydrate consumption among children of different age groups.

ETHICAL CONSIDERATION

The research proposal entitles 'Carbohydrate consumption by children of different age groups (from 24 our recall method)' was approved by the Institutional Ethical Committee (IEC) on 16th July, 2016.

SAMPLING

Study area: The study was conducted in Mumbai city, Maharashtra, India. Mumbai urban, being one of the largest metropolises in the world, has a heterogeneous population with diverse cultural, religious and economic backgrounds. Due to its diverse economic background; the city provides an ideal setting to study the Carbohydrate consumption by children of different age groups. 14 BMC wards were selected from Mumbai city (Maharashtra, India) by purposive sampling and samples were selected from them.

Sr. No	Ward Selected	Areas/clusters where we are likely to find families from
1	K East	Mithi river, Kalina to Kurla, Vile Parle E, Andheri E Slum areas near airport, Koldongri and other areas near Saki naka, Chakalaetc, Jogeshwari E, Goregaon E
2	P North	Malwani, Orlem(Malad), Madh Island
3	H West	Bandra, Khar near railway quarters DandaKhar, Ambedkar Rd, GazdarBandh, Mangelwadi, Shastrinagar, Chimbai, Shivajinagar
4,5	M East M West	Chembur, Ghatkopar, Mulund, Mankhurd, Trombay, Govandi, Shivajinagar, Baiganwadi
6	A	Crawford market areaNear VT station, Anjuman Islam
7	B	Dongri
8	D	Tardeo, Lamington Rd, Grant rd, Mumbai Central, Near VT station, Anjuman Islam,

9	**F North**	**Sion, Wadala, Chunabhatti, Dharavi,GuruTeghBahadur Nagar, Pratiksha Nagar, Matunga**
10	**F South**	**Sewri, Parel, Mazgaon, Lalbaug, Chinchpokli, Naigaon, Bhoiwada**
11	**N West**	**Ghatkopar, Vikhroli, Pantnagar, Bhatwadi, Vidyavihar**
12	**S**	**Bhandup, Nahur, Powai, Kanjurmarg, Vikhroli, Kannamwar Nagar, Utkarsh Nagar, Samarth Nagar, Tagore Nagar**
13	**P South**	**Goregaon W, parts of Malad, Oshiwara**
14	**L**	**Kurla, (Kamani) Sakinaka, Chandivali, Chunabhatti**

Table 3.1: Selected wards and areas of Mumbai city

Target group selection:

Children's from selected wards and falling under different socio-economic groups were selected by random, purposive sampling. (6-15 years age group)

HYPOTHESIS

There is no difference between carbohydrate consumption of children of different age groups.

STUDY DESIGN

Data was collected by a group of interviewers, where each interviewer collected 45 samples. The 45 samples included 15 samples each belonging to LSES, MSES and HSES. 15 samples contained 5 each from 3-6years age group (both sexes), 6-9/9-15 years age group (both sexes) and 19-25years age group (females).

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SES GROUP /CATEGORY	Type of Residence	Income	Actual income per year (annual income in Rs)	Colour of ration card	Occupation			Vehicle ownership	Club membership
LOW	Chawl/slum	No fixed income	Less than Rs 3 lakhs	Orange	-			No vehicle	No club membership
MIDDLE	Building/chawl	At least one fixed income Small business	Rs 3 to 9.99 lakhs	White	Lawyer/Teacher/Scientist/ Jr or Sr position in public sector (government or municipal services)/Clerical/Administrative in any sector			Own no vehicle or two/three or four wheeler	No club membership
HIGH	Building/Condominium/ Duplex/Row house/ residence given by company/ Living in a tower/gated complex	Business or an occupation or position/designation with a high salary and perks such as paid vacations, driver and fuel paid by company, house given by company etc	≥Rs 10 lakhs	White	Corporate Sr level/Airline Pilots/Ship Captain/Doctor/ Physiotherapist/Architect/Interior Designer/Chartered Accountant			Own at least one or more four wheeler	Either have or do not have club membership

Table 3.2: Criteria for classification of families into socioeconomic category (modified Kuppuswamy index)

SAMPLING TECHNIQUE

Random, purposive sampling technique was employed for the sampling.

SAMPLE SIZE: 480

INCLUSION CRITERIA

Age From: 6.00 Year(s)

Age To: 15.00 Year(s)

Gender: Both (Male and Female)

Details:

1. School going children between the ages of 6-9 years
2. Adolescent between the ages of 10-12, 13-15 years

EXCLUSION CRITERIA

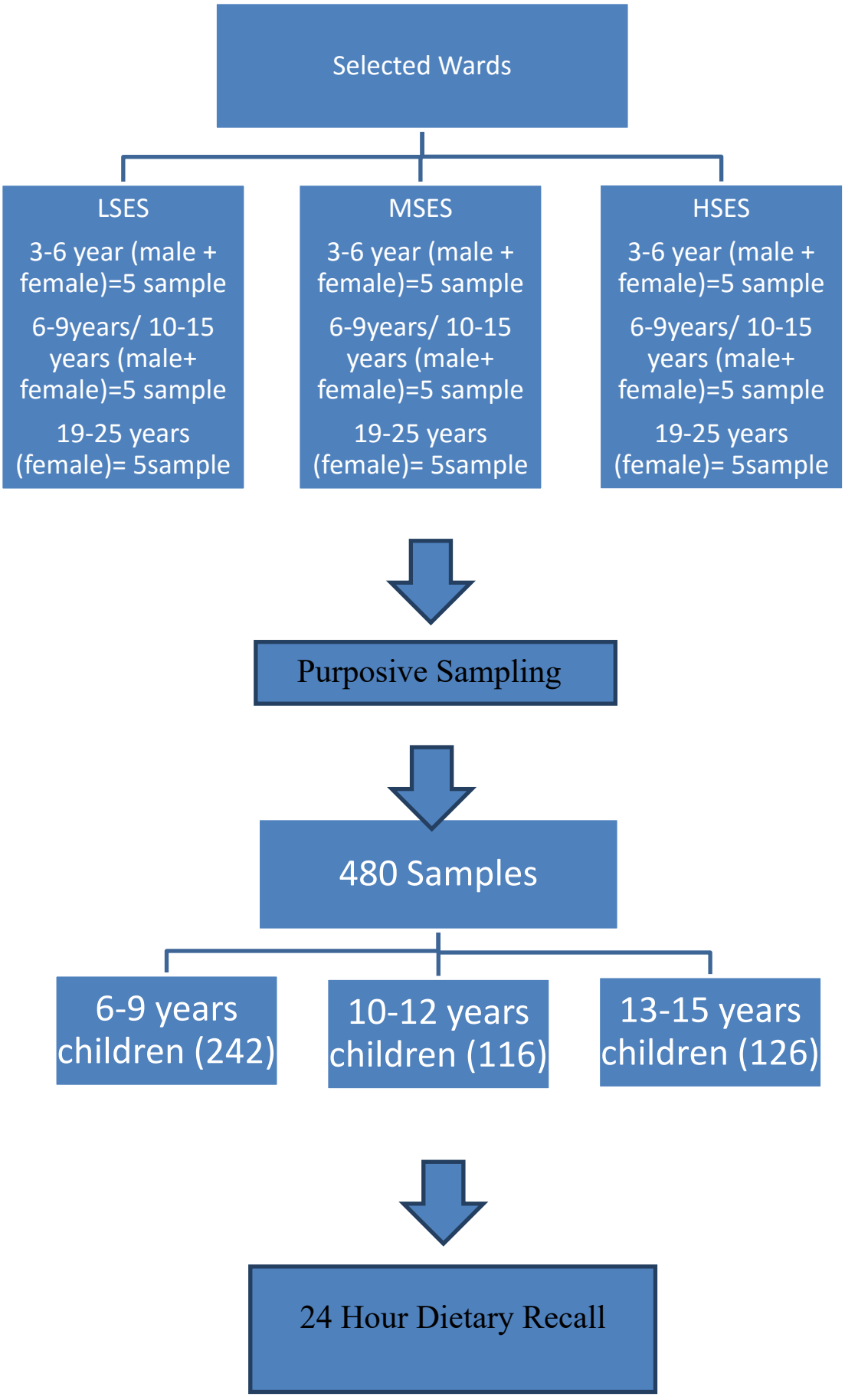
Details:

1. Children and Adolescents not staying in Mumbai and not coming under the selected wards.
2. Any one less than 6 years or more than 15 years of age.

DIETARY BEHAVIOUR

24 hour recall of the participant was recorded. The participants were asked to recall all the foods and drinks consumed by them on the previous day. In this the quantity of food consumed by the respondents in terms of standardized household measures (cup, spoons, ladles, serving spoons, katories, plates etc.) was recorded. The specific details like the time of consumption of meals, number of meals, method of reparation, portion sizes etc were included in the dietary record by which nutrient values were calculated by using CS Dietary System software. The food intakes were converted into grams to compute nutrient intakes. Nutrient intakes were calculated based on the Nutritive value of Indian Foods given by the NIN. Wherever values for nutrients were not available, the FAO or USDA database was use

28 Researchers


Selected Wards
LSES
3-6 year (male + female)=5 sample
6-9years/ 10-15 years (male+ female)=5 sample
19-25 years (female)= 5sample
MSES
3-6 year (male + female)=5 sample
6-9years/ 10-15 years (male+ female)=5 sample
19-25 years (female)= 5sample
HSES
3-6 year (male + female)=5 sample
6-9years/ 10-15 years (male+ female)=5 sample
19-25 years (female)= 5sample
Purposive Sampling
480 Samples
6-9 years children (242)
10-12 years children (116)
13-15 years children (126)
24 Hour Dietary Recall

