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Research article

The relationship between body mass index (BMI) and dental caries (dmft) and simulation of mechanical properties of lithium disilicate restoration

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Abstract

Tooth extract is a chronic disease affecting a large number of people, especially children. Due to the high rate of tooth decay and the effect of nutrition and obesity on dental caries, this paper aims to investigate the relationship between body mass index (BMI) and dental caries (dmft) in children. This descriptive-analytical study was performed on a sample of 232 children age 6 to 9 years referred to Khorramabad Dental School in the academic year 2020-2021. The height, weight and BMI were measured for all children and their dmft score was determined based on the criteria of standards defined by the World Health Organization (WHO) and the data were analyzed using STATA 14 software. The obtained results showed that the mean age of students was 7.351±0.07 years, their BMI was 15.39 ± 2.81 and their dmft was 5.51 ± 2.8 are underweight, 26.29% are normal weight, 12.5% are overweight and 6% are fat. Moreover, in this research molecular dynamics (MDs) simulation was used to predict the physical and mechanical properties of lithium disilicate as a restorative material. According to the experimental results, the mean dmft index in Khorramabad students is high and programs should be considered to control dental caries and reduce them. Regarding the relationship between dmft and BMI, contradictory results were obtained that due to the multifactorial nature of caries and obesity, the relationship between the two is complex and needs further investigation. The average density value of the simulated model of lithium disilicate is 2.551 at 300 K and 2.479 gr/cm^3 at 450 K, which is very close to the real value of 2.6 ± 0.3 gr/cm^3. The obtained results from the MDs showed that it is in good agreement with the experimental observation.

Keywords: Dmft index, Tooth decay, BMI, Restoration, Simulation

1- Introduction

Dental caries seems to be the most common chronic disease and the consequence of this disease is tooth extraction. This disease is the result of complex interactions between acid-producing bacteria and adhesives to the tooth surface with fermentable carbohydrates [1-4]. They may demineralize the acids in dental plaque, enamel, and dentin in grooves and smooth surfaces. The earliest macroscopic

evidence of dental caries is known as a white spot lesion [2-5]. These lesions are best watched when the tooth surface is clean and air-dried. These lesions form in areas of plaque accumulation, such as occlusal surface grooves, on the interdental surfaces, and in the gingival third of the teeth. Enamel is hard in the white spot stage and the surface may not be rougher than the surrounding surfaces [2-6]. A white spot lesion indicates significant enamel loss in an area affected by demineralization due to metabolic acids. As white spot demineralization continues, it may form on the surface of the cavity [6-9]. The white spot may be remineralized when the demineralization medium is reduced or eliminated. Evidence of white spot remineralized is that the lesions do not enlarge, and there are no other lesions on the gingival margin of the tooth you are growing. Thin incisions observed under polarized light microscopy indicate that demineralization and remineralization are often associated with white spot lesions [9-14]. An external 30-micron lesion is called a white spot on the surface area. This area appears relatively intact in the incision, however may be more porous than healthy enamel. The superficial area remains relatively intact due to the remineralization of calcium, phosphorus and fluoride in saliva [15-18]. Below this surface area is the lesion body, which is the most demineralized part of the lesion. In this area, the volume of porosity is 5% to 25% and is seen as a dark brown with a polarized microscope due to the loss of enamel [19-34]. The upper layers of the teeth must have high resistance to wear and impact, and the inner layers must be more flexible so that they can withstand fatigue loads. As the lesion progresses, the surface area forms small imperfections that allow acids to diffuse faster below the surface. As the demineralization environment continues, the enamel surface may collapse from below and a cavity can form. Once the cavity is formed, the bacteria can invade the lower dentin and are less likely to be affected by preventative treatments [35-50]. Dental materials are generally known as natural functional graded materials (FGM). FGM are materials which consist of different layers and the mechanical properties of different layers are different and change gradually in layers [51-54]. One of the methods of investigating the physical and mechanical properties of materials is the use of molecular dynamics (MDs) simulation. This method helps to extract the physical and mechanical properties of the material in conditions where it is not possible to measure the properties in the laboratory. These special conditions can be various temperatures or pressures that cannot be created in the laboratory [50-55]. Aside from the fact that clinical findings support determine the activity of these primary lesions, there is a tendency to use caries risk assessment tools to assess the likelihood of caries progression for each tooth and different individuals. As an active lesion is considered, the goal of treatment should be a patient-centered approach to reduce the cariogenic environment by affecting the patient's diet and acid-forming bacteria, as well as evidence-based preventative measures such as fluoride and sealants [43-49]. Caries includes a high number of cariogenic bacteria, high frequency of sugar consumption, insufficient saliva flow, insufficient fluoride exposure, poor oral hygiene and poverty. The caries prevention approach to reducing risk factors and increasing prevention factors should be

