ASSOCIATION BETWEEN DENTAL CARIES AND BODY MASS INDEX OF 12 AND 15 YEAR SCHOOL GOING CHILDREN OF LUCKNOW CITY, UTTAR PRADESH.

DISSERTATION

Submitted to the

BABU BANARASI DAS UNIVERSITY, LUCKNOW, UTTAR PRADESH

In the partial fulfillment of the requirement for the degree

Of

MASTER OF DENTAL SURGERY

In

PUBLIC HEALTH DENTISTRY

By

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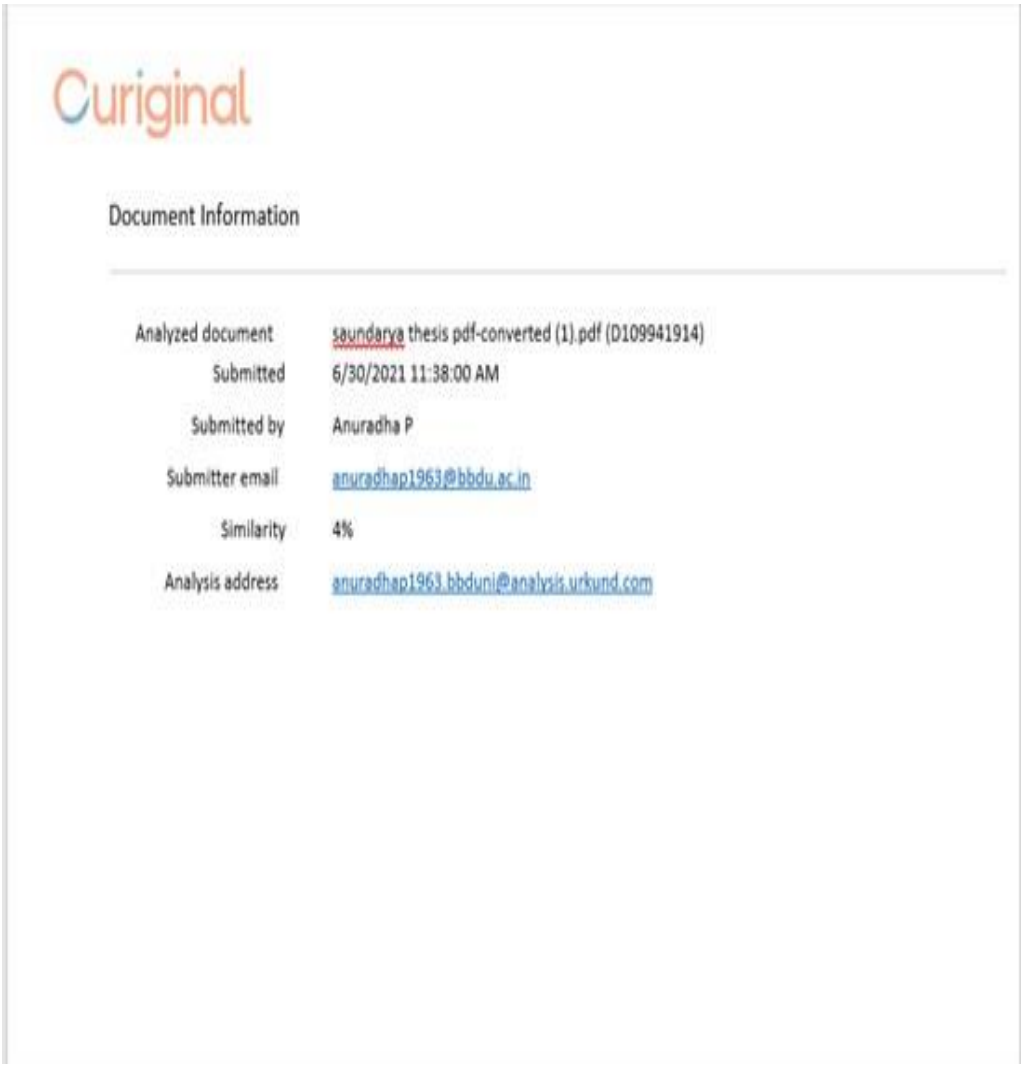

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I hereby declare that this dissertation entitled **'Association between Dental Caries and Body Mass Index of 12 and 15-year old school going children of Lucknow city, Uttar Pradesh'** is a bonafide, & genuine research work carried out by me under the guidance of **Dr. Anuradha P, Professor and Head,** Department of Public Health Dentistry, Babu Banarasi Das College of Dental sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

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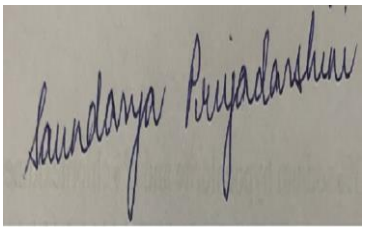
Place: Lucknow



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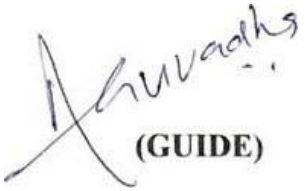

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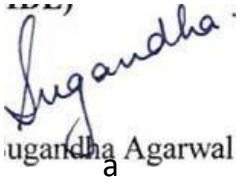

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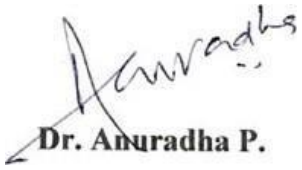

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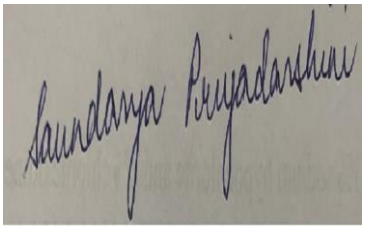

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Above all I bow my head in gratitude to ALMIGHTY GOD for bestowing his blessings on me.

DR. SAUNDARYA PRIYADARSHINI

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LIST OF ABREVIATION

BMI	**Body Mass Index**
DC	**Dental Caries**
SD	**Standard Deviation**
WHO	**World Health Organization**
CDC	**Centre for Disease Control**
p	**Level of significance**

CPI	**Community Periodontal Index**

ABSTRACT

INTRODUTION

Dental caries occurs due to demineralization of enamel and dentine by organic acids formed by bacteria in dental plaque through the anaerobic metabolism of sugars derived from the diet. When sugars or other fermentable carbohydrates are ingested, the resulting fall in dental plaque pH caused by organic acids increases the solubility of calcium hydroxyapatite in the dental hard tissues and demineralization occurs as calcium is lost from the tooth surface. The relationship between ingestion of refined carbohydrates, especially sugars, and the prevalence of dental caries is well documented in the literature. One of the etiological factors of obesity is diet which also has an equally important role in the caries process. Not much literature is available to know if there is any direct relationship between obesity and dental caries in children. So, the present study was carried out with an aim to determine if there is an association between body mass index (BMI)-for-age and dental caries in children and to find out the role of diet with respect to BMI-for-age and dental caries.

METHODOLGY

A cross sectional study was conducted on 1000 school going children of 12- and 15years age group. A cluster random sampling method was used to obtain the desired sample. Intra examiner reliability was observed using kappa statistics. Clinical examination was conducted in the school premises after obtaining informed consent from parent and permission of school authority. WHO 1997 proforma was used for recording dental

caries. Body Mass Index was calculated The obtained data Was analyzed using SPSS version 22.0 using Pearson correlation and linear regression test was used keeping $p<0.05$

RESULT

A negative correlation was obtained between Dental Caries and Body Mass Index of 12- and 15-year-old school going children.

CONCLUSION

The assumption that "overweight/obesity correlates with more caries" cannot be statistically proven. This study showed higher percentage of children was in the underweight category of BMI. Further, higher percentage of underweight children was in government schools as compared to private schools. Mean DMFT was higher in underweight children as compared to other strata of BMI. Correlation analysis showed BMI had a negative correlation with DMFT. Many of the children can have a poor health status due to lack of knowledge about general and oral health. Continuous education and motivation of parents and children can help to some extent to improve their health status.

INTRODUCTION

The relation between diet and nutrition and oral health and disease can best be described as a synergistic 2-way street. Diet has a local effect on oral health, primarily on the integrity of the teeth, pH, and composition of the saliva and plaque. Nutrition, however, has a systemic effect on the integrity of the oral cavity, including teeth, periodontium (supporting structure of the teeth), oral mucosa, and alveolar bone. Alterations in nutrient intake secondary to changes in diet intake, absorption, metabolism, or excretion

can affect the integrity of the teeth, surrounding tissues, and bone as well as the response to wound healing. [1]

Dental caries occurs due to demineralization of enamel and dentine by organic acids formed by bacteria in dental plaque through the anaerobic metabolism of sugars derived from the diet[2].When sugars or other fermentable carbohydrates are ingested, the resulting fall in dental plaque pH caused by organic acids increases the solubility of calcium hydroxyapatite in the dental hard tissues and demineralization occurs as calcium is lost from the tooth surface. The pH at which demineralization occurs is often referred to as the critical pH and is approximately 5.5. Saliva is one of the mouth's natural defenses against this process. Saliva promotes remineralization, i.e., it is capable of depositing mineral in porous areas where demineralization of enamel or dentine has occurred. Saliva is super-saturated with calcium and phosphate at pH 7; this favors the deposition of calcium. If a demineralized lesion is formed it will be remineralized; although this is a slow process that competes with factors that cause demineralization. If the pH in the mouth remains high enough for sufficient time then complete remineralization of enamel may occur. However, if the acid challenge is too great, demineralization dominates and the enamel becomes more porous until finally a carious lesion forms[3]. The rate of demineralization is affected by the concentration of hydrogen and fluoride ions (i.e. pH at the tooth surface). Fluoride inhibits the demineralization process and the frequency with which the plaque pH falls below the critical pH without subsequent remineralization. So overall, caries occurs when demineralization exceeds remineralization.

The development of caries requires sugars and bacteria to occur but is influenced by the susceptibility of the tooth, the bacterial profile, quantity and quality of the saliva, and the time for which fermentable dietary carbohydrates are available for bacterial fermentation. Streptococcus mutans and Streptococcus sorbrinus are important bacteria in the development of dental caries. Both these bacteria readily produce organic acids from dietary sugars and like most aciduric bacteria can synthesize insoluble plaque matrix polymers (extracellular dextran) from dietary sugars—a factor that aids bacterial

colonization of the tooth surface. Growth of these streptococci requires the presence of fermentable monosaccharides. Mutans streptococcal invertase splits sucrose into glucose and fructose, which can be metabolized to produce mainly lactic but also other acids including acetic and formic acids. The resulting low pH alters the plaque ecology. A low pH in plaque is ideal for aciduric bacteria such as streptococci, lactobacilli and bifidobacterial as these are more competitive at low pH than bacteria not associated with dental caries.3 Untreated dental caries are prevalent in developing countries, and its unesthetic nature hinders self-esteem and social development of children.[4] Untreated dental caries and associated infection cause pain, discomfort and irritability compromising the ability to eat and sleep well, and function well at home and school among children. The consequent effect of dental caries on weight, growth, hormone production, quality of life, and cognitive development of young children [5]

Consumption of free sugars is a risk factor both for dental caries and obesity. Childhood obesity is increasing rapidly worldwide1 and is one of the most serious public health challenges of the 21st century. Diet plays an important role in the obesity epidemic, as dietary habits in children have suffered major changes in the last thirty years.[6]

Consumption of soft drinks is associated with reduced vitamin and mineral intake and an excess of dietary carbohydrates. The oral health implications of nutritional practices were demonstrated by a review of children's eating habits in the United States between 1988 and 1994.[7] The authors of that study found an association between poor dietary practices (meal fragmentation, missed breakfast, low fruit, and higher carbohydrate intake) and caries. Several characteristics of today's society contribute to the widespread childhood obesity problem.

Children today lead more sedentary lifestyle. The factors contributing to the increase in childhood Obesity include excessive consumption of soda

and juice, large-sized portions of food served over the past 10 years, fewer meals eaten together as a family, consumption of fewer fruits and vegetables, dependency on

readymade food items, decreased physical activity with great popularity of television and computer games, and shortage of space in many schools for outdoor sports.[8-10]

An increase in energy stored, as fat, can lead to obesity and a number of mechanisms can contribute to an increase in stored energy. If energy intake is in excess of energy expenditure or there is 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.[11]

In India, the problem of obesity has been scantily explored even in the affluent population groups.[3] Obesity appears to influence the general health as well as the oral health of an individual, and particularly in children, it increases the risk of subsequent morbidity, with increased prevalence of hypertension, type 2 diabetes mellitus, dyslipidemia, left ventricular hypertrophy, non-alcoholic steatohepatitis, obstructive sleep apnea, and orthopedic and psychosocial problems, accelerates dental development, and decreases masticatory performance.[12-16]

Obesity in childhood is an alert to the public health, a serious and emergency issue because it tends to persist into adulthood, constituting a risk factor for the occurrence of several chronic diseases[17-18]. According to WHO, the high sugar consumption is a major cause of weight gain1.As for obesity, the high frequency of intake of sugar-rich foods is closely related to the etiology of dental caries. Eating habits are key factors in these two diseases[19].