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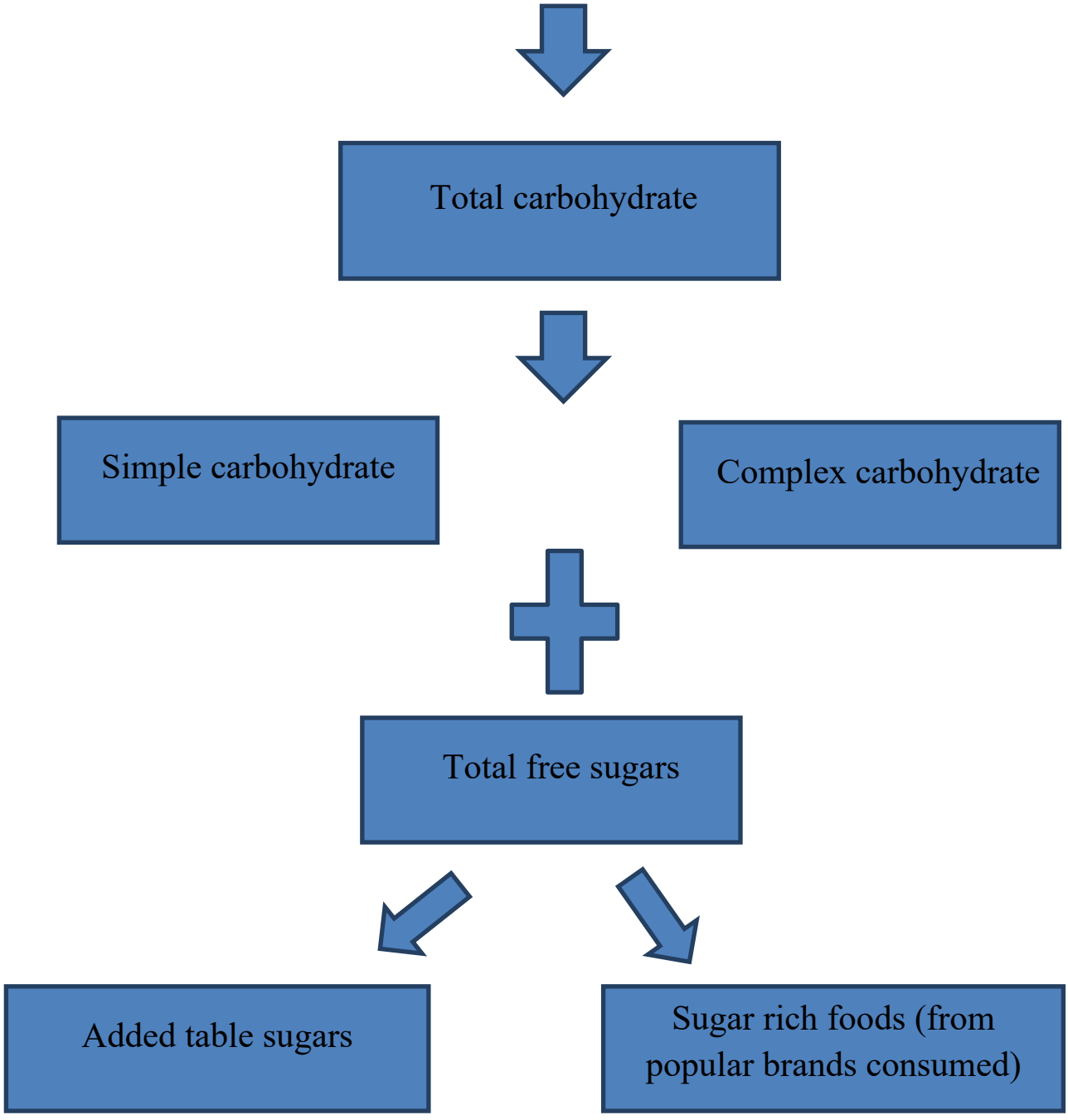

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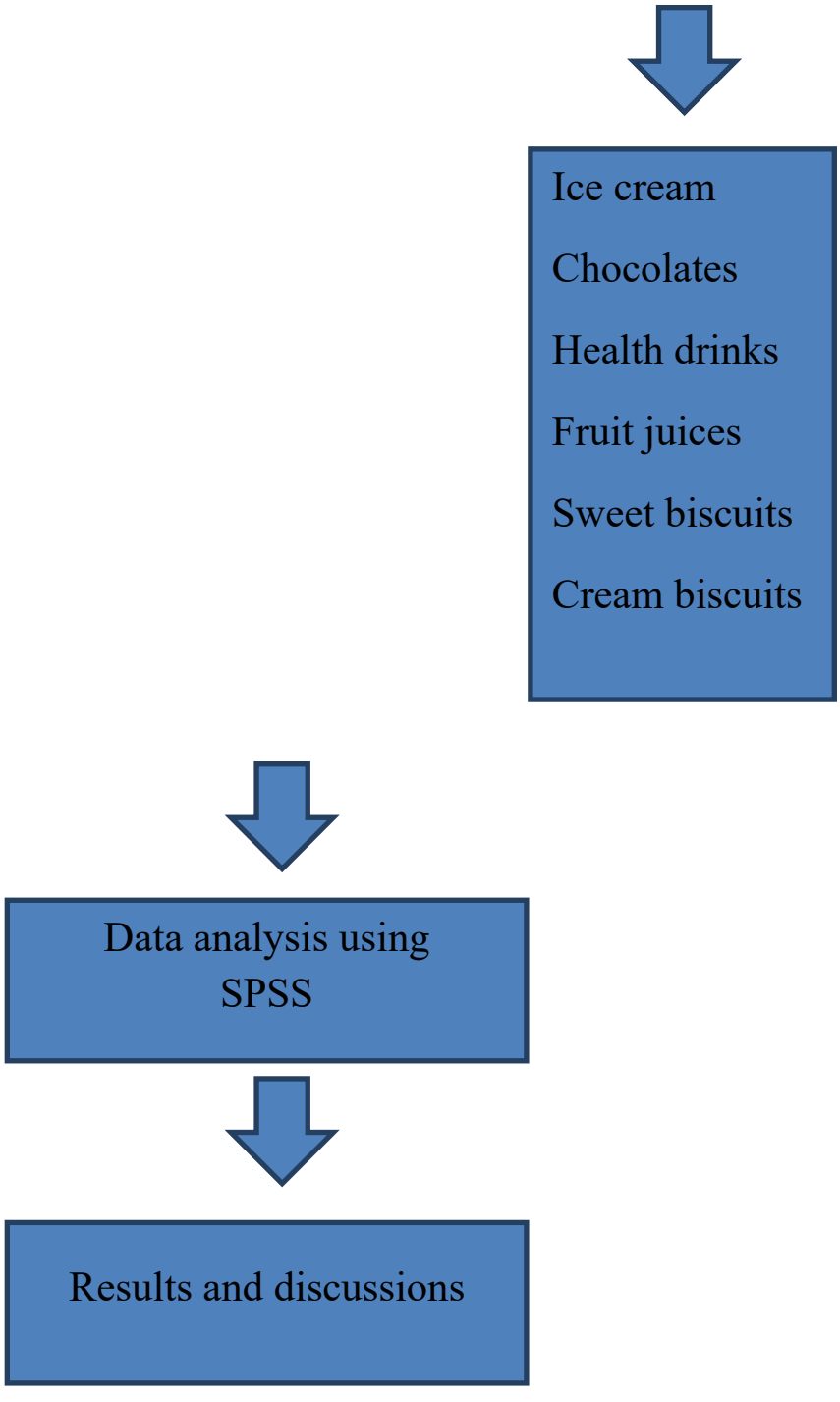

CHAPTER FOUR

RESULTS

&

DISCUSSION

The present study was done to identify the consumption pattern of carbohydrates among children of ages 6 to 15 years, as these age groups are probably more vulnerable to overweight/obesity and related disorders. The present study included subjects from three different age groups, 6-9 years; 10-12 years and 13-15 years. . The total number of subjects who participated was 480. 6-9 year's age group had 242 subjects, 10-12 years age group had 112 subjects and 13-15 years age group had 126 subjects. Carbohydrate consumption in these three different age groups was studied briefly in three socioeconomic strata –low SES, middle SES, high SES in Mumbai city. The data was collected using the 24 hour dietary recall method.

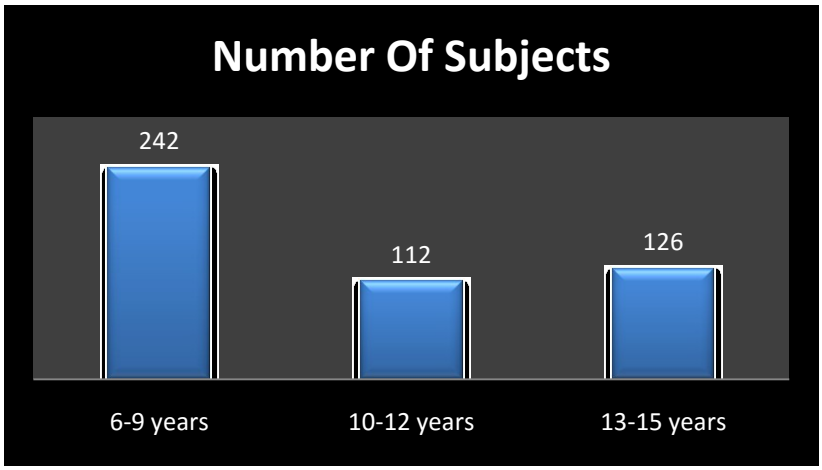

Figure 4.1: Total number of subjects

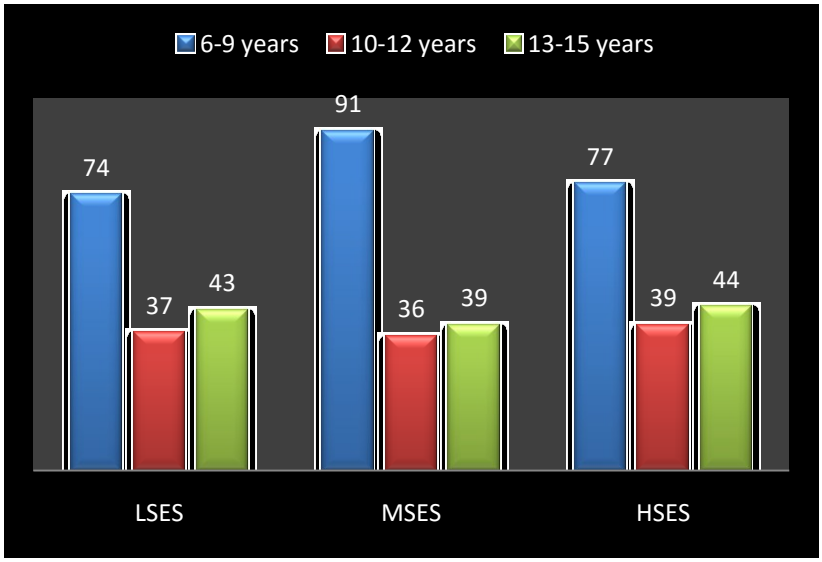

Figure 4.2: Number of subjects according to SES

MEAN INTAKE				
	Age	**Number of subjects**	**Mean Intake**	**Sig. (p 0.05)**
Energy (kcal/day)	6-9 years	242	1259±826	0.00*
	10-12 years	112	1473±694	
	13-15 years	126	1555±684	
	Total	480	1387±771	
Carbohydrates (grams/day)	6-9 years	242	171.5±104.2	0.000*
	10-12 years	112	208.0±100.9	
	13-15 years	126	226.2±106.2	
	Total	480	194.4±106.5	
% Energy from carbohydrate (% energy/day)	6-9 years	242	57.8±19.2	0.046*
	10-12 years	112	60.7±20.3	
	13-15 years	126	63.6±26.7	
	Total	480	60.0±21.7	

Table 4.1: Mean intake of energy/day, carbohydrates/day and % energy from carbohydrates/day

The above table represents the mean daily intake of energy, carbohydrates and % energy from carbohydrates between the three age groups 6-9 years, 10-12 years and 13-15 years. The highest energy intake (1555±684) kcal/day was observed in the age group 13-15 years as compared to age group 10-12 years (1473±694) kcal/day and age group 6-9 years (1259±826) kcal/day.