patient-centered and evidence-based. Exacerbation and social costs of dental caries in children are high. Tooth decay is still a public health problem in high-income countries and in many low- and middle-income countries. Consequences of dental caries often include high treatment costs, lost school days, reduced ability to learn from pain, hospitalization and emergency room visits, disability and even death, reduced quality of life related to oral health, and other problems such as embarrassment [48-50]. Although therapists deal with children with toothache periodically, there are few studies on the epidemiology of toothache in children [40-50]. A study from the children delays compensation program reported that 16.6% of children with dental caries had toothache and 9.8% cried because of toothache. A study of emergency department visits in California found that the prevalence of preventable visits for children under 6 was 189 cases per 100,000 cases in 2005 and 203 cases per 100,000 cases in 2007. Regarding the cost of dental care, a national study of children under the age of 18 found that the cost of dental care was 539 $ in 2005. This cost is significantly higher due to medical inflation. With any estimation, dental caries has a major impact on children's quality of life, physical health, family and community costs [4-8]. DMF is a quantitative indicator of the effect of caries on teeth and is used to examine permanent teeth. D is the number of decayed teeth, M is the number of teeth extracted due to caries, and F is the number of restored teeth. DMF is evaluated in two ways, DMFT and DMFS, T is the Tooth mark and S is the Surface mark. The DMFT examines the number of affected teeth, regardless of whether one or more surfaces of a tooth are decayed, but the DMFS examines the decay or filling of individual surfaces, and as the tooth is extracted, the posterior teeth have 5 levels and the anterior teeth have 4 levels.

2-Materials and Methods

The study population is children aged 6 to 9 years old who referred to Khorramabad Dental School in the academic year 2021-2022 and the sampling method was using a simple random sampling method, the required sample size may be selected and entered into the study [21]. This study is cross-sectional and descriptive-analytical which analytical performed. The height and weight of all children entering the study are measured using a tape measure and a standard floor scale. BMI of each child is calculated by dividing weight (Kg) by height squared (meters). The BMI of each child is then compared with the standard CDC2000 percentile curve [43-50]. BMI less than the 5th standard is considered low, BMI between the 5th and 85th percentiles is normal, BMI between the 85th and 95th percentiles is considered overweight, and BMI above the 95th standard is considered obese. Clinical examination of children's teeth is performed by catheters and mirrors under natural light. The criterion for diagnosing the condition of teeth in terms of caries, filling and loss is based on the standards defined by the WHO. Thus, whenever there was an injury on the smooth surfaces of the tooth or inside the pits and grooves of the tooth, in which the enamel was empty or the floor and around the injury were soft and this softness was felt with a catheter, it is considered a decayed tooth. It came and every tooth that was dressed with one of the temporary filling materials and also a tooth that was repaired but had

decay was considered decayed. The white spot was not considered a caries. A tooth whose surface had one or more permanent fillings and showed no old or new caries was considered a restored tooth. Stata 14 software is used for data analysis and also for descriptive analysis of data, depending on the distribution of variables, central indicators such as mean and median and dispersion indices such as SD and distance between quartiles are used. Also, multivariate linear regression (by controlling confounding variables) is used to measure the relationship between dmft index and body mass index. The most important limitation of this study is the lack of cooperation of children for examination. Information is confidential (patients' first and last names are not mentioned in the questionnaire but are coded). The names of the research team should be included in all the products of the dissertation, including the article and the research plan. The atomic structure of LD is made of a large number of plate-like acicular crystals that are randomly oriented. This microstructure causes deviation and slows down the growth of cracks. The chemical structure of the MDs model of LD with the chemical formula $Li_2Si_2O_5$ is shown in Fig. 4. In this simulation, after creating the atomic structure and creating a simulation with periodic neural conditions, the system was brought to equilibrium.

3- Results and discussion

3-1- Experimental observation

Global differences in caries rates are due to environmental differences, to intrinsic ethnic traits. Although, the incidence of caries in permanent teeth is generally declining, its distribution among ethnic and racial groups in terms of severity and prevalence persists in the 21st century. Of course, there is no evidence to support the inherent differences in caries susceptibility between different racial and ethnic groups. The important issue is socio-economic differences and differences in the social environment, i.e., differences in education, income and access to health care. Another factor that is difficult to study is cultural beliefs that influence behaviors related to oral health [9-11]. According to Table 1, the frequency of distribution was the same in both male and female groups.

