# EVALUATION OF THE RELATIONSHIP BETWEEN BODY MASS INDEX, DENTAL CARIES AND DIET AMONG A GROUP OF 6-12 YEARS OLD SCHOOL GOING CHILDREN IN CHENNAI CITY

***Dissertation submitted to***

**THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY**

***In partial fulfillment for the degree of***

**MASTER OF DENTAL SURGERY**

**BRANCH VIII**

**PEDODONTICS AND PREVENTIVE DENTISTRY**

**APRIL 2012**

# CERTIFICATE

This is to certify that this dissertation titled "**EVALUATION OF THE RELATIONSHIP BETWEEN BODY MASS INDEX, DENTAL CARIES AND DIET AMONG A GROUP OF 6-12 YEARS OLD SCHOOL GOING CHILDREN IN CHENNAI CITY**" is a bonafide record of work done by **Dr. E. ARUN,** under my guidance during his postgraduate study period between **2009 – 2012**.

This dissertation is submitted to **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY**, in partial fulfillment for the degree of **Master of Dental Surgery in Branch VIII –Pedodontics and Preventive Dentistry**.

It has not been submitted (partially or fully) for the award of any other degree or diploma.

RAGAS DENTAL COLLEGE & HOSPITAL CHENNAI

M. Jayanthi 30/11/11

**Dr. M. Jayanthi, M.D.S.,**
Professor and Head
Department of Pedodontics & Preventive Dentistry,
Ragas Dental College & Hospital,
Chennai

Dr. M. JAYANTHI, MDS.
Professor & Head of the
Dept. of Pedodontics & Preventive Dentistry
Ragas Dental College & Hospital
Chennai-600 119

30.11.11

**Dr. S. Ramachandran, M.D.S.,**
Principal
Ragas Dental College & Hospital,
Chennai

PRINCIPAL
RAGAS DENTAL COLLEGE & HOSPITAL
CHENNAI

**Date :** 30/11/11

**Place :** Chennai

# ACKNOWLEDGEMENT

*I would like to take this opportunity to thank my mentor and guide* ***Dr.M.Jayanthi, MDS,*** *Professor and Head of the Department of Pedodontics and Preventive Dentistry, Ragas Dental College and Hospital, Chennai, who has been a constant inspiration and instrumental in shaping my views. Her enthusiasm, unmatched tireless patience and unlimited zeal proved to be a major driving force throughout my post graduation life. Madam, I solemnly express my deep felt gratitude for your valuable and great guidance and suggestions.*

*I take this opportunity to thank* ***Dr. S. Ramachandran, MDS,*** *Principal, Ragas Dental College & Hospital, for his constant support throughout my post graduation course.*

*I express my deep sense of gratitude to* ***Dr.Elizabeth Joseph, MDS,*** *Professor, Department of Pedodontics and Preventive Dentistry, Ragas Dental College and Hospital, Chennai, who was there at each step guiding me to prepare this dissertation. I am deeply grateful for her detailed and constructive comments and for her important support throughout this work.*

*I would like to thank* ***Dr.Senthil, MDS,*** *Reader, Department of Pedodontics and Preventive Dentistry, Ragas Dental College and Hospital, Chennai for his continuous encouragement throughout my study period.*

*I extend my sincere thanks to* ***Dr.Shakthivel, MDS,*** *Senior Lecturer,* ***Dr.Poornima, MDS,*** *Senior Lecturer and* ***Dr.Girija, MDS,*** *Senior Lecturer, Department of Pedodontics and Preventive Dentistry, Ragas Dental College and Hospital, Chennai for their motivation towards the completion of the dissertation.*

*I take this opportunity to thank* ***Dr.N.S.Azhagarasan, MDS,*** *and* ***Dr.N.R.Krishnaswamy, MDS,*** *Vice-Principals, Ragas Dental College and Hospital, for their generous support rendered throughout my post graduation course.*

*I would like to thank the* ***Management of Ragas Dental College and Hospital*** *for their help and support.*

*I would like to extend my gratitude* ***to Mr. Porchelvan,*** *Statistician, for his valuable help in statistical analysis.*

*I would also like to thank the* ***management of all the schools*** *for giving me permission to carry out this dissertation in their esteemed institutions. A special thanks to* ***all the children participated in this study*** *without whom this project would have ever been possible.*

*I am profoundly thankful to my batch mate* ***Dr. Madhulika Injeti*** *for encouraging me and helping me throughout my post graduation course. I extend my gratitude to my Seniors* ***Dr.Madhavan, Dr. Arun Prasad*** *and Juniors* ***Dr.John Philip****,* ***Dr.Rajakumar, Dr. Vignesh Guptha*** *and* ***Dr.Shilpa Priya*** *for their friendly help, support and cooperation throughout my postgraduate life.*

*I express my love and thanks to my loving* ***Dad, Mom*** *and my* ***grand father*** *for their love, support and encouragement throughout these years without which I would not have reached so far.*

*This dissertation is dedicated to* ***my HOD*** *who had been my support from the day one till today, who really deserves more than a mere word of acknowledgement.*

## TABLE OF CONTENTS

## LIST OF TABLES

# LIST OF GRAPHS

# LIST OF FIGURES

# ANNEXURE

| S.NO. | TITLE |
|---|---|
| 1. | DATA RECORDING PROFORMA |
| 2. | CONSENT FORM (ENGLISH) |
| 3. | CONSENT FORM (TAMIL) |
| 4. | CDC BMI-FOR-AGE PERCENTILES- BOYS |
| 5. | CDC BMI-FOR-AGE PERCENTILES- GIRLS |
| 6. | DIET RECORDING SHEET (ENGLISH) |
| 7. | DIET RECORDING SHEET (TAMIL) |

# INTRODUCTION

Obesity has become an epidemic in many parts of the world.[1] Obesity is not only a problem found in the adult population but has also become an increasing problem in paediatrics.[2,3] Obesity appears to influence the general health as well as oral health of an individual. Obesity in children increases the risk of subsequent morbidity, increased prevalence of hypertension, type 2 diabetes mellitus, dyslipidaemia, left ventricular hypertrophy, non-alcoholic steatohepatitis, obstructive sleep apnoea, and orthopaedic and psychosocial problems,[4,5,6] accelerates dental development[7] and decreases masticatory performance.[8]

Several characteristics of today's society contribute to the widespread childhood obesity problem. Children today lead more sedentary life style.[9] The factors contributing to the increase in childhood obesity include excessive consumption of soda[10-12] and juice[13], large sized portions of food served over the past ten years[10], fewer meals eaten with together as a family and consumption of fewer fruits and vegetables[14,15], dependency on readymade food items, decreased physical activity with great popularity of television and computer games[16], shortage of space in many schools for sports (play grounds).

An increase in energy stored, as fat, can lead to obesity and a number of mechanisms can contribute to an increase in stored energy.[17] If energy intake is in excess of energy expenditure or normal intake with reduced expenditure, it results in the

disturbance in the energy balance equation and increases the stored energy resulting in increase in weight or obesity.[17]

On the other hand, one of the most common oral diseases is dental caries which has multifactorial aetiology among which diet plays a vital role. The relationship between ingestion of refined carbohydrates, especially sugars and the prevalence of dental caries is well documented in the literature.[18] Childhood obesity and childhood dental caries are co-incidental in many populations, probably due to common confounding risk factors such as intake frequency, cariogenic diet and poor oral health.[9]

As diet is a risk factor common to both obesity and dental caries, this study was set to explore the relationship between body mass index, dental caries and dietary pattern amongst a group of children between 6-12years of age and to utilize the data in educating parents and their children through health care providers regarding the ill effects of excessive/frequent consumption high caloric and cariogenic foods.

# AIMS AND OBJECTIVES

The aim of the study was

1. To determine the association between body mass index-for-age and dental caries in children.

2. To find out if there is any relationship between body mass index-for-age and dietary pattern of children.

# REVIEW OF LITERATURE

**Willershausen B et al** (2004)[19] studied the relationship between height, weight and caries frequency in elementary school children. 842 children between the ages 6-11 years from Germany were included in the study and DF-T/ df-t values were determined along with height, body weight and body mass index. The results of the study showed that 33.7% of the children had no decayed or filled teeth, 73.9% were within the normal weight range, 12.9% of the children were overweight and 13.2% children were obese. 35.5% of the children with normal weight had healthy teeth while 27.5% of children in the overweight category had healthy teeth and 29.7% of the obese children had healthy teeth. Children with normal weight had mean df-t value of 2.09 and DF-T value of 0.57, overweight children had average df-t value of 2.48 and DF-T value of 0.91 and obese children had average df-t value of 3.3 and DF-T value of 0.88. The caries prevalence showed a significant association to weight when Fisher test was carried out. It was concluded that there is an association between an increase in dental caries and high weight in children going to elementary school.

**Patricia Vasconcelos Leitao Moreira et al** (2006)[20] conducted a cross-sectional study to know the prevalence of dental caries in obese and normal weight Brazilian adolescents aged 12 to 15 years. Initially a pilot study was carried out to obtain the prevalence of dental caries among obese and normal weight individuals. 1665 normal weight and 1665 obese individuals from seven state schools and six private schools in the state of Paraiba, Brazil were included in the study. Height and

weight measurements were recorded and were compared with growth standards established by the National centre for health statistics (NCHS) for age and gender. The WHO (1997) dental caries diagnostic criteria were used for the calculation of caries. Caries in primary teeth were not calculated. The results showed that the mean DMFT for obese adolescents from private schools was 1.90 and for those of normal weight was 1.91. The mean DMFT for obese adolescents from state schools was 4.27 and for those of normal weight were 4.25. Caries prevalence in obese groups was 9.0% and 50.9% in private and state schools respectively. Likewise, caries prevalence in normal weight group was 9.6% in private schools and 52.4% in state schools. The overall caries prevalence irrespective of the schools was 30.0% in obese and 31.0% in normal weight group. From this result, it was concluded that there was no statistically significant association between dental caries and obesity.

**Hilgers KK, Kinane DF, Scheetz JP** (2006)[9] conducted a preliminary study to determine whether childhood obesity is positively associated with increased risk for smooth surface caries in posterior teeth. The study included 178 children between 8 to 11 years of age who participated in a school based dental treatment program called "Smile Kentucky". Comprehensive dental examination, height and weight measurements and prescribed bitewing radiographs were taken for all the children who participated in the program. Body mass index was calculated for age and gender and children were grouped as recommended by the International obesity task force. A published caries index by Pitts in 2001 was modified and used to rank caries severity. The results showed that the overall caries average ranged from 0.00 to 4.40, but did not vary significantly with patient age, BMI or gender. But, permanent molar caries average significantly increased with increase in body mass index. This study

concluded that children with increased body mass indices had an increased interproximal caries incidence in their permanent molars. Neither age nor gender was found to be related to the incidence of proximal caries.

**Macek MD, David J. Mitola** (2006)[21] explored the association between overweight and dental caries among US children. The study was conducted to examine the relationship between age- specific body mass index and dental caries in children between 2 to 17 years old. Survey data (NHANES) from 1999 to 2002 were used in this study and body measures and oral health (dentition section) were merged for this analysis. The outcome variables were measure of dental caries prevalence and severity for primary and permanent dentition. BMI for age percentiles were used. From the results it was found that approximately 36% of overweight children between 2 to 6 years old and 39% of overweight children between 6 to 17 years old had dental caries. Mean dental caries scores for overweight children were dft= 3.3 and DMFT= 2.5 for primary and permanent dentitions, respectively. The study showed that there was no significant association between BMI for age and dental caries prevalence in both the dentitions. There was also no significant association between BMI for age and dental caries severity in children in primary dentition. Overweight children with a positive history of dental caries in the permanent dentition exhibited fewer decayed, missing, filled teeth than normal weight group.

**Willershausen.B et al** (2007)[22] studied the correlation between oral health and body mass index in 2071 children including 1073 girls and 998 boys attending primary school. Children aged 6 to 10 years attending primary schools in the city of Mainz were enrolled in this study. A dental examination including the assessment of

carious lesions (df-t and DF-T) and measurements of height and weight in order to determine the BMI were done. Results showed that 6.8% of the elementary school children were underweight, 76.4% had normal weight, and 10.5% were overweight and 6.3% were obese. 50% of the underweight children showed healthy teeth, 47.4% with normal weight showed healthy teeth, while 41.5% of overweight and 38.3% of obese children displayed healthy teeth. No gender related differences, regarding the prevalence rates for high weight and obesity could be established. The study concluded that there was significant correlation between body mass index and caries frequency.

**Marshall TA et al** (2007)[23] conducted a study to determine whether caries and obesity were associated in paediatric population and if found associated, then to explore the role of diet and socio economic status. Children and their parents who were participants in the Iowa fluoride study and Iowa bone development study were included in this study. A questionnaire to gather information regarding parental age, parental educational levels and family income was mailed. Children's primary dentition was examined for dental caries and their anthropometric measurements were recorded at 4.5 – 6.9 years of age. Dietary data was collected from a three day food and beverage diaries which was completed at 1,2,3,4 and 5 years of child's age. The results showed that children at the risk of overweight had higher caries than normal and overweight children. Further, children with caries had low family incomes, less parental education than children without caries. The study concluded that caries and obesity coexists in children belonging to low socio economic status.

**Isabelle Bailleul-Forestier et al** (2007)[24] conducted a transversal study to assess the caries experience in severely obese adolescent population who were treated for obesity. Eighty two adolescents aged 12- 18 years from the suburbs of Paris were included in the study. The study population was categorized into obese group (n=41) and non-obese group (n=41). None of the study population had taken part in preventive dental program in the past. Body mass index was calculated and in the obese group, the values ranged from 29 to 66.6 while, in the non-obese group the BMI values ranged from 14.7 to 23.9. Dental examination was conducted and the caries experience of both the groups was expressed using DMFT index. Restorative index (RI) was calculated using the formulae: (F/D+F) * 100%. The results showed the mean DMFT index of obese group was 6.9 $\pm$ 4.1 and for the non-obese group was 4.3 $\pm$ 3.5. Further, there was significant association between body mass index and DMFT indices in the obese group. The obese adolescents had more caries than the non-obese adolescents. It was concluded that severely obese children had high caries experience.

**Pinto A et al** (2007)[25] conducted a study to evaluate the association between weight and dental caries among children during their first dental visit at an urban dental school in Pennsylvania. It was hypothesized that there was a significant association between obesity and presence of untreated dental caries. The study was conducted on 135 children for a period of four months. Anthropometric measurements were taken and BMI percentile was calculated prior to dental examination. DS/ds index was used to assess dental caries. Results showed that approximately 12% of the subjects fell into the risk of being overweight category and 15% were considered over weight. Mean Ds scores was 2.06% with 16% in 2 subjects, 14% in 1 subject and 10%

in 3 subjects. Spearman's correlation between DS/ds and BMI was not significant. The study concluded that no correlation between obese and non- obese children exists.

**Mostafa Sadeghi, Farnosh Alizadeh** (2007)[26] conducted a cross- sectional study in Isfahan, Iran to determine the association between age- specific body mass index and dental caries in children. An initial screening was done for 1003 children between 6-11 years of age from six private and state elementary schools from different social backgrounds. From this, 633 (317 boys, 316 girls) children were clinically examined for dental caries using the World Health Organization criteria Decayed and filled teeth (DFT/dft) indices were used. . Weight, height, BMI-for-age was also calculated for the study population. BMI-for-age and dental caries were analyzed with multiple linear regression, chi-square and t-tests. The results showed that 16% of the children had normal weight, 16.9% were at risk of overweight and 67.1% were overweight. In the normal weight, at risk of overweight and overweight groups, the mean ± SE for DFT were 0.34 ± 0.08, 1.23 ± 0.13 and 0.73 ± 0.05, respectively and 2.01 ± 0.19, 2.76 ± 0.18 and 2.59 ± 0.13 respectively for dft. there was no statistically significant association between BMI-for-age and DFT and dft indices. It was also found that 27.7%, 14% and 37.2% of children with normal weight, at risk of overweight and with overweight were caries free, respectively. From the results, it was concluded that there was no association between BMI-for-age and dental caries.

**Hong L et al** (2008)[27] conducted a cross- sectional study using the data from the National health and nutrition examination survey (NHANES) 1999-2002. The study population included 1507 children aged 2-6 years in the United States. dft counts for

the primary dentition was recorded followed by measuring height and weight. Body mass index was calculated and the participants were categorized using age and gender specific criteria given by centre for disease control, 2000. The results showed that 48% were male and 52% were female children and 74% of the children had normal BMI, 11% were at the risk of overweight, and 11% were in overweight category. 30% of the study population had 1-5 dft and 12% had more than 5 dft. Significant relationship between caries and obesity was found only for children between 60-72 months of age and not in any other age groups. From the results, the study concluded that there appears no association between childhood obesity and caries experience.