Age and gender specific BMI values for children are referred as “BMI-for-age”. Categories describing amount of body fat for children and teenagers are also different from the categories describing amount of body fat in adults. BMI categories used for children and teenagers include underweight, normal-weight, at risk of overweight and overweight. [20]

Nowadays overweightness and underweights are two main public health problems,[21] and their association with dental caries is still an unanswered question.

Weight status in children is measured by assessment of body mass index (BMI) corresponding to gender and age-ranked percentages. Children are considered at risk of being overweight if they are between the 85th and 95th percentile of age and genderrelated BMI and are considered overweight if they are at or beyond the 95th percentile of age and gender-related BMI according to Centers for Disease Control and Prevention (CDC) guidelines.[22,23]For example, an eight-year-old boy with a BMI of 19 is classified in the at-risk-of-being-overweight category (less than 95th percentile BMI adjusted by age and gender), while a six-and-a-half-year-old boy with the same BMI is considered overweight (at or beyond the 95th percentile).

The relationship between ingestion of refined carbohydrates, especially sugars, and the prevalence of dental caries is well documented in the literature. One of the etiological factors of obesity is diet which also has an equally important role in the caries process. Not much literature is available to know if there is any direct relationship between obesity and dental caries in children. So, the present study was carried out with an aim to evaluate the association between Body Mass Index (BMI) and Dental Caries among 12 and 15-year school going children in Lucknow city, Uttar Pradesh

AIM

To evaluate the association between Body Mass Index (BMI) and Dental Caries among 12 and 15-year school going children in Lucknow city, Uttar Pradesh

OBJECTIVES

1. To assess Dental Caries among 12 and 15-year school going using the WHO criteria
2. To assess the Body Mass Index (BMI) among 12 and 15-years old school going children.
3. To establish correlation if any, between Dental Caries and Body Mass Index (BMI) among 12 and 15-years old school going children.

REVIEW OF LITERATURE

Rao A, Sequeria SP, Peter S in **1999** carried a survey among 2902 children aged between 5 and 12 years attending 13 primary schools in various areas of Moodbidri, in Udupi district. The oral health status was assessed using the simplified WHO Oral Health Assessment Form. The caries prevalence was found to be 76.9%. The mean DMFT was 0.78 and the mean deft was 3.48. Although the mean DMFT score between males and females did not show any significant difference, the mean deft was found to be higher among males compared to females. It was also found that the mean DMFT score increased with age whereas the mean deft score decreased with age.[49]

Proctor MH in **2003** To prospectively examine the relation between television watching and body fat change in children from preschool to early adolescence. In a longitudinal study, 106 children were enrolled during preschool years and followed into early adolescence. Parents completed an annual questionnaire on the child's television and video habits. Body mass index (BMI), triceps skinfolds, and sum of five skinfolds were recorded yearly at annual clinic visits. Longitudinal statistical analyses were carried out using mixed modeling procedures to control for potential confounding by a number of factors. Television watching was an independent predictor of the change in the child's BMI, triceps, and sum of five skinfolds throughout childhood. Its effect was only slightly attenuated by controlling for the baseline body fat, level of physical activity, percent of calories from fat, total calorie intake, or the parents' BMI or education. By age 11, children who watched 3.0 h or more of television per day had a mean sum of skinfolds of 106.2 mm, compared with a mean sum of skinfolds of 76.5 mm for those who watched less than 1.75 h per day. Furthermore, the adverse effect of television viewing was worse for those children who were also sedentary or had a higher-fat diet. Children who watched the most television during childhood had the greatest increase in body fat over time. Healthy lifestyle education designed to prevent obesity and its consequences should target television-watching habits of children. [46]

Gidding SS, Dennison BA et al in the year **2006** used data from the third National Health and Nutrition to investigate the relationship between healthful eating practices and dental caries in the primary dentition among children aged 2 through 5 years. The odds of experiencing caries in primary teeth were significantly greater in nonpoor children who did not eat breakfast daily or ate fewer than five servings of fruit and

vegetables per day. No association was found between breast-feeding and caries in primary teeth. [6]

Matthiessen J, Fagt S, Biltoft-Jensen A, Beck AM, Ovensen L. in **2003** did a study to elucidate status and trends in portion size of foods rich in fat and/or added sugars during the past decades, and to bring portion size into perspective in its role in obesity and dietary guidelines in Denmark. Information about portion sizes of low-fat and fullfat food items was obtained from a 4-day weighed food record . Trends in portion sizes of commercial foods were examined by gathering information from major food manufacturers and fast food chains . Data on intakes and sales of sugarsweetened soft drinks and confectionery were obtained through nation-wide dietary surveys and official sales statistics . it showed that Subjects ate and drank significantly more when they chose low-fat food and meal items, compared with their counterparts who chose food and meal items with a higher fat content. As a result, almost the same amounts of energy and fat were consumed both ways, with the exception of sliced cold meat and milk.

Portion sizes of commercial energy-dense foods and beverages, and fast food meals rich in fat and/or added sugars, seem to have increased over time, and in particular in the last 10 years. The development in portion sizes of commercial foods has been paralleled by a sharp increase of more than 50% in the sales of sugarsweetened soft drinks and confectionery like sweets, chocolate and ice creams since the 1970s. [8]

Hilgers KK, Matthew Akridge BA, Scheetz JP, Kinane DF. In the year **2006** conducted a study to determine if increased body mass index (BMI) is associated with accelerated dental development in children ages 8 to 15. The dental development ages of 104 children were determined using the Demirjian method and panoramic radiographs. Using the system developed by the International Obesity Task Force, BMI status was determined for each subject (63 normal weight, 23 overweight, and 18 obese subjects). The difference between chronologic age and dental age was analyzed against BMI, age, and gender using 3way analysis of variance. Children who were overweight

or obese had accelerated dental development, even after adjusting for age and gender. Accelerated dental development in obese children is an important variable to consider in pediatric dental and orthodontic treatment planning where timing is crucial. [15]

Souza Filho MD, Carvalho GDF, Martins MCC in the year 2010 did a study to determine the association between dental caries, Body Mass Index (BMI) and sugar intake in children attending primary school. A cross-sectional study was conducted with 91 children, considering anthropometric measurements, according to standardized methodology of the Ministry of Health and occurrence of dental caries was recorded from clinical examinations (dmft). The sugar intake level was measured with a questionnaire that was applied to parents/caretakers of the children. The association of the variables was checked using a correlation with the Contingency C coefficient test. There was no association between BMI and caries. It was concluded that there was a correlation between sugar intake and dmft and BMI, but not between caries and BMI.[19]

Marshall T.A et al in conducted a study in **2007** to determine if caries and obesity were associated in a pediatric population and if so, then to explore diet and socioeconomic status as additional risk factors.Subjects were recruited at birth and are members of the Iowa Fluoride Study. Data such as parental age, parental education levels and family incomes were obtained by questionnaire at recruitment. Children's primary dentition was examined and their weight and height measured at 4.5–6.9 years of age. Parental weight and height were measured when children were 7.6–10.9 years of age. Beverage and nutrient intake patterns were obtained from 3-day food and beverage diaries completed at 1, 2, 3, 4 and 5 years of age. Children with caries had lower family incomes, less educated parents, heavier mothers and higher soda-pop intakes at 2, 3 and for 1–5 years than children without caries 'Overweight' children had less educated fathers and heavier parents than 'normal' weight children . Children 'at risk' of overweight had higher caries rates than 'normal' or 'overweight' children. it was concluded that Caries and obesity coexist in children of low socioeconomic status. Public health measures to improve dietary education and access to appropriate foodstuffs could decrease the risk of both diseases.[31]

Bhayat A, Ahmad M., Fadel H in **2016** conducted a study to **assess** the association between dental caries, body mass index (BMI) and dietary habits of 12-year-old boys from four geographically distinct schools in Medina. Mean BMI was 22.17 kg/m²; 41% had normal BMI, 25% were overweight and 30% were obese. The mean Decayed, Missing and Filled Teeth (DMFT) score was 1.46. Those in the normal BMI range had a significantly higher prevalence of caries and DMFT score compared with the overweight and obese groups. These differences remained significant after controlling for possible confounders via linear regression. Mean BMI was significantly lower in boys with severe compared with mild or no caries. Normal and underweight participants had an almost 2 times greater risk of developing caries compared with their overweight and obese counterparts. The children had poor dietary habits and there were no significant associations between dietary variables and caries. [32]

Alkarimi H.A in **2018** did a study to explore the association between obesity and dental caries in children and adolescents. A database search for papers published between January 2015 and May 2018, inclusive, addressing the association between obesity and dental caries was conducted. A review and critical appraisal of all included studies was performed. *Results*. Twenty-six studies were included in this review from different populations worldwide. Eight studies assessed the primary dentition, nine studies were conducted on permanent dentition, and remaining nine studies on both dentitions. The results regarding the association between obesity and dental caries were conflicting and inconsistent. Nine studies concluded that there was no relationship between obesity and dental caries. A positive association was reported in five studies, while the inverse association was reported in eleven studies. Studies included in this review had significant variations in methodology and the investigated cofactors. Possible

explanations of the controversial association between obesity and dental caries was discussed in this review. [33]

Goodson M., Tavares M., WangX in **2013** did a study to evaluate the relationship of children's obesity and dental decay. The percentage of children with decayed or filled teeth varied inversely with the body weight category. The percentage of decayed or filled teeth decreased from 15.61% in underweight children, to 13.03% in normal healthy weight children, to 9.73% in overweight children to 7.87% in obese children. Differences between all groups were statistically significant. Male children in this population had more dental decay than female children but the reduction of tooth decay as a function of BMI was greater in male children. The finding of an inverse obesitydental decay relationship contradicts the obesity-sugar and the obesity-dental decay relationship hypotheses. Sugar is well recognized as necessary and sufficient for dental decay. Sugar is also hypothesized to be a leading co-factor in obesity. If the later hypothesis is true, one would expect dental decay to increase with obesity. This was not found. The reasons for this inverse relationship were not currently clear.[34]

Sheiham A. in **2006** did a study to examine the association between untreated dental caries in primary and permanent teeth with age-adjusted height and weight among 6–12-year-old children in Bangladesh. 26% of the children were underweight and 55% had untreated dental caries. Children with at least one decayed tooth were significantly underweight with odds ratios 1.6 and 1.5 for 6–8-years and 9–12-year-old children, respectively, in the adjusted model. The number of decayed teeth was inversely and significantly associated with the standardized age-adjusted weight. It highlights the association between untreated dental caries and being underweight in primary school children in socially deprived areas in low-income developing countries and emphasize the need to integrate oral and general health policies with social policies.[35]

Gilchrist F., Marshman Z, Deery C, Rodd H. D.in **2015** did a study to allow children to describe the impact of dental caries on their daily lives and to describe the terminology they used. Children aged 5-14 years, with caries experience were purposively sampled from primary and secondary care dental clinics. Focus groups and in-depth interviews were recorded and transcribed verbatim. Data analysis took a narrative approach and themes were derived from the data using framework analysis. Pain was the main theme which emerged. Within this, three sub-themes were identified: impacts related to pain; strategies adopted to reduce pain and emotional aspects resulting from pain. A second theme was also identified relating to the aesthetic aspects of caries. Children as young as five years of age were able to competently discuss their experiences of dental caries. Participants reported a number of impacts affecting various aspects of their lives. [36]

Rodd H.D, Blankenstein R in the year **2019** did a study to explore the association between obesity and dental caries in children and adolescents and to consider the possible reasons behind this relationship. A database search for papers published between January 2015 and May 2018, inclusive, addressing the association between obesity and dental caries was conducted. A review and critical appraisal of all included studies was performed. Twenty-six studies were included in this review from different populations worldwide. Eight studies assessed the primary dentition, nine studies were conducted on permanent dentition, and remaining nine studies on both dentitions. The results regarding the association between obesity and dental caries were conflicting and inconsistent. Nine studies concluded that there was no relationship between obesity and dental caries. A positive association was reported in five studies, while the inverse association was reported in eleven studies. Studies included in this review had significant variations in methodology and the investigated cofactors. Possible

explanations of the controversial association between obesity and dental caries are discussed in this review. [38]

Bafti L A, Hashemipour M A, Poureslami H, Hoseinian M in **2015** conducted a study to evaluate the relationship between BMI and tooth decay in a population of Iranian children. 1482 children were selected from kindergartens and preschool centers in Kerman, Iran. The children underwent examination of deciduous teeth after determination of height and weight for calculation of BMI. The mean of dmft in children with normal BMI was 1.5-fold that in subjects with extra body weight. Age had a significant effect on dmft. In addition, dmft was higher in boys compared to girls. The results of the study showed that caries rate in the deciduous teeth of 3-6-year-old children decreases with an increase in body weight. [39]