Table 1: Investigation of gender frequency distribution in the studied samples

Percentage	Frequency	Group	variable
50	116	Male	Gender
50	116	Female	

Tooth decay in blacks is 25% less than in whites, which may be due to certain standards in the lives of blacks. The yellow race is also more resistant to rot than the white race and the four main factors that contribute to tooth decay are: microbes, sugars, time and the decrease in resistance of the person and his teeth. The purpose of mentioning these 4 four factors is that if one of these factors is not present, caries will not occur [10, 12]. Due to the high prevalence of dental caries as well as childhood obesity, today more attention is paid to the number of sugary foods and drinks those children consume daily, allocated. Due to dental caries, simple sugars (e.g., sucrose, glucose and fructose, facilitate the growth and metabolism of MS and other bacterial and acid-tolerant bacterial species). Produce and lower the pH of the environment, leading to demineralization of teeth Fruits, fruit-flavored beverages Non-alcoholic beverages have a significant cariogenic

potential due to their high sugar content and frequent consumption between meals. National and International Suggestions for Per capita Sugar Consumption Suggestions for Obesity and the Risk of Tooth Decay in Children Their recommendations for children ages 4 to 8 are that added sugar should be less than 10% of daily caloric intake. Or about 32.5 grams of sugar [13]. It is clear that certain drinks and foods, especially drinks that child often consume, have significant amounts of sugar for daily consumption of sugar in children. Health professionals and parents should be aware of the sugar content be aware of and processed foods and beverages as well as new recommendations for daily sugar intake. In addition, dentists should be more involved in identifying children with high sugar intake and providing nutritional information or referrals for nutritional counseling [1]. MS is most associated with dental caries and is key to understanding caries in preschool children. MS participates in the development of dental caries by its increased ability to bind to dental surfaces, produce large amounts of acid and survive and continue metabolism under low pH conditions. Preschoolers with high levels of MS colonization have a higher prevalence of caries and are also at much higher risk for new lesions than children with low levels of MS. In addition, colonization with MS at an early age is an important factor in the onset of premature caries. Body mass index (BMI), also known as the Cutlet Index, is a tool used to indicate weight status in adults and is one of the criteria that can be used to describe overweight and obesity. BMI is obtained by dividing weight in kilograms by height squared in meters. BMI as one of the nutritional-health indicators is the best indicator to determine a person's health and therefore has a very close relationship with the overall mortality rate of diseases such as diabetes, gastrointestinal, pulmonary, cardiovascular (CVD) and gallbladder diseases. Relative mortality increases in people with a BMI of less than 20 and more than 30 m^2/kg. People with a BMI of less than 18.5 m^2/kg are classified as underweight. The normal range of BMI is 18.5-25 m^2/kg. Over 25 m^2/kg overweight (relatively obese) and BMI over 30 m^2/kg are considered obese, which includes type 1 obesity (30 to 35 m^2/kg), type 2 obesity (35 to 40 m^2/kg 40) [14-17]. Some researchers believe that BMI is not as usable for children and adolescents as it is for adults. Accordingly, some researchers have used body mass index based on BMI criteria for age and sex recommended by the WHO to determine overweight and obesity. In this process, the mineralized tissue of the tooth is dissolved by the acid resulting from the decomposition of sugars due to the activity of pathogenic bacteria in the mouth and a caries cavity is formed [19]. Various factors, including: genetic factors, nutritional status, obesity, dental anatomy, oral hygiene, use and absorption of fluoride, age, sex, composition and amount of saliva, parental education and socioeconomic status in causing tooth decay have been discussed. Proper nutrition from the beginning of life; not only does it improve the child's physical growth and development [21], however it also has a major effect on the general health of the child [22]. Sweetening baby food makes the child accustomed to the taste of sugary substances, and this shows a greater interest in consuming sweets at an older age. Inadequate nutritional patterns among children and adolescents, especially between sweet meals, of which more is outside the home, lead to this age group is