**Ana F. Granville-Garcia et al** (2008)[28] studied the relationship between childhood obesity and dental caries. The study was done in the city of Recife, Brazil and included 2651 children between 1- 5 years of age from 84 public and private elementary schools. Dental caries and anthropometric measurements were calculated according to WHO criteria. The results showed that obesity was present in 9% of the children and dental caries prevalence was 19%. Upon statistical analysis, it was found that there was no difference in DMFT score between the obese and non- obese children. Based on these results, it was concluded that there was no relationship between dental caries and childhood obesity.

**Anita Alm, Christina Fahraeus Lill-Kari Wendt, Goran Koch** (2008)[29] investigated the relationship between body weight status in adolescents and snacking habits in early childhood to approximal caries prevalence at 15 years of age. The cross sectional study was conducted a part of the longitudinal surveys of oral health in children followed from the ages of 1-15 years in Sweden. A total of 402 teenagers

were included in the study and body adiposity status was estimated at 13.5-16.4 years using International Obesity Task Force cut-off values (isoBMI). Information about snacking habits in early childhood was obtained from interviews conducted at 1 year and 3 years. Approximal caries information was obtained from Bitewing radiographs at 15 years. The results showed that adolescents with isoBMI ≥25 had an approximal caries prevalence that was a mean of 1.6 times higher than those with isoBMI < 25. Furthermore, it was found that children's snacking habits at an early age were associated with approximal caries at 15 years (P<0.05). The study concluded that overweight and obese teenagers had more approximal caries than normal weight individuals and the frequent consumption of snacking products during early childhood appeared to be a risk indicator for caries at 15 years. The study recommended that preventive programs should include multidisciplinary level approach to prevent and reduce both obesity and dental caries at an early age.

**Gerdwin EW et al** (2008)[30] conducted a study in Sweden to evaluate the association between dental caries, childhood body mass index and socio economic status. The study population included 2303 children who were born in 1991 and living in the country of Ostergotland, Sweden in 2001. Data on weight and height at 4, 5, 7 and 10 years of age were extracted from the records of child welfare centres and school health services. Data on dental caries was obtained from the country council at 6, 10 and 12 years of age. deft score was calculated for primary teeth at 6 years and DFT and DFSa was calculated for permanent teeth at 10 and 12 years of age. The results showed that 69%, 76.9% and 68% were caries free at 6, 10 and 12 years respectively. Likewise obese, but not overweight children had more caries affected teeth than non- obese children. The study confirmed that caries prevalence is

positively associated with obesity in the study population but the association was weak .it was also concluded that childhood BMI and socio economic status were unrelated.

**Freire MCM et al** (2008)[31] studied the relationship between height and dental caries in adolescents in Brazil. The study was conducted to test the hypothesis that taller Brazilian adolescents have lower levels of caries experience. A questionnaire was used to collect the data for 664 adolescents aged 15 from a cross sectional study on the relationship between psychosocial factors and oral health in Brazilian adolescents. Sampling method used was two staged sampling and stratified sampling. Height measurements were taken. Caries experience was calculated using DMFT AND DMFS index. Information regarding socio economic status, frequency of sugar consumption, fluoride exposure and school performance were also obtained. The results clearly stated that there was a decreased risk of having higher DMFT/DMFS levels among taller adolescents. Further, caries experience was higher among low socio economic status. This study concluded that taller adolescents have low caries experience.

**Sheller B et al** (2009)[32] conducted a retrospective case study to describe the body mass index of children with severe early childhood caries receiving dental rehabilitation under general anaesthesia. The study population included 293 healthy children between 2-5 years of age. Demographic measurements like birth date, gender, and ethnicity were obtained. Anthropometric measurements were recorded and BMI for age and gender was calculated based on recommendations given by centers for disease control. Radiographs were used to determine dmft index and

number of pulp involved teeth. The results showed that 11% of the study population was under weight, 67% had normal weight, 9% was at the risk of overweight and 11% was obese. The mean dmft score was 11.8. It was found that the BMI percentile did not have any correlation with neither dmft index nor pulp involved teeth. From this study, it was concluded that age and gender specific BMI percentile had no correlation with caries experience or pulp involvement.

**Sharma A, Hegde AM** (2009)[33] studied the relationship between body mass index, dental caries experience and preferences of diet in children in the age group 8-12 years. The study was done in Mangalore, India and it included 500 children of whom 255 were boys and 245 were girls. Anthropometric measurements were calculated using balanced beam scale and stadiometer and BMI was calculated. Caries experience was calculated using DMFS/dmfs index by a single examiner. Preferences to various sweet and fatty foods were obtained using a 35 item food frequency questionnaire. Older children completed the questionnaire by themselves while parents of the younger children were asked to fill the questionnaire. The results showed that 58.4% children had normal weight, 8.6% were under weight, 22.2% were at the risk of overweight and 10.8% were obese. The mean DMFS for obese children was 2.85 and normal weight children was 1.58 (p- 0.013). The mean dfs for normal weight was 2.14 where as in obese group, it was 3.25. It was found that there was an increase in mean caries experience in both primary and permanent dentition as body weight increases from underweight to obese with an exception of higher increase in caries experience in permanent dentition among underweight children compared to children with normal body weight, over weight and obese. Likewise, 25.2% of the overweight and 25.9% of obese children preferred sweet and fatty foods more

frequently whereas only 7.9% of children in normal weight group preferred sweet and fatty foods more frequently. From this study, it was concluded that there is a higher prevalence of dental caries in over weight and obese children in both permanent and primary dentition and children who are obese and overweight prefer sweet and fatty foods more frequently than children with normal weight. The study recommended that calculation of BMI in routine examination of the children.

**Tripathi S et al** (2010)[34] studied the relation between dental caries and obesity among 2688 students between 6-17 years of age from two private schools and one government schools, India. Teeth missing for orthodontic reasons, extraction or trauma were not included in the DMFT scores. Caries in primary teeth was not recorded. Radiographs were not taken. For anthropometric assessment, a 150 KG digital scale, a 100 g scale and a 200 cm tape were used according to WHO criteria and National Centre for Health Statistics guidelines. Assessment and classification of BMI were performed following established guidelines by National Center for Health Statistics (NCHS, 1976) for age and gender. The results showed that 7.5% of students from private schools were obese while 1.57% from government school was obese. Likewise, 92.6% students from private schools were non- obese while 98.4% students from government schools were non- obese. Dental caries prevalence was 27.6% in private school students and 9.6% in public school students. The mean DMFT score in obese and non- obese group from private school students were 1.163 and 1.072 respectively (p-0.836). The mean DMFT score in obese and non- obese group from government school students were 0.298 and 0.490 respectively (p-0.098). The study concluded that although the obese children studying both in private and government schools had more dental caries in comparison to

non-obese children, there was no significant association between obesity and increase incidence of dental caries.

**Kelishadi R et al** (2010)[35] conducted a case control study to find out whether there is any association between dental caries and cardio metabolic risk factors among youths in Isfahan. The study population included 132 participants between 11 to 16 years. Cardio metabolic risk factors like body mass index, blood pressure, blood glucose level, cholesterol level and serum lipid profile were measured from blood samples. Decayed, missing, filled surfaces were calculated based on WHO criteria. The study results showed a significant difference between mean values of DMFS, BMI and other measured variables. The authors recommended that more attention should be paid to oral health and to create a sense of responsibility among medical health professionals to inform children and families about hazards of having high caries index and poor oral hygiene and their potential association with cardiovascular disease risk factors.

**Tambelini CA et al** (2010)[36] conducted a cross sectional study in Brazil to evaluate the prevalence of dental caries and investigate its association with excess weight in adolescents and socio demographic factors. The study included a sample of 424 adolescents between 15 to 19 years of age. The prevalence of dental caries was assessed according to the WHO criteria (1997). Body mass index was calculated from anthropometric measurements and the samples were assigned into one of the four groups namely obese, overweight, normal weight and underweight. Socio demographic characteristics were obtained through interviews with the adolescents. The results showed that prevalence of dental caries was 72.9% and excess weight

(overweight and obese) was diagnosed in 22.4% of the sample. 5.4% had low weight, 72.2% had normal weight. The study stated that socio demographic factors like age, skin colour and area of residence had a positive influence on the prevalence of dental caries but, excess weight was not found to be associated with the prevalence of dental caries.

**Niraj Gokhale et al** (2010)[37] conducted a study to find out if there was any correlation between dental caries and body mass index among 100 children aged 3 to 14 years at Nellore, India. Dental examination included DMFT and def indices followed by weight and height measurements and socioeconomic status determination. Body mass index was calculated and children were categorized into one of the three groups namely ideal weight (BMI 14-17), underweight (BMI less than 14) and over weight (BMI more than 17). The results showed no statistically significant values between body mass index, socioeconomic status and dental caries. From this study it was concluded that there was no association between body mass index and dental caries and as well as socioeconomic status and dental caries. Other factors have a role to play in caries process.

**Giselle D'Mello et al** (2011)[38] studied the relationship between dental caries experience in deciduous dentition and Body mass index among pediatric dental clinic attenders in Newzeland. The study included 200 children aged 8 years for whom height and weight were measured and BMI was calculated and deciduous dental caries experience was recorded. The results showed that the overall mean BMI was 16 and dmft ranged from 0 to 15 with a mean of 6. 24% had dmft less than 3 and 38% had

dmft greater than 8. It was concluded that there was no association between BMI and dental caries experience.

**Davies PSW** (1997)[39] conducted a study to investigate the relationship between composition of the diet and body mass index in children between 1.5 years to 4.5 years. The study included 1444 children from Great Britain. Data regarding diet were obtained from the National Diet and Nutrition Survey (NDNS) were used to calculate percentage of total energy intake derived from fat, carbohydrate and protein following a four day weighed intake carried out by the parents or care givers of the children. Height and weight measurements were used to calculate the body mass index the children. The results showed that taller and heavier than girls and there was a significant difference between mean energy intake in the boys and girls ($P<0.01$). Girls consumed more energy from proteins and less from carbohydrates than the boys ($P<0.05$). There was no significant difference in the percentage energy obtained from fat between boys and girls. The results also revealed that there were no obvious trends for BMI and carbohydrates, fat and protein intake. The study concluded that it was not possible to confirm the recent findings in much smaller samples that diet composition affects body size. It was suggested that other findings like energy intake *per se* and habitual physical activities might have an important role on the size, BMI and body composition of pre-school children.

**Atkin LM and Davies PSW** (1999)[40] conducted a study to determine whether diet composition was related to percentage body weight in children aged 1.5 – 4.5 years. The study included 77 preschool children for whom the data were provided by the feasibility study for the National Diet and Nutritional Survey, Great Britain. The

child's mother or primary caregiver was asked to keep a weighed food record for a period of 4 consecutive days including a Saturday and a Sunday. Comprehensive instructions on how to weigh and record all the food and drinks consumed were provided by a field worker before the recording period began. Likewise, body composition was assessed by measurement of total body water (oxygen 18- dilution method). Habitual physical activity was assessed by calculating the ratio of total energy expenditure to predicted basal metabolic rate. Dietary intake and body composition were analyzed to evaluate whether diet composition was related to body fat. The results showed that the average energy intake was 4759KJ/d for the total sample. Mean values for diet composition indicated that carbohydrate provided 57.4% of energy, fat provided 30.5% and protein provided 12.1% of energy. It was found that there were no significant correlations between percentage body fat and dietary intake or percentage of energy from carbohydrate, fat or protein 9dietary intake). The study concluded that physical activity level may have a greater influence on body composition in early childhood.

**Brien GO and Davies M** (2006)[41] conducted a study to investigate the relationship between nutritional knowledge and body mass index. The study was conducted on first 500 patients (261 females and 239 males) listed in alphabetical order aged between 18 and 65 years on the database of a general practice in Belfast, Northern Ireland. Levels of nutritional knowledge were assessed using the general nutritional questionnaire which is a self-reported measure. Demographic questions concerned age and gender. Participants were asked to report their weight and height in order to calculate their BMI. The results showed that 145 people returned completed questionnaires. The sample comprised 91 females (63%) and 54 males (37%). The

mean age of responders was 43.8 years. The World Health Organisation obesity classification system was used to categorize participants according to their BMI: underweight (2.8%), normal (43.4%), overweight (31%), obese class I (22.1%) and obese class II (0.7%). There was no significant correlation between levels of nutrition knowledge and BMI; however, a high level of nutrition knowledge was found among the sample. The study stated that a knowledge deficit may not be the most significant factor preventing overweight individuals from adopting a healthier diet and questions the utility of purely educational approaches to dietary behaviour change.

**LaRowe TL, Moeller SM and Adams AK** (2007)[42] conducted a study to evaluate diet quality and body mass index (BMI) by beverage patterns in children aged 2 to 11 years. The sample consisted of 541 children aged 2 to 5 years and 793 children aged 6 to 11 years. Beverage patterns were formed using 24-hour dietary recall diet variables from the 2001-2002 National Health and Nutrition Examination Survey. Beverages were aggregated into eight beverage groups: high-fat milk, reduced-fat milk, fruit juices, soda, diet soda, sweetened beverages, coffee and tea, and water. Anthropometric data were collected at the medical portions of the mobile examination centre. Height and weight were used to calculate BMI and BMI percentiles for age and sex according to Centers for Disease Control and Prevention growth reference charts Cluster analysis was used to identify beverage patterns in preschool and school-aged children. The results showed that four and five beverage clusters were identified for children aged 2 to 5 and 6 to 11 years, respectively. Among children aged 2 to 5 years, they were labelled as mix/ light drinker, high-fat milk, water, and fruit juices. Similar beverage patterns were also observed for children aged 6 to 11 years and were labelled the five beverage patterns as mix/light drinker,

high-fat milk, water, sweetened drinks, and soda. The average percentage of total energy from beverages differed significantly across beverage clusters. Children aged 2 to 5 and 6 to 11 years in the high-fat milk pattern had significantly higher total percentage of energy intakes from beverages (35.2% of energy and 25.7% of energy, respectively) compared to other beverage clusters. 29% of energy came from beverages in the fruit juice cluster for preschool children and 24.3% and 22.8% of total daily energy intake came from beverages in the sweetened drinks and soda clusters, respectively, for school-aged children. BMI was not significantly different across beverage patterns for children aged 2 to 5 years. For children aged 6 to 11 years, BMI was significantly higher in the water, sweetened drinks, and soda patterns compared to the mix/light drinker and high-fat milk patterns The study concluded that beverage patterns were related to diet quality among preschool and school-aged children, but were only related to BMI in school-aged children. It was recommended that children from all clusters could benefit by decreasing their intake of soda and other calorically sweetened beverages that may displace important micronutrient-dense foods needed for growth and development.

**Heuberger R and Boyle IO** (2009)[43] conducted a non-experimental, cross sectional study to examine the risks of beverage consumption choices and the intake of beverages. a convenience sample of 706 community participants aged 17 to 72 years living in rural Michigan were included in the study. Standard health and lifestyle questionnaires adapted from the Chronic Illness Resources Survey (CIRS), Harvard Food Frequency Questionnaire, Michigan alcohol screening test and alcohol use disorders identification test and 24 hour food recall for food, alcohol and beverage were used in this study. The participant's body mass index was calculated by the

interviewers using self-reported height and weight. Nutrient composition for classes of beverages was determined using the Nutrition Pro Software System. The results showed that the mean age of the participants was 23.67 years and 49.7% were females and 50.1% were males. 86% of the sample consumed carbonated beverages. 99% were alcohol drinkers. For all the participants' coffee, tea and hot chocolate consumption showed an inverse relationship with body mass index but statistical significance was not achieved. The level of alcohol intake was found to be significantly associated with increase in BMI. Older persons drank fewer carbonated beverages and consumed significantly more caffeinated beverages. The results of this study provides an opportunity for discussion for health education professionals in all disciplines to work together to impact the overall health outcome of the communities.