Chauhan A, Nagarajappa S, Dasar P.L, P. Mishra. in **2016** did a study to determine the association of body mass index with dental caries among malnourished tribal children of Indore division (M.P.) A cross-sectional house to house survey was carried out among 275 study subjects, 6-15 years old tribal children in two major tribal districts of Indore division. Permissions and consent was obtained from local administrative authorities, ethical committee and parents respectively. Anthropometric measurements like height, weight, mid-arm and head circumference were recorded. Children with confirmed malnourishment on basis of BMI index were considered for data collection. Oral examination for caries was conducted according to WHO 1997 survey methods. The caries prevalence among permanent dentition of malnourished children was 61.4% . Among tribes, malnourished children of Bhilala tribe showed significantly higher caries prevalence. Increase in caries prevalence was seen with increase in severity of malnourishment. Caries was more prevalent in malnourished tribal children and was seen to increase with severity of malnourishment. [40]

Panwar N.K et al in **2014** the study was undertaken to determine the association of nutritional status with dental caries in 8- to 12-year-old children of Udaipur city. Method: The study was conducted on a random sample of 1000 boys and girls, aged 812 years. The children were selected from schools located in the Udaipur City, Rajasthan. The schools examined were of government and private sector schools in Udaipur city. The children from schools of Udaipur city was taken in the study with male, female and age group ratio as per distribution in population. A proforma was used to record children's age, gender, school, year, height, weight, parental income and dental caries status. Study shows that the children with normal BMI for age had more caries in their primary teeth, as well as in their permanent teeth, than the overweight children.[41]
Swati T, Kiran K, Kamala BK in **2010** did a study to assess the association between obesity and dental caries. A total of 2688 students were examined from three schools. The students from private school were more obese than government school. The study was done by means of an anthropometric study using height/weight indices according to WHO criteria and National Centre for Health Statistics guidelines. BMI and DMFT indices were used. The prevalence of caries was 19.1%. No correlation between dental decay in obese and non-obese children was detected. These findings support US population-based literature and study done by Pinto et al. Nevertheless, the impact of interventions to address the epidemic in the dental setting has not been investigated. [42]

Prashanth ST, Venkatesh B, Vivek DK, Amitha HA in 2011 conducted a study to evaluate the relationship between dental caries and BMI in pre-school children of Bangalore City.A cross-sectional study was conducted on 208 healthy preschool children with the age range of 3-5 years recruited from nursery schools of Bangalore City. The Anthropometric measurements, weight and height were evaluated by calculating the z-scores using WHO Anthro software to elucidate the subject's status on the age- and sex-specific growth chart. Every Child who has received two Z-scores

under the normal value (<-2) was considered as abnormal (deficient). This study showed that lesser percentage of the participants had deficient height, weight and BMI. As the weight and BMI increased there was a significant increase in the number of caries and fillings among the participants.[43]

Pinto A, Kim S, Wadenya R, Rosenberg H in **2007** did a study to evaluate the association between weight and dental caries in a random prospective cohort of children at their initial visit at an urban dental school. One hundred and thirty-five children were recruited in a four-month period. The DS/ds index was used to assess caries, and BMI percentile was calculated based on age and gender-adjusted published scales. No correlation between dental decay in obese and non-obese children was detected. These findings support recent U.S. population-based literature that reports an inverse association between caries and weight in certain pediatric groups. Nevertheless, the impact of interventions to address the epidemic in the dental setting has not been investigated. As part of a health care team, dental students should be exposed to the changing demographics and sequelae of overweight in children.[44]

Moreira PV, Rosenblatt A, Severo AM in **2006** did a study to measure the association between dental caries and obesity in adolescents aged 12 to 15 years attending state and private schools. 1665 obese and 1665 normal-weight adolescents. These were chosen by means of an anthropometric study using height/age and weight/height indices, adopting as baseline the National Center for Health Statistics indices. The diagnostic criteria for caries were those of the World Health Organization (1997). The average DMFT for obese adolescents from state schools was 4.27 and for those of normal weight it was 4.25 . In private schools, the corresponding figures were 1.90 and 1.91, respectively. In state schools, the caries prevalence amongst the obese group was 50.9%

and amongst those of normal weight, 52.4% . In private schools, it was 9.0% amongst the obese group and 9.6% amongst those of normal weight. There was no statistically significant association between dental caries and obesity. Caries levels were higher amongst adolescents attending state schools. [45]

Feese M, Franklin F in **2003** did a study using The Multiphase Optimization Strategy, employed in this study, is a cutting-edge approach to maximizing resources in behavioral interventions by identifying the most effective intervention components. We are currently testing the main, additive and interactive effects of 6 intervention components, thought to support family meals, on family meal frequency and dietary quality (Primary Outcomes) as compared to Usual Head Start Exposure in a Screening Phase (N = 512 low-income families). Components yielding the most robust effects will be bundled and evaluated in a two-group randomized controlled trial (intervention and Usual Head Start Exposure) in the Confirming Phase (N = 250), testing the effects of the bundled intervention on children's adiposity indices (Primary Outcomes; body mass index and skinfolds). The current intervention components include: home delivery of pre-made healthy family meals; home delivery of healthy meal ingredients; (3) community kitchens in which parents make healthy meals to cook at home; healthy eating classes; cooking demonstrations; and cookware/flatware delivery. Secondary outcomes include cooking self-efficacy and family mealtime barriers. Moderators of the intervention include family functioning and food security. Process evaluation data includes fidelity, attendance/use of supports, and satisfaction.Results will advance fundamental science and translational research by generating new knowledge of effective intervention components more rapidly and efficiently than the standard randomized controlled trial approach evaluating a bundled intervention alone. Study

results will have implications for funding decisions within public programs to implement and disseminate effective interventions to prevent obesity in children. [47]

Naidu R, Prevatt I, Simeon D in **2006** did a study to describe the oral health and treatment need of schoolchildren in Trinidad and Tobago, using stratified cluster sampling. Participants were children in primary (aged 6-8 years) and secondary school (aged 12 and 15 years). Main outcome measures were DMFT/dmft, treatment need, and fluorosis. The caries experience of 12- and 15-year-old children were low but was high for schoolchildren aged 6-8 years, in terms of prevalence and severity. Effective oral health promotion strategies need to be implemented to improve the oral health of primary schoolchildren in Trinidad and Tobago. [50]

Petersen PE and Kaka M. in the year 1999 did a study to analyse the oral health status of children and adults in rural and urban areas of Burkina Faso; to provide epidemiological data for planning and evaluation of oral health care programmes. Cross-sectional survey including different ethnic and socio-economic groups was conducted through Multistage cluster sampling of households in urban areas and random samples of participants selected based on the recent population census in rural areas. At age 6, 38% of children had caries, with prevalence higher in urban than rural areas. At age 12, the mean DMFT was 0.7 with prevalence significantly higher among urban than rural children. Mean DMFT was 1.9 in 18-year-olds and 6.3 in 35-44-yearolds and figures were higher for women than men. In adults, no differences in caries experience were found by location whereas the caries index was significantly affected by ethnic group and occupation. [51]

Salapata J, Blinkhorn AS, Attwood D. in **1990** conducted a study to assess Dental health of 12-year-old children in Athens A 10% sample (684) of boys and girls in the

final year of state primary schools in three different areas of the city of Athens were examined. Their mean age was 11 yr 7 months and a mean DMFT of 2.41 was found. The majority of children claimed to be regular dental attenders. When the dental data from the three different socio-economic areas of the city were analysed independently, differences in the caries experience were noted. This investigation has reported lower DMFT scores than other Greek studies.[53]

Dummer PM, Addy M, Hicks R, Kingdon A, Shaw WC. In **1987** asessed the effect of social class on the dental disease status of a group of 11–12-year-old schoolchildren in South Wales . There were a number of differences between the social classes for the DMFT, DMFS and DFS indices, with social class I having significantly less caries experience than the others. These differences, however, were largely confined to the boys. There appeared to be no significant difference in reported toothbrushing frequency between the social classes but the children from the lower social classes admitted spending significantly more on sweets per week. The plaque and gingival bleeding scores showed an overall trend to increase from social class I through to social class V. The girls, in particular, showed progressively increasing and significantly different mean plaque and gingivitis scores. [54]

Parkar SM, Chokshi M. in **2013** did a study to assess whether dental caries was related to body mass index (BMI) in school going children of Ahmedabad city (Gujarat), India. Dental and anthropometric examinations were conducted on 750 school going children. Dental caries was diagnosed according to World Health Organization (WHO) criteria using deft/decayed, missing and filled teeth (DMFT) index. Nutritional status was obtained using BMI and classification of nutritional status was achieved using the standards of WHO. There was a highly significant difference when the prevalence of dental caries (deft/DMFT) was compared in different age groups of children. About 87.1% were underweight. There was a highly significant difference when the BMI and

mean deft score was compared; however, when the BMI and mean DMFT score was compared the result was not reached to the significant level . Significant correlation was observed between the different age groups and caries. There was a negative correlation between deft and BMI showing a significant result. Increase in age and underweight children were more likely to have caries experience. [55]

METHODOLOGY

The present cross-sectional study was done to evaluate the association between Body Mass Index (BMI) and Dental Caries among 12 and 15-year school going children in Lucknow city, Uttar Pradesh

STUDY AREA:

- Lucknow is the capital city of the Indian state of Uttar Pradesh.
- The city stands at an elevation of approximately 123 meters (404 ft) above sea level. Lucknow district covers an area of 2,528 square kilometers (976 sq mi)
- Bounded on the east by Barabanki, on the west by Unnao, on the south by Raebareli and in the north by Sitapur and Hardoi, Lucknow sits on the northwestern shore of the Gomti River.
- According to the provisional report of 2011 Census of India, Lucknow city had a population of 2,815,601, of which 1,470,133 were men and 1,345,468 women.
- The city has a total literacy level in 2011 of 84.72% In Lucknow city, the total literate population totalled 2,147,564 people of which 1,161,250 were male and 986,314 were female.

STUDY DESIGN:

- A descriptive cross-sectional epidemiological study was conducted among the school going children aged 12 and 15 years in Lucknow.

METHODOLOGY

- Lucknow city was divided into 5 geographical regions, North, South, West, East & Central zone.
- The study was conducted in the government and private schools of Lucknow city. There are around 4000 schools in Lucknow city.
- Schools from each region was randomly selected to obtain the desired sample size, such that there is an equal representation from each of the five zones.

- In the second stage, eligible school children were stratified according to age and gender, and randomly selected in proportion to the total number of 12 and 15years old students to reach sample size of 1000 students.
- Body weight was recorded to the nearest 100-gram using a standard beam balance scale with the subject barefoot and wearing light dresses.
- Body height was recorded to the nearest 0.5 cm without shoes, heels together and head touching the ruler with line of sight aligning horizontally.
- Body Mass Index (BMI) was calculated using the standard formula – Mass (Kg)/ height ^{2}(m).
- All the children were clinically examined for Dental Caries.
- The procedure for diagnostic criteria was those recommended by the World Health Organization (2013) for assessment of dental caries by Type III clinical examination recommended by ADA.

BODY MASS INDEX

  - Body Mass Index (BMI) is a person's weight in kilograms divided by the square of height in meters.
  - A high BMI can be an indicator of high body fatness. BMI can be used to screen for weight categories that may lead to health problems but it is not diagnostic of the body fatness or health of an individual.

- It is an inexpensive and easy-to-perform method of screening for weight categories that may lead to health problems.

- For children and teens, BMI is age- and gender-specific and is often referred to as BMI-for-age. In children, a high amount of body fat can lead to weight-related

diseases and other health issues. Being underweight can also put one at risk for health issues.

- A high BMI can indicate high body fatness. BMI does not measure body fat directly, but BMI is correlated with more direct measures of body fat.

- For children and teens, BMI is not a diagnostic tool instead it is used to screen for potential weight and health-related issues.

- If children have a high BMI for their age and gender, a health care provider may perform further assessments to determine if excess fat is a problem.

- These assessments might include skinfold thickness measurements, evaluations of diet, physical activity, family history, and other appropriate health screenings.

- The American Academy of Pediatrics recommends using BMI to screen for overweight and obesity in children beginning at 2 years old. For children under the age of 2 years old it is instructed to consult the World Health Organization (WHO) standards

STUDY POPULATION:

The age group was chosen based on index age group by World Health Organization *12 years*

This age is especially important as it is generally the age at which children leave primary school. Therefore, in many countries, it is the last age at which a reliable sample may be obtained easily through the school system. Also, it is likely that by this age all the permanent teeth except the third molars will have erupted. For these reasons, age 12 years has been chosen as the global indicator age group for international comparisons and surveillance of disease trends.

15 years

By 15 years, the permanent teeth have been exposed to the oral environment for three to nine years. The assessment of caries prevalence in adolescents may therefore be relevant. The age group of 15–19 years is also important in the assessment of periodontal disease in adolescents. In countries where it is difficult to obtain reliable samples from this age group, it is customary to examine individuals in two to three areas only, in the capital city or another large town and in one rural area.

INCUSION CRITERIA:

School children who have completed their 12 years of age at the time of study.

School children who have completed 15 years at the time of study.

Female students.

EXCLUSION CRITERIA:

1. Those children who refused to participate will be excluded.

2. Medically compromised children.

ETHICAL ISSUES:

Ethical clearance was given by the Institutional Ethical committee of Babu Banarasi Das College Of Dental Sciences.