more at risk of obesity, overweight and dental caries [23]. Studies have shown that childhood nutrition is associated with most diseases in adulthood [21]. At the same time, research has shown that diet plays an important role in the development of obesity, premature tooth loss, gum problems and bad breath [20]. Many oral health problems, including tooth decay start in childhood. It can be prevented with early care. Despite a reduction in the incidence of dental caries from 75% in 1970 to 42%, dental caries is still one of the most common infectious diseases [24], especially in developing countries such as Iran [25]. The most important reason for reducing caries in developed countries is prevention, which is done in the form of oral health education, proper diet and fluoride toothpaste, adding fluoride to drinking water, fluoride therapy and institutionalization of caries and sealant prevention programs from childhood [26]. Body mass index (BMI) is one of the best indicators for assessing overweight and obesity [27]. Today, special attention is paid to the relationship between dental caries and obesity. The relationship between the two is complex. Because both are influenced by various factors including biological, economic, social and environmental factors and lifestyle [28]. Tooth decay and obesity are both costly for the individual and society, but can be corrected by correcting diet and lifestyle [29]. Some studies have shown a positive relationship between obesity and caries [30]. However, some other studies have shown a negative relationship and some have shown a lack of relationship between these two indicators [27-32]. Overweight and obesity predispose a person to some diseases. Among the diseases associated with weight gain are dental caries, which are due to increased consumption of carbohydrate foods [29]. Tooth decay is one of the most common chronic diseases of childhood. Premature dental caries that affects deciduous teeth can have a major impact on a child's oral health and general health and quality of life. Due to the high prevalence of dental caries and the effect of nutrition and obesity on dental caries, this study was performed to determine the relationship between dmft and BMI in children aged 6 to 6 years in Khorramabad. Tooth decay is a chronic infectious disease that unlike other diseases Infection does not stop with the use of antibiotics and can affect a large number of teeth in a short time [34]. Oral health is an integral part of general health beyond having healthy teeth. The mouth is a mirror of health or disease [35], has an important role in body health, poor oral hygiene leads to dental infections, pain and tooth loss, affects the body and mind [36], reduces Growth, increase in pain, discomfort, acute and chronic infections, damage to the quality of voice and speech and positive mental self-image and consequently mental health, negative impact on self-esteem, pain and anxiety, low birth weight and decreased social functioning [37]. Weight gain and obesity are important indicators of health that are steadily increasing in many countries and obesity is recognized as the most common nutritional problem in children [38]. Among the causes are physiological, biochemical, metabolic or anabolic causes, and not paying attention to it increases the risk of cardiovascular disease, diabetes and some cancers [39]. Lifestyle changes including diet (increasing fat and carbohydrate intake and reducing fiber intake), reducing physical activity as well as genetic characteristics play an important role in weight gain,

especially in children [29]. Its broad effects on health and life's also due to the prevalence of obesity and poor eating habits and its effects on oral health, it is necessary to investigate the relationship between tooth decay and BMI. Silva et al. [39] conducted a study to investigate the relationship between body mass index (BMI) and tooth decay in children [39]. In this study, BMI and dental caries status of 344 twin children aged 18 months and six years were measured. Tooth decay in primary teeth was classified as caries-free or severely decayed, and BMI was analyzed as a changing and classified variable. The results showed that in children without dental caries there was no significant difference in terms of BMI at any age, but in children with severe dental caries at the age of six there was a significant positive relationship between caries and BMI [41]. Sharma et al. [40] study entitled about tooth decay and overweight/obesity related. A cross-sectional study was performed on rural and urban preschool children. This cross-sectional study was performed on rural and urban preschool children in hesar district (Haryana) in India. A total of 500 urban and 500 rural children (age group 3-6 years) were selected from Hesar schools and BMI and dmft indices were measured using WHO criteria. The results showed that the BMI of men was significantly higher than women and the BMI of urban preschool children was significantly higher than rural preschool children. No significant correlation was observed between dmft and BMI in different regions and sexes. The overall prevalence of obesity and overweight was 20.2% (25.6% in urban preschool children and 14.8% in rural preschool children) [40]. Alghamdi et al. [41] in a study examined the relationship between body mass index (BMI) and tooth decay in adolescents in Saudi Arabia. This cross-sectional study was performed on 610 male students aged 14 to 16 years in Riyadh [41]. The results showed that the prevalence of tooth decay (DMFT> 0) was 54.1%. About 32% of students were either overweight or obese. A statistically significant relationship was found between dental caries (DMFT) and BMI. Fat students had 1.79 times more healthy teeth than non-obese students. Also, students with higher socioeconomic status 1.26 times and students who used fluoride toothpaste had 1.63 times more healthy teeth than others [43]. Amiri et al. [42] conducted a study entitled the relationship between eating habits and body mass index with tooth decay in 4–6-year-old children in kindergartens in Ahvaz. In this descriptive cross-sectional study, 359 samples from 4–6-year-old children of both sexes were randomly selected from different regions. A questionnaire containing general and individual information such as gender, age, education and occupation of parents, etc [42]. Quantitative food frequency questionnaire including 53 food items was used. BMI and dmft were also measured. The results showed a significant positive correlation between tooth decay index and body mass index. There was also a significant positive correlation between tooth decay index and consumption of cocoa milk and flavored milks and fat consumption. Montazeri et al. [43] conducted a study entitled "Study of the relationship between dietary intake and obesity with dental caries in 6–7-year-old children referred to the pediatric clinic of Zahedan Dental School. This descriptive-analytical study was performed on 79 children aged 6-11 years. Body mass index