**Collison KS et al** (2010)[44] conducted a study to examine the dietary patterns that may affect anthropological factors. The cross sectional study was conducted in Saudi Arabia among 9433 (5033 boys and 4400 girls) children aged 10 to 19 years. Anthropometric measurements like height, weight and waist circumference were measured and Body Mass Index was calculated for all the participants. A 7- day food frequency questionnaire translated in Arabic and including coloured pictures of the food items was used in the study. The frequency of physical activity was monitored by asking the students to report the number of occasions per week they took part in exercise consisting of 30 or more minutes. The results showed that the overall prevalence of overweight children was 15.5%, obese children was 21.1%. 55% of the children in the study population were in normal range and 16.8% were in underweight category. The mean waist circumference significantly increased with age with boys having larger waist circumference. Sugar- sweetened carbonated beverage consumption

varied from 5.93 to 9. 04 servings a week and was found to be significantly higher than consumption of non- caloric sweetened diet carbonated beverage, which varied between 0.92 and 1.52 servings per week. Older children reported eating significantly less fruits and vegetables, less egg, fish and cereals than younger children. The number of children reporting less than 6 hours of night time sleep increased with advancing age and frequency of exercise decreased with increasing age. Waist circumference and BMI were positively correlated with sugar- sweetened carbonated beverage consumption in boys, but not in girls. The study concluded that a high intake of sugar- sweetened carbonated beverage is associated with poor dietary choices and it correlates with waist circumference and BMI in boys.

# MATERIALS AND METHODS

This cross sectional study was conducted to evaluate the relationship between body mass index, dental caries and dietary pattern among a group of 600 healthy school going children in Chennai between 6 to 12 years of age of both the genders.

**Inclusion Criteria**

1. Healthy school going children between 6-12 years of age.
2. Children for whom parental consents were obtained.

**Exclusion Criteria**

1. Children above 12 years and below 6 years of age.
2. Children with long standing systemic illness.
3. Children who were on any medication within the past 2 months.
4. Children with physical or mental disability.
5. Children for whom parental consent was rejected.
6. Children who are under any active medical/ dental treatment.

**Armamentarium**

The following materials were used in the study.

- Stature meter, size 200 cm (Golechha Diagnostics, Chennai)
- Portable electronic weighing scale (EB9003L, Ishimura med supplies, Japan)

- Sterile mouth mirrors
- Sterile CPI Probes
- Sterile Tweezers
- Sterile kidney trays
- Sterile Cotton
- Disposable gloves and mouth masks
- Dettol antiseptic solution
- Pen, Pencil
- Data recording proforma (ANNEXURE-1)

**Methodology**

This study was conducted to evaluate the relationship between body mass index, dental caries and dietary pattern among a group of 600 school going children in Chennai between 6 to 12 years of age of both the genders by the department of Pedodontics and Preventive dentistry, Ragas Dental College and Hospital, Chennai. After obtaining approval of the study design from the Institutional review board, the study was conducted for a period of 7 months from January 2011 to July 2011. Permission from school authorities was obtained to conduct the study in schools. Following this, the study design was explained to the teachers and consent forms were sent to parents through the schools. (ANNEXURE-2&3) After obtaining parent's consent, children were randomly included in the study. Demographics including age were obtained from school records, anthropometric measurements were recorded using stature meter and electronic weighing machine and children were examined for their dental caries status. Dietary patterns were obtained using diet charts.

**Calculation of Body Mass Index**

Height and weight measurements were recorded for all the children who participated in the study. Weight of each child on bare foot was measured to the nearest 0.1 kg using a portable glass electronic personal weighing scale (EB9003L, Ishimura med supplies, Japan) which was calibrated before use. Each child was instructed to stand still, with mass equally distributed between feet, until the scale reading stabilized. The reading was then recorded. Height was measured to the nearest 0.1cm using a stature meter attached to the wall (size 200 cm, Golechha Diagnostics, Chennai). For the calculation of body mass index, the following formula was used.

$$\text{BMI} = \frac{\text{Weight in Kg}}{(\text{Height in m})^2}$$

The value obtained was then plotted on age and gender specific percentile curves given by the centres for disease control, 2000[45] and children were categorized into 4 groups based on their BMI percentiles as

- **UNDER WEIGHT** group children with BMI for age less than 5$^{th}$ percentile
- **NORMAL** group children with BMI for age greater than or equal to 5$^{th}$ percentile and less than 85$^{th}$ percentile
- **OVER WEIGHT** group children with BMI for age greater than or equal to 85$^{th}$ percentile and less than 95$^{th}$ percentile
- **OBESE** group children with BMI greater than or equal to 95$^{th}$ percentile. (ANNEXURE-4&5)

**Evaluation of Dentition status**

Caries status (deft and DMFT) was recorded using WHO oral health assessment form (1997).[46] Children were made to sit on the chair and examination was conducted under bright daylight by a single examiner. Sterile mouth mirrors and CPI probes were used to examine the oral cavity and to detect caries. Caries was recorded as present when a lesion in a pit and a fissure or on a smooth surface has an unmistakable cavity, undermined enamel or a detectably softened floor or wall. Recording of the data was performed by an assistant.

**Diet recording**

Food groups were divided into rice and cereal group, meat and poultry group, dairy and dairy products group, vegetable and fruit group (four basic food groups), fat and oil group and snacks for the study purpose.[47] The most commonly eaten food items and the food groups they belong to were enlisted in a sheet in their vernacular names for clear understanding at the time of recording data. After obtaining anthropometric measurements and caries status, dietary intake of children for three days including a weekend was obtained by sending the recording sheet to parents through school authorities.[48.49] Children/parents were asked to mark the appropriate food group and time of consumption in the recording sheet each time when anything is eaten. Older children (9 years and above) were asked to fill the diet recording sheet by themselves under parent's supervision, while parents were asked fill the sheet for younger children (children < 9 years of age). From the data obtained, mean intake of food groups was calculated. (ANNEXURE-6&7)

All the data obtained from anthropometric measurements, dental examination and diet records were analysed. The results were tabulated and statistical analysis was done using Chi-square test, Tukey's HSD Post Hoc test, Student t- test and Multiple linear regression method (SPSS software version 11).

**FIGURE 1: MATERIALS USED TO MEASURE HEIGHT AND WEIGHT**

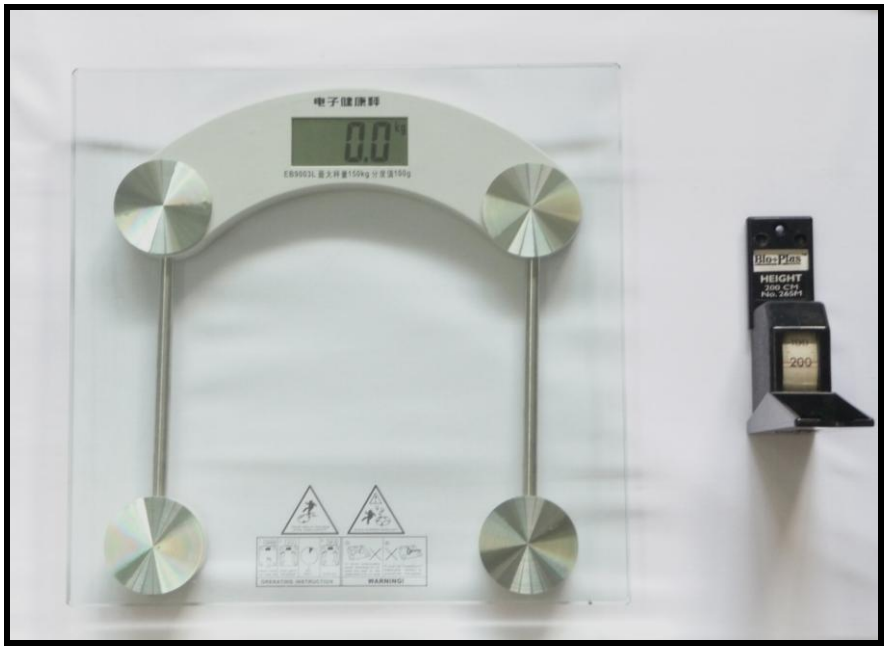



**FIGURE 2: MATERIALS USED FOR INTRA ORAL EXAMINATION**

**FIGURE 3: HEIGHT MEASUREMENT**

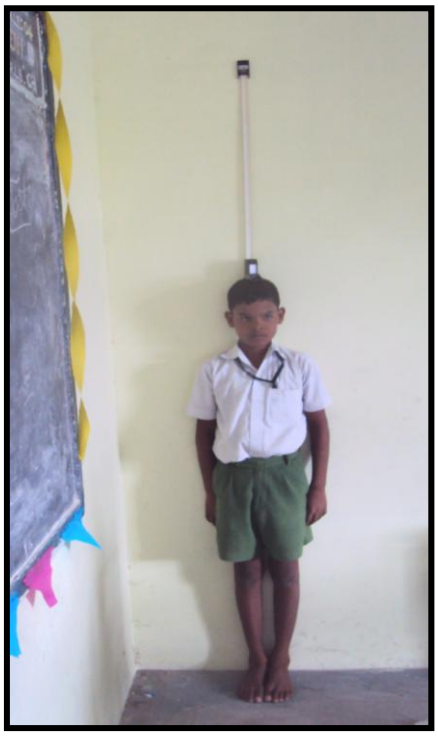


**FIGURE 4: WEIGHT MEASUREMENT**

**FIGURE 5: INTRA ORAL EXAMINATION**

# RESULTS

A total of 600 school going children in the age group of 6 to 12 years were screened and examined in this study. Among them, 90 children who did not fill the diet recording sheet properly were eliminated from the study and finally 510 children's data were subjected to statistical analysis.

**Table 1 and Graph 1** shows distribution of the study population according to their gender and body mass index for age. Of the 510 samples, 266 (52.15%) were males and 244 (47.84%) were females. A total of 113 (22.15%) samples belong to the underweight BMI-for-age. Of them, 64 (56.63%) were males and 49 (43.36%) were females. 249 (48.82%) children belong to normal BMI- for-age category and in them, 129 (51.80%) were males and 120 (48.19%) were females. 88 (17.25%) children belong to the overweight category. In this category, 45 (51.13%) were males and 43 (48.85%) were females. A total of 60 (11.76%) children belong to obese category. Of them, 28 (46.66%) were males and 32 (53.33%) were females.

There was no statistically significant difference in the distribution of males and females within each BMI group ($P>0.05$). On comparing the body mass index of both males and females belonging to various BMI categories, there was statistical difference between groups with more number of males and females belonging to the normal BMI-for-age category followed by underweight category and the least in obese category.

**Table 2 and Graph 2** shows the caries prevalence of children belonging to various BMI-for-age categories. Out of the total sample (n=510), 109 (21.40%) children were caries free and 401 (78.60%) children had caries either in primary or permanent dentition. In the underweight category, 22 (19.46%) children were free from caries and 91 (80.53%) children had caries. In the normal BMI-for-age category, out of 249 children, 56 (22.50%) children were free from caries and 193 (77.50%) children had carious teeth. In the overweight category, out of 88 children, 22 (25%) children were free from caries and 66 (75%) children had caries. In the obese category, out of 60 children, 9 (15%) children were caries free and 51 (85%) children had carious teeth.

Among the study population significant number of children were affected with caries (overall caries prevalence-78.6%) with P=0.000**. On comparing caries affected children belonging to various BMI categories, a statistically significant difference was observed between all the categories (P=0.000**) except between overweight and obese category (P= 0.166). Highest prevalence of caries was seen in to obese category children followed by underweight category, normal category and the least number of children affected by caries belonged to overweight category.

**Table 3 and Graph 3** shows gender distribution of the study population of the caries affected and caries free children belonging to various BMI-for- age categories. Among the 109 (21.40%) caries free children, 55 (50.45%) were males and 54 (49.54%) were females. Among the 401 (78.60%) caries affected children, 211 (52.61%) were males and 190 (47.38%) were females. In the underweight category, out of 113 children, 10 (8.84%) males were caries free, 54 (47.78%) males were caries affected, 12 (10.61%) females were caries free and 37 (32.74%) females were caries affected. In the normal BMI- for- age category, out

of 249 children, 30 (12.04%) males were caries free, 99 (39.75%) males were caries affected, 26 (10.44%) females were caries free and 94 (37.75%) were caries affected. Among the 88 overweight children, 11 (12.5%) males were caries free, 34 (38.63%) were caries affected, 11 (12.5%) females were caries free and 32 (36.36%) females were caries affected. Among the 60 obese children, 4 (6.66%) males were caries free, 24 (40%) males were caries affected, 5 (8.33%) females were caries free and 27 (45%) females were caries affected. There was no statistical difference between males and females in any BMI-for-age categories with respect to their caries prevalence ($P>0.05$).

**Table 4 and Graph 4** shows mean caries scores of the study population belonging to various BMI-for-age categories. The overall mean deft score was 2.06±2.473 and overall mean DMFT score was 1.025±1.129. The mean deft score and mean DMFT score for the underweight category were 1.98 ± 2.735 and 0.85± 0.966 respectively. For the children in normal BMI-for-age category, the mean deft score was 1.78 ± 2.205 and mean DMFT score was 0.90 ± 1.137. The mean deft score for overweight category was 1.94 ± 2.246 and mean DMFT score was 1.10 ± 1.077. The mean deft and DMFT scores in the obese category were 2.55± 3.191 and 1.25 ± 1.385 respectively. Caries scores in primary dentition was higher than in the permanent dentition in all the BMI-for-age categories which was statistically significant ($P<0.01$). There was no statistical significant difference in mean caries scores (both deft and DMFT) between children belonging to various BMI-for-age categories ($P>0.05$).

**Table 5 and Graph 5** shows distribution of mean caries scores of males and females belonging to different BMI-for-age categories. In the underweight group, the mean deft score for males is 2.28 ± 3.139 and for females is 1.59 ± 2.061. The mean DMFT score for males in

the underweight group is 0.89±0.945 and for females is 0.80±1.00. In the normal BMI-for-age group, the mean deft score for males is 1.57±1.911 and mean deft score for females is 2.01±2.472. The mean DMFT score for males in the normal BMI-for-age category is 0.94±1.130 and for females is 0.86±1.147. In the overweight BMI-for-age category, the mean deft scores for males and females are 1.77±1.698 and 2.11±2.719 respectively. The mean DMFT score for boys in the overweight category is 1.13±1.014 and for girls is 1.09±1.151. In the obese category, the mean deft scores for males and females are 2.46±3.727 and 2.65±2.697 respectively. The mean DMFT scores for males and females in the obese category is 1.25±1.506 and 1.25±1.295 respectively. There was no statistical significant difference in caries scores (deft and DMFT) between males and females in any BMI-for-age category ($P>0.05$).

**Table 6 and Graph 6** shows mean values of daily dietary intake of various food groups of children in various BMI-for-age categories. In the underweight BMI-for-age category, the mean score for rice and cereal group is 1.30±0.828, 0.59±0.516 for meat and poultry group, 0.73±0.503 for dairy and dairy products group, 0.77±0.535 for fat and oil group, 0.71±0.501 for vegetable and fruit group and 1.16±0.791 for snack group. In the normal BMI-for-age category, the mean score for rice group is 1.44±0.745, 0.71±0.610 for meat and poultry group, 0.93±0.579 for dairy and dairy products group, 0.82±0.669 for fat and oil group, 0.77±0.537 for vegetable and fruit group and 1.55±0.887 for snack group. In the overweight BMI-for-age category, the mean score for rice group is 1.53±0.723, 0.82±0.727 for meat and poultry group, 0.90±0.489 for dairy and dairy products group, 1.39±0.900 for fat and oil group, 0.75±0.532 for vegetable and fruit group and 1.83±0.872 for snack group. In the obese BMI-for-age category, the mean score for rice group is 1.54±0.657, 0.84±0.595 for meat and poultry group, 0.91±0.563 for dairy and dairy products group,

1.62±0.916 for fat and oil group, 0.80±0.650 for vegetable and fruit group and 2.10±1.094 for snack group.

The mean values of all the food groups increased from underweight to obese group in an ascending order except for dairy group and vegetable and fruit group. Maximum consumption of dairy products was observed in normal BMI-for-age category children followed by obese, overweight and underweight category in a descending order. Likewise, maximum consumption of vegetables and fruits was observed in obese category followed by normal, overweight and underweight category in a descending order.

**Table 6a** shows the comparison of mean daily dietary intake between various BMI-for age categories. A statistical significant difference in the consumption of meat and poultry food items was observed between underweight and overweight category with overweight children taking more of meat and poultry items (P=0.05*) and between underweight and obese categories (P=0.05*) with obese group taking more of meat and meat products. On comparing dairy consumption between underweight and normal BMI categories, a statistical significant difference was found (P=0.009**) with more of dairy product consumed by normal BMI-for-age category children. Comparison of daily intake of fatty foods and oily items showed statistically significant difference between all BMI-for-age categories (P<0.05) except between underweight and normal BMI-for-age categories (P=0.936) and between overweight and obese categories (P=0.210). Fat and oil consumption was more in obese group followed by overweight, normal and underweight in a descending order. Likewise, statistical significant difference in the daily consumption of snack items was found between all the BMI-for-age categories (P<0.05) except between overweight and obese categories (P=0.279). Daily consumption of snacks was more in obese group followed by overweight,

normal and underweight in a descending order. There was not statistically significant difference in the daily intake of other food groups between various BMI-for-age categories (P>0.05).