The highest intake for carbohydrates (226.24±106.23)grams/day was also observed in the age group of 13-15 years, followed by 10-12 years of age with the intake of (208.00±100.94)grams/day and

then in the age group 6-9 years (171.53±104.26)grams/day.

The percentage energy obtained from carbohydrates was found highest (63.69±26.73) (percentage) %/day in the age group 13-15 years, whereas the lowest percentage energy obtained from carbohydrate (57.83±19.26)%/ day was observed in the age group 6-9 years

It was observed that there exists a significant difference in the intake of energy ($p<0.001$), intake of carbohydrates ($p<0.000$) and % energy from carbohydrate ($p<0.046$) between the three age groups.

Industrialization, urbanization, economic development and market globalization have resulted in rapid changes in dietary patterns described as 'nutrition transition' which reflects both quantitative and qualitative changes in the diet.

The modern sedentary life, the growing number of fast food and restaurant, technological changes and women participation in the labour market are often popular justifications of the growing calories consumption and the reduce physical activity.

The adverse dietary changes include shifts in the structure of the diet towards a higher energy density with a greater role for fat and sugars in foods, greater saturated fat intake (mostly from animal sources), reduced intakes of complex carbohydrates and dietary fibre and reduced fruit and vegetable intakes (WHO, 2003).

ENERGY INTAKE IN COMPARISION WITH RDA

SES	Age	Gender	Number of subjects	Mean (kcal/day)	Recommended Dietary Allowances (RDA)(kcal/day)
LOW SES	6 years	Children	28	1104±306	1350
	7-9 years	Children	46	1195±508	1690
	10-12 years	Boys	17	1384±488	2190
		Girls	20	1394±445	2010
	13-15 years	Boys	22	1574±564	2750
		Girls	21	1575±691	2330

	Total		154	1371±449	
MIDDLE SES	6 years	Children	41	1220±481	1350
	7-9 years	Children	50	1405±386	1690
	10-12 years	Boys	18	1934±635	2190
		Girls	18	1635±605	2010
	13-15 years	Boys	21	1685±585	2750
		Girls	18	1582±512	2330
	Total		166	1576±534	
HIGH SES	6 years	Children	33	1294±531	1350
	7-9 years	Children	44	1377±357	1690
	10-12 years	Boys	21	1588±449	2190
		Girls	18	1568±401	2010
	13-15 years	Boys	22	1637±673	2750
		Girls	20	1737±595	2330
	Total		160	1533±501	

Table 4.2: Energy intake of three SES in comparison with RDA

Table 4.2 depicts energy intake in 6-15 years children and their energy intake was compared with RDA. The overall trend indicated that children belonging to all age groups had a lower energy intake as compared to RDA. In the age group of 6 year, HSES was found to have more or less the similar intake of energy (1294±531) kcal/day as compared to RDA (1350) kcal/day. The least intake was observed in LSES (1104±306) kcal/day where approx. 250kcal consumption was less as compared with RDA. For the age group7-9 years, a similar trend was observed, where the children's intake was less as compared to the respective RDA (1690) kcal /day, and the least intake was again seen in the LSES (1195±508) kcal/day. For the girls in the age group 10-12 years, both in MSES (1635±605) kcal/day and HSES (1560±401) kcal/day girls had low consumption of energy than boys and also in comparison with RDA (2010) kcal day. However in LSES, girls belonging to 10-12 years age group had more (1394±445) kcal/day energy

consumption in a day than boys in the same age group. For boys in 10-12 years age group, highest intake of energy was observed in MSES (1934±635) kcal/day, followed by HSES (1588±449) kcal/day and LSES (1384±488) kcal/day, however data showed no correlation between the observed SES and with their RDA (2190) kcal/day. For the age group 13-15 years a minimum difference in consumption of energy was observed between boys and girls for all SES, where the highest consumption was observed in HSES, for both boys (1637±673) kcal/day and girls (1737±595) kcal/day, followed by boys (1685±585) kcal/day and girls (1582±512) kcal/day in MSES. According to the above scenario, a similar trend was also observed in the age group 13-15 years where the least intake of energy was observed in boys (1574±564) kcal/day and girls (1575±691) kcal/day under the same LSES category. It was also observed that this age group also in all SES did not meet their respective RDA set for both boys (2750) kcal/day and girls (2330) kcal/day.

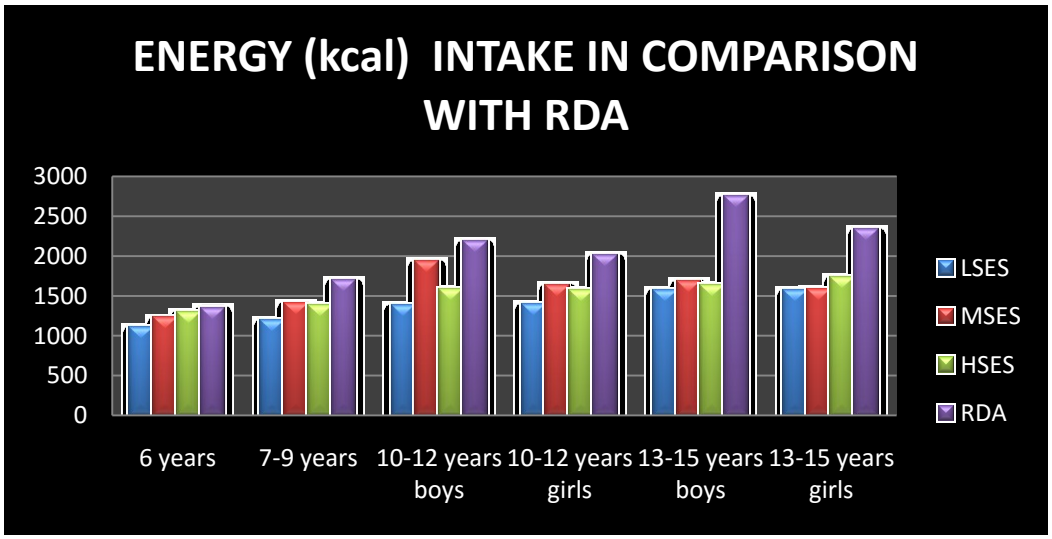

Figure 4.3: Energy intake in comparison with RDA.

The above condition probably explains that there might be relationship between health and income, with the poorest sections of the population being the most vulnerable. Low energy intake might be due to the reason which shows that today's generation were more health conscious and trends for sudden weight loss at younger age.

A study done by Gharib and Rasheed in 2010 on energy and macro nutrient intake and dietary pattern among school children in Bahrain concluded that the mean energy intake of Bahraini students ranged between

82.5% and 103% of the recommended EARs (Estimated Average Requirements) for different age groups and gender. Overall the mean energy intake in boys was significantly higher than that in girls ($p < 0.01$) and this pattern was consistent at all ages.

CARBOHYDRATE (GRAMS)						
SES	**Age**	**Number Of subjects**	**Mean (grams/day)**	**% difference**		
LOW SES	6-9 years	74	166.4±65.6	-19.6		
	10-12 years	37	207.1±77.4		-6.50	
	13-15 years	43	221.5±102.0			-24.88
	Total	154	184.0±85.9			
MIDDLE SES	6-9 years	91	192.0±143.9	-11.6		
	10-12 years	36	217.4±220.5		-1.44	
	13-15 years	39	220.5±96.6			-12.92
	Total	166	204.2±132.1			
HIGH SES	6-9 years	77	167.2±69.5	-16.4		
	10-12 years	39	200.1±85.9		-15.13	
	13-15 years	44	235.8±119.3			-29.06
	Total	160	194.1±93.6			

Table 4.3: Mean consumption of carbohydrate of the three SES

The highest mean carbohydrate intake was observed in the age group 13-15 years for all the SES. Within SES, HSES showed highest (235.8±119.3)grams/day consumption of carbohydrates, followed by LSES (221.5±102.0)grams/day and MSES (220.5±96.6)grams/day. In LSES the least carbohydrate intake (166.4±65.6)grams/day was observed in 6-9 years age group, followed by MSES (192.0±143.9)grams/day and HSES 167.2±69.5) grams/day within the same age group.

Between 6-9 and 10-12 years age group in LSES, an approximately 20% less carbohydrate intake was observed in 6-9

years age group, whereas when 10-12 years and 13-15 years age group were compared ,stats showed that 10-12 years had approximately 7% less intake than 13-15 years age group. The highest percentage difference was observed in 6-9 years and 13-15 years of LSES, where 13-15 years had approximately 25% more carbohydrate consumption. In MSES, between 6-9 years and 10-12 years, it was observed that 6-9 years had an approx. 12% less carbohydrate consumption than 10-12 years, a minimum difference of approx. 2% was observed between 10-12 years and 13-15 years age group where 10-12 years age group had 2% less intake of carbohydrate. When 6-9 years and 13-15 years age group were compared, 13-15 years age group showed an approx. 13% more carbohydrate intake than 6-9 years age group. In HSES, highest % difference in carbohydrate consumption was observed between 6-9 years and 13-15 years age group, where 6-9 years age group showed an approx. 29% less carbohydrate intake. Similarly, between 6-9 years and 10-12 years, 6-9 years showed an approx. 16% less intake of carbohydrate than 10-12 years. When 10-12 years and 13-15 years were compared, 10-12 years showed an approx. 15% less intake than 13-15 years age group.