(BMI) was also used to assess obesity and a semi-quantitative food frequency questionnaire (FFQ) was used to assess dietary intake. Findings showed that the frequency of caries index (≥4) in overweight and obese children was significantly higher than other children. The results of food frequency showed that all children except dairy group consumed fruits and vegetables from other food groups. There was an inverse correlation between tooth decay with the average consumption of milk and dairy products, fruits and vegetables and a significant positive correlation with BMI and the frequency of consumption of sweets [45]. Dental examination data were collected and recorded using WHO standard criteria for caries diagnosis (DMFT for permanent teeth) and height and weight measurements to calculate BMI. The obtained results showed that the mean index of the number of decayed, extracted and filled teeth in the study population was 2.68. 2.4. In calculating BMI, 55% of children were normal weight, 13.8% were overweight, 4.2% were obese and 27% were underweight. No significant correlation was observed between body mass index and caries sizes, tooth loss and tooth filling. Thippeswamy et al. [47] conducted a study to investigate the relationship between body mass index and tooth decay in adolescent children in southern India. The study population included 463 school children in the age group of 13 years. BMI and dental caries index (DMFT) were measured according to standard criteria for each student. The results showed that most of the children were normal weight (BMI <25), 18.6% of the children were overweight and 3.5% were obese (BMI> 30). Frequency of sweets consumption had a significant positive relationship with children's BMI. Obese children also had more dental caries than overweight and normal weight children. There was a significant positive correlation between BMI and dental caries [47]. Mohtadinia et al. [21] conducted a study entitled the relationship between tooth decay and body mass index and eating habits in children referred to the dental clinic of Tabriz University of Medical Sciences (TUMS). In this cross-sectional study, 202 children aged 3-12 years were randomly selected. In order to evaluate tooth decay, the index of number of decayed, extracted and filled teeth was used and to evaluate eating habits, a semi-quantitative food frequency questionnaire was used [21]. The results showed that with increasing fruit consumption, the rate of tooth decay decreased and among the studied foods, the consumption of nuts was a significant predictor of the number of decayed teeth. The mean number of decayed, extracted and filled teeth in the studied children was 7.61 as shown in Fig. 1.

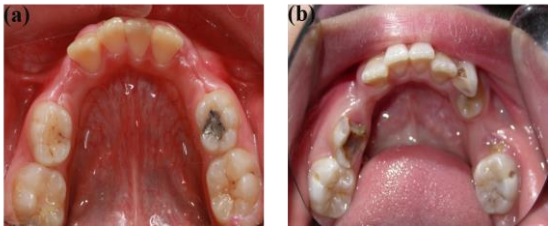

Fig. 1 Image of (a) restored and extracted teeth in a 7 years old child, and (b) dental caries and extracted teeth in an 8 years old child

There was a significant inverse correlation between this index, age and fruit consumption. No significant correlation was found between tooth decay and body mass index. According to the final regression model, the variables of age, mother's job and frequency of consumption of nuts (nuts) were significant predictors of the number of decayed teeth [23]. In this

retrospective study, body measurement data and oral health data were taken from the National Health and Nutrition Survey 1999-2002. The data for children aged 2 to 17 years were the incidence of tooth decay (dft and DMFT), age; Gender; Race/Ethnicity and Poverty Status. The results of their study showed that approximately 36% of overweight children aged 2 to 6 years and 39% of overweight children aged 6 to 17 years had tooth decay. The mean DMFT in overweight children was 3.3 for primary and permanent teeth, respectively. By controlling the variables, no significant relationship was observed between BMI and the prevalence of dental caries (permanent and deciduous). In addition, there was a significant relationship between BMI and the index of permanent tooth decay among children with a positive history of dental caries, so that overweight children had lower mean DMFT than normal weight children [56-62].

The aim of this study was to investigate the relationship between body mass index (BMI) and tooth decay rate (dmft) in children aged 6 to ۹ years in Khorramabad in the academic year 2021-2022. In this section, first the demographic information and descriptive statistics of the studied samples are examined and then in order to achieve the objectives and hypotheses of the research, the relevant tables and statistical results of each are reported. Stata14 was used for data analysis. For descriptive part (variance, mean, mean and standard deviation) and for analytical analysis (analysis of variance, correlation, linear regression) “Ttest” was used.