**Table 7 and Graph 7** shows the mean dietary intake of various food groups and mean caries scores among various BMI-for-age categories. In underweight category, the mean score for rice and cereal group was 1.30±0.828, 0.59±0.516 for meat and poultry group, 0.73±0.503 for dairy group, 0.77±0.535 for fat and oil group, 0.71±0.501 for vegetables and fruits, 1.16±0.791 for snack items. The mean deft and DMFT scores for underweight category are 1.98± 2.735 and 0.85± 0.966 respectively. In the normal BMI-for-age category, the mean score for rice group is 1.44±0.745, 0.71±0.745 for meat and poultry group, 0.93±0.579 for dairy and dairy products group, 0.82±0.669 for fat and oil group, 0.77±0.537 for vegetable and fruit group and 1.55±0.887 for snack group. The mean deft and DMFT scores for normal BMI-for-age category are 1.78± 2.205 and 0.90± 1.137 respectively. In the overweight BMI-for-age category, the mean score for rice group is 1.53±0.723, 0.82±0.727 for meat and poultry group, 0.90±0.489 for dairy and dairy products group, 1.39±0.900 for fat and oil group, 0.75±0.532 for vegetable and fruit group and 1.83±0.872 for snack group. The mean deft and DMFT scores for overweight category are 1.94± 2.246 and 1.10± 1.077 respectively. In the obese BMI-for-age category, the mean score for rice group is 1.54±0.657, 0.84±0.595 for meat and poultry group, 0.91±0.563 for dairy and dairy products group, 1.62±0.916 for fat and oil group, 0.80±0.650 for vegetable and fruit group and 2.10±1.094 for snack group. The mean deft and DMFT scores for obese category are 2.55± 3.191 and 1.25± 1.385 respectively.

**Table 7a** shows the relationship between caries and BMI-for-age and dietary intake. When compared to children in normal BMI-for-age, caries showed no statistically significant relation to underweight, overweight or obese categories (P>0.05). A significant relation was observed between caries and consumption of snack items (P=0.006**). No significant relation was found between caries and any other food groups (P>0.05)

**Table 1: Distribution of study population according to BMI-for-age**

| Category | Male n (%) | | Female n (%) | | Total n (%) | | Male vs. Female ( P value) |
|---|---|---|---|---|---|---|---|
| Underweight | 64 | (56.63%) | 49 | (43.36%) | 113 | (100%) | 0.158 |
| | (24.06%) | | (20.08%) | | (22.15%) | | |
| Normal | 129 | (51.80%) | 120 | (48.19%) | 249 | (100%) | 0.568 |
| | (48.49%) | | (49.18%) | | (48.82%) | | |
| Over weight | 45 | (51.13%) | 43 | (48.85%) | 88 | (100%) | 0.831 |
| | (16.91%) | | (17.62%) | | (17.25%) | | |
| Obese | 28 | (46.66%) | 32 | (53.33%) | 60 | (100%) | 0.606 |
| | (10.52%) | | (13.11%) | | (11.76%) | | |
| Total | 266 | (52.15%) | 244 | (47.84%) | 510 | (100%) | 0.641 |
| | (100%) | | (100%) | | (100%) | | |

| | **P values** | |
|---|---|---|
| | **Male** | **Female** |
| Underweight vs. Normal | 0.000** | 0.000** |
| Underweight vs. Overweight | 0.069 | 0.532 |
| Underweight vs. Obese | 0.000** | 0.059 |
| Normal vs. Overweight | 0.000** | 0.000** |
| Normal vs. Obese | 0.000** | 0.000** |
| Overweight vs. Obese | 0.047 | 0.204 |

- Among the various BMI-for-age categories, more children belong to normal BMI-for-age category followed by underweight category and the least in obese category which is statistically significant (P=0.000**)

Level of Significance*: $P \leq 0.05$
Not Significant: $P > 0.05$
Highly Significant** : $P \leq 0.01$

**Table 2: Caries prevalence of study population according to BMI-for-age**

| Category | Children without caries n (%) | Children with caries n (%) | Total n (%) | Children without caries vs. children with caries (P value) |
|---|---|---|---|---|
| Underweight | 22 (19.46%) | 91(80.53%) | 113 | 0.000** |
| Normal | 56 (22.50%) | 193 (77.50%) | 249 | 0.000** |
| Overweight | 22 (25%) | 66 (75%) | 88 | 0.000** |
| Obese | 9 (15%) | 51 (85%) | 60 | 0.000** |
| Total | 109 (21.40%) | 401 (78.60%) | 510 | 0.000** |

**P values**

| | **Children without caries** | **Children with caries** |
|---|---|---|
| Underweight vs. Normal | 0.000** | 0.000** |
| Underweight vs. Overweight | 1.000 | 0.046* |
| Underweight vs. Obese | 0.020* | 0.001** |
| Normal vs. Overweight | 0.000** | 0.000** |
| Normal vs. Obese | 0.000** | 0.000** |
| Overweight vs. Obese | 0.020* | 0.166 |

- Significant number of study population were affected with caries (78.6%) P=0.000**
- Maximum number of caries affected children belongs to obese group followed by underweight, normal and least in overweight category.

Level of Significance*: $P \leq 0.05$
Not Significant: $P > 0.05$
Highly Significant** : $P \leq 0.01$

**Table 3: Caries prevalence of males and females according to BMI-for-age**

| Category | Caries free children | | P value | Children with caries | | P value |
|---|---|---|---|---|---|---|
| | Male n (%) | Female n (%) | | Male n (%) | Female n (%) | |
| Underweight | 10 (8.84%) | 12 (10.61%) | 0.670 | 54 (47.78%) | 37 (32.74%) | 0.075 |
| Normal | 30 (12.04%) | 26 (10.44%) | 0.593 | 99 (39.75%) | 94 (37.75%) | 0.719 |
| Over weight | 11 (12.5%) | 11 (12.5%) | 1.000 | 34 (38.63%) | 32 (36.36%) | 0.806 |
| Obese | 4 (6.66%) | 5 (8.33%) | 0.739 | 24 (40%) | 27 (45%) | 0.674 |

- No difference in caries prevalence was seen among males and females belonging to various BMI-for-age categories (P>0.05).

Level of Significance*: $P \leq 0.05$
Not Significant: $P > 0.05$
Highly Significant** : $P \leq 0.01$

**Table 4: Mean caries score and Standard Deviation of children according to BMI-for-age**

| Category | deft | DMFT | P value |
|---|---|---|---|
| Underweight | 1.98 ± 2.735 | 0.85 ± 0.966 | 0.000** |
| Normal | 1.78 ± 2.205 | 0.90 ± 1.137 | 0.000** |
| Overweight | 1.94 ± 2.246 | 1.10 ± 1.077 | 0.002** |
| Obese | 2.55 ± 3.191 | 1.25 ± 1.385 | 0.005** |
| Total | 2.06±2.473 | 1.025±1.129 | 0.000** |

| | **P values** | |
|---|---|---|
| | **deft** | **DMFT** |
| Underweight vs. Normal | 0.893 | 0.979 |
| Underweight vs. Overweight | 1.000 | 0.350 |
| Underweight vs. Obese | 0.475 | 0.116 |
| Normal vs. Overweight | 0.954 | 0.417 |
| Normal vs. Obese | 0.136 | 0.134 |
| Overweight vs. Obese | 0.458 | 0.887 |

- Mean scores of deft Vs. DMFT were highly significant among children belonging to all the BMI-for-age categories (P<0.01).
- Mean scores of both deft and DMFT were not significant between children belonging to various BMI-for-age categories (P>0.05).

Level of Significance*: $P \leq 0.05$
Not Significant: $P > 0.05$
Highly Significant** : $P \leq 0.01$

**Table 5: Distribution of mean caries scores of males and females according BMI-for-age**

| Category | Deft | | P value | DMFT | | P value |
|---|---|---|---|---|---|---|
| | Male | Female | | Male | Female | |
| Underweight | 2.28±3.139 | 1.59±2.061 | 0.562 | 0.89±0.945 | 0.80±1.00 | 0.476 |
| Normal | 1.57±±1.911 | 2.01±2.472 | 0.125 | 0.94±1.130 | 0.86±1.147 | 0.470 |
| Over weight | 1.77±1.698 | 2.11±2.719 | 0.844 | 1.13±1.014 | 1.09±1.151 | 0.707 |
| Obese | 2.46±3.727 | 2.65±2.697 | 0.203 | 1.25±1.506 | 1.25±1.295 | 0.809 |

- Both deft and DMFT scores between males and females among various BMI-for-age categories was not statistically significant (P>0.05).

Level of Significance*: $P \leq 0.05$
Not Significant: $P > 0.05$
Highly Significant** : $P \leq 0.01$

**Table 6: Mean daily dietary intake according to BMI-for-age categories**

| Category | Rice and cereal group | Meat and poultry group | Dairy group | Fat and oil group | Veg and fruit group | Snacks and confectionaries |
|---|---|---|---|---|---|---|
| Underweight (n= 113) | 1.30±0.828 | 0.59±0.516 | 0.73±0.503 | 0.77±0.535 | 0.71±0.501 | 1.16±0.791 |
| Normal (n= 249) | 1.44±0.745 | 0.71±0.610 | 0.93±0.579 | 0.82±0.669 | 0.77±0.537 | 1.55±0.887 |
| Overweight (n= 88) | 1.53±0.723 | 0.82±0.727 | 0.90±0.489 | 1.39±0.900 | 0.75±0.532 | 1.83±0.872 |
| Obese (n= 60) | 1.54±0.657 | 0.84±0.595 | 0.91±0.563 | 1.62±0.916 | 0.80±0.650 | 2.10±1.094 |

- Mean scores of daily intake of rice and cereal group, meat and poultry group, fat and oil group and snacks increased from underweight category to obese category.

- Mean scores of snacks were more than other food groups in all the BMI-for-age categories except in the underweight category.

**Table 6a: Comparison of mean daily dietary intake between BMI-for-age categories**

| Comparison | Rice and cereal group (P value) | Meat and poultry group (P value) | Dairy group (P value) | Fat and oil group (P value) | Veg and fruit group (P value) | Snacks and confectionaries (P value) |
|---|---|---|---|---|---|---|
| Underweight vs. Normal | 0.380 | 0.315 | 0.009** | 0.936 | 0.779 | 0.001** |
| Underweight vs. Overweight | 0.130 | 0.05* | 0.140 | 0.000** | 0.944 | 0.000** |
| Underweight vs. Obese | 0.185 | 0.05* | 0.176 | 0.000** | 0.738 | 0.000** |
| Normal vs. Overweight | 0.728 | 0.509 | 0.974 | 0.000** | 0.996 | 0.05* |
| Normal vs. Obese | 0.764 | 0.454 | 0.996 | 0.000** | 0.980 | 0.000** |
| Overweight vs. Obese | 1.000 | 0.995 | 0.999 | 0.210 | 0.959 | 0.279 |

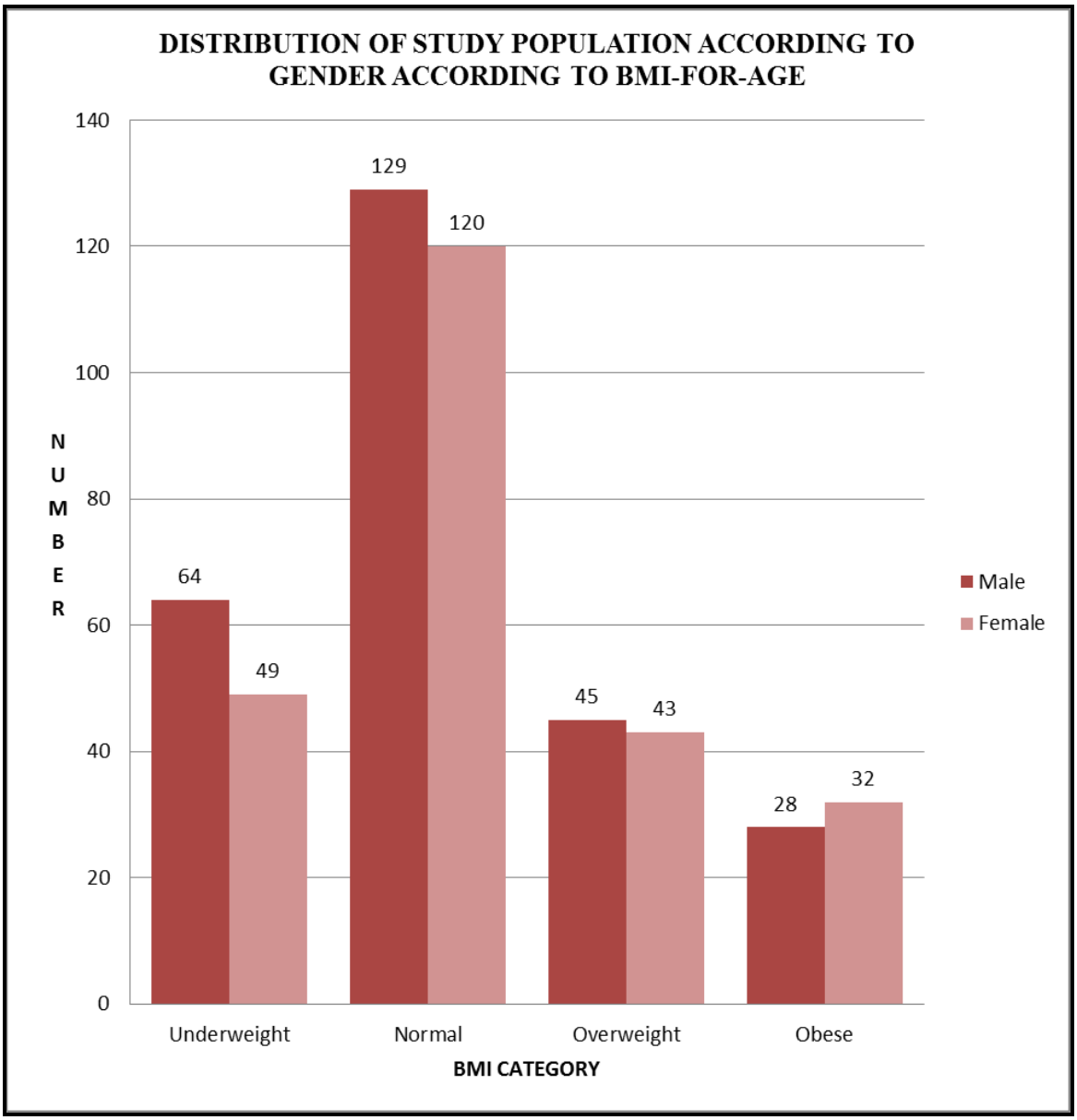
**Table 7: Mean dietary intake and caries scores among various BMI-for-age categories**

| Category | Rice and cereal group | Meat and poultry group | Dairy group | Fat and oil group | Veg and fruit group | Snacks and confectionaries | deft | DMFT |
|---|---|---|---|---|---|---|---|---|
| Underweight (n= 113) | 1.30±0.828 | 0.59±0.516 | 0.73±0.503 | 0.77±0.535 | 0.71±0.501 | 1.16±0.791 | 1.98±2.735 | 0.85±0.966 |
| Normal (n= 249) | 1.44±0.745 | 0.71±0.610 | 0.93±0.579 | 0.82±0.669 | 0.77±0.537 | 1.55±0.887 | 1.78±2.205 | 0.90±1.137 |
| Overweight (n= 88) | 1.53±0.723 | 0.82±0.727 | 0.90±0.489 | 1.39±0.900 | 0.75±0.532 | 1.83±0.872 | 1.94±2.246 | 1.10±1.077 |
| Obese (n= 60) | 1.54±0.657 | 0.84±0.595 | 0.91±0.563 | 1.62±0.916 | 0.80±0.650 | 2.10±1.094 | 2.55±3.191 | 1.25±1.385 |