CONSENT:

Verbal Informed consent was obtained from the participating population and permission was taken from the school authorities.

Patients' informed consent is a legal regulation and a moral principle. It represents patients' rights to take part in the clinical decision.

PILOT STUDY:

Pilot study consisting of two classes of 12-year-old and 15-year-old children consisting of 50 children each, in local schools was carried out.

Examiner calibration and training of recording clerks has been done at the same time.

The team of the survey consisted of administrators, coordinators, examiners and recorders participated in the pilot study.

A pilot study saves precious time, identify potential difficulties and prompt modifications that may be necessary before the actual survey is initiated.

SAMPLING TECHNIQUE:

A cluster random sampling technique was used to collect the sample.

Cluster sampling is applicable when preparing the sampling frame is difficult.

In it, geographical area is divided into small area called cluster like in our study
Lucknow city was divided into geographical area: North, East, West, South and Central

Population divided into several "clusters" in our study clusters are school

Each cluster representative of the population

Simple random sample selected from each

The samples are combined into one

The advantage is that cost of study is reduced.

SCHEDULE:

The collection of data was carried for 6 months between October 2019- February 2020.

As a guideline, a basic examination of a child usually takes about 10 minutes.

Daily and weekly schedules were prepared.

The schedule was made available to school authorities.

The schedules allowed for some flexibility, so that unexpected delays do not cause major upsets in the survey timetable.

The plan for scheduling the time survey included: Introducing the examining team to the school director and class teachers concerned; Choosing an appropriate place to carry out the examinations in each school, and setting up equipment; Examining one class of 12-year-olds or 15 years old, Providing a brief oral report to the school director; Travelling to the next school.

SAMPLE SIZE:

The sample size was estimated using the formula $n=Z^2P(1-P)/d^2$. The sample size was estimated to be 720, which was increased to 1000 for generalizability of the study.

Where Z=1.96 p= 21%

CALIBRATION AND TRAINING

The calibration of the principal investigator was done by the research head who had conducted various epidemiological study and has thorough knowledge of the subject.

Research head who was trained in accordance with the recommended methods for basic oral health surveys was appointed to act as a validator for the survey team.

The calibrator examined at least 25 subjects who was also examined by each member of the survey team.

INTRA-EXAMINER REPRODUCIBILITY

Examiner first practiced the examination on a group of 10 subjects with a wide range of levels of dental caries

The examiner determined how consistently she can apply the diagnostic criteria by examining a group of about 25 subjects twice, on successive days, or with a time interval of at least 30 minutes between examinations

These subjects were pre-selected so that they collectively represent the full range of conditions expected to be assessed in the actual survey.

DUPLICATE EXAMINATION

To allow detection and correction of this tendency, the examiner performed duplicate examinations on 5–10% of the sample (no fewer than 25 subjects) in the actual survey.

The most convenient age groups for duplicate examinations are likely to be the 12- and 15-years age groups because of ease of access.

RECORDING CLERK

Examiner was assisted by an alert and cooperative recording clerk who was seated close to the examiner, followed instructions precisely and neatly note down numbers and letters.

Clear instruction was given to the clerk clear about recording the data on the assessment form. The meaning of the terms that will be used in the proforma was explained to the clerk and she were instructed in the coding systems so that, with practice, she will be able to recognize obvious mistakes or omissions made by the examiner.

Before the survey begins, the clerk practiced recording the findings of a few preliminary examinations.

Special instructions were given and additional practice was undertaken as the clerk was not familiar with the alphabetical or numerical symbols used on the assessment form.

Failure to ensure that the recording clerk is making clear entries may result in confusion between codes later on in the process.

ORGANIZING CLERK

Organizing clerk was to maintain a constant flow of subjects to the examiner(s) and to enter general descriptive information on the record forms.

The organizing clerk also checked the finished records for accuracy and completeness, so that missing information may be obtained before the survey team moves to another location.

This person was also be responsible for ensuring that the examiners have an adequate supply of sterile instruments.

INSTRUMENTS AND SUPPLIES

The quantity and weight of instruments and supplies used in the survey was kept to a minimum; however, sufficient numbers of instruments were available to avoid the need to temporarily stopping examinations while used ones are being sterilized.

A table or platform to hold the dental instruments and basins should be within easy reach of the examiner.

The following instruments and supplies were used

- instruments for oral examination: plane mouth mirrors; metallic periodontal probes (Community Periodontal Index (CPI) probe) that conform to WHO specifications, i.e. 0.5 mm ball tip; a black band between 3.5 and 5.5 mm and rings at 8.5 and 11.5 mm from the ball tip; and several pairs of tweezers;
- containers (one for used instruments and one for disinfecting or sterilizing instruments) and concentrated disinfecting solution in sufficient quantity;
- rubber gloves;
- wash basin for either water and soap or disinfectant solution;
- cloth or paper hand towels; and
- gauze.

A minimum of 30 mouth mirrors and 30 periodontal probes per examiner was provided.

Used instruments was placed in disinfectant solution, then washed and drained well before sterilization.

INFECTION CONTROL

The investigator and all personnel participating in the survey were made aware of the possibility of cross-infection when conducting examinations or handling contaminated instruments

Current national recommendations were responsibly followed for both infection control and waste disposal.

Adequate number of instruments were carried for the survey, which was later autoclaved in the institution.

EXAMINATION AREA

The examination was carried in the class room or field of the school premises with consistent lighting

Subjects can also be examined seated in a chair with a high backrest with the examiner standing behind or in front of the chair

SURVEY FORMS

An adequate supply of assessment forms, hardboard bases and clips, sharpened pencils, erasers and copies of the recording instructions, coding lists and measurement criteria was readily available

DAILY REVIEW OF ASSESSMENT FORMS

It is very important that every examiner reviews each day's assessment forms on the same day, for completeness and accuracy of recordings.

DATA ANALYSIS

The data collected were entered in IBM SPSS statistics 20

Descriptive analysis of qualitative variable is shown as number and percentages.

Descriptive statistics represents the total number of participants, gender wise distribution, types of school: government or private.

Inferential statistics used are ANOVA, co- relation and liner regression

One-way ANOVA was done to check for the equality of quantitative data.

ANOVA was done to compare the mean difference between the groups

A Pearson product correlation was run to determine the relationship between BMI and dental caries.

Linear regression was performed to predict the value of BMI on dental caries (If there is a relationship, is it dependent on each other).

P value less than 0.05 was considered statistically significant. All the data were reported with exact p-values and 95% confidence intervals (CI) and 5% margin of error (z).

CLINICAL EXAMINATION

DENTAL CARIES

The Boxes 45–108 in the Oral Health Assessment Form was used for Adults and 45–72 in the Oral Health Assessment Form was used for Children.

The examination for dental caries was conducted with a plane mouth mirror.

The use of radiographs for detection of approximal caries was not recommended because the equipment is unfeasible to use in field survey.

Dentition status was obtained using, the following points:

- the examination was carried in sequence from one tooth to another
- a tooth was considered present in the mouth when any part of it is visible
- if a permanent and primary tooth occupy the same tooth space, the status of the permanent tooth was only recorded.

Permanent dentition status for crown was recorded using number scores and the primary dentition status was recorded using letter scores in the boxes.

Boxes 45–76 were used for maxillary teeth and Boxes 77–108 for mandible teeth.

An entry was made in every box coinciding to the coronal status of a tooth.

In children, root status was not assessed; therefore the boxes was omitted in the Oral Health Assessment Form for Children.

Considerable care was taken to identify tooth coloured fillings.

Coding the dentition status – primary and permanent teeth

Code			Condition/status
Primary	**Permanent teeth**		
Crown	**Crown**	**Root**	
A	0	0	Sound
B	1	1	Caries
C	2	2	Filled, with caries
D	3	3	Filled, no caries
E	4	–	Missing due to caries
–	5	–	Missing for any other reason
F	6	–	Fissure sealant
G	7	7	Fixed dental prosthesis abutments, special crown or veneer/implant
–	8	8	Unerupted tooth (crown)/unexposed root
–	9	9	Not recorded

The criteria for diagnosing a tooth status and the coding are as follows

0 **(A)** *Sound crown.*

A crown was coded sound if it shows no evidence of treated or untreated clinical caries . The stages of caries that precede cavitation, as well as other conditions similar to the early stages of caries, were excluded because they cannot be reliably identified in most field conditions.

Thus, a crown with the following defects, in the absence of other positive criteria, was coded as sound:

- white or chalky spots; discoloured or rough spots that are not soft to touch with a metal CPI probe;
- stained enamel pits or fissures that do not have visible cavitation or softening of the floor or walls detectable with a CPI probe;
- dark, shiny, hard, pitted areas of enamel in a tooth showing signs of moderate to severe enamel fluorosis; • lesions that, on the basis of their distribution or history, or on examination, appear to be due to abrasion.

(B) *Carious crown.*

Caries was recorded as present when a lesion in a pit or fissure, or on a smooth tooth surface, has an unmistakable cavity, undermined enamel, or a detectably softened floor or wall.

A tooth with a temporary filling, or one which was sealed but also decayed, was also included in this category.

In cases where the crown has been destroyed by caries and only the root is left, the caries was judged to have originated in the crown and was therefore scored as crown caries only.

The CPI probe was used to confirm visual evidence of caries on the tooth surface(s). Where any doubt exists, caries was not recorded as present.[24]

BODY MASS INDEX

BMI is interpreted differently for children and teens even though it is calculated with the same formula.

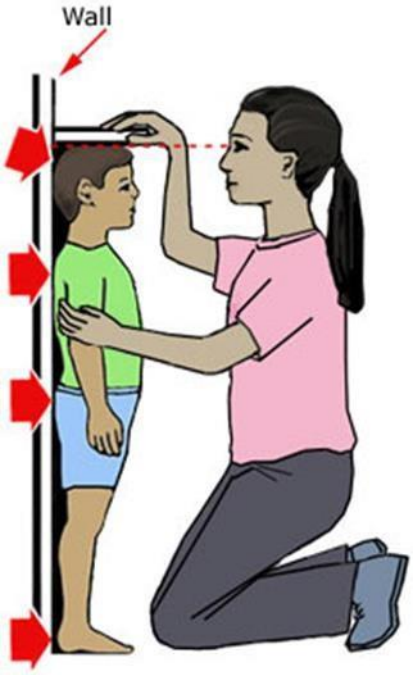
Due to changes in weight and height with age, as well as their relation to body fatness, BMI levels among children and teens are expressed relative to other children of the same sex and age.

These percentiles were calculated from the CDC growth charts, which were based on national survey data collected from 1963-65 to 1988-944.

To measure height accurately to calculate BMI-for-age:

1. child or teen's shoes, bulky clothing, and hair ornaments, and unbraid hair that interferes with the measurement was removed.
2. The height was measured on flooring that was not carpeted and against a flat surface such as a wall with no molding.
3. The child or teen were instructed to stand with feet flat, together, and against the wall and made sure legs were straight, arms were at sides, and shoulders were at level.
4. The child or teen was asked to look straight ahead and that the line of sight was parallel with the floor.

5. The measurement was taken while the child or teen stands with head, shoulders, buttocks, and heels touching the flat surface (wall). Depending on the overall body shape of the child or teen, all points may not touch the wall.
6. A flat headpiece was used to form a right angle with the wall and lower the headpiece until it firmly touches the crown of the head.
7. Care was taken to make sure the measurer's eyes were at the same level as the headpiece.
8. Light mark was made where the bottom of the headpiece meets the wall. Then, a metal tape was used to measure from the base on the floor to the marked measurement on the wall to get the height measurement.
9. Accurately the height was recorded to the nearest 1/8th inch or 0.1 centimeter.



To measure weight accurately to calculate BMI-for-age:

1. A digital scale was used. Bathroom scales that are spring-loaded were avoided. The scale was placed on firm flooring (such as tile or wood) rather than carpet.
2. The child or teen was asked to remove shoes and heavy clothing, such as sweaters.

3. The child or teen was made to stand with both feet in the center of the scale. 4. The weight was recorded to the nearest decimal fraction

The data were entered in CDC widget and Body Mass Index was calculated

This calculator provides body mass index (BMI) and the corresponding BMI-for-age percentile based on CDC growth charts for children and teens ages 2 through 19 years. Because of possible rounding errors in age, weight, and height, the results from this calculator may differ slightly from BMI-for-age percentiles calculated by other programs.

Weight Status Category	**Percentile Range**
Underweight	Less than the 5th percentile
Normal or Healthy Weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obese	Equal to or greater than the 95th percentile

After BMI is calculated for children and teens, it was expressed as a percentile obtained from percentile calculator .

These percentiles express a child's BMI relative to US children who participated in national surveys from 1963-65 to 1988-944.

Weight and height change during growth and development, as does their relation to body fatness.

Consequently, a child's BMI must be interpreted relative to other children of the same sex and age.