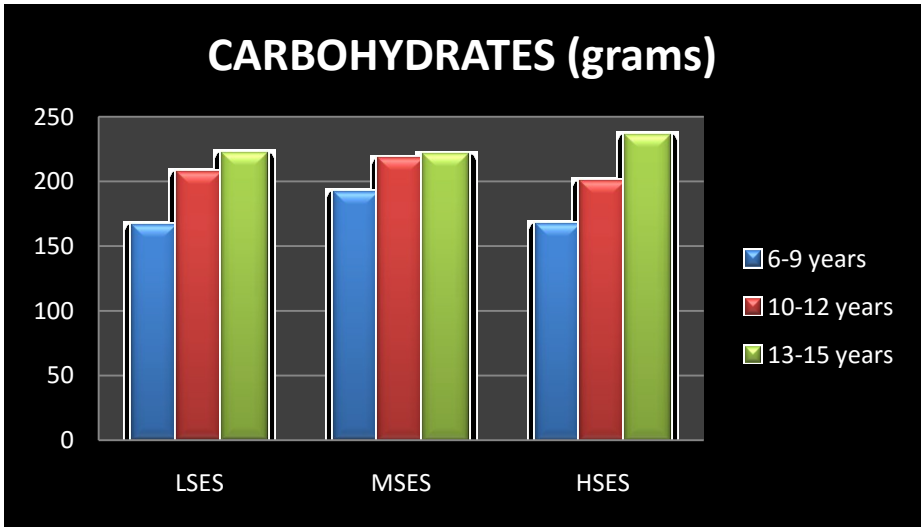

Figure 4.4: Mean carbohydrate intake of the three SES

A similar study was done in Bahrain in the year 2010, to identify the energy and macronutrient intake and dietary pattern among school children in Bahrain among 2594 subjects of age groups 6- 18 years boys and girls concluded that the mean daily intake of carbohydrate in boys was

(276.8 g ± 73.3) and in girls was (232.4 g ± 60.7). (Gharib, 2010).

ADDED SIMPLE (SUGARS) CARBOHYDRATE (GRAMS)						
SES	**Age**	**Number Of subjects**	**Mean (grams/day)**	**% difference**		
LOW SES	6-9 years	74	10.2±12.6	-25.9		
	10-12 years	37	13.8±12.2		6.44	
	13-15 years	43	13.0±9.0			-21.08
	Total	154	11.9±11.6			
MIDDLE SES	6-9 years	91	10.3±9.6	-16.5		
	10-12 years	36	12.4±10.4		-18.12	
	13-15 years	39	15.1±12.9			-31.64
	Total	166	11.9±10.8			
HIGH SES	6-9 years	77	9.7±8.2	-24.59		
	10-12 years	39	12.9±10.6		1.56	
	13-15 years	44	12.7±10.0			-23.41
	Total	160	11.3±9.4			

Table 4.4: Mean consumption of added simple carbohydrate of the three SES

When simple carbohydrate intake was observed in table 4.4, 13-15 year age group in MSES showed highest (15.1±12.9)grams/day simple carbohydrate consumption, followed by 10-12 year age group in LSES (13.8±12.2)grams/day and 13-15 year age group (13.0±9.0)grams/day in LSES. In HSES a marginal difference in simple carbohydrate consumption was observed in the age group 10-12 years (12.9±10.6)grams/day and 13-15 years (12.7±10.0)grams/day. The least simple carbohydrate consumption was observed in the age group 6-9 years for all SES, HSES having the lowest simple carbohydrate consumption (9.7±8.2)grams/day.

The data on % difference in LSES showed that, between 6-9 years and 10-12 years age group, 6-9 years had an approx. 30%less simple carbohydrate consumption. A different trend was observed between age group 10-12 years and 13-15 years, where age group 10-12 years had an approx. 7% more simple carbohydrate intake. Further, an approx. 22% less simple carbohydrate consumption was observed in 6-9 years age group as compared to 13-15 years. In MSES highest difference was observed between 6-9 years and 13-15 years age group, where 6-9 years age group had an approx. 32% less simple carbohydrate intake, followed by age group 10-12 years and 13-15 years where an approx. 18% less simple carbohydrate intake was observed in 10-12 years than 13-15 years. Similar ways, 6-9 years of age showed an approx. 17% less intake of simple carbohydrate. In HSES, 6-9 years age group resulted in an approx. 25% less consumption of simple carbohydrate. A minimum difference of approx. 2% was observed where 10-12 years showed more consumption than 13-15 years. Similarly, 6-9 years had an approx. 24% less consumption of simple carbohydrate than 13-15 years age group. This trend might be probably due to an increasing awareness among children related to overweight and obesity, where children develop an attitude to remain healthy since younger age itself.

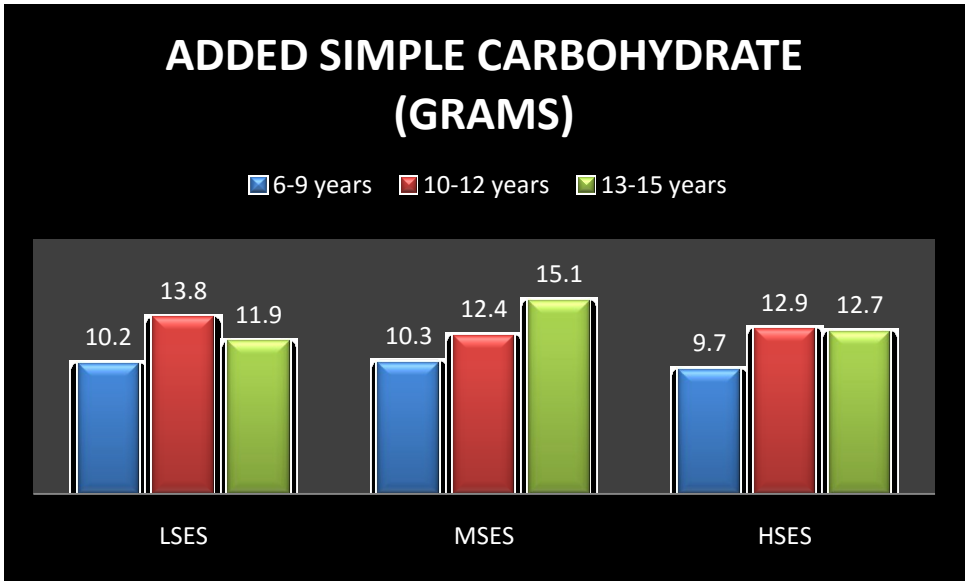

Figure 4.5: Mean added simple carbohydrate intake of the three SES

Similar study was done on interrelationships of added sugars intake, socioeconomic status, and race/ethnicity in adults in the United States: National Health Interview Survey 2005, showed that The intake of added sugars was higher among males than females and inversely related to age, educational status, and family income. Asian-Americans had the lowest intake and Hispanics the next lowest intake. It also reported that groups with low income and education were particularly vulnerable to diets with high added sugars.

Another study done on family socioeconomic status and nutrition habits of 7–8 year old children in 2015 reported that consumption of soft drinks with sugar were lower in families with high income comparing with low income families (Petrauskiene; *et al,* 2015).

A study in 2010, observed Energy and macronutrient intake amongst 6-18 years in Bahrain and concluded that the mean daily intake of total sugars (intrinsic and extrinsic sugars) was 101.3 g ± 37.3 for boys and 89.1 g ± 36.1 for girls which was high according to the maximum recommended intake of 60 g/day by the DRV of UK. (Gharib;*loc.cit*).

COMPLEX CARBOHYDRATE (GRAMS)						
SES	**Age**	**Number Of subjects**	**Mean (grams/day)**	**% difference**		
LOW SES	6-9 years	74	156.1±74.7	-18.41		
	10-12 years	37	191.3±105.2		-9.23	
	13-15 years	43	210.8±110.5			-25.94
	Total	154	179.9±95.9			
MIDDLE SES	6-9 years	91	188.2±147.6	-1.04		
	10-12 years	36	190.2±97.3		-5.80	
	13-15 years	39	201.9±117.2			-6.79
	Total	166	191.9±130.8			
HIGH SES	6-9 years	77	160.8±74.6	-11.12		
	10-12 years	39	181.0±111.7		-7.54	

	13-15 years	44	195.8±79.7			-17.82
	Total	160	175.3±87.0			

Table 4.5: Mean consumption of complex carbohydrate of the three SES

The above table depicts that the highest mean complex carbohydrate consumption was observed in the age group of 13-15 years for all SES, LSES having the highest consumption (210.6±110.5)grams/day, followed by MSES (201.9±117.2)grams/day and then by HSES (195.8±79.7)grams/day. The least complex carbohydrate consumption was observed in the age group 6-9 years for all SES, LSES having the lowest complex carbohydrate consumption (156.1±74.7)grams/day.

Further % difference of complex carbohydrate consumption in LSES showed that between 6-9 years and 10-12 years, 6-9 years had an approx. 19% less complex carbohydrate consumption than 10-12 years. Moreover, 10-12 years age group showed an approx. 10% less complex carbohydrate intake than 13-15 years. It was also observed that 6-9 years had an approx. 26% less complex carbohydrate consumption than 13-15 years age group. In MSES, between 6-9 years and 10-12 years, 6-9 years showed a minimum difference of 1% in complex carbohydrate consumption. Data on complex carbohydrate consumption showed that there was an approx. 6% less consumption of complex carbohydrate in 10-12 years age group when compared with 13-15 years age group. Whereas 6-9 years showed an approx. 7% less consumption of complex carbohydrate than 13-15 years. In HSES, again data depicts that, 6-9 years had an approx.11% less consumption of complex carbohydrate than 10-12 years. In age group 10-12 years and 13-15 years, 10-12 years showed an approx. 8% less carbohydrate consumption, whereas, 6-9 years showed an approx. 18% less consumption of complex carbohydrate as compared to 13-15 years.