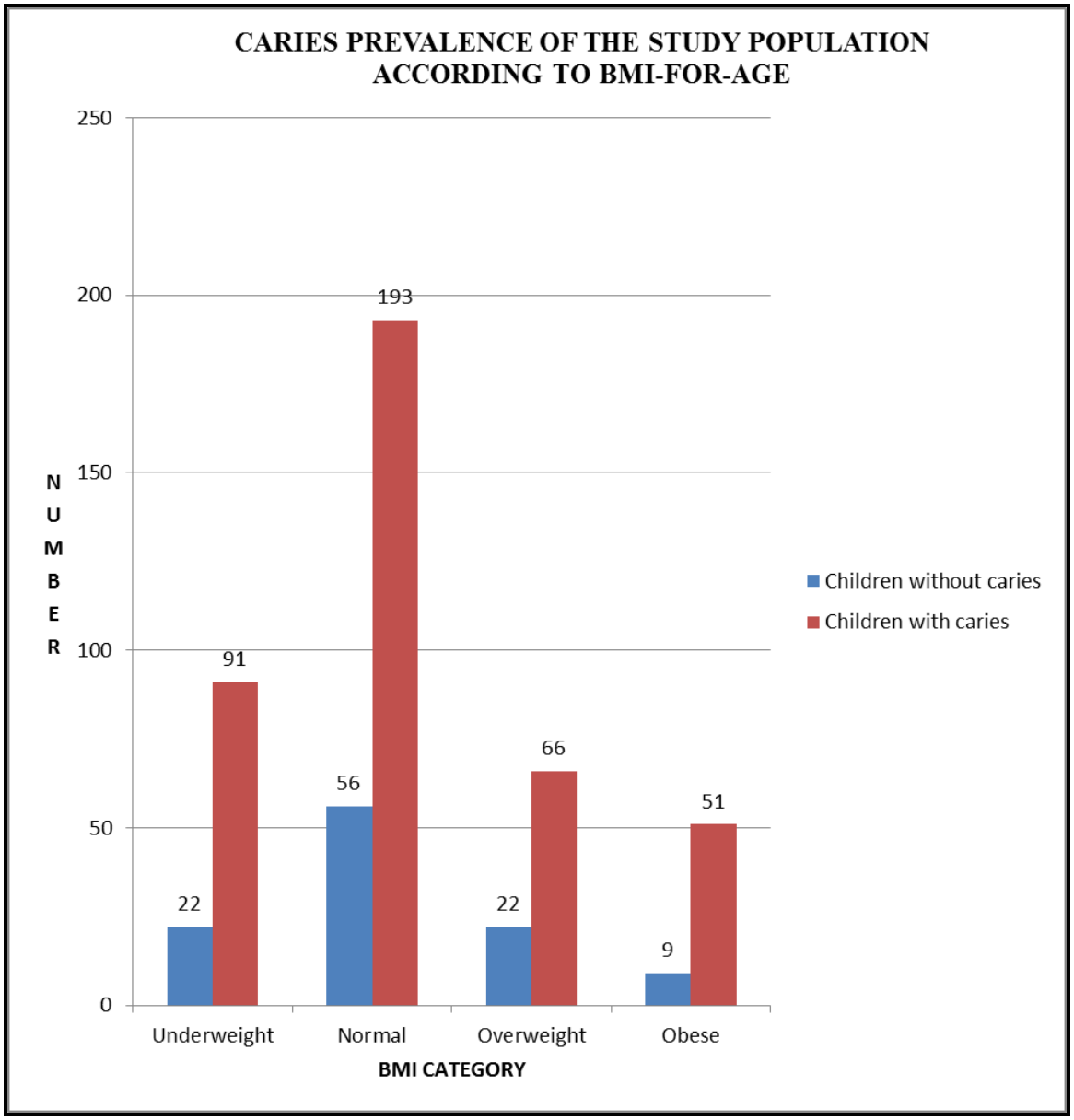
**Table 7a: Relationship of caries with BMI-for-age and dietary intake**

| Independents | Unstandardized coefficient | | Standardized coefficient | P value |
|---|---|---|---|---|
| | B co- efficient | Standard Error | β | |
| Normal | Referent | | | |
| Underweight | 0.238 | 0.304 | 0.74 | 0.436 |
| Overweight | -0.116 | 0.159 | -0.079 | 0.465 |
| Obese | -0.064 | 0.136 | -0.062 | 0.638 |
| Rice and cereal group | 0.183 | 0.163 | 0.051 | 0.262 |
| Meat and poultry group | -0.120 | 0.202 | -0.027 | 0.553 |
| Dairy group | -0.276 | 0.222 | -0.056 | 0.214 |
| Fat group | 0.006 | 0.167 | 0.002 | 0.972 |
| Vegetable and fruit group | 0.061 | 0.222 | 0.012 | 0.783 |
| Snacks and confectionaries | 0.386 | 0.141 | 0.132 | 0.006** |

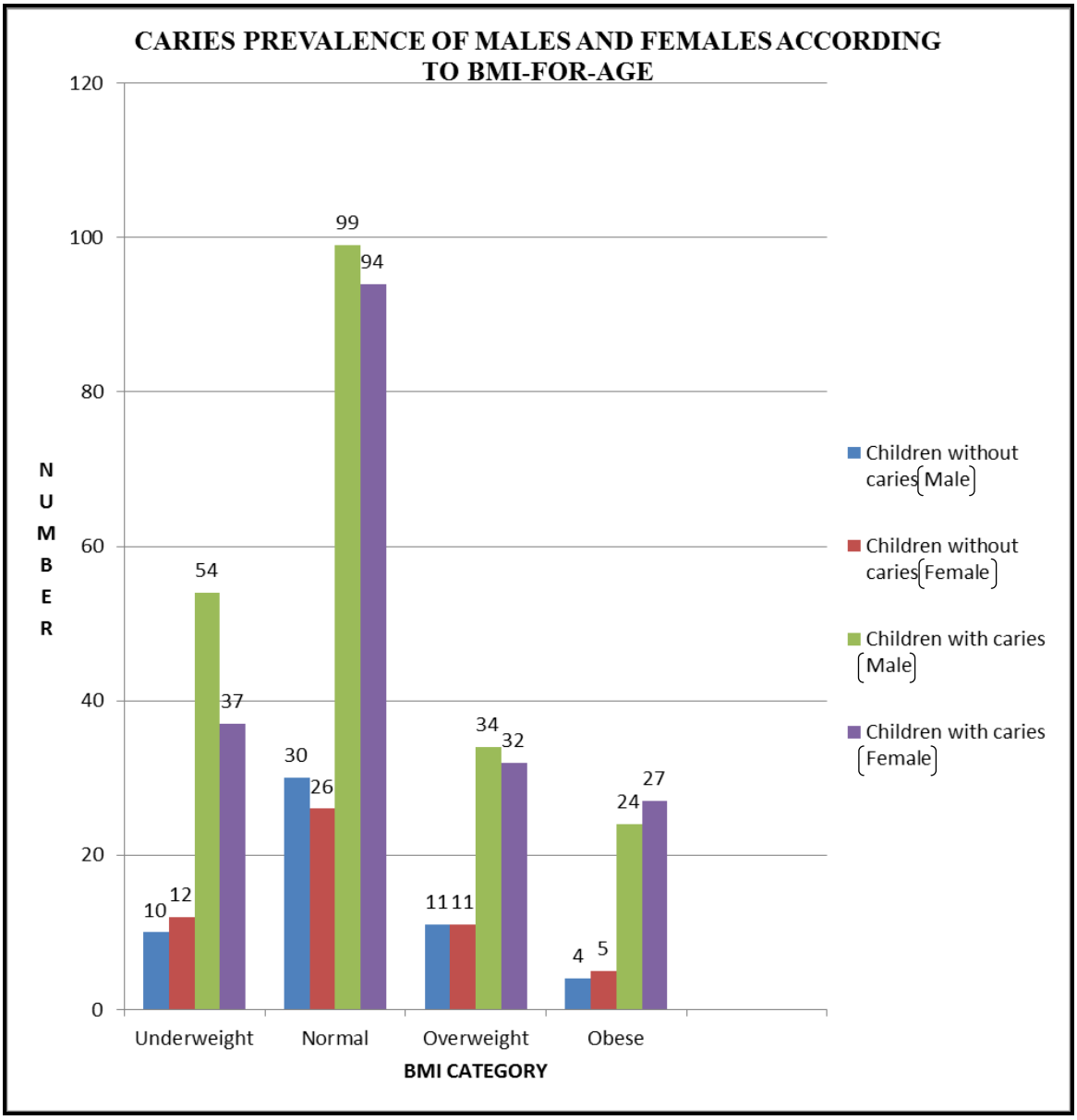
## GRAPH-1


DISTRIBUTION OF STUDY POPULATION ACCORDING TO GENDER ACCORDING TO BMI-FOR-AGE
NUMBER
140
120
100
80
60
40
20
0
64
49
129
120
45
43
28
32
Underweight
Normal
Overweight
Obese
BMI CATEGORY
Male
Female

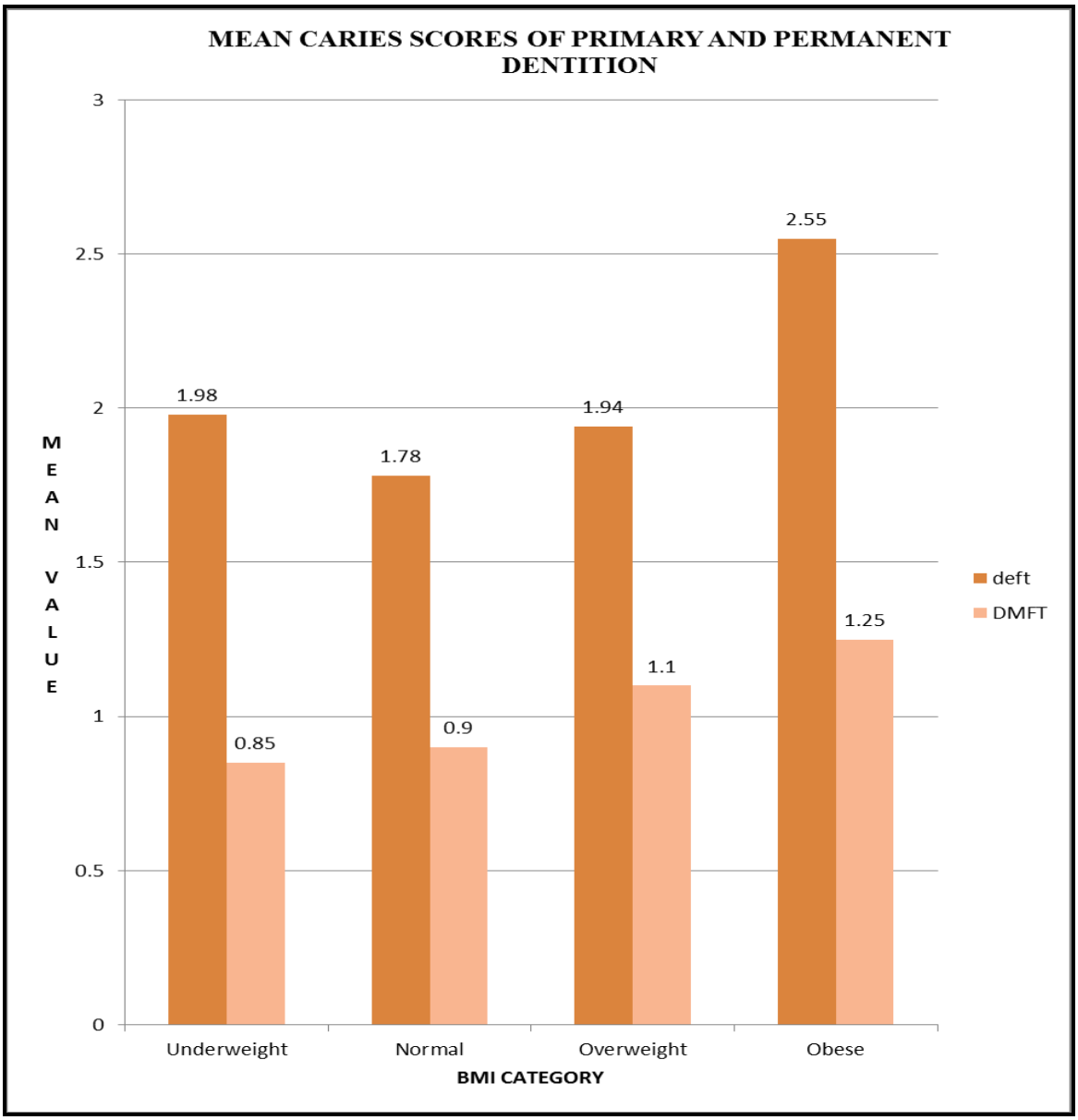
# GRAPH-2


CARIES PREVALENCE OF THE STUDY POPULATION ACCORDING TO BMI-FOR-AGE
250
200
150
100
50
0
NUMBER
193
91
66
56
51
22
22
9
Underweight
Normal
Overweight
Obese
BMI CATEGORY
Children without caries
Children with caries

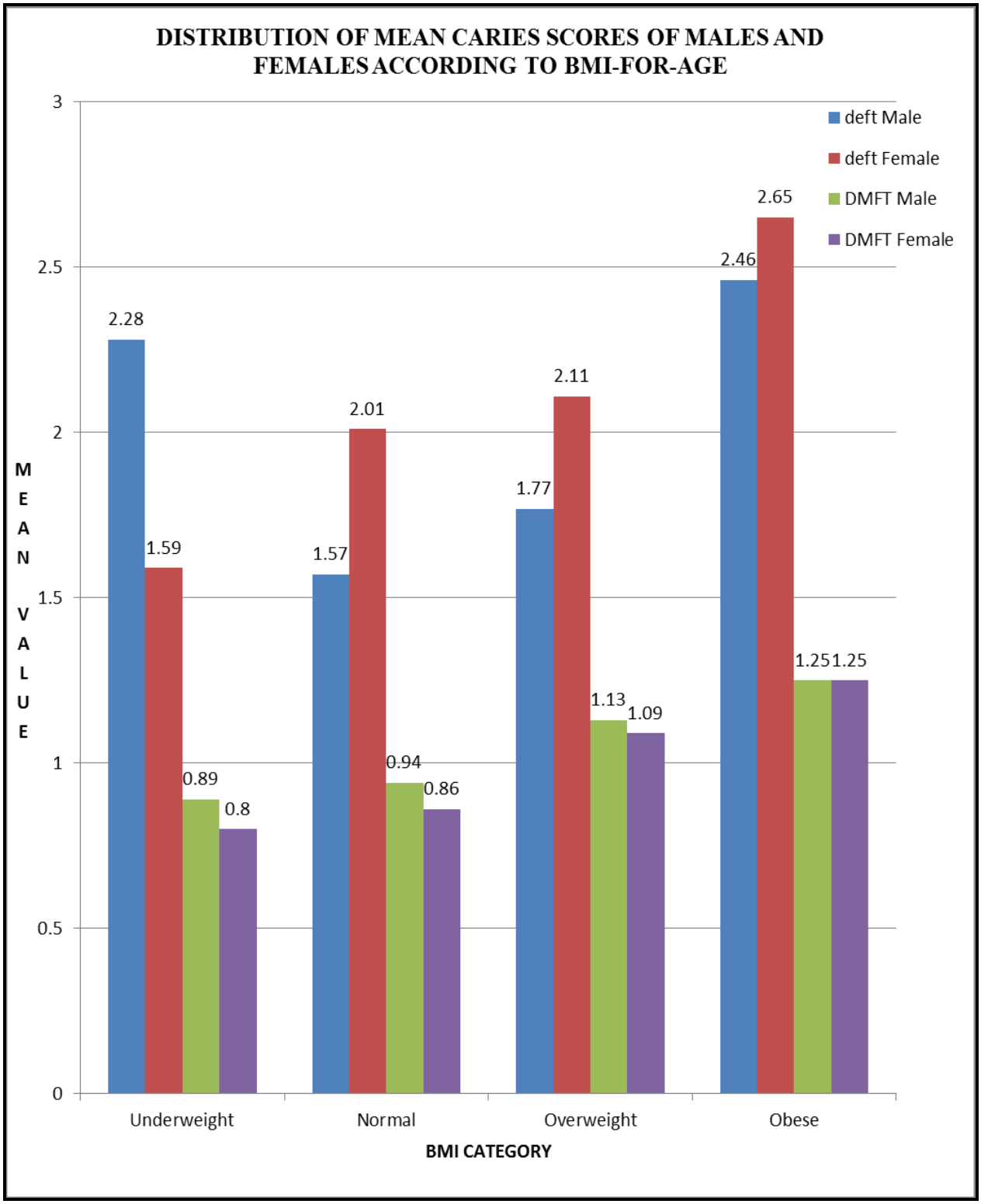
# GRAPH-3


CARIES PREVALENCE OF MALES AND FEMALES ACCORDING TO BMI-FOR-AGE
120
100
80
60
40
20
0
NUMBER
10
12
54
37
30
26
99
94
11
11
34
32
4
5
24
27
Underweight
Normal
Overweight
Obese
BMI CATEGORY
Children without caries (Male)
Children without caries (Female)
Children with caries (Male)
Children with caries (Female)