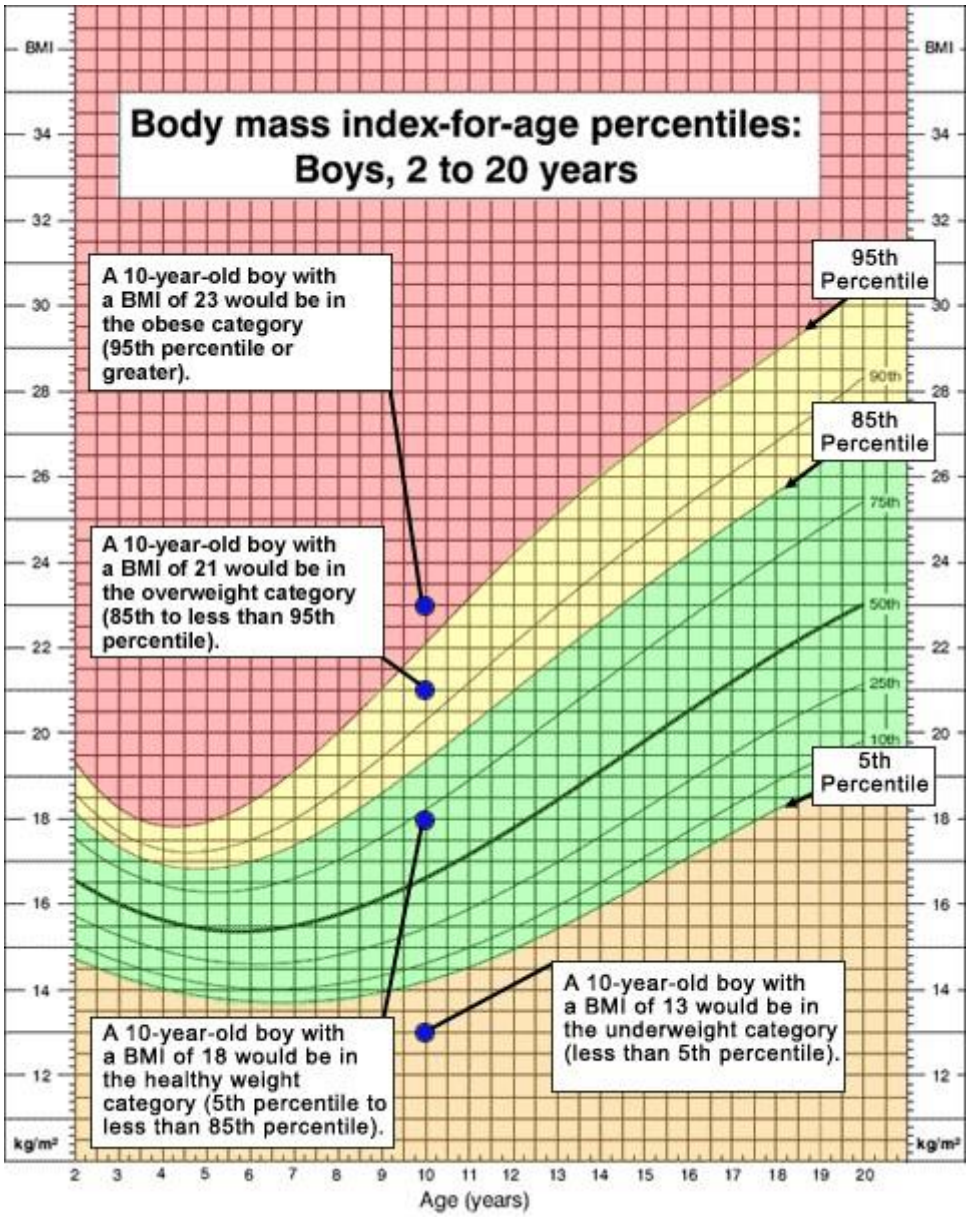


Figure: Growth chart example showing range of different BMI percentiles for height and age.

PELLET: EXAMINING HEIGHT OF PARTICIPANT

PELLET: EXAMINING WEIGHT OF PARTICIPANTS

PELLET: EXAMINING DENTAL CARIES OF PARTICIPANT

PELLET: CAMP HELD AT SCHOOL

RESULT

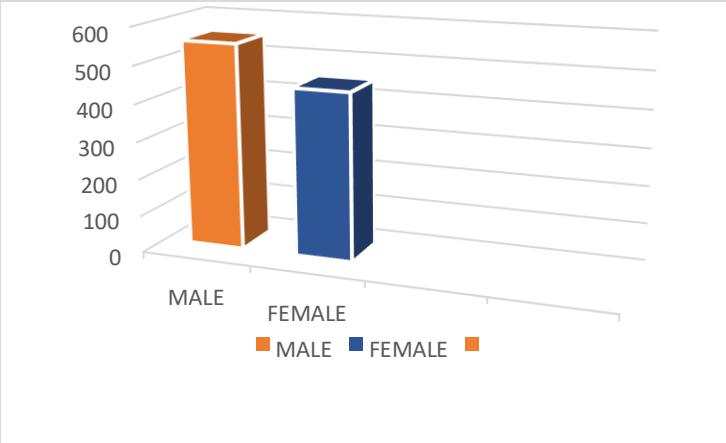
Table 1 shows the demographic data of the participants of the study. Out of 1000 participants 449 consisted of 12-year-old school going children, where as 551 consisted of 15-year-old school going children.

Among 12 year there were 223 male participants and 226 female participants, while there were 329 males among 15 years old and 222 females.

The total male participants in the study were 552 and 448 females.

TABLE 1: DISTRIBUTION OF STUDENTS AGE AND GENDER WISE

Age	Male	Female	Total
12	22.3% (223)	22.6% (226)	44.9% (449)
15	32.9% (329)	22.2% (222)	55.1% (551)
Total	55.2% (552)	44.8% (448)	100% (1000)



GRAPH1: GENDER WISE DISTRIBUTION OF OVERALL STUDENTS

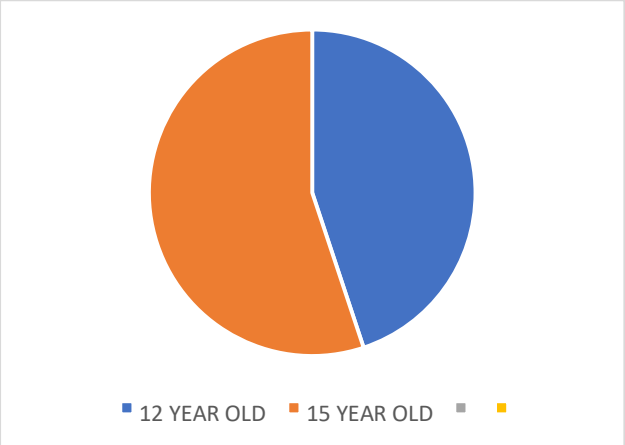
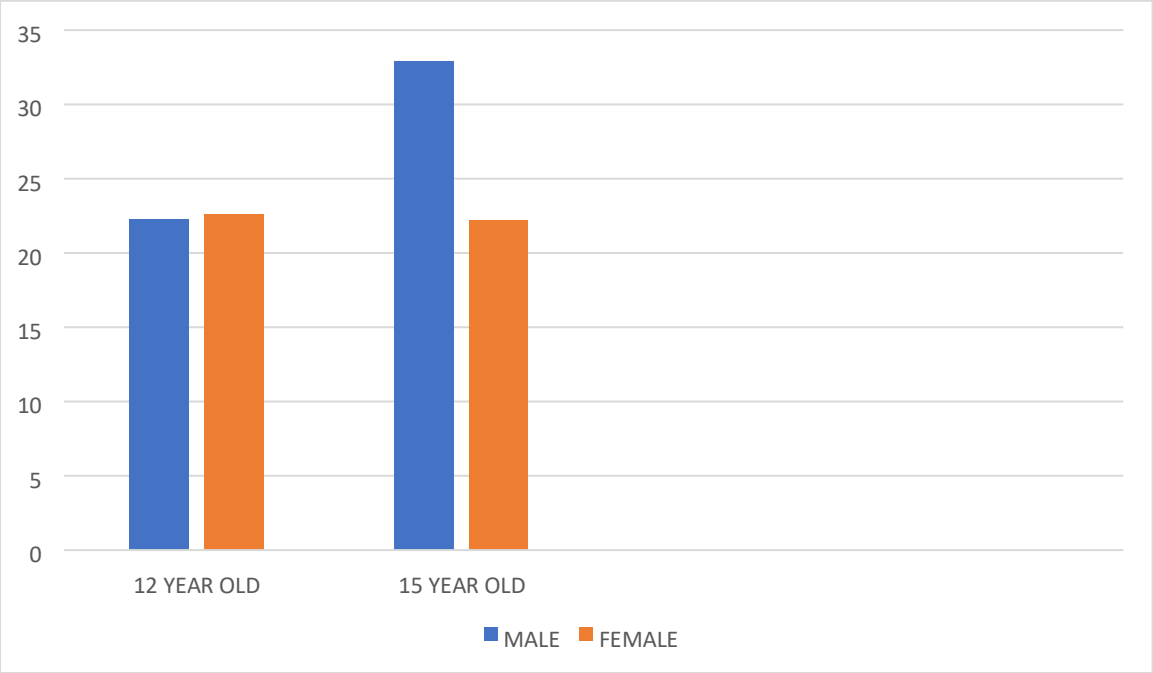


FIGURE 1 : AGE WISE DISTRIBUTION OF PARTICIPANTS



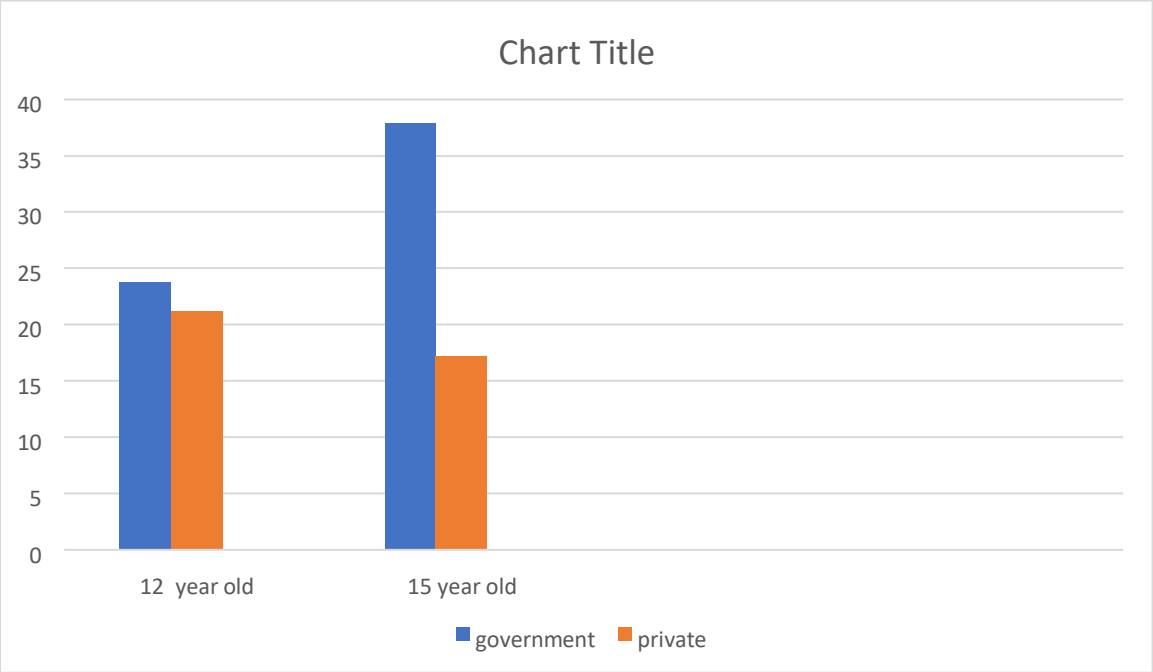
GRAPH 2: AGE AND GENDERWISE DISTRIBUTION OF PARTICIPANTS

Table 2 shows the distribution of schools in government and private schools and gender wise. 23.7% of 1000 participant belonged to 12 years old of government school of which 14.3% were males and 9.4% were females; while 21.2% belonged to private schools of which 13.1% were males and 8.1% were females.

Out of 15-year-old 37.9% went to government school of which 19.5% were males and 8.3% were females. Whereas, 17.2% went to private school which comprised of 8.3% males and 8.9% females.