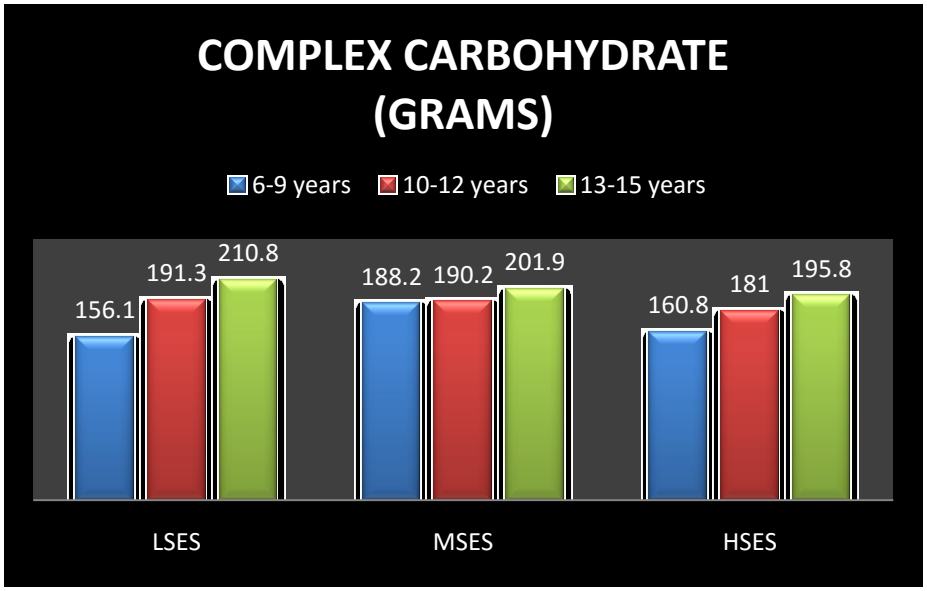

Figure 4.6: Mean complex carbohydrate intake

PERCENTAGE ADDED SIMPLE (SUGARS) CARBOHYDRATE						
SES	**Age**	**Number Of subjects**	**Mean (% /day)**	**% difference**		
LOW SES	6-9 years	74	20.1±85.6	84.43		
	10-12 years	37	10.9±26.0		-46.6	
	13-15 years	43	20.4±65.9			-1.61
	Total	154	18.0±69.7			
MIDDLE SES	6-9 years	91	13.7±45.8	-63.9		
	10-12 years	36	38.1±36.6		15.69	
	13-15 years	39	32.9± 25.0			-58.23
	Total	166	23.4±88.0			
HIGH SES	6-9 years	77	12.0±39.0	-31.54		
	10-12 years	39	17.5±57.0		57.92	
	13-15 years	44	11.1±34.4			8.10
	Total	160	13.0±42.7			

Table 4.6: Mean consumption of percentage added simple carbohydrate of the three SES

The above table represents the percentage simple carbohydrate intake. In LSES, the highest (20.4±65.9) % simple carbohydrate/day was observed in the age group 13-15 years, whereas in MSES age group 10-12 years showed the highest (38.1±116.6) % of simple carbohydrate/day consumption. In HSES, age group 10-12 years showed highest (17.5±57.0) % simple carbohydrate/day consumption. The least (10.9±26.0) percentage simple carbohydrate/day consumption was observed in LSES in the age group 10-12 years.

In LSES between age group 6-9 years and 10-12 years, age group 6-9 years showed an approx.84% more percentage consumption of simple carbohydrate. Further, 10-12 years age group showed approx. 47% less percentage consumption of simple carbohydrate than 13-15 years, 6-9 years showed a minimum of 2% less percentage consumption of simple carbohydrate. In MSES % difference data showed that, 6-9 years age group had approx. 64% less percentage simple carbohydrate consumption than 10-12 years. Moreover, age group 10-12 years showed approx. 16% more percentage simple carbohydrate consumption than 13-15 years. Data also depicted that age group 6-9 years had approx. 58% less simple carbohydrate consumption as compared to 13-15 years. In HSES the highest percentage difference was observed between the age group 10-12 years and 13-15 years, where 10-12 years had approx. 58% more simple carbohydrate consumption. Further, 6-9 years age group showed approx. 32% less simple carbohydrate consumption than10-12 years. Whereas, age group 6-9 years also showed approx. 8% more simple carbohydrate consumption than 13-15 years.

PERCENTAGE COMPLEX CARBOHYDRATE				
SES	**Age**	**Number Of subjects**	**Mean (% /day)**	**% difference**

LOW SES	6-9 years	74	79.8±85.6	-10.35		
	10-12 years	37	89.0±26.0		12.00	
	13-15 years	43	79.5±65.9			0.41
	Total	154	81.9±69.7			
MIDDLE SES	6-9 years	91	86.2±45.8	39.37		
	10-12 years	36	61.8±36.6		-7.71	
	13-15 years	39	67.0±25.0			28.62
	Total	166	76.5±88.0			
HIGH SES	6-9 years	77	87.9±39.0	6.70		
	10-12 years	39	82.4±57.0		-7.23	
	13-15 years	44	88.8±34.4			-1.01
	Total	160	86.9±42.7			

Table 4.7: Mean consumption of percentage complex carbohydrate of the three SES

In LSES, age groups 6-9 years (79.8 ±85.6) % complex carbohydrate and 13-15 years (79.5±65.9) % complex carbohydrate showed approx. similar % complex carbohydrate consumption. However in LSES age group 10-12 years showed the highest (89.0±26.0) % complex carbohydrate consumption among all the three SES, followed by HSES age group 13-15 years (88.8±34.4)% complex carbohydrate consumption. The least (61.8±116.6) % complex carbohydrate consumption was observed in MSES in the age group 10-12 years.

In LSES, 6-9 years age group showed approx. 10% less percentage complex carbohydrate than 10-12 years, whereas when age group 10-12 years and 13-15 years were compared, 10-12 years age group showed 12% more percentage complex carbohydrate consumption. Further 6-9 years showed approx. 1%more percentage complex carbohydrate consumption than 13-15 years. In MSES,

on the contrary, age group 6-9 years showed approx. 39% more percentage complex carbohydrates consumption than 10-12 years. However 10-12 years showed approx. 8% less percentage consumption of complex carbohydrates than 13-15 years. But 6-9 years showed approx. 29% more percentage consumption of complex carbohydrates than 13-15 years. In HSES, 6-9 years showed approx. 7% more percentage complex carbohydrate consumption as compared to 10-12 years. Approx. 7% more percentage consumption of complex carbohydrates was observed in 13-15 years in comparison to 10-12 years. Whereas 6-9 years showed approx. 1% less percentage complex carbohydrate consumption than 13-15 years.

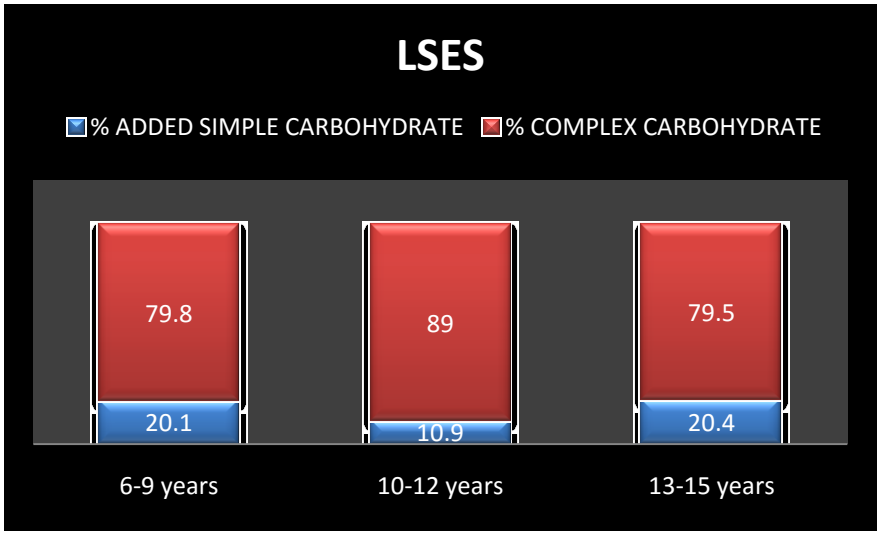

Figure 4.7: percentage (%) added simple carbohydrate and % complex carbohydrate in LSES

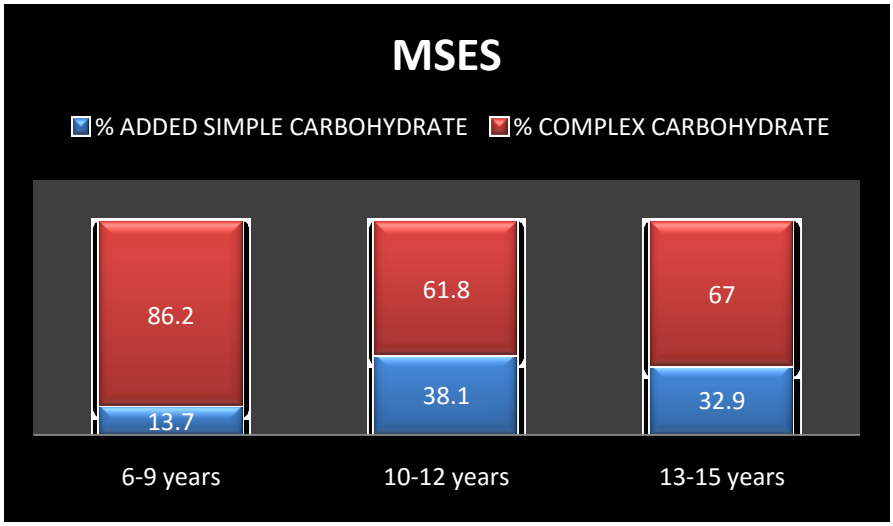

Figure 4.8: percentage (%) added simple carbohydrate and % complex carbohydrate in MSES

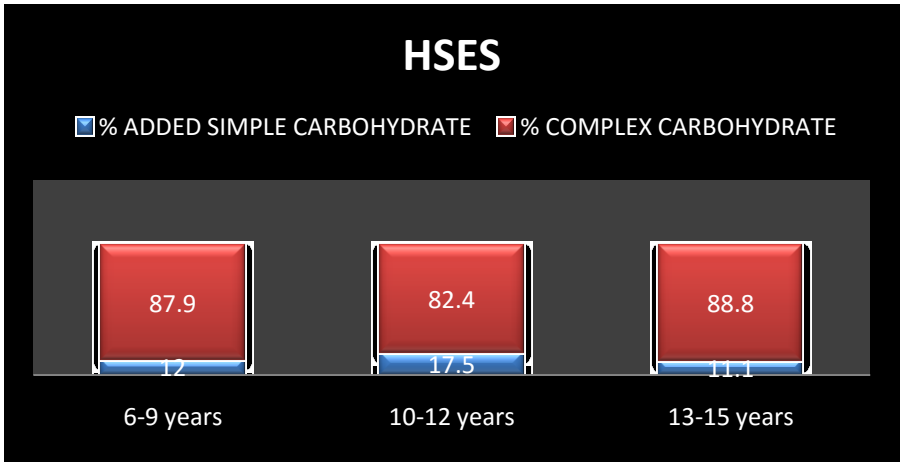

Figure 4.9: percentage (%) added simple carbohydrate and % complex carbohydrate in HSES

CARBOHYDRATE PERCENT FROM TOTAL ENERGY						
SES	**Age**	**Number Of subjects**	**Mean (% energy/day)**	**% difference**		
LOW SES	6-9 years	74	57.3±18.7	-3.71		
	10-12 years	37	59.5±8.1		-11.2	
	13-15 years	43	67.0±31.2			-14.5
	Total	154	60.5±21.6			
MIDDLE SES	6-9 years	91	57.2±12.8	-6.42		
	10-12 years	36	61.1±20.9		1.20	
	13-15 years	39	60.4±15.7			-5.29
	Total	166	58.8±15.6			
HIGH SES	6-9 years	77	59.0±25.3	-4.18		
	10-12 years	39	61.6±27.1		-2.68	
	13-15 years	44	63.3±29.6			-6.75

	Total	160	60.8±26.9	

Table 4.8: Carbohydrate percentage from total energy of the three SES

From the above table it can be noted that carbohydrate percentage from total energy ranged from 57% to 67% within the three age groups. The lowest carbohydrate percentage from total energy was observed in the age group 6-9 years for all the three SES, such as LSES (57.30±18.71) % energy/ day, MSES (57.2±12.8) % energy/day and HSES (59.0±25.3) % energy/day. The highest (67.0±18.7) carbohydrate percentage from total energy was observed in LSES in the age group 13-15 years, followed by HSES (63.3±29.6) % energy/day in the same age group.