Table 2: Sample classification based on BMI

Percentage	Frequency	BMI
17.55	128	Underweight
26.29	61	normal
50.12	29	Overweight
6.03	14	Fat
100	232	Total

Table 2 shows that the mean age of all children were 7.35, mean BMI was 15.39, mean dmft was 5.51, mean height was 121.15 cm, and weight was 22.79 Kg. The CDC2000 standard is compared. BMI less than the 5th percentile of the standard is considered as underweight, BMI between the 5th to 85th percentile of the standard is considered normal, BMI between the 85th and 95th percentile of the standard is considered overweight, and BMI above the 95th percentile of the standard is considered obese. The results show that most students (55.17%) are underweight and only 6% of them are obese as shown in Fig. 2.

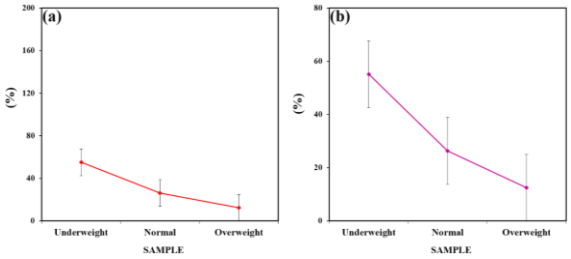

Fig. 2 Sample classification based on BMI

In addition, 26.29% are normal weight and 12.5% are overweight. A 4-year-old Khorramabad city was observed due to the amount of correlation between dmft and BMI and also the p-value. There was no significant relationship between these two variables in the group of girls, i.e., decreasing/increasing BMI did not have a significant effect on the dmft variable. Table 3 and Table 4 showed that there was a significant positive and direct

relationship between dmft and BMI in boys. The boy gender group with increasing BMI, the amount of dmft also increases, and vice versa.

Table 3: A study of the relationship between dmft and BMI in 6- to 9-year-old girls in Khorramabad

p-value	Spearman correlation value	Variable
0.088	0.16	Correlation between dmft and BMI

According to the above Tables 3 and 4, it was observed that no significant difference was observed between the mean BMI in the two groups and the mean of the BMI variable. The mean of dmft variable was not the same in these two groups, so that the mean in the group of boys was higher than the others. In order to evaluate the prediction of dmft based on BMI. The results show that for each unit increase in BMI, the dmft value increases by an average of 0.27.

Table 4: Study of the relationship between dmft and BMI in 3- to 6-year-old boys in Khorramabad

p-value	Spearman correlation value	Variable
0.001	0.43	Correlation between dmft and BMI

Multivariate regression was used to evaluate the prediction of dmft based on BMI and age and gender, the results of which are presented in the following table. In the adjusted model with the effect of age and gender, for each increase in BMI, the dmft value increases by an average of 0.24 units. The 95% confidence interval is equal to the average population 0.37. The present study aimed to investigate the relationship between body mass index (BMI) and the rate of dental caries (dmft) was performed on children aged 6 to 3 years in Khorramabad in the academic year 2019-2020. The obtained results of this study are consistent with the present study, although the mean caries index was lower in Amiri's study, which is probably due to the lower age of the test group (4-6 years) [42]. Montazerifar et al. (2015) reported that the mean DMFT index in children aged 6 to 11 years was 3.97, Sahebnasagh et al. [44] reported DMFT for 14-year-old students as 2.68 4 2.4, which the present sample is lower [43- 46]. In this study, most of the children were in the range of underweight and normal weight. Also, most of the children had high dmft index, which can have a great impact on the present findings and explain the differences between the results of this study and previous research. However, since many factors play a role in tooth decay, it is difficult to determine why the mean dmft index in Khorramabad children was higher than some studies and requires further investigation. In addition, the results of Spearman correlation coefficient between dmft and BMI in girls 0.16 Was not statistically significant ($p < 0.05$) but was 0.43 in boys, which was statistically significant ($p < 0.05$). Contradictory results have been reported in various studies regarding the relationship between dental caries and growth indices. Some studies, such as the study of Sahebnasagh et al. [44], did not show a significant correlation between body mass index and caries sizes, tooth loss and tooth filling [46]. While some studies have found that children with higher weights or BMIs are more prone to more caries. Hooley et al. [27] found that 35% of studies on obesity and caries found such an association. These studies are mainly in highly developed countries with high living standards and high access to public health programs such as Fluoride was obtained. Another common feature of these studies is the use of more accurate methods