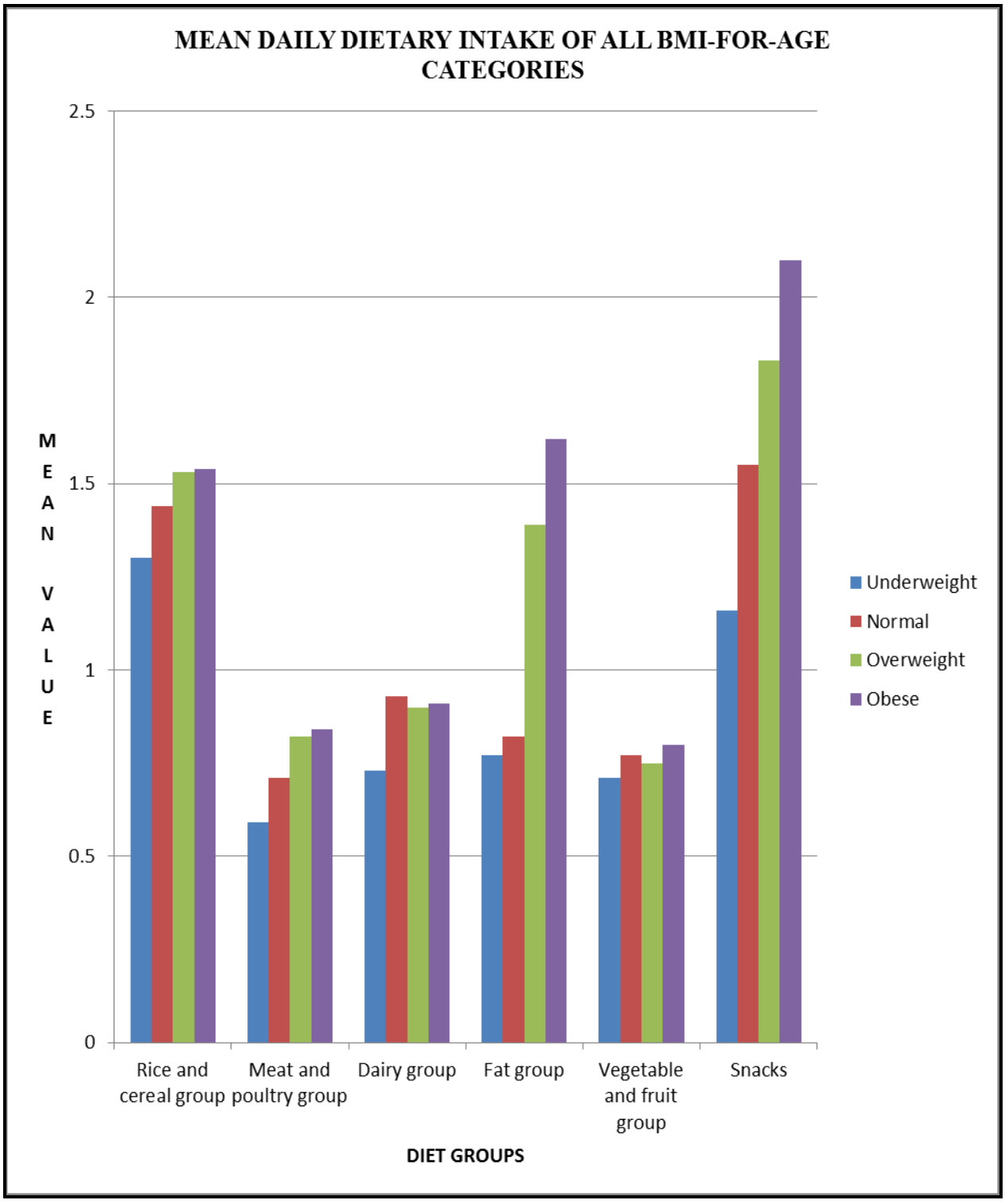
# GRAPH-4


MEAN CARIES SCORES OF PRIMARY AND PERMANENT DENTITION
MEAN VALUE
3
2.5
2
1.5
1
0.5
0
1.98
0.85
1.78
0.9
1.94
1.1
2.55
1.25
Underweight
Normal
Overweight
Obese
BMI CATEGORY
deft
DMFT

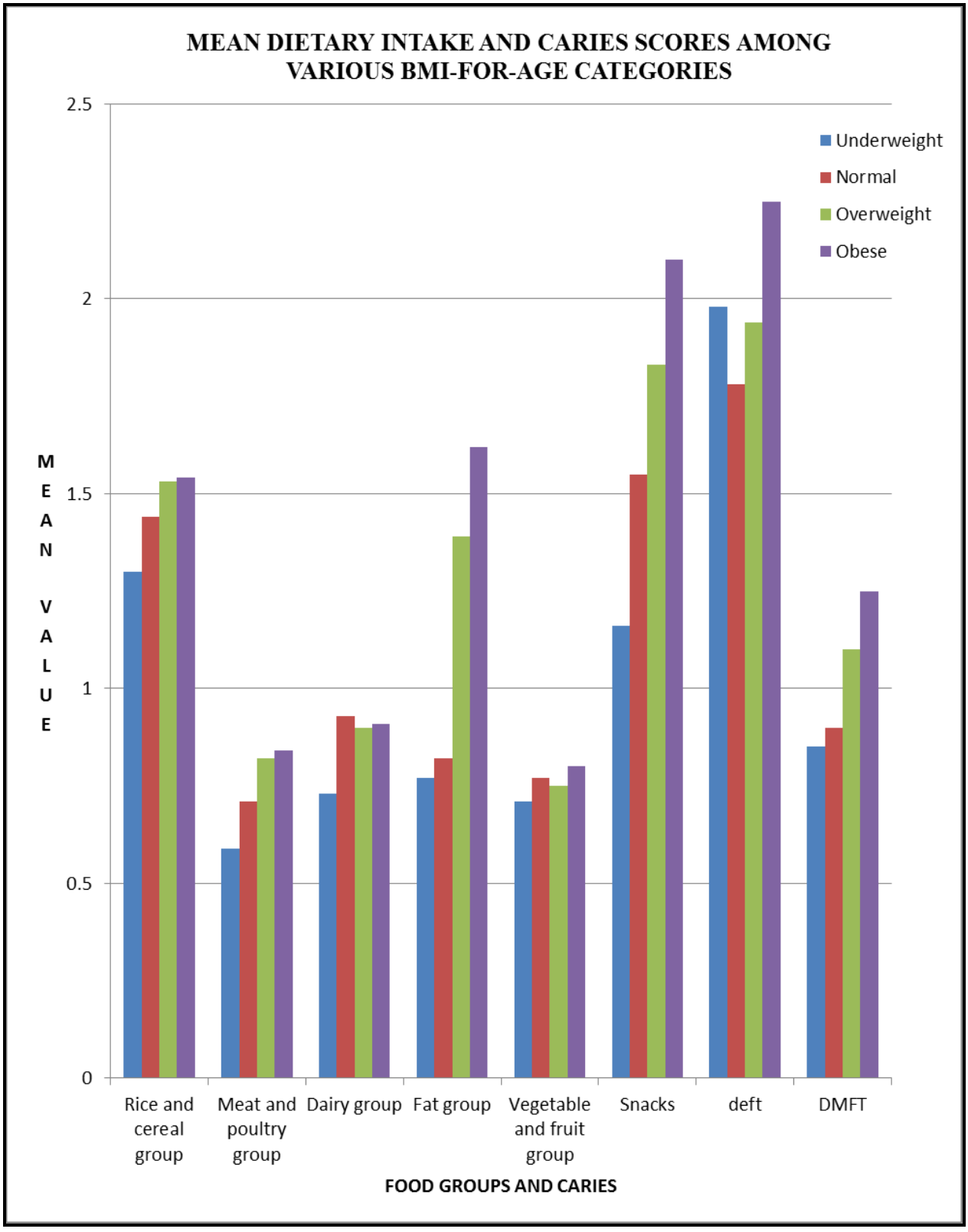
## GRAPH-5


DISTRIBUTION OF MEAN CARIES SCORES OF MALES AND FEMALES ACCORDING TO BMI-FOR-AGE
deft Male
deft Female
DMFT Male
DMFT Female
MEAN VALUE
3
2.5
2
1.5
1
0.5
0
2.28
1.59
0.89
0.8
1.57
2.01
0.94
0.86
1.77
2.11
1.13
1.09
2.46
2.65
1.25
1.25
Underweight
Normal
Overweight
Obese
BMI CATEGORY

# GRAPH-6


MEAN DAILY DIETARY INTAKE OF ALL BMI-FOR-AGE CATEGORIES
2.5
2
1.5
1
0.5
0
MEAN VALUE
Rice and cereal group
Meat and poultry group
Dairy group
Fat group
Vegetable and fruit group
Snacks
DIET GROUPS
Underweight
Normal
Overweight
Obese

## GRAPH-7


MEAN DIETARY INTAKE AND CARIES SCORES AMONG VARIOUS BMI-FOR-AGE CATEGORIES
2.5
2
1.5
1
0.5
0
MEAN VALUE
Underweight
Normal
Overweight
Obese
Rice and cereal group
Meat and poultry group
Dairy group
Fat group
Vegetable and fruit group
Snacks
deft
DMFT
FOOD GROUPS AND CARIES

# DISCUSSION

Childhood overweight and obesity are global problems that are on the rise due to modernization and change in life style.[50] Despite many alarming findings, health professionals in both medicine and dentistry have been slow to implement clinical protocols to aid in the diagnosis and treatment of childhood overweight/obesity.[51- 53] This may be due in part to the sensitive nature of the weight-related matters, but it has been shown that health professionals also may lack self-efficacy, knowledge and information needed to properly diagnose and address the problem.[54] As the obesity epidemic escalates, it is apparent that screening solely during well child visits may no longer be a viable strategy for addressing the issue[55] and dentists can play a role in handling this problem as children can visit the dentists at the earliest age of 1 year or below and they also can help by providing diet counselling and anticipatory guidance to the parents. Even though the role of dentists is small compared to the physicians, this small success, however, make a significant difference on a population level.[56]

Children's dietary habits are significant contributors to childhood obesity[30,33] and dietary imbalance causes dental caries which is well established in the literature.[57,58] As both dental caries and obesity share some common risk factors like dietary, biological, genetic, socioeconomic, cultural, environmental and lifestyle issues,[23] the current study was done to explore if there is any relationship between body mass index, dental caries and diet in a group of healthy school going children between 6 – 12 years of age in Chennai city.

Ethical committee approval was obtained from the Institutional review board. Children from 1st to 5th standards were randomly included in the study. Demographics like name, age, gender were recorded. Anthropometric measurements like height and weight were measured and recorded. Obesity and malnutrition represent opposite extremities on the spectrum of adiposity and both are routinely quantified in terms of weight and height relative to the child's age. The most convenient and commonly used tool to screen for overweight/obesity is the BMI ($Kg/m^2$), a measure of body weight adjusted for height. Due to differential changes in height and weight during growth and development, BMI percentiles specific for age and sex are used to describe childhood weight status. The Centers for Disease Control and Prevention (CDC) have published standardized BMI charts to determine BMI percentiles for children.[45] Any weight category other than "healthy weight" (5th to 84th percentile) as well as a rapidly rising BMI growth trajectory may be a cause for concern and discussion among the providers, parents and patient.

In the present study, intra oral examination was based on WHO oral health assessment for caries detection (1997) using community periodontal index (CPI) probe and mouth mirror.[46] Caries was recorded following deft and DMFT criteria for primary and permanent dentition respectively.

Dietary intake of children was obtained for three days including a weekend through a self-reported diet record.[48] Children above 9 years filled the diet recording sheet by themselves under parental supervision. For younger children, parents filled the diet recording sheet. After eliminating improperly filled diet recordings, 510 children's data were subjected to statistical analysis using SPSS software.

Among the 510 children, 266 (52.15%) were males and 244 (47.84%) were females and more children (48.82%) belonged to the normal BMI-for-age category followed by underweight category (22.15%), overweight (17.25%) and obese categories (11.76%) in descending order (Table-1). There was no statistically significant association between BMI-for-age and gender in our study which is similar to the findings of **Mostafa Sadeghi**, **Ramachandran A et al**.[26,59] Further, the prevalence of overweight in the present study (17.25%) is in accordance to the findings of **Ramachandran A et al** (16.8%) and more than the findings of **Kumar S et al** (5.74%) and **Kotian MS et al** (9.9%).[59,60,61] It is worth mentioning that the calculated global prevalence of overweight (including obesity) in children aged 5-17 years is estimated by the WHO, IOTF to be approximately 10%, but this is "unequally distributed".[62]

In the present study overall caries prevalence is 78.6%. The results of this study are slightly higher than the findings of **Willershausen** (caries prevalence-63%), **Tambeline CA et al** (caries prevalence- 72.9%), higher than the findings of and lesser than the findings of **Freire MCM et al** (caries prevalence-87.8%).[19,36,31] In the present study, maximum number of children affected by caries belonged to obese category followed by underweight category, normal BMI-for-age category and the least number of children affected by caries belonged to overweight category and there was no statistical difference between males and females in any BMI-for-age categories with respect to their caries experience ($P>0.05$) (Table-3). The findings of the present study are contrary to the findings of **Mostafa Sageghi** (maximum caries affected children in overweight category (86%) followed by normal BMI-for-age (72.3%) and least in obese category (62.8%).[26]

In the present study, the mean deft score of the study population is 2.06±2.473 and mean DMFT score is 1.025±1.129 (Table-4). The mean deft and mean DMFT scores in the present study are less compared to the findings of **Mahesh KP et al** (mean deft - 3.51 and mean DMFT - 3.955), **Macek MD** (mean deft -3.3 and mean DMFT - 2.5), **Moses J et al** (deft- 2.33 and DMFT- 2.67), **Saravanan S et al** (deft- 3.00 and DMFT- 0.42) .[63,21,64,65] The results of the present study show that there is no statistically significant difference in the caries scores of both primary and permanent dentition between boys and girls in any BMI-for-age category (P>0.05). Similar findings were seen in the study done by **Hilgers KK et al**.[9]

The present study findings shows an increase in mean deft and DMFT scores from underweight (deft-1.98± 2.735, DMFT-0.85± 0.966) BMI-for-age category to obese category (deft-2.55± 3.191, DMFT-1.25± 1.385) with exception of higher caries scores in primary dentition in underweight category than in normal BMI-for-age category and overweight category. This result is similar to the findings of **Hilgers KK et al** (mean overall caries for low BMI -0.73 and mean overall caries for high BMI - 1.06) and **Sharma A and Hegde AM** (DMFS for underweight children-3.11, DMFS for normal body weight children -1.58, DMFS for overweight children -2.48 and obese DMFS for obese children-2.85). [9,33]

In the present study, caries scores gradually increased in both primary and permanent dentition as BMI increased which shows an association between BMI- for-age and caries but this was not to the statistically significant level (P>0.05). An association between BMI-for-age and dental caries was found in the studies done by

**Hilgers KK et al**, **Willershausen et al, Isabelle Baileul Forestier et al** and **Sharma A and Hegde AM**.[9,19,24,33]

On the contrary, the studies conducted by **Patricia Vasconcelos LM et al, Macek MD**, **Andres Pinto A et al**, **Mostafa Sadhegi**, **Hong L et al**, **Ana F. GG et al**, **Tripathi S**, **Tambelini CA et al** and **Giselle D'Mello et al** showed no correlation between body mass index and dental caries.[20,21,25,26,27,28,34,36,38]

The findings of the present study shows that the mean scores of all the food groups increased from underweight to obese group except for dairy group and vegetable and fruit group. Except for the underweight group children (who ate more rice and cereals than other food groups), children belonging to all other BMI categories consumed more snacks compared to other food groups which seeks attention.

In the present study, a statistically significant difference in the intake of meat and poultry items was seen between underweight and overweight children, underweight and obese children. There is suggestion in the literature that protein intake, not fat intake, may be associated with the development of adiposity in childhood.[66] It has been proposed that a high protein intake during early childhood stimulates insulin like growth factor 1 production, thereby triggering precocious adipocyte multiplication.[67]

Consumption of dairy products showed statistically significant difference between underweight and normal BMI-for-age children. Comparison of daily intake of fatty foods showed statistically significant difference between BMI-for-age categories except between underweight and normal BMI-for-age categories (P=0.936) and

between overweight and obese categories (P=0.210). So it can be assumed that children with high BMI values consume more of fatty foods than children with normal or low BMI.