In LSES, 6-9 years age group showed approx. 4% less percentage of carbohydrate from total energy as compared to 10-12 years. Similarly, age group 10-12 years showed approx. 11% less energy percentage consumption from carbohydrate than 13-15 years. Moreover 6-9 years age group showed approx. 15% less percentage of energy from carbohydrate when compared to 13-15 years. In MSES, 6-9 years age group had approx. 7% less percentage energy consumption from carbohydrates than 10-12 years. Whereas 10-12 years had only approx.1% more percentage energy consumption from carbohydrate than 13-15 years. On the contrary, 6-9 years showed approx. 6%less percentage energy consumption from carbohydrates than 13-15 years. In HSES, 6-9 year age group showed approx. 4% less percentage energy consumption form carbohydrates than 13-15 year whereas 10-12 years showed approx. 3% less percentage energy consumption form carbohydrates than 13-15 years. Age group 6-9 years showed approx. 7% less percentage energy consumption from carbohydrates than 13-15 years.

According to joint WHO/FAO report consultation (2003), the goal of carbohydrate intake should be in the range of 55%- 75% of the total energy. From the above table it can be seen that children belonging to all the three the age groups met their total carbohydrate consumption goal, however the consumption of simple carbohydrate from the total carbohydrate is what which needs to be monitored.

A similar study was done on Bahrain children aged 6-18 years concluded that

the carbohydrate Energy % was 52.9% in boys and 52.1% in girls which is close to the recommendations of COMA (Committee on Medical Aspects of *Food* and Nutrition Policy) for energy intake from carbohydrate (50%) (Gharib;loc.cit).

Another study done by Le Ngoc Dien*et al*., 2004 on 5999 households concluded that increase in the family income , significantly increases carbohydrate energy %, high (75.4% in rural areas and 68.2% in urban areas) (Vlismas, 2009).

PERCENTAGE ENERGY FROM SIMPLE (SUGARS) CARBOHYDRATE						
SES	**Age**	**Number Of subjects**	**Mean (% energy/day)**	**% difference**		
LOW SES	6-9 years	74	3.7±2.0	-34.91		
	10-12 years	37	5.7±8.2		19.49	
	13-15 years	43	4.7±6.6			-22.22
	Total	154	4.7±5.6			
MIDDLE SES	6-9 years	91	5.8±8.3	5.22		
	10-12 years	36	5.5±8.0		-20.14	
	13-15 years	39	6.9±31.6			-15.97
	Total	166	6.1±16.7			
HIGH SES	6-9 years	77	3.1±2.2	-36.23		
	10-12 years	39	4.9±7.2		22.88	

	13-15 years	44	4.0±7.6			- 21.64
	Total	160	4.03±5.7			

Table 4.9: Percentage energy consumption from simple carbohydrate of the three SES

The above table depicts the data on percentage energy consumption from simple carbohydrate within the three SES. The highest (6.9±31.6) percentage energy consumption from simple carbohydrate was observed in the age group 13-15 years in MSES, followed by (5.8±8.3) percentage energy consumption from simple carbohydrates in the age group 6-9 years in the same SES. Further in LSES, the highest (5.7±8.2) percentage energy consumption from simple carbohydrates was observed in the age group 10-12 years. In HSES the highest (4.9±7.2) percentage energy consumption from simple carbohydrates was found in the age group 10-12 years. The least (3.1±2.2) percentage energy consumption from simple carbohydrates was observed in the age group of 6-9 years in HSES.

Data on % difference in LSES depicted that, 6-9 years age group showed approx. 35% less percentage energy consumption from simple carbohydrates than 10-12 years. Whereas, 10-12 years age group showed approx. 20% more percentage energy consumption from simple carbohydrates than 13-15 years. Further 6-9 years age group showed approx. 22% less percentage energy consumption from simple carbohydrates than 13-15 years. In MSES, 6-9 years showed approx. 5% more percentage of energy consumption from simple carbohydrates than 10-12 years but 10-12 years age group showed approx. 20% less percentage energy consumption from simple carbohydrates than 13-15 years. Further, 6-9 years showed approx. 16% less percentage energy consumption from simple carbohydrates than 13-15 years. In HSES, highest % difference was observed in the age group 6-9 years and 10-12 years, where 6-9 years showed approx. 36% less percentage energy consumption from simple carbohydrates. Whereas 10-12 years age group showed approx. 23% more percentage energy consumption from simple carbohydrates than 13-15 years. When ages between 6-9 years and 13-15 years were compared, 6-9 years showed approx. 22% less percentage

energy consumption from simple carbohydrates than 13-15 years.

PERCENTAGE ENERGY COMPLEX CARBOHYDRATE						
SES	**Age**	**Number Of subjects**	**Mean (% energy /day)**	**% difference**		
LOW SES	6-9 years	74	53.5±12.8	-0.59		
	10-12 years	37	53.8±12.9		-13.62	
	13-15 years	43	62.3±26.6			-14.13
	Total	154	56.5±17.4			
MIDDLE SES	6-9 years	91	51.2±18.4	-7.12		
	10-12 years	36	55.1±8.3		3.95	
	13-15 years	39	53.0±11.8			-3.44
	Total	166	53.1±12.8			
HIGH SES	6-9 years	77	56.8±18.6	1.40		
	10-12 years	39	56.0±19.7		-4.95	
	13-15 years	44	58.9±21.2			-4.96
	Total	160	56.2±19.8			

Table 4.10: Percentage energy consumption from complex carbohydrates of the three SES

The highest percentage energy consumption from complex carbohydrates was observed in the age group 13-15 years in both LSES (62.3±26.6) and HSES (58.9±21.2). However in MSES, the highest (55.1±8.3) percentage energy consumption from complex carbohydrates was observed in the age group 10-12 years. The overall least (53.0±11.8) percentage energy consumption from complex carbohydrates was observed in the age group 13-15 years in MSES.

In LSES, 6-9 years age group showed approx. 1% less percentage energy consumption from complex carbohydrates than 10-12 years, whereas 10-12 years showed approx. 14% less percentage energy consumption from complex carbohydrates than 13-15 years. Further, 6-9 years showed approx. 14% less percentage energy consumption from complex carbohydrates than 13-15 years. In MSES, the highest % difference was observed in 6-9 years and 10-12 years age group where 6-9 years showed approx. 7% less percentage energy consumption from complex carbohydrates than 10-12 years. Moreover 10-12 years had approx. 4% more percentage energy consumption from complex carbohydrates than 13-15 years, whereas 6-9 years showed approx. 5% less percentage energy consumption from complex carbohydrates than 13-15 years. In HSES, 6-9 years age group showed approx. 2% more percentage energy consumption from complex carbohydrates than 10-12 years and 10-12 years showed approx. 5% less percentage energy consumption from complex carbohydrates than 13-15 years. Further 6-9 years showed approx. 5% less percentage energy consumption from complex carbohydrates than 13-15 years.