Table 2: Distribution of subjects according to gender and schools

Age	Schools	Male	Female	Total
12	Government	14.3% (143)	9.4% (94)	23.7% (237)
	Private	13.1% (131)	8.1% (81)	21.2% (212)
15	Government	19.5% (195)	18.4% (184)	37.9% (379)
	Private	8.3% (83)	8.9% (89)	17.2% (172)
Total		55.2% (552)	44.8% (448)	100% (1000)



GRAPH 3: distribution of school according to age

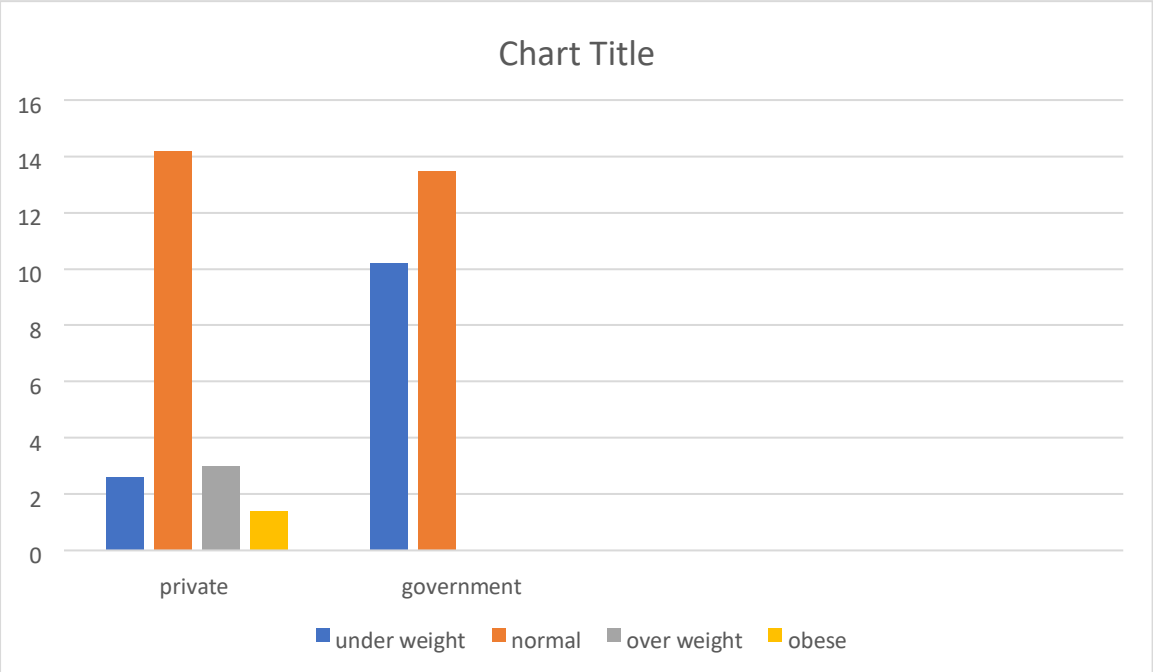
Out of the total 12-year-old who attended government school 102 were found to be underweight whereas 0nly 26 of private school children were found to be underweight. 135 students of government school, 142 students of private school children were in the normal Body Mass Index. There were no overweight students from government school

or obese group whereas 30 participants of private schools were over weight and 14 were obese.

Table 3: Distribution of subjects according to BODY MASS INDEX among 12-yearold

Age	BODY MASS INDEX	Private	Government
12	Under weight	2.6% (26)	10.2% (102)
	Normal	14.2% (142)	13.5% (135)
	Over weight	3% (30)	0
	Obese	1.4% (14)	0

P<0.000. BODY MASS INDEX: Body Mass Index



GRAPH 4: school wise distribution of B.M.I

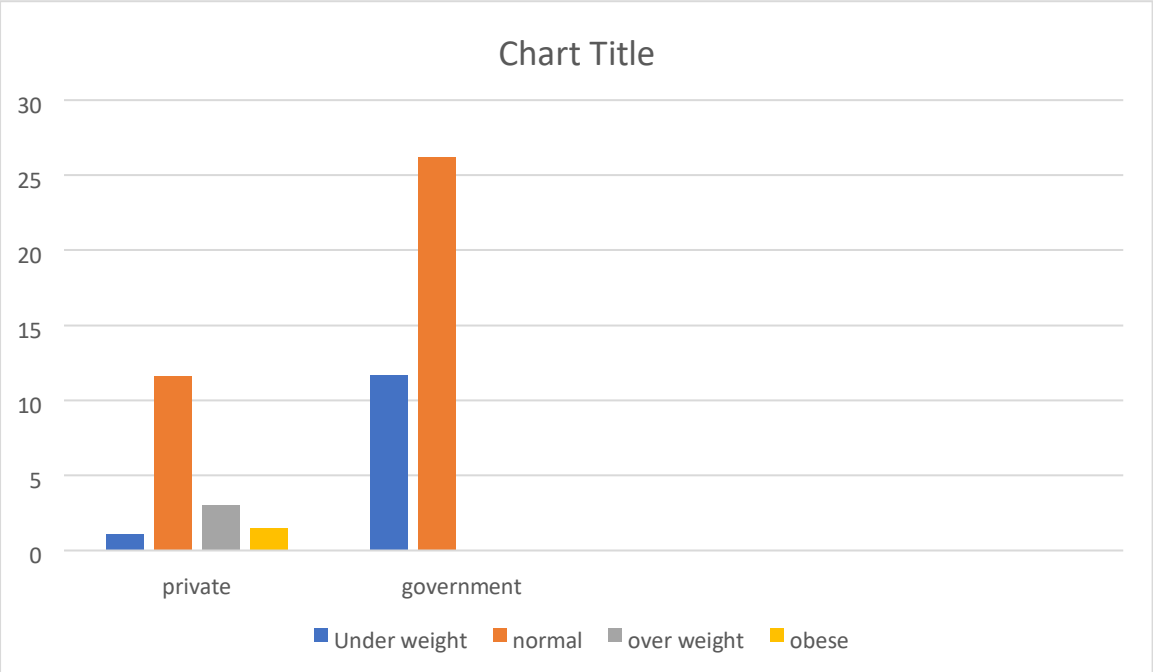
Table 4 shows the Body Mass Index of 15-year-old, 117 participants attending government schools were found to be underweight where as the number for private school were 11. 262 government school children were normal while this number for

private school were 116. There were 28 overweight students and 17 obese students in private schools while none was found in government schools.

Table 4: Distribution of subjects according to BODY MASS INDEX among 15-yearold

Age	BODY MASS INDEX	Private	Government
15 year old	Under weight	1.1% (11)	11.7% (117)
	Normal	11.6% (116)	26.2% (262)

	Over weight	2.8% (28)	0
	Obese	1.7% (17)	0



GRAPH 5: school wise distribution of Body Mass Index among 15 year old

Table 5 shows gender wise distribution of Body Mass Index of 12-year-old. 101 males were found to be underweight; 27 females were under weight. 149 males fell under normal category while 128 females were in normal category. 11 of males were found to be overweight, and 3 were obese. While there was 19 overweight and 11 obese females.

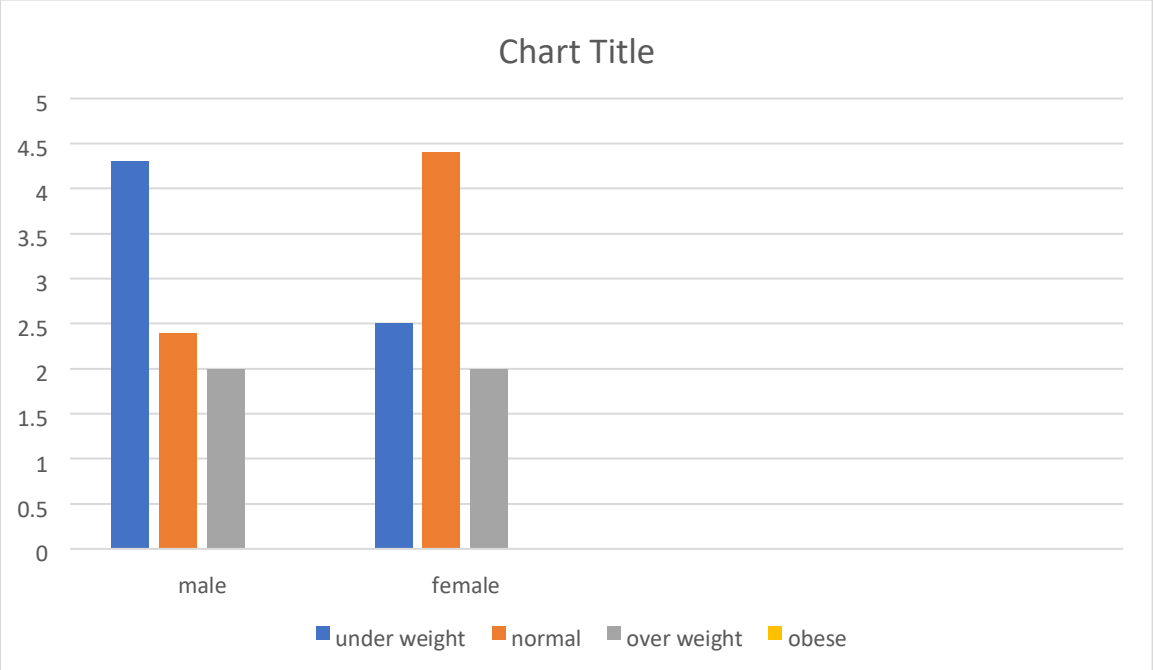
Table 5: distribution of gender wise BODY MASS INDEX among 12 year old

12 year old	B.M.I	Male	Female
	Under weight	10.1% (101)	2.7%(27)
	Normal	14.9%(149)	12.8%(128)
	Over weight	1.1%(11)	1.9%(19)
	Obese	0.03%(3)	1.1%(11)

Table 6 shows gender wise distribution of Body Mass Index of 15-year-old. 75 males were found to be underweight; 53 females were under weight. 177 males fell under normal category while 201 females were in normal category. 17 of males were found to be overweight, and 9 were obese. While there was 11 overweight and 8 obese females.

6: distribution of gender wise BODY MASS INDEX among 15-year-old

15-year-old	B.M. I	Male	Female
	Under weight	7.5% (75)	5.3% (53)
	Normal	17.7% (177)	20.1% (201)
	Over weight	1.7% (17)	1.1% (11)
	Obese	0.9% (9)	0.8% (8)



Table

GRAPH 6: gender wise distribution of Body Mass Index among 15-year-old Table 7 shows result on continuous measurement present as mean +/- SD. The mean DMFT was found to be significant in respect with 12-year-old school going children.

7: Mean DMFT according to gender

Age	Gender	Mean dental caries	SD	P value
12 years	Male	0.533	0.939	0.006*
	Female	0.799	1.126	
15 years	Male	0.997	1.341	0.212
	Female	1.142	1.591	

DMFT: Decayed missing filled teeth,

SD: Standard deviation.

*Statistically significant

The highest mean Dental Caries (0.721+/- 1.001) was seen in under weight category and the lowest mean dental caries was reported in over weight category (0.021+/-0.164) of Body Mass Index at the age of 12 years but the difference was not statistically significant. At the age of 15 years also underweight category had highest mean Dental

Table

Caries as compared to other categories and the difference was statistically significant shown in table 8.

8 shows dental caries compared to different Body Mass Index categories.

Age	Body Mass Index	Mean dental caries	SD	P value
12-year-old	Under weight	0.721	1.001	0.091
	Normal	0.713	1.191	
	Over weight	0.021	0.164	
	Obese	0.063	0.131	
15year old	Under weight	1.128	1.413	0.113
	Normal	0.978	1.371	
	Over weight	0.714	0.530	
	Obese	0.712	0.513	

Table 9 depicts correlation between BODY MASS INDEX and dental caries of 12-yearold school going children. The result was found to be significant (p=0.00) with a Pearson correlation to be 0.444.