The results of the present study show that fatty food consumption was found to more in obese group followed by overweight, normal and underweight in a descending order. Fatty foods, which can be assumed to play a vital role in the in contributing to the body mass or obesity was found to be consumed more by obese children than by children in any other BMI-for-age category. Similar results are given by the study conducted by **Sharma A and Hegde AM** who stated that children who were obese and overweight preferred sweet and fatty foods more frequently compared to children with normal weight.[33] It is evident that the deposition of excess adipose tissue results from a positive energy balance. However, a significant body of research findings suggests that the macronutrient composition of the diet affects the composition of human body. In particular, it appears that the proportion of fat ingested, compared to carbohydrates and proteins, influences the amount of body fat. The greater energy density of lipids (38KJ/g as opposed to 17 KJ/g for other macronutrients) may be one way in which fat exerts its obesity promoting effect. Thus a higher fat diet necessarily results in a higher energy intake, which leads to a positive energy balance if energy expenditure is not increased proportionately.[40]

A statistical significant difference in the daily consumption of snack items was found between all the BMI-for-age categories except between overweight and obese categories (P=0.279). Obese category children consumed more snacks followed by overweight, normal and underweight in a descending order.

A balanced diet helps in the development of a healthy child. It should be noted that a proper diet should include all the essential nutrients in adequate quantity. In the modern society, people eat more of fast foods outside home; the frequency of snacking as well as the contribution of snacks to the total caloric intake has drastically increased. Drinks rich in free sugars increase overall energy intake by limiting the appetite control. Thus, there is less of compensatory reduction of food intake after the consumption of high sugar drinks than when additional foods of equivalent energy content are provided.[33] There are few other factors that contribute to the increase in body weight. They are excessive consumption of soda and juices,[10-12] larger sized proportions of food served over the past 10 years,[10] fewer meals eaten together as a family and consumption of fewer fruits and vegetables, watching television for more hours, preference of computer games over outdoor sports.

The present study is an attempt to find out if there is any relationship between body mass index and dental caries and the role of diet in contributing to both the problems. Using multiple linear regression, when BMI-for-age and diet were compared with caries (Table 7a), a statistically significant association was found only between snacks and caries (P=0.006**). It should be remembered that the concept of biological plausibility suggests that neither the hypothesis "obesity increases risk of caries" nor "caries increases the risk of obesity" is particularly logical. Rather, it is more realistic that a common risk factor increases the likelihood of both diseases, which are then observed in association.[23]

The assumption that "overweight/obesity correlates with more caries" cannot be statistically proved in this study though caries scores in both the dentitions increased as BMI-for-age increased. Only one of the etiologies common to both dental caries and obesity has been explored in the present study. The present study is cross sectional and so a cause-effect relationship over a limited period of time cannot be established. Also, the self-reporting of dietary data is worth mentioning. Both obesity and dental caries are complex issues with multiple etiological factors. Our analysis was limited to dietary pattern alone. Further studies should be targeted on exploring many other contributing factors to obesity like physical activity, genetic makeup of the child and caloric quantification of dietary intake on a larger scale.

Our country is in the midst of a childhood obesity epidemic that threatens nation's long term health. It is easy to speculate that we are only seeing the tip of the iceberg and that the future economic, health and social consequences of this epidemic may be one of our nation's most serious challenges in this century. As members of the pediatric health team, it is critical that pediatric dentists maintain awareness of this epidemic and participate in the assessment and prevention of childhood obesity.[68]

# CONCLUSION

Within the limitations of this study, it can be concluded

1. The overall caries prevalence is 78.6%. Caries prevalence was found to be maximum in obese category children (85%) followed by underweight children (80.53%), normal BMI-for-age children (77.50%) and overweight children (75%) in descending order.

2. The present study shows that the overall mean deft score is 2.06±2.473 and the overall mean DMFT score is 1.025±1.129 and there is no statistically significant difference in the caries scores of boys and girls between any BMI-for-age categories.

3. Caries scores gradually increased in both primary and permanent dentition as BMI increased (except in the primary dentition of underweight children where deft score was more than normal and overweight children) which shows an association between BMI- for- age and caries but this was not statistically significant ($P>0.05$).

4. Caries in primary dentition is more compared to permanent dentition (overall as well as in all BMI-for-age categories) which is statistically significant ($P<0.05$) but when compared between groups, there is no statistically significant difference in caries scores both in primary and permanent dentition ($P>0.05$).

5. The mean scores of all the food groups increased from underweight to obese group except for the dairy group and vegetable and fruit group. Except for the underweight group, children belonging to all other BMI categories consumed more snacks compared to other food groups.

6. Comparison of daily intake of fatty foods showed statistically significant difference between BMI-for-age categories ($P<0.05$) except between underweight and normal BMI-for-age categories ($P=0.936$) and between overweight and obese categories ($P=0.210$).

7. A statistical significant difference in the daily consumption of snack items was found between all the BMI-for-age categories ($P<0.05$) except between overweight and obese categories ($P=0.279$).

8. When compared to children in normal BMI-for-age, caries showed no statistically significant relationship to underweight, overweight or obese categories and with any food groups ($P>0.05$) except with snack items ($P<0.05$).

Based on the conclusion from this study, it is recommended to create a sense of responsibility among the health care professionals dealing with children especially dentists to inform children and parents about the short term and long term effects of obesity, caries and improper dietary patterns and their potential association with cardio vascular diseases. The importance of diet counselling is worth mentioning in this regard.

# SUMMARY

The present study was done to find out if there is any relationship between body mass index, dental caries and dietary intake on a group of 6-12 years old healthy school going children in Chennai city. Demographics were obtained from school records and height was measured using stature meter and weight was measured using a portable electronic weighing machine. BMI-for-age was calculated using CDC growth charts (2000). Caries was assessed through intra oral examination based on WHO (1997) criteria. Dietary intake was obtained for three consecutive days including a weekend through a self-reported diet history.

The overall caries prevalence of the study population was found to be 78.6% with mean deft score of 2.06 and mean DMFT score of 1.025. As BMI-for-age increased, the overall caries scores gradually increased (primary and permanent dentitions) which showed an association between BMI- for- age and caries but this was not statistically significant in the present study ($P>0.05$).The mean scores of all the food groups increased from underweight to obese group except for the dairy group and vegetable and fruit group. Except for the underweight group, children belonging to all other BMI categories consumed more snacks compared to other food groups. As BMI-for-age increased, consumption of fatty foods and snacks gradually increased.

When compared to children in normal BMI-for-age, caries showed no statistically significant relation with any BMI-for-age categories and with any food groups except with snack items.

Both childhood obesity and caries have common determinants and require a comprehensive, integrated management approach by multidisciplinary medical teams and Pediatric dentists should thus be actively involved in limiting this global issue.

# BIBLIOGRAPHY


1. **Strauss RS, Pollack HA.** Epidemic increase in childhood overweight, 1986-1998. *JAMA*: 2845-8, 2001.
2. **Ogden CL, Flegal KM, Carroll MD, Johnson CL**. Prevalence and trends in overweight among US children and adolescents 1999-2000. *JAMA* 2002; 288: 1728-1732.
3. **US Department of Health and Human Services.** The surgeon General's call to action to prevent and decrease overweight and obesity. Rockville, Md: US DHHS, Public Health Service, Office of the surgeon General; 2001.
4. **Barlow SE, Dietz WH.** Obesity evaluation and treatment: Expert Committee Recommendations. The Maternal and Child Health Bureau, Health resources and Services Administration and the Department of Health and Human Services. *Pediatrics* 1998;102:E29.
5. **Nanda K.** Non-alcoholic Steatohepatitis in Children. *Pediatr transplant* 2004;8:613-18.
6. **Li X, Li S, Ulusoy E, Chen W, Srinivasan SR Berenson GS.** Childhood Adiposity as a Predictor of Cardiac Mass in Adulthood: The Bogalusa Heart Study. *Circulation* 2004;110:3488-92.
7. **Hilgers KK, Matthew Akridge BA, Scheetz JP, Kinane DF.** Childhood Obesity and Dental Development. *Pediatr Dent* 2006;28:18-22.
8. **Maria CM, Tais SB, Maria BD.** Associations of Masticatory Performance with Body and Dental Variables in Children. *Pediatr Dent* 2010;32:283-88.

9. **Hilgers KK, Kinane DF, Scheetz JP**. Association between Childhood Obesity and Smooth Surface Caries in Posterior Teeth: A Preliminary Study. *Pediatr Dent* 2006;28:23-8.
10. **Matthiessen J, Fagt S, Biltoft-Jensen A, Beck AM, Ovensen L.** Size makes a difference. *Public Health Nutr* 2003;6:65-72.
11. **Rampersaud GC, Bailey LB, Kauwell GP.** National survey beverage consumption data for children and adolescents indicate the need to encourage shift toward more nutritive beverages. *J AM Diet Assoc* 2003;103:97-100.
12. **French SA, Lin BH, Githrie JF.** National trends in soft drink consumption among children and adolescents 6 to 17 years: Prevalence, amounts and sources, 1977/1987 to 1994/1998. *J Am Diet Assoc* 2003;103:1326-1331.
13. **Dennison B.** Fruit juice consumption by infants and children: A review. *J Am Coll Nutr* 1996;15(suppl):4S-11S.
14. **American Academy of Pediatrics.** Prevention of pediatric overweight and obesity. *Pediatrics* 2003;112:424-430.
15. **Birch LL, Davison K.** Family environmental factors influencing the developing behavioural controls of food intake and childhood overweight. *Pediatr Clin North Am* 2001;48:893-907.
16. **Dietz WH**. The obesity epidemic in young children. Reduce television viewing and promote playing. *Br Med J* 2001;322:313-14.
17. **Davies PSW, Coward WA, Gregory J, White A, Millis A.** Total energy expenditure and energy intake in the pre-school child: A comparision. *Br J Nutr* 1994;72:13-20.
18. **Shigeyuki Hamada**. Role of sweeteners in the etiology and prevention of dental caries. *Pure Appl Chem* 2002;74:1293-1300.

19. **Willershausen B, Haas G, Krummenauer F, Hohenfellner K.** Relationship between High Weight and Caries Frequency in German Elementary School Children. *Eur J Med Res* 2004;9:400-404.
20. **Patricia Vasconcelos LM, Rosenblatt A, Ribeiro Severo AM.** Prevalence of dental caries in obese and normal- weight Brazilian adolescents attending state and private schools. *Community Dental Health* 2006;23:251-53.
21. **Macek MD, Mitola DJ.** Exploring the Association between Overweight and Dental Caries among Us Children. *Pediatr Dent* 2006;28:375-380.
22. **Willershausen B, Moschos D, Azrak B, Blenttner M.** Correlation between oral health and body mass index (BMI) in 2071 primary school pupils. *Eur J Med Res* 2007;12:295-99.
23. **Marshall TA, Eichenberger-Gilmore JM, Broffitt BA, Warren JJ, Levy SM.** Dental caries and childhood obesity: roles of diet and socioeconomic status. *Community Dent Oral Epidemiol* 2007;35:449-458.
24. **Isabelle Bailleul-Forestier, Lopes K, Souames M, Azoguy-Levy S, Frelut ML, Lefevre ML.** Caries experience in a severely obese adolescent population. *Int J Pediatr Dent* 2007;17:358-363.
25. **Pinto A, Kim S, Wadenya R, Rosenberg H.** Is there an association between weight and dental caries among pediatric patients in an urban dental school? A correlation study. *J Dent Educ* 2007:71:1435-1440.
26. **Mostafa Sadeghi, Farnosh Alizedeh.** Association between Dental Caries and Body Mass Index-for-Age among 6-11 Year Old Children in Isfahan in 2007. *JODDD*;1:119-124.
27. **Hong L, Ahmed A, McCunniff M, Overman P, Mathew M.** Obesity and Dental Caries in Children Aged 2-6 years in the United States: National Health

and Nutrition Examination Survey 1999-2002. *J Public Health Dent* 2008;68:227-233.

28. **Ana F. GG, Menezes VA, Lira PI, Ferreira JM Cavalcanti AL.** Obesity and Dental Caries among Preschool Children in Brazil. *Rev Salud Publica* 2008;10:788-795.
29. **Alm A, Fahraeus C, Wendt LK, Koch G, Gare BA, Birkhed D.** Body adiposity status in teenagers and snacking habits in early childhood in relation to approximal caires at 15 years of age. *Int J Pediatr Dent* 2008; 18:189-196.
30. **Gerdwin EW, Angbratt M, Aronsson K, Eriksson E, Johansson I.** Dental caries and body mass index by socio-econimic status in Swedish children. *Community Dent Oral Epidemiol* 2008;36:459-465.
31. **Freire MCM, Sheiham A, Netuveli G**. Relationship between Height and Dental Caries in Adolescents. *Caries Res* 2008;42:134-140.
32. **Sheller B, Churchill SS, Williams BJ, Davidson B.** Body Mass Index of Children with Severe Early Childhood Caries. *Pediatr Dent* 2009;31:216-221.
33. **Sharma A, Hegde AM.** Relationship between Body Mass Index, Caries Experience and Dietary Preferences in Children. *J Clin Pediatr Dent* 2009;34:49-52.
34. **Tripathi S, Kiran K, Kamala BK.** Relationship between obesity and dental caries in children- A preliminary study. *J Int Oral Health* 2010;2:65-72.
35. **Kelishadi R, Mortazavi S, Hossein TR, Poursafe P.** Association of cardiometabolic risk factors and dental caries in a population based sample of youths. *Diabetology & Metabolic Syndrome* 2010;2:1-5.
36. **Tambelini CA, Ramos DM, Frederico RC, Tomasetti CS, Maciel SM.** Dental caries in adolescents and its association with excess weight and

sociodemographic factors in Londrina, Parana, Brazil. *Rev Odonto Cienc* 2010;25:245-49.

37. **Gokhale N, Sivakumar N, Nirmala SVSG, Abinash M.** Dental Caries and Body Mass Index in Children of Nellore. *J Orofac Sci* 2010;2:4-6.
38. **Giselle D'Mello, Chia L, Hamilton SD, Thomson WM, Drummon BK**. Childhood obesity and dental caries among paediatric dental clinic attenders. *Int J Pediatr Dent* 2011;21:217-222.
39. **Davies PSW.** Diet composition and body mass index in pre-school children. *Eur J Clin Nutr* 1997;51:443-48.
40. **Atkin LM, Davies PSW.** Diet composition and body composition in preschool children. *Am J Clin Nutr* 2000;72:15-21.
41. **Brien GO, Davies M**. nutrition knowledge and body mass index. *Health Educ Res* 2006;22:571-75.
42. **LaRowe TL, Moeller SM, Adams AK.** Beverage patterns, Diet quality and body mass index of US preschool and school aged children. *J Am Diet Assc* 2007;107:1124-1133.
43. **Heuberger R, Boyle IO.** Beverage Consumption and its Association with BMI and Lifestyle factors in Rural Community Participants. *Californian J Health Prom* 2009;7:62-74.
44. **Collison KS, Subani SN, Rubeaan KA, Shoukri M, Mohanna FA.** Sugar sweetened carbonated beverage consumption correlates with BMI, waist circumference and poor dietary choices in school children. *BMC Public Health* 2010;10:1-13.

45. **Centers for Disease Control and Prevention.** Growth charts body mass index for age percentiles, boys and girls. Avaliable at htpp://www.cdc.gov/bmi/bmimeans.htm. Accessed July 13 2005.
46. **World health organization**. Oral health survey, basic methods. 4th Ed Geneva: *World Health Organization*; 1997.
47. **U.S. Department of Agriculture**. Human Nutrition Information Service. 1992. The Food Guide Pyramid. *Home and Garden Bull*. No. 252, 32 pp.
48. **Per.Axelson**. Diagnosis and risk prediction of dental caries. Vol II *quintessence publishing co.inc*, Sweden; pg 71, 2002.
49. **Burke BS.** The dietary history as a tool in research. *J. Am. Diet. Assoc.* 1947.23, 1041–1046.
50. **World Health Organization**. Preventing chronic diseases: A vital investment. World Global Report. Geneva: *World Health Organization*; 2005.
51. **Kolagotla L, Adams W.** Ambulatory management of childhood obesity. *Obes Res* 2004;12:275-83.
52. **Braithwaite AS, Vann WF Jr, Switzer BR.** Nutritional counselling practices; how do North Carolina pediatric dentists weigh in? *Pediatr Dent* 2008;30:488-95.
53. **Perrin EM, Flower KB, Garrett J.** Preventing and treating obesity. Pediatrician's self-effeciency, barriers resources and advocacy. *Ambul Pediatr* 2005;5:150-56.
54. **Jelalian E, Boergers J, Alday CS.** Survey of physician's attitudes and practices related to pediatric obesity. *Clin Pediatr* 2003;42:235-45.