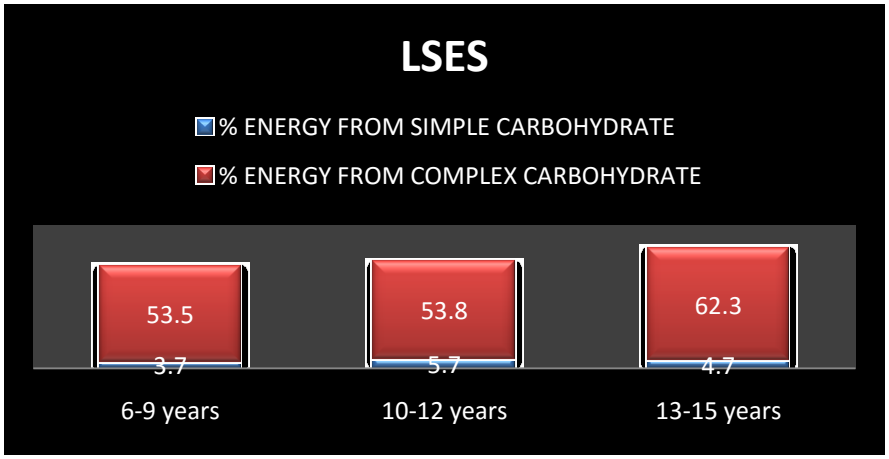

Figure 4.10: % Energy from complex and simple carbohydrate in LSES

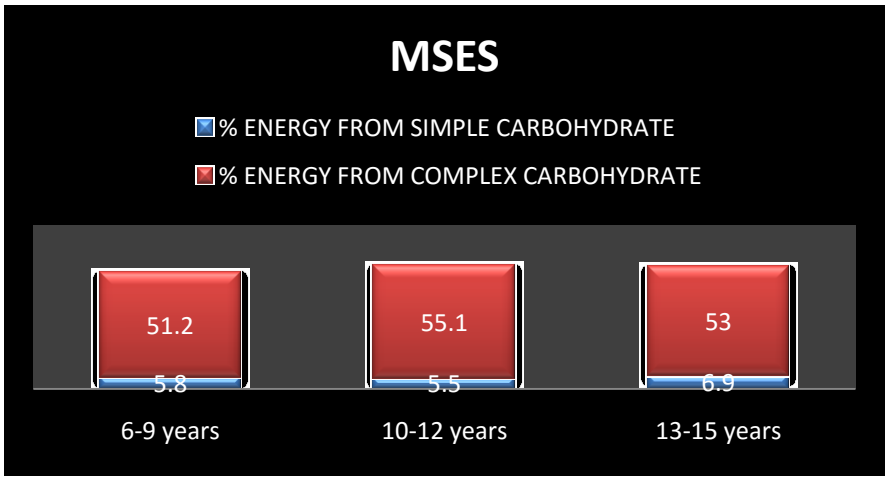

Figure 4.11: % Energy from complex and simple carbohydrate in MSES

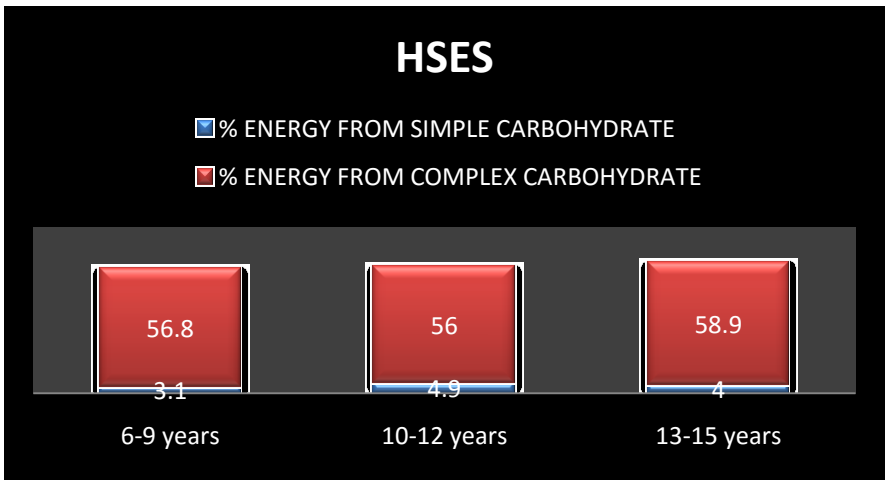

Figure 4.12: % Energy from complex and simple carbohydrate in HSES

A similar study was done on U.S. children and adolescents for the year 2005 – 2008, to identify the contribution of percentage of added simple sugar energy to total energy consumed which resulted that 6–11 year olds consumed 16.6% of their calories from added sugars, and 12–19 year-olds consumed 17.5% of their calories from added sugars.

The same study also concluded that was no significant differences in the percentage of total calories intake from added sugars based on poverty income ratio (PIR) either for boys or girls. (NCHS data brief, 2012).

DIETARY FIBRE (GRAMS)						
SES	**Age**	**Number Of subjects**	**Mean (grams/day)**	**% difference**		
LOW SES	6-9 years	74	8.91±6.75	-64.07		
	10-12 years	22	24.8±13.7		-0.08	
	13-15 years	43	24.82±15.8			-64.10
	Total	154	19.5±12.0			
MIDDLE SES	6-9 years	91	10.3±9.4	-56.17		
	10-12 years	26	23.5±13.3		-15.46	
	13-15 years	39	27.8±2.0			-62.9
	Total	166	20.5±8.2			
HIGH SES	6-9 years	77	9.1±6.9	-49.4		
	10-12 years	39	18.0±10.8		-15.88	
	13-15 years	44	21.4±18.2			-57.47
	Total	160	16.1±11.9			

Table 4.11: Mean dietary fibre intake of the three SES

The highest (27.8±2.0) grams/day mean dietary fibre consumption was observed in MSES in the age group 13-15 years, followed by the same age group 13-15 years (24.82±15.8)grams/day in LSES. In HSES the highest (21.4±18.2)grams/day mean dietary fibre consumption was also observed in the age group. The least mean dietary fibre consumption was observed in 6-9 years age group for all SES, where LSES showed the least (8.91±6.75) grams/day consumption.

In LSES, 6-9 years showed approx. 64% less mean dietary fibre consumption than 10-12 years. Whereas, 10-12 years age group showed approx. 1% less mean dietary fibre consumption than 13-15 years. Further 6-9 years age group again showed approx. 65% less mean dietary fibre consumption than 13-15 years. A similar trend was seen in MSES, where age group 6-9 year hap approx. 56% less mean dietary fibre consumption than 10-12 years and approx. 63% less mean dietary

fibre consumption than 13-15 years age group. Moreover 10-12 years showed approx. 15% less mean dietary fibre consumption than 13-15 years. Further in HSES, 6-9 years showed approx. 49% less mean dietary fibre consumption than 10-12 years and approx. 57% less mean dietary fibre consumption than 13-15 years. Similarly 10-12 years had approx. 16% less mean dietary fibre consumption than 13-15 years.

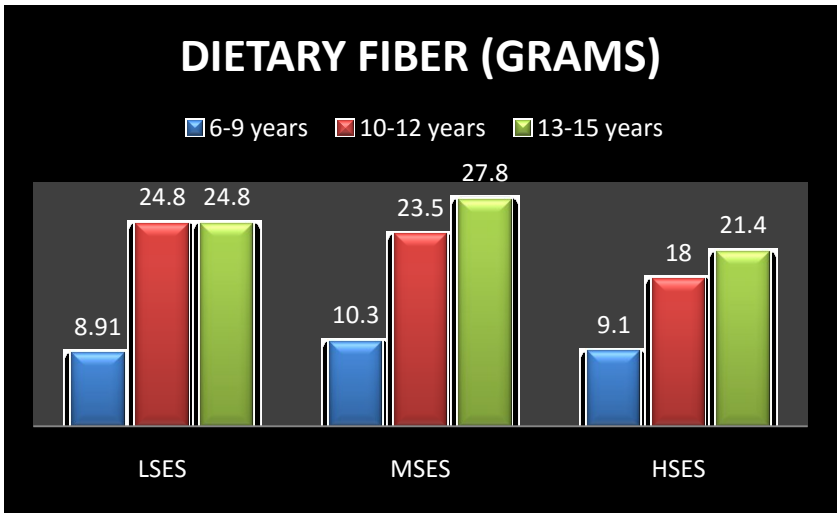

Figure 4.13: Mean dietary fibre intake of the three SES

There have been no studies on evaluating the dietary fibre requirements in Indians. However, the recommendations of US Agencies that a minimum intake of 20-35 g of fibre is conducive for long-term good health. Even the WHO Committee on chronic degenerative diseases recommended a daily intake of 30 g dietary fibre (ICMR 2009). From the above table it could be noted that the children did not meet the required energy requirement which may be due to low consumption of fresh fruits and vegetables and possibly due to insufficient quantities of other sources of fibre such as whole grains, legumes, and high fibre cereals

A similar study was done in UK in 2010 to identify the mean daily intake of dietary fibre was identified which concluded that daily fibre intake in boys (13.5g ±.8) was higher than girls (12.4 g ± 5.9) ($p < 0.05$), but anyway less than the recommended intake for fibres(DRV- UK 18g) (Gharib; *loc.cit).*

TOTAL FREE SUGARS AND % ENERGY FROM FREE SUAGRS				
SES	**Age**	**Number Of subjects**	**Mean (free sugars grams/day)**	**Mean (% energy from free sugars)**
LOW SES	6-9 years	74	26.2±21.1	9.4±17.1
	10-12 years	37	23.2±12.2	6.6±10.5
	13-15 years	43	24.5±11.8	6.5±6.7
	Total	154	24.6±15.0	7.5±11.4
MIDDLE SES	6-9 years	91	89.1±35	25.6±12.0
	10-12 years	36	38.9±19.4	9.8±8.0
	13-15 years	39	47±27.7	12.1±17.0
	Total	166	58.3±82.1	15.8±12.3
HIGH SES	6-9 years	77	49.9±20.6	15.8±15.1
	10-12 years	39	46.4±31.8	12.6±21.5
	13-15 years	44	32.1±42.7	7.8±23.8
	Total	160	42.8±95.1	12.0±20.1

Table 4.12: Intake of total free sugars and consumption of % energy from free sugars of three SES

The above table represents the intake of total free sugars which takes into account the added table sugars and consumption of common sugar rich foods such as ice

cream, chocolates, fruit juices, health drinks, cream biscuits and sweet biscuits.

Out of all the sugar rich foods consumed, highest consumption of added simple sugar was found to be of sweet biscuits, of which most preferred brand was Marie biscuit.

When consumption of total free sugars was observed, highest consumption (89.1±35) grams/day was noted in MSES in the age group 6-9 years, followed by HSES (49.9±20.6) grams/day in the same age group. In LSES also the highest consumption (26.2±21.1) grams/day was observed in 6-9 years. The overall least consumption (23.2±12.2) grams/day was observed in LSES in the age group 10-12 years. In MSES also the least consumption (38.9±19.4) grams/day was observed in the same age group. However in HSES the least consumption (32.1±42.7) grams/day was observed in 13-15 years age group.

When % energy consumption from free sugars was observed, it was noted that MSES had the highest (25.6±12.0) % energy from mean sugars in the age group 6-9 years whereas LSES had the lowest (6.5±6.7) % energy from free sugars in the age group 13-15 years.

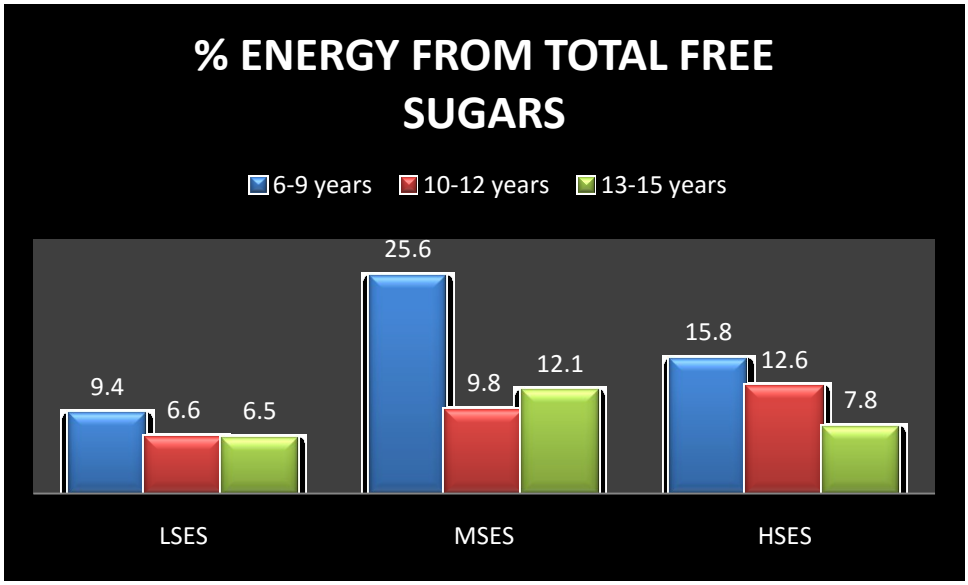

Figure 4.13: % energy from total free sugars

WHO recommends not more than 10% of free sugar in the diet (WHO, 2015) Taking this into account, it is evident that two groups in the MSES (6-9 and 13-15) category and two groups in the HSES (6-9 years and 10-12 years) category are

consuming more than the recommended value. This may put them at risk of obesity. And thus, achieving goals for intake of carbohydrates does not ensure nutritional adequacy. Carbohydrate foods provide a range of nutrients and other substances essential for health in addition to energy. It is therefore essential to consume a variety of foods such as vegetables, fruits, pulses and cereals to include remarkable amount carbohydrates in the diet.