of dental examinations that allow the diagnosis of even the primary caries [51-57]. The reason for such a positive relationship is the common risk factor in both diseases. Excessive consumption of soda or foods high in carbohydrates, highly processed foods or other high-energy foods that reduce saliva flow are both fattening and cariogenic [46]. Some studies also suggest weight gain and inhibitors for dental caries have been reported, including the study of Khosravani et al. [45], which showed an inverse correlation between DMFT and BMI [47]. The reason for this connection is that the pain and infection caused by dental caries is a barrier to eating and weight gain of the child and the evidence of this claim is that with the reconstruction of the oral cavity of these children and the repair of painful teeth, the weight gain process has resumed [46-50].
Tooth decay is one of the most common chronic diseases in the world. Tooth decay has a multifactorial etiology and is the result of the interaction of microbial factors, diet, host and time. The use of preventative measures helps prevent the progression of caries and reduces treatment costs. One of the advantages of preventive methods is maintaining the structure of the teeth, being cheaper and more accessible and not needing different and expensive equipment. In laboratory and clinical studies, many products containing topical fluoride have shown positive results in preventing tooth decay. The process of decay is a dynamic process involving demineralization and remineralization cycles. In the process of crown decay, the hard tooth tissue (enamel and then dentin) loses calcium and phosphorus minerals due to the acid produced by cariogenic bacteria (mainly Streptococcus mutans). Primary carious lesions are the first sign of caries in the enamel, which is a very important stage, because by changing the environmental conditions of these lesions, the development of caries can be prevented.

3-2- Mechanical properties of teeth and lithium disilicate ceramic restoration

In terms of mechanical properties, dental materials are considered as a natural FGM material [1].

Table 5: Mechanical properties of Enamel Junction

Enamel Elastic modulus	65 GPa
Dentin- Enamel Junction Dentin Elastic modulus	Graded
Dentin Elastic modulus	20 GPa

Fig. 4 shows examples of gradual changes in elastic modulus in different layers of the tooth [1].

Table 6: Mechanical properties of dental materials

Material	**Elastic Modulus (GPa)**	**Hardness (GPa)**
Enamel	80-120	2.0–3.5
Dentin	10-40	0.3–0.7

In the normal state, tooth enamel in the outer layer has an elastic modulus of about 65 GPa, dentin in the inner layer has an elastic modulus of about 20 GPa, and between these two layers, there is a layer in which gradual changes in properties occur [50-53]. This structure can reduce the amount of stress and improve the anti-failure properties. Dental caries occurs due to two main environmental factors and the application of force on the dental surfaces [4]. Many researchers used various flow chart to detect the dental disease as shown in Fig. 3. The most susceptible area of caries in permanent teeth is peat and

fissures with a prevalence of 90%, of which two-thirds occurs in occlusal surfaces, while the most susceptible area of decay in deciduous teeth is smooth proximal surfaces. The prevalence of occlusal caries in deciduous teeth is 44%. In the pre-tooth stages, the uptake of fluoride causes it to enter the dentin-forming structure and enamel of undeveloped teeth. This makes the teeth more resistant to acid attack after eruption into the oral cavity.

Mechanically, environmental factors cause corrosion and the growth of fine cracks, and forces cause wear in the surface layers, the corrosive environment causes an increase in abrasive materials. On the other hand, material wear causes an increase in corrosion [50-51]. It should be noted that human saliva as a natural electrolyte has a pH between 3 and 8 and creates a corrosive environment [51]. Both of these factors may weaken the mechanical properties [54-59].