Table 9: correlation between BODY MASS INDEX and dental caries 12-year-old

		DC	BODY MASS INDEX
DC	Pearson Correlation	1	.444**
	Sig. (2-tailed)		.000
	N	449	449
BODY MASS INDEX	Pearson Correlation	.444**	1
	Sig. (2-tailed)	.000	
	N	449	449

**. Correlation is significant at the 0.01 level (2-tailed).

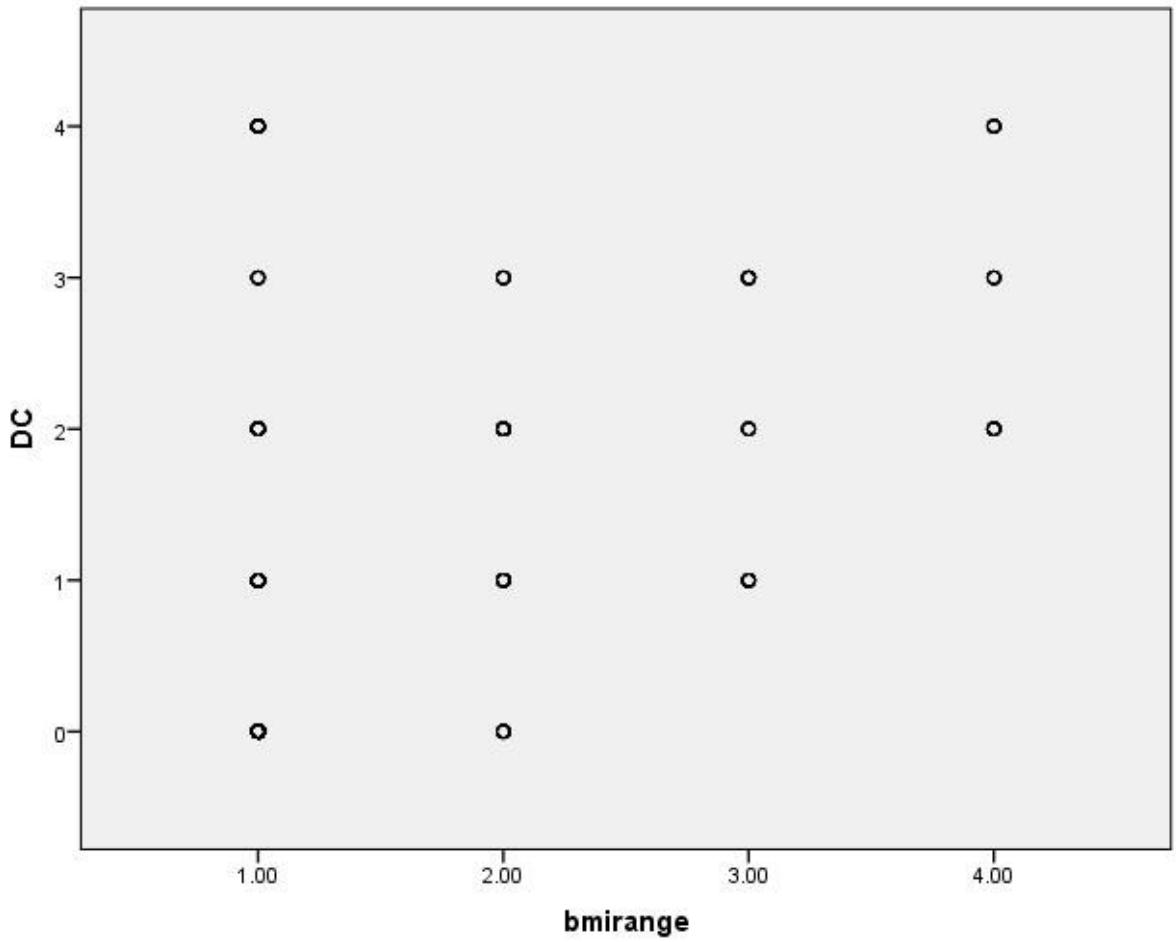


FIGURE2: correlation between Body Mass Index and dental caries 12 years old Table 11 shows the correlation between BODY MASS INDEX and dental caries with p=0.00 interpreted as significant.

Table 10: Correlations between Body Mass Index and dental caries of 15-year-old

		dc	Body Mass Index range
Dc	Pearson Correlation	1	.435**

	Sig. (2-tailed)		.000
	N	551	551
Body Mass Index range	Pearson Correlation	.435**	1
	Sig. (2-tailed)	.000	
	N	551	551

**. Correlation is significant at the 0.01 level (2-tailed).

DMFT: Decayed missing filled teeth, SD: Standard deviation, BODY MASS INDEX: Body Mass Index

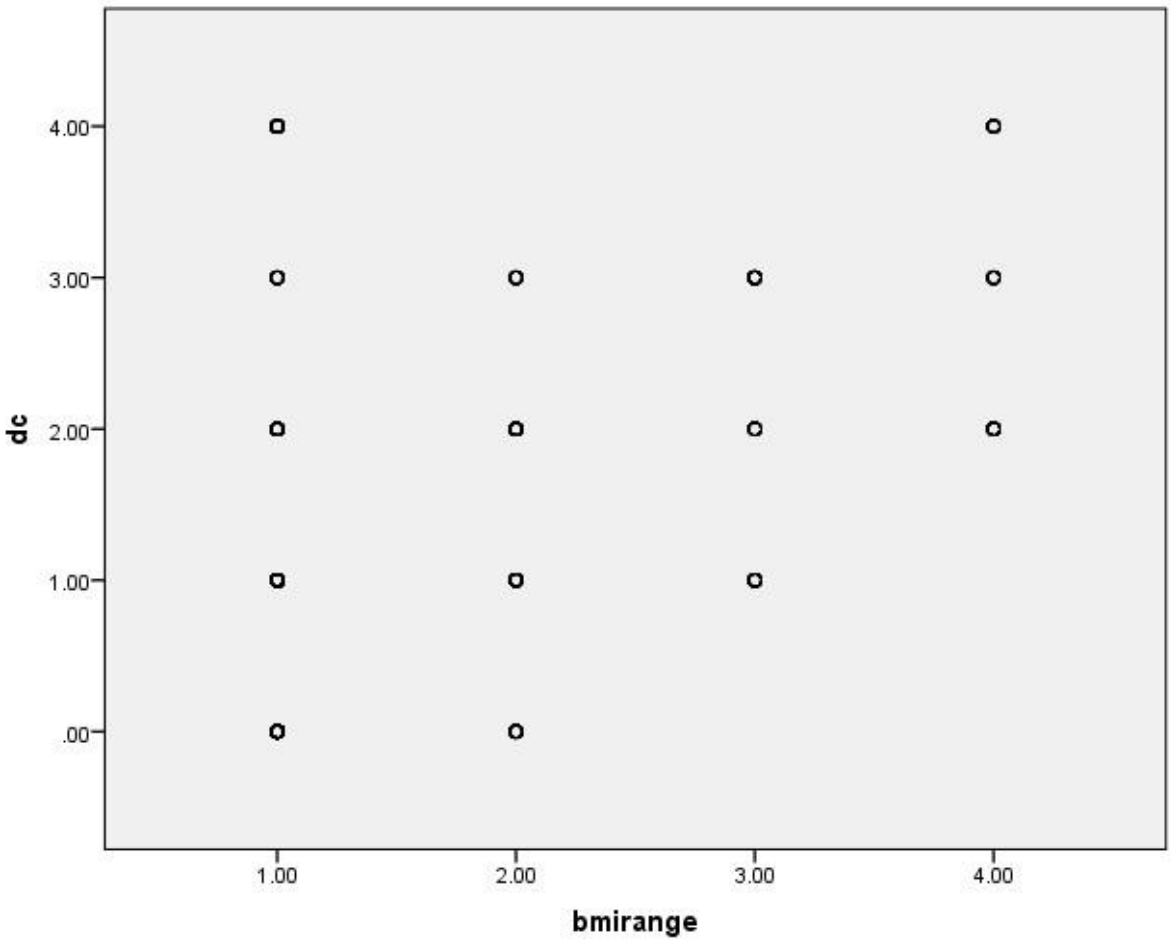


Figure 3: correlation between Body Mass Index and Dental Caries 15 years old

Correlation analysis was seen in table 10 it shows BODY MASS INDEX had a negative correlation with Dental caries. ($r=0.412$, $p<0.011$)

Table 11: Correlation analysis between strata of BODY MASS INDEX and dental caries.

Pearson's correlation coefficient	Decayed teeth
R	-0.412
P value	<0.01

DISCUSSION

The prevention and control of dental caries and its associated factors remains a daunting task to the healthcare professional due to its multifactorial nature. Over the period of time, alterations in lifestyle and diet have been accelerated by industrialization, urbanization, economic development, and market globalization. The present study was conducted to know the association between Body Mass Index and dental caries.

In the past decades, these changes in lifestyle and diet have been impacting on nutrition and oral health, notably through higher carbohydrate intake and lower physical activity levels, particularly among the younger members of the population. [25]

Children with underweight Body Mass Index were found to have more dental caries. The numbers were prominent in government school as compare to private schools. The reason can be because of poor oral hygiene status and knowledge among the parents of the participants.

However, when it came to students with private school the underweight students with working mothers are found to be fussy eaters, they eat more chocolates and cariogenic food. The school have rules regarding diet plan, junk food is prohibited in the tiffin only one day is assigned for junk food in tiffin, even the tuck room in school don't keep junk food. Underweight children were given more diet and number of meals by grandparents and caretakers so to increase weight as malnutrition is a major concern of parent of growing children.

The role of diet is significant in the development of obesity and dental caries. Both conditions share some common diet-related risk, which influences the incidence of both obesity and dental caries. These diet factors include poor food choices, dietary habits, frequency and high consumption of fermentable carbohydrates, consumption of sweetened junk foods, and high-calorie and cariogenic diets. [26,27]

Lifestyle characteristics that may play a role in the development of both conditions include reduced physical activity, increased consumption of snacks, and increased time spent watching TV and using new multimedia technologies. [28, 29]

Additionally, it has been suggested that both conditions are more prevalent in some specific communities due to unhealthy food, lower parental education levels, and inability to obtain sufficient health care and services. [26, 30,31]

Although sugar is one accepted risk factor for obesity and dental caries, the inverse relationship may also be attributable to dietary patterns. Obese children and adolescents might consume more fatty foods, fried foods, and unrefined carbohydrates, but not necessarily more foods high in sugar and refined carbohydrates. This could increase obesity, but not necessarily have a direct link to dental caries [32, 33, 34.]

Further to the diet itself, the process of mastication has also been reported to be affected by dental caries, which in turn could lead to reduced nutritional intake by children and young people [35]. Gilchrist et al. [36]reported that some children with caries may have restricted diets for lengthy periods of time, relating to difficulty eating hard foods, and getting food stuck in their teeth.

The effects of these dietary limitations may extend further than just weight. A number of earlier studies have investigated the association between iron-deficiency anemia, a common form of malnutrition, and dental caries [37.] Rodd and Blankenstein identified a statistically significant increase in the number of teeth which required extraction amongst UK children with anemia, compared to those without, indicating that caries severity may be greater in anemic children [38.]

Further to this, dietary nutrients such as vitamins A and D, calcium, and phosphate play important roles in tooth morphology, chemical composition, and tooth eruption patterns. Reduced consumption of these nutrients may in turn affect the susceptibility of teeth to dental caries [39, 40, 41.]

In the present study, most of the children in both the age groups i.e 102 in 12 year group and 117 in 15 year old, were in the underweight category which may be due to poor socio- economic strara and diet. Further higher percentage of overweight and obese children was found in private schools in both the age groups which was also reported by Swati Tripathi (19.1%),[42] Prashant ST,[43]Ana F Granvile-Garcia et al.,[44] and Partrica vasconcelos leitao moreira·[45] This may be explained by low-intensity physical activities together with consuming high-energy value food among the higher socio economic levels (private schools) as compared to lower socioecomic levels (Govt. schools).[46,47]

Many studies involving body weight use BMI percentile as the measure of "body fatness," as it is age and sex adjusted and allows for the ability to accurately compare children of differing ages and gender.[48]Growth charts can be computed for different genders and age groups and compared to CDC norms. However, since growth chart below 2 years is not specified by CDC, the age group selected in the present study was above 2 years.

Oral diseases, especially dental caries, are still mainly prevalent in most developing countries, affecting people from all races, socioeconomic status, and ages. This disease, dental caries, still continues to be a public health problem in spite of technological advancements and a better understanding of the carious process [49] Dental caries is a multifactorial disease attributed to both modifiable risk factors like dietary factors, water fluoride levels, tooth brushing frequency, and nonmodifiable risk factors like

socioeconomic status and previous caries experience. The focus now is shifted to modifiable factors, specifically diet, in the prevention of dental caries.

It is a general concept that people with high BMI will tend to have more caries as compared to people with lower Body Mass Index, but in the present study an inverse correlation was found among the participants. A mean DMFT of 1.128+-1.413 was found among the underweight participants of 15-year-old school going children which was also highest among the underweight students of 12-year-old with a mean DMFT of 0.721+- 1.001. The observation was found to be non-significant when done in between group comparison.

In the present study, the mean DMFT at 12 years and at 15 years was 0.62 and 1.06 respectively which was also reported by Naidu R[50] and Peterson PE[51] Females had a significantly higher mean DMFT value than males. This is in line with the findings of Al Shammery et al, [52]Salapatal et al,[53] Dummer.[54]This may be due to the fact that teeth erupt earlier in females than males which leads to prolonged exposure of the teeth to the oral environment in females.

The study result had a significant correlation with respect to the age which was in accordance with a study done by Parkar et al.[55]

It was observed that there was an inverse relation between Body Mass Index and Dental Caries.

which was also reported by Prashant S,[55] Mojard,[56] Sheiham A,[57] Kantovitz KR,[58] and Macek and Mitola.[59] Bhayat et al. [60] (KSA, 402, 12 to 14)

Chauhan et al. [61] ,Alghamdi and Almahdy et al. [62] Fernández et al. [63] and Sharma B. [64] This may be because the underweight children would have acute or chronic nutritional stress due to poor socioeconomic status and lack of knowledge about general and oral health.

Another explanation for the inverse association might be that children with untreated caries could experience pain and infection, thus preventing them from consuming adequate nutrition. In addition, other factors that contribute to overall wellbeing could be affected, including the ability to sleep, which in turn may lead to malnutrition and growth impairment [65,66.67]. The wider literature suggests that underweight children gained weight after receiving dental treatment [68,69].

However, this possible explanation is more apparent in populations with a high proportion of severe and untreated dental caries [70]. Another possible explanation for an inverse relationship is that saliva production increases due to increased food consumption in obese groups . The protective effect of saliva as a mechanical cleanser and pH buffer could thus reduce the incidence of dental caries [71]. Many authors have suggested that both being underweight and having dental caries could be due to poverty and low socioeconomic status [66,70]. Nonetheless, this association is not present in all populations, and there is great variation globally that can be partially attributed to cultural differences [72].