CHAPTER FIVE

SUMMARY

&

CONCLUSION

The present study showed that the carbohydrate consumption among 6-9 years, 10-12 years and 13-15 years using a 24 hour recall method, it was concluded that children's of age 13-15 years had highest consumption of carbohydrate. They also had highest consumption of energy and percentage energy from carbohydrates than the other two age groups.

On comparing the energy consumption with RDA, it was observed that children belonging to LSES had lower energy intake as compared to other SES, whereas the highest energy intake was observed in 10-12 years boys of MSES. However irrespective of SES, data showed that there was no correlation between consumption of energy with the respective RDA among any age groups.

The mean carbohydrate intake was highest among 13-15 years children belonging to HSES and the least intake was observed in 6-9 years children of LSES.

Data on added simple carbohydrate intake depicted that, highest intake was observed in MSES in 13-15 years children whereas the least intake was observed in 6-9 years children of HSES. On the other hand, 13-15 years children of LSES showed the highest complex carbohydrate intake whereas the least intake of complex carbohydrate was also observed in the same SES in 6-9 years children.

Of the total carbohydrate highest percentage complex carbohydrate intake

was observed in 10-12 years of LSES whereas the highest percentage simple carbohydrate intake was observed in 10-12 years children belonging to MSES.

Data on percentage energy from complex carbohydrate indicated that 13-15 years children of LSES had the highest consumption of percentage energy from complex carbohydrate. Whereas children of age group 13-15 years in MSES had the highest consumption of percentage energy from simple carbohydrate.

Fibre consumption showed that 13-15 years children in MSES had the highest daily intake of fibre, whereas the least daily intake of fibre was observed in 6-9 years children in LSES.

Data on total free sugars showed that 6-9 years children in MSES had the highest total free sugar intake which includes added table sugar and consumption of common sugar rich foods. Whereas the lowest total free sugars intake was observed in 10-12 years in LSES.

Mean percentage energy from total free sugars indicated that 6-9 years children belonging to MSES had the highest mean percentage of energy consumption from total free sugars. The least mean percentage energy from total free sugars was observed in LSES children of 10-12 years and 13-15 years age group.

Thus it can be concluded that there exists a significant difference between the age groups and also among the SES for the consumption of carbohydrates, simple sugars, total free sugars and dietary fibre.

CHAPTER SIX

RECOMMENDATIONS

&

LIMITATIONS

Recommendations

The present study was conducted using a 24 hour dietary recall method. Detailed consumption pattern analysis can be done using a 3 day dietary recall method which will be able to generate more accurate results.

Also consumption of carbohydrates in each meal- breakfast, lunch, snacks and dinner can be analysed briefly which might show which meal could have the highest possible intake of free sugars and complex carbohydrate.

The present study lacks consumption pattern according to gender classification which could be scope of analysis in future.

Limitations

Data collected represents consumption pattern of carbohydrate solely of children's residing in Mumbai city. This information should be kept in mind when generalizing the results of the study.

CHAPTER SEVEN

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CHAPTER EIGHT

APPENDICES

APPENDICES 'a'

Abbreviations

AI	AI- Adequate Intake
AMDR	AMDR- Acceptable Macronutrient Distribution Ranges
CHD	CHD- Coronary Heart Disease
CHO	CHO- Carbohydrate
COMA	COMA- Committee on Medical Aspects of food and nutrition policy
CSFII	CSFII- Continuing Survey of Food Intakes by Individuals
CVD	CVD- Cardiovascular Diseases
DP	DP-Dietary Patterns

DRI	DRI- Dietary Reference Intake
DRV-UK	DRV –UK – Dietary Reference Values- United Kingdom
EAR	EAR- Estimated Average Requirements
ED	ED-Energy Dense
EFSA	EFSA- European Food Safety Authority
EPIC	EPIC- European Prospective Investigation into Cancer and Nutrition
ESPGHAN	ESPGHAN- European Society for Paediatric Gastroenterology Hepatology and Nutrition
FAO	FAO-Food and Agriculture Organisation
FDA	FDA- Food and Drug Administration
FITS	FITS- Feeding Infants and Toddler Study
GI	GI- Glycaemic Index
GL	GL- Glycaemic Load
HFCS	HFCS- High Fructose Corn Syrup
ICMR	ICMR- Indian Council Of Medical Research
IoM	IoM- Institute of Medicine
NCD	NCD- Non Communicable Disease
NCHS	NCHS- National Centre for Health Statistics
NHANES	NHANES- National Health and Nutrition Examination Survey
NIN	NIN- National Institute of Nutrition
NMES	NMES-Non Milk Extrinsic Sugars
NNR	NNR- Nordic Nutrition Recommendations
NSP	NSP- Non Starch Polysaccharide
PIR	PIR- Poverty Income Ratio
RDA	RDA- Recommended Dietary Allowances
RS	RS- Resistant Starch
SES	SES- socioeconomic status
SSB	SSB- Sugar Sweetened Beverages
USDA	USDA- United States Department of Agriculture
VAT	VAT-Visceral Adipose Tissue
WHO	WHO- World Health Organisation
WWEIA	WWEIA-What We Eat In America

APPENDICES 'b'

The following were the popular products which were used for accounting total free sugars intake among children.

Popular brands

Items	Brands
Chocolates	Dairy milk

Ice cream	Amul
Health drinks	Bournvita
Cream biscuits	Bourn bourn
Sweet biscuits	Marie biscuits
Fruit juices	Real

Reference values used from the above mentioned brands

Item	Brand	Energy (kcal)	Carbohydrate (grams)	Sugars (grams)
		(Per 100 grams)		
Chocolate	Dairy milk	523	60.5	57.4
Ice cream	Amul	219	21.8	16
Health drinks	Bournvita	382	84	71
Cream biscuits	Bourn bourn	484	71	37.5
Sweet biscuits	Marie biscuits	448	77	21.5
Fruit juices	Real	56	13.5	6.8

APPENDICES 'c'

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24 HOUR DIETARY RECALL FORM

24-hour Dietary Recall and Anthropometry Form (Form I-4.1)

Registration Form

Good morning, my name is ______________________ and I'm working on a child feeding project for the ____________.

Could I ask you some questions regarding what the child you care for ate yesterday? The information that you provide will remain confidential.

1. Child's code: ☐☐☐☐ 2. Date of interview ☐☐ (Day) ☐☐ (Month) ☐☐ (Year) 3. Location ☐☐☐☐ 4. Field worker's code: ☐☐

Child's name: ____
Paternal last name Maternal last name First name

Careviger's name: ____
Paternal last name Maternal last name First name

5. Child's sex (1 = M, 2 = F) ☐ 6. Date of birth: ☐☐ (Day) ☐☐ (Month) ☐☐ (Year)

7. Age (months): ☐☐ NOTE: IF THE CHILD IS YOUNGER THAN 6.0 MONTHS OR 24.0 MONTHS OLD OR OLDER, DO NOT APPLY THE SURVEY

8. Was (child) breastfed yesterday? (0 = No, 1 = Yes) ☐ 9. Yesterday, was it a holiday in the community? (0 = No, 1 = Yes) ☐

10. Yesterday, was there a celebration in the family? (0 = No, 1 = Yes) ☐ 11. Yesterday, was the child sick with fever, cough or diarrhea? (0 = No, 1 = Yes) ☐

If anthropometric measurements were taken:

12. Child weight in kilograms ☐☐☐☐ 13. Child length in centimeters ☐☐☐☐☐

14. Child mid-upper arm circumference (MUAC) in millimeters ☐☐☐☐

Explain the questionnaire to the caregiver before beginning.

Help her recall (remember) the previous day, based on the times when the child woke up, the activities the child had, etc. Go slowly.

ProPAN: Process for the Promotion of Child Feeding

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Child's Code ____________

Ask the caregiver the following: *Please tell me everything that the child ate and drank yesterday.*

After the child woke up, what was the first thing you gave him/her to eat or drink?

After that, what other food or drink did you offer the child?

Write all the foods or dishes consumed the day before that the caregiver mentions.

Be sure to ask this: *What is the name of that mealtime (e.g., breakfast, lunch, or dinner, or morning, afternoon, or evening snack)?*

Mealtime (as defined by caregiver)	Name of food or preparation

Module I: Assessment

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Child's Code ____________

Measurements taken in the home			Office	Measurements taken in the home						Net Grams		
15. Meal-time	Name of food or dish	Ingredients and charac-teristics	16. Code of food or dish	Served	Not Consumed	Consumed	Weighed (1=gross 2=net)	How consumed (1=cooked 2=raw)	17. Days consumed in past week	Conversion to grams	18. Served	19. Consumed

Mealtime:
Main meals: 10 morning (breakfast); 20 midday (lunch); 30 evening (dinner)
Snacks: 01, 02, 03 … 09 morning (before breakfast); 11, 12, 13 … 19 morning (after breakfast); 21, 22, 23 … 29 afternoon; 31, 32, 33 … 39 evening

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Child's Code ______________

Measurements taken in the home				Office		Measurements taken in the home				Office	
Dish:				Total weight of cooked ingredients:		Dish:				Total weight of cooked ingredients:	
Ingredients	Quantity used	Weighed (1=gross 2=net)	Used (1=cooked 2=raw)	Conversion to cooked	Cooked grams	Ingredients	Quantity used	Weighed (1=gross 2=net)	Used (1=cooked 2=raw)	Conversion to cooked	Cooked grams