55. **Tseng R, Vann WF, Perrin EM.** Addressing Childhood Overweight and Obesity in the Dental Office: Rationale and Practical Guidelines. *Pediatr Dent* 2010;32:417-23.
56. **Cabana MD, Ebel BE, Cooper-Patrick L.** Barriers pediatricians face when using asthma practice guidelines. *Arch Pediatr Adolesc Med* 2000;154:685-93.
57. **Krasse B.** The Vipeholm Dental Caries Study: recollections and reflections 50 years later. *J Dent Res* 2001;80:1785-88.
58. **Moynihan P.** The interrelationship between diet and oral health. *Proc Nutr Soc* 2005;64:571-80.
59. **Ramachandran A, Snehalatha C, Vinitha R et al.** Prevalence of overweight in urban Indian adolescent school children. *Diabetes Res Clin Pract* 2002;57:185-190.
60. **Kumar S, Mahabalaraju DK, Anuroopa MS.** Prevalence of obesity and its influencing factor among affluent school children of Davangere city. *Indian J Community Med* 2007;32:15-17.
61. **Kotian MS, Kumar SG, Kotian SS.** Prevalence and determinants of overweight and obesity among adolescent school children of South Karnataka, India. *Indian J Community Med* 2010;35:176-78.
62. **Lobstein T, Baur L, Uauy R.** Obesity in children and young people: A crisis in public health. *Obesity reviews* 2004;5:4–85.
63. **Mahesh KP, Joseph T, Varma RB, Jayanthi M.** Oral health status of 5 years and 12 years school going children in Chennai city. An epidemiological survey. *J Indian Soc Pedod Prev Dent* 2005;23:17-22.

64. **Moses J, Rangeeth BN, Gurunathan D.** Prevalence of dental caries, socioeconomic status and treatment deeds among 5 to 15 year old school going children of Chidambaram. *J Clin & Diagn Res* 2011;5:146-51.

65. **Saravanan S, Kalyani V, Vijayarani MP et al.** Caries prevalence and treatment needs of rural school going children in Chidambaram Taluk, TamilNadu, South India. *Indian J Dent Res* 2008; 19:186-90.

66. **Rolland-Cachera MF.** Prediction of adult body composition from infant and child measurements. In: Davies PSW, Cole TJ, eds. Body composition techniques in health and disease. Cambridge, United Kingdom: *Cambridge University Press*, 1995:100-45.

67. **Rolland-Cachers MF.** Adiposity rebound and prediction of adult fatness. In: Ulijaszek SJ, Johnston FE, Preece MA, eds. The Cambridge encyclopedia of human growth and development. Cambridge, United Kingdom: *Cambridge University Press*, 1998:51-3.

68. **Vann WF, Bouwens TJ, Braithwaite AS, Lee JY.** The Childhood Obesity Epidemic: A Role for Pedatric Dentist? *Pediatr Dent*;27:271-76.

# ANNEXURE-1

## DATA RECORDING PROFORMA

**Name:** **Date:**

**Age/ Gender:**

**Date of Birth:**

**School and Class:**

**Height (in metre):**

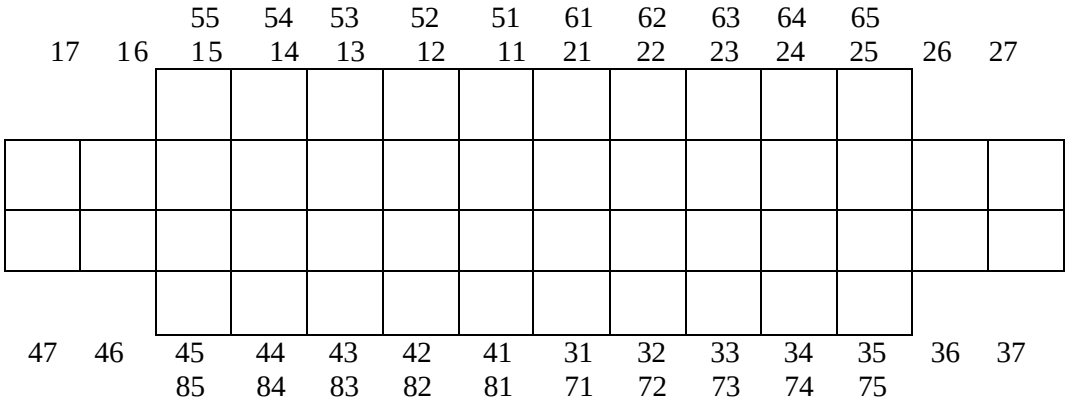
**Weight (in Kilogram):**

**Body mass index (BMI) =** $\frac{\text{Weight (in kg)}}{(\text{Height in meter})^2} =$

**BMI Category:**

- ☐ **Underweight**
- ☐ **Normal**
- ☐ **Overweight**
- ☐ **Obese**

**Dentition status (WHO criteria- 1997)**




**Primary dentition caries score (deft):**

**Permanent dentition caries score (DMFT):**

# ANNEXURE-2

## CONSENT FORM (ENGLISH)

I, _____, the parent/ guardian of _____ hereby give consent for the participation of my son/ daughter in the study. I have been informed clearly about the procedure/ techniques of the study and I voluntarily, unconditionally, freely give my consent for the active participation of my son/ daughter without any form of pressure in mentally sound and conscious state.

SIGNATURE OF THE DOCTOR

SIGNATURE OF THE CHILD'S PARENT/ GUARDIAN

**ANNEXURE-3**

## சிகிச்சை ஒப்புதல் படிவம்

**_____ ஆகிய நான் _____என்கிற**

**(பெற்றோரின் பெயர்) (குழந்தையின் பெயர், வயது)**

**என் குழந்தையின் எடை மற்றும் உயரத்தினை குறிக்கவும், வாய் / பல் பகுதியை ஆராய்ந்து பார்க்கவும் ஒப்புதல் அளிக்கிறேன். மேலும், இந்த ஆராய்ச்சியினை மேற்கொள்வதினால் விளையக்கூடிய நன்மைகளையும், அதனால் விளையக்கூடிய அசௌகரியங்களையும் அறியப்பெற்றப்பின், நான் எவ்வித அச்சமுமின்றி தன்னிச்சையாக, முழுமனதுடன் என்னுடைய சம்மதத்தினை அளிக்கிறேன்.**

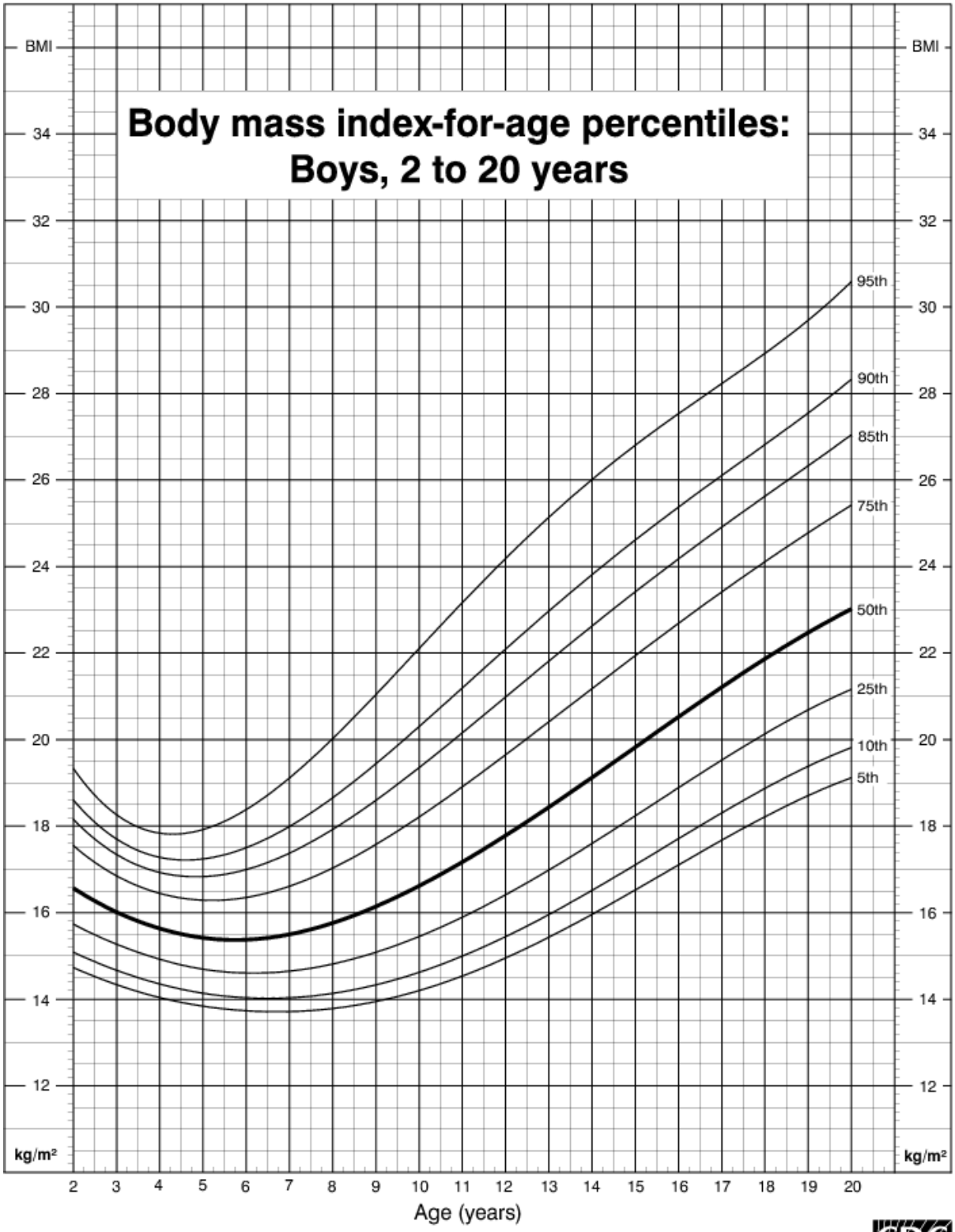
**கையொப்பம் :**

**தேதி / இடம் :**

**சாட்சிகள் :**

# ANNEXURE-4

## CDC BMI-for-age PERCENTILES- BOYS

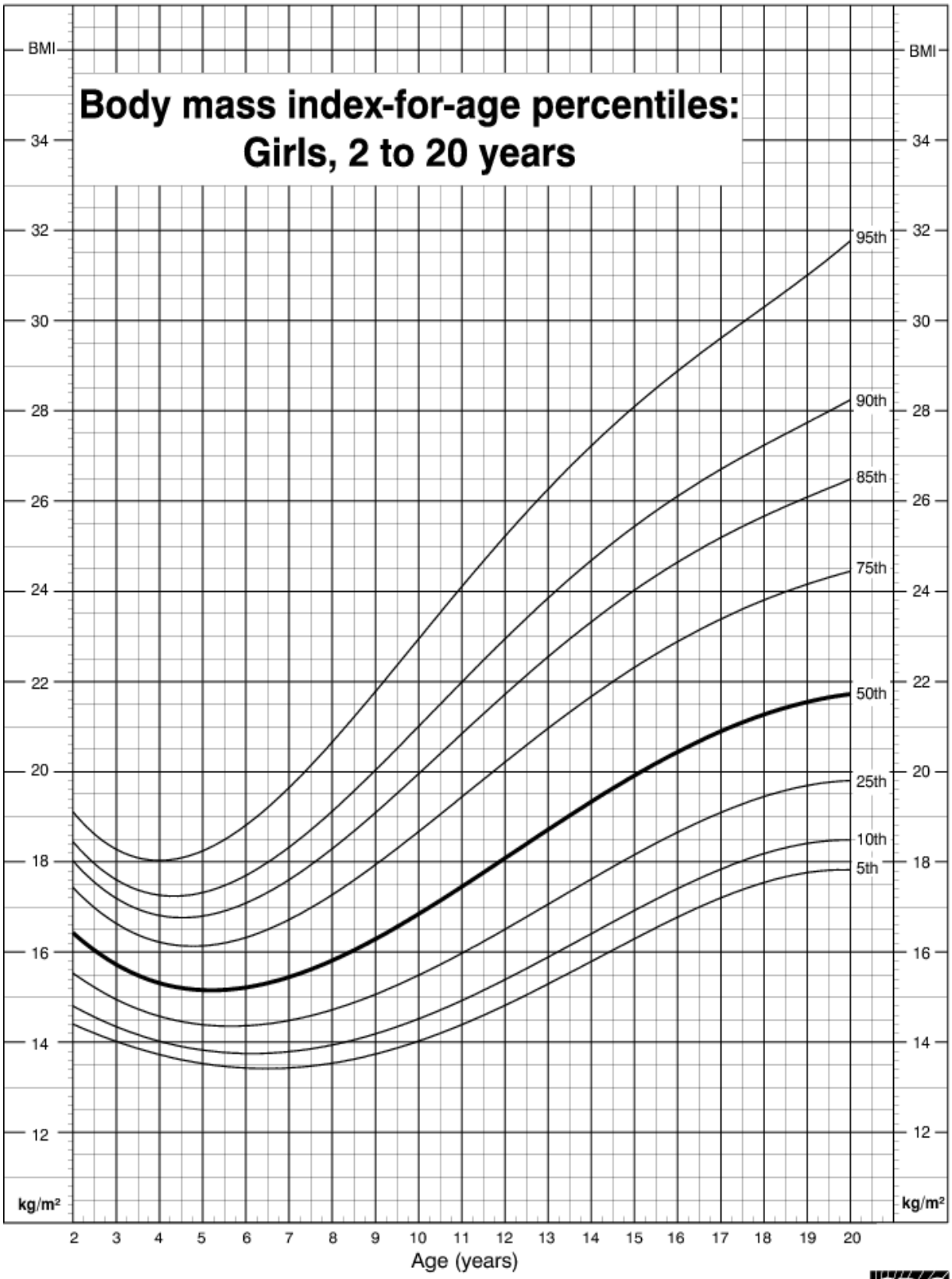



Published May 30, 2000.
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

SAFER • HEALTHIER • PEOPLE™

# ANNEXURE-5

## CDC BMI-for-age PERCENTILES- GIRLS




Published May 30, 2000.
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

SAFER • HEALTHIER • PEOPLE™

# ANNEXURE-6

## DIET RECORDING SHEET-ENGLISH

| FOOD GROUP | DAY-1 | DAY-2 | DAY-3 | MEAN |
|---|---|---|---|---|
| **Rice and cereal group**<br><br>(rice, idly, dosai, Bun, noodles, cornflakes etc) | | | | |
| **Meat and poultry group**<br><br>(fish, egg, chicken, beef, mutton etc) | | | | |
| **Dairy and dairy products**<br><br>(milk, butter, ghee, cheese, curd, butter milk) | | | | |
| **Fat and oil group**<br><br>(fried items, oily foods) | | | | |
| **Vegetables and fruits**<br><br>(carrot, beans, brinjal, mango, banana, apple etc) | | | | |
| **Snacks and Sweet items**<br><br>(biscuits, chocolates, beverages, chips etc) | | | | |

# ANNEXURE-7

## DIET RECORDING SHEET-TAMIL

| உணவு வகை | முதல் நாள் | இரண்டாம் நாள் | மூன்றாம் நாள் | சராசரி தொகை |
|---|---|---|---|---|
| **அரிசி, கோதுமை, தானிய வகை உணவுப் பொருட்கள்** (சப்பாத்தி,இட்லி, ரொட்டி,தோசை, பிரெட், நூடில்ஸ், சோளம், மற்றும் இதர உணவுகள்) | | | | |
| **புரதசத்து நிறைந்த உணவுப் பொருட்கள்** (சோயா, மீன், இறைச்சி, முட்டை, அசைவம் மற்றும் இதர உணவுகள்) | | | | |
| **பால் மற்றும் பால் சார்ந்த உணவுப் பொருட்கள்** (பால், தயிர், மோர், வெண்ணெய் மற்றும் இதர பால் சார்ந்த உணவுப் பொருட்கள்) | | | | |
| **கொழுப்பு மற்றும் எண்ணெய் வகை உணவுப் பொருட்கள்** (எண்ணெயில் பொறிக்கப்பட்ட உணவுப் பொருட்கள்) | | | | |
| **காய்கறி மற்றும் பழங்கள்** (கேரட், பீன்ஸ், வெண்டைக்காய், கத்தரிக்காய், மாம்பழம், வாழைப்பழம், அன்னாச்சிபழம், ஆப்பிள் மற்றும் இதர காய் / பழ வகைகள்) | | | | |
| **நொறுக்கு தீனிகள்** (பிஸ்கெட், இனிப்புகள்,முறுக்கு, சாக்லெட், சிப்ஸ், கேக், மற்றும் இதர நொறுக்கு தீனிகள்) | | | | |