On the contrary, Kenan Cantekin[73] on a sample of 12 yrs in Turkey reported a positive relationship between BMI and mean DMFT. Another Swedish study of 15-year-old children revealed a significant positive correlation between DMFS indices and relative BMIs in the obese group[74] High caries experience and higher BMI have also been shown by Hilgers et al.[75] Willershausen.[76] Li et al. [77], Qadri et al. [78] Basha et al. [79]. The literature has also suggested that positive associations between obesity and dental caries may be the result of other shared contributing factors, such as those relating to lifestyle.

Lifestyle characteristics that may play a role in the development of both conditions include reduced physical activity, increased consumption of snacks, and increased time spent watching TV and using new multimedia technologies [80].

Additionally, it has been suggested that both conditions are more prevalent in some specific communities due to unhealthy food, lower parental education levels, and inability to obtain sufficient health care and services [81].

Few studies showed no association between Body Mass Index and dental caries i.e Kottayi et al. [82] and Kumar et al. [83] Some investigators found no correlation between obesity and dental caries. One possible explanation for this stems from the fact that both obesity and dental caries are multifactorial in etiology, and various genetic and environmental factors have an impact on them. Consequently, the many confounding factors, including age, gender, and lifestyle, might determine the development of these conditions. Nonetheless, the literature suggests that dietary factors, oral hygiene practices, and socioeconomic status are more significant risk factors for dental caries than for the development of obesity [84].

Moreover, as stated previously, obesity can be due to an increased intake of dietary fats, which has less influence on the development of dental caries than a diet high in sugar [60].

Interestingly, where proper oral hygiene is maintained with adequate fluoride exposure, dental caries prevalence has decreased despite increases in sugar consumption [85].

The exact mechanism for the association of body weight and dental caries is not yet known. It has been proposed that consumption of refined carbohydrates might serve as a link between obesity and the onset of dental caries. Marshall et al.[86] found that children <5 years of age with dental caries had a higher soft drink intake than children without caries. However, they could not establish a relation between soft drink consumption and BMI levels. On the other hand, a study by Ochoa et al.[87] found that children who consume sugar-sweetened beverages have a 1.74 times greater risk of being obese as compared with children who do not consume this type of beverage. Anita Alm et al.[88] showed that overweight and obese adolescents had more proximal caries than normal

weight individuals and the frequent consumption of snacking products during early childhood was a risk indicator for caries at 15 years.

The dentists should be in the forefront in promoting good nutrition for general health and oral health by informing caregivers and parents about the importance of integrating healthful snack and meal patterns into their oral hygiene practices.

LIMITATION

The limitations of the present study were that, No cause-effect relationship could be deduced from a cross-sectional design study such as this.

Second, numerous confounding variables related to socio-economic factors, dietary pattern and oral hygiene practices among schoolchildren were not been taken into consideration, which may play a major role.

Third, in India most of the people with lower socioeconomic group send their children to government school

CONCLUSION

It is assumed that obese or overweight individual will have more caries the study showed a significant negative correlation. In the present study majority of the school going children fell in underweight category of which most of the children were from the private school. It was found that Mean DMFT score was high in underweight school going children in comparison with other Body Mass Index groups. Pearsons Correlation was found to be negative and significant. This study proves Body Mass Index has an association with dental caries thus rejecting the null hypothesis. The prevailing health status among the children can be a result of poor knowledge regarding oral and general health. Parents and teachers should be motivated and educated for the same.

Utmost care should be taken to prevent caries formation. Dental caries can lead to serious problem in children. Unhealthy practice among children can be a major contributor to the existing health problem.

RECOMMENDATION

The dentists should be in the forefront in promoting good nutrition for general health and oral health by informing caregivers and parents about the importance of integrating healthful snack and meal patterns into their oral hygiene practices.

School health program by educating and training the teachers can be a beneficial in improving the health of school going children.

As a means of decreasing the prevalence of both diseases it would be effective to strengthen and improve the knowledge of the health and educational work force, families, legislators and other key players.

To eradicate the present dental health problem suitable community dental health programmes should be conducted to improve the overall wellbeing of the population.

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ANNEXURE

PERMISSION FROM ETHICAL COMMITTEE

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES
(FACULTY OF BBD UNIVERSITY), LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled **"Association between Dental Caries and Body Mass Index Among 12- and 15-Years School Going Children in Lucknow City, Uttar Pradesh."** submitted by **Dr Saundarya Priyadarshini** Post graduate student from the **Department of Public Health Dentistry** as part of MDS Curriculum for the academic year 2018-2021 with the accompanying proforma was reviewed by the Institutional Research Committee present on **26th November 2018** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Prof. Vandana A Pant
Co-Chairperson

Prof. B. Rajkumar
Chairperson

Babu Banarasi Das College of Dental Sciences,
Babu Banarasi Das College of Dental Sciences
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Dr. Lakshmi Bala
Professor and Head Biochemistry and
Member Secretary, Institutional Ethics Committee

Communication of the Decision of the VII[th] Institutional Ethics Sub-Committee

BBDCODS/012019

IEC Code: 14

Title of the Project: Association between Dental Caries and Body Mass Index Among 12- and 13-Years School Going Children in Lucknow City, Uttar Pradesh.

Principal Investigator: Dr. Soundarya Priyadarshini Department: Public Health Dentistry

Name and Address of the Institution: BBD College of Dental Sciences Lucknow

Type of Submission: New: MDS Project Protocol

Dear Dr. Soundarya Priyadarshini,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 10[th] January 2019.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow
2.	Dr. Amrit Pandey Member	Prof. & Head, Department of Prosthodontics and Crown & Bridge, BBDCODS, Lucknow
3.	Dr. Rana Pratap Maurya Member	Reader, Department of Orthodontics & Dentofacial Orthopedics, BBDCODS, Lucknow
4.	Dr. Suvalatha M.N. Member	Reader, Department of Oral Medicine & Radiology, BBDCODS, Lucknow

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.
The comments were communicated to PI thereafter it was revised.

Decision: The committee approved the above protocol from ethics point of view.

Lakshmi Bala 22/1/2019

Dr. Lakshmi Bala
Member-Secretary
IEC
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow

Forwarded by

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
BBD City, Faizabad Road, Lucknow

CASE RECORDING PROFORMA

ASSOCIATION BETWEEN DENTAL CARIES AND BODY MASS INDEX OF 12-

AND 15-YEARS SCHOOL GOING CHILDREN IN LUCKNOW CITY, UTTAR PRADESH

Date:

Name:

Age/ Gender:

Address:

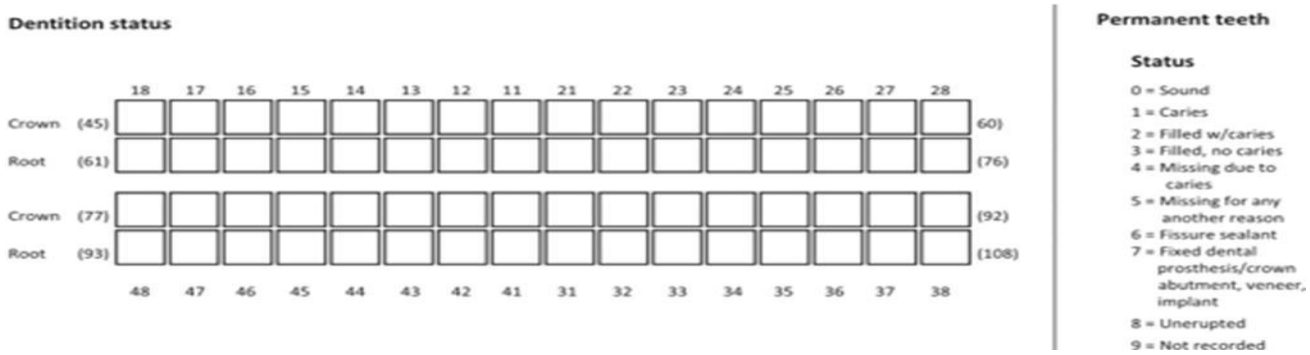
PHYSICAL EXAMINATION

HEIGHT	WEIGHT	BMI

INFERENCE:

<18.5	UNDERWEIGHT
18.5-25	NORMAL
25-30	OVERWEIGHT
>30	OBESE

DENTITION STATUS



PERMISSION LETTER FROM SCHOOL AUTHORITY

To,

The Principal

Government Secondary School

Uttardhwana

Lucknow

Subject: Seeking permission to conduct survey in your school

Respected Sir/Madam,

This is to inform you that I am planning to conduct a survey in your school. The aim of the survey is to evaluate the association between Body Mass Index and Dental caries among 12 and 15 year school going children.

I am writing this letter in order to seek your kind permission for conducting the survey. The above-said survey could help us gain better knowledge about the user's experience/ user's interest in the required fields.

We look forward to a quick and positive response from your side. For any queries feel free to contact on 118033002@bbdu.acin.

Thanking you,

Yours Truly,

Dr. Saundarya Priyadarshini,

Public Health Dentistry,

Babu Banarasi Das College of Dental Science, Lucknow.

Babu Banarasi Das College of Dental Sciences

(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Child Information Document

Study title: ASSOCIATION BETWEEN DENTAL CARIES AND BODY MASS INDEX AMONG 12- AND 15-YEARS SCHOOL GOING CHILDREN IN LUCKNOW CITY, UTTAR PRADESH

Introduction

1. assess Dental Caries among 12 and 15-year school going using the WHO criteria
2. To assess the Body Mass Index (BMI) among 12 and 15-years old school going children.
3. To establish correlation if any, between Dental Caries and Body Mass Index (BMI) among 12 and 15-years old school going children.

What will you have to do?

To participate in this research study, you will be interviewed/examined by Dr. Saundarya Priyadarshini and if found to fulfill pre-specified criteria, you will be eligible to be enrolled in this research study.

Since you are in the age group of 8-18 years we ask your accompanying parent / guardian will also sign a similar form called as the Parent Informed Consent Form.

List all procedures, which will be employed in the study. Point out any that are considered experimental/or otherwise, and explain technical and medical terminology in simple, nontechnical & direct language.

In addition, to record the same parameters daily your parent / guardian will also be provided with a diary where they will enter the same findings accordingly. You will have

to tell them about your symptom and they will mark accordingly in the diary.

Risks and discomforts

There is no foreseen significant risk / hazard to your health, if you wish to participate in the study. If you follow the directions of the …….. in charge of this study and you are injured due to any procedure given under the study plan, the Sponsor will pay for the medical expenses for the treatment of that injury.

Benefits

If you participate in the study you will receive knowledge on dental caries and Body Mass Index If you appear to have any acute illness ……you will be offered free treatment for those visits in accordance with local standard

medical care. You will not be offered free treatment for chronic diseases or conditions not related to study procedures.

Your participation in the study may help others, because this participation will help us determine if the study drug/procedure is safe.

Confidentiality

Your existing medical records may be accessed; personal health information about you may be collected and processed by study investigators for the purpose of performing the study. Information about you will be collected and stored in files with an assigned number, and not directly with your name. All documents related to the study will only be accessed by the study investigator, sponsor, the Ethics Committee and the Regulatory authority.

Your parent / guardian will have the right to access personal information about you at any time with the study doctor and the right to correct this personal information. Your parent / guardian can take away your authorization to collect process and disclose data about you at any time.

Right to refuse or withdraw

You do not have to take part in this research if you do not wish to do so. You may stop participating in the research at any time you wish. The study investigator may decide to withdraw you from the study if he/she considers it is in your best interest

You will be informed of important new findings developed during the course of the study so you will be able to consider your participation in the study in light of new information

Parents responsibilities

It is the responsibility of your parent / guardian to come along with you to the centre during the study period for all the visits unless you withdraw or are prematurely discontinued from the study. It is also your responsibility and your parent / guardian to report any expected or unexpected reactions (side effects) that you notice during the study period.

We expect your co-operation throughout the study.

***(please translate in Hindi also)**

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Child Assent Form

Study Title___ ASSOCIATION BETWEEN DENTAL CARIES AND BODY MASS INDEX AMONG 12- AND 15-YEARS SCHOOL GOING CHILDREN IN LUCKNOW CITY, UTTAR PRADESH

Study

Number_____

Subject's Full Name

_____

Date of
Birth/Age_____

Address

_____

_____
__

I_____, exercising my free power of choice, hereby give my consent for participation in the study entitled:

"……"

I have been informed, to my satisfaction, by the attending physician, about the purpose of the study and the nature of the procedure to be done. I am aware that my parents/guardians do not have to bear the expenses of the treatment if I suffer from any trial related injury, which has causal relationship with the said trial drug. I am also aware of right to opt out of the trial, at any time during the course of the trial, without having to give reasons for doing so

Signature of the study participant
_____Date:_____ Name of the study participant_____

Signature of the Witness
_____Date_____ Name of the Witness _____

Signature of the attending

Physician_____Date:_____ Name of the attending Physician