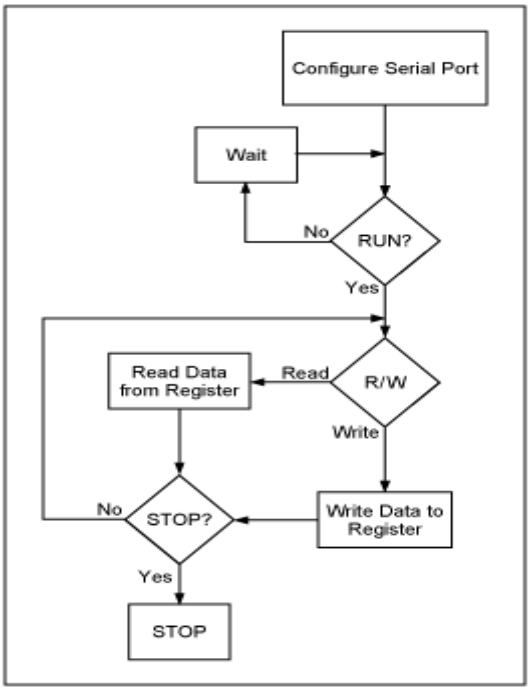

Fig. 3 Simulation of position of maxilla based on treatment evaluation

The most important mechanical properties that are of interest in teeth are compressive strength, elastic modulus and hardness [58-61]. Usually, standard tests should be used to measure these properties in biological materials [54-58]. The materials used to treat tooth decay should have mechanical properties similar to or stronger than the mechanical properties of the natural material. Table (5) indicates an example of approximate mechanical properties of dental materials [54-55]. One of the materials used for tooth decay restoration is lithium disilicate (LD), which is a ceramic material with medical and dental applications that has special mechanical properties that can be used. The compressive strength of this material is about 360 MPa to 400 MPa, and it has a hardness of about 5 GPa and a fracture toughness of about 3.3 MPa $m^{1/2}$. Then, the molecular model made at two different temperatures of 300 K and 450 K was subjected to the NPT effect. The simulation results are presented in Figs. 5 and 6. According to the results, it is clear that the density value of the simulated model is close to the real density value of the material. The average density value of the simulated model is 2.551 at 300 K and 2.479 gr/cm^3 at 450 K, which is very close to the real value of 2.6 ± 0.3 gr/cm^3 [57-61].

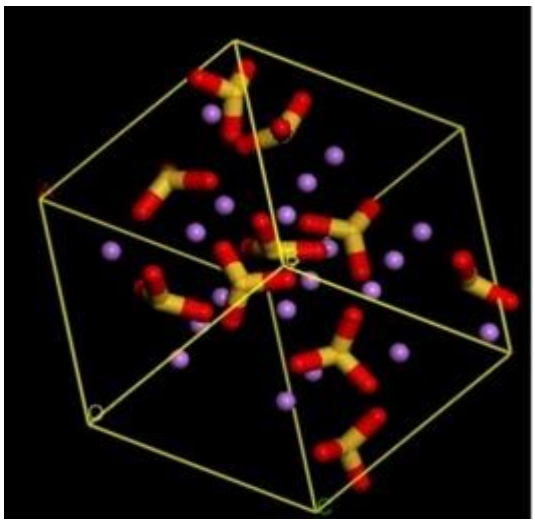

Fig. 4 Atomic model for simulation of lithium disilicate material

According to the results, it is clear that the density value has decreased slightly with increasing temperature.

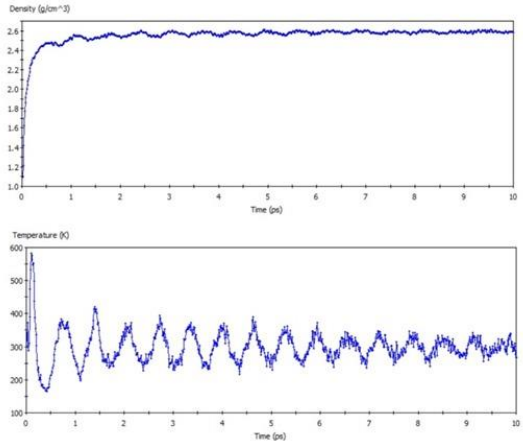

Fig. 5 Simulation results at 300 K

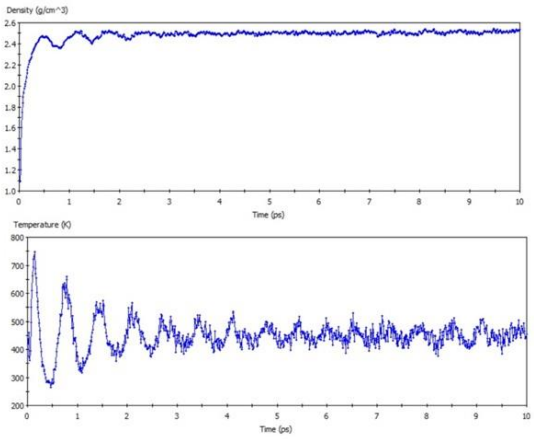

Fig. 6 Simulation results at 450 K

The obtained young modulus from MDs for this material is approximately 88 GPa, which is in good agreement with other works [51]. The use of fluoride is effective in the recovery of enamel minerals and leads to increased enamel microhardness. Creating artificial caries: The purpose of this demineralization step was to be as similar as possible to all samples in order to simulate primary caries in enamel blocks. After reviewing various studies in the present study, a standard demineralizing solution containing 2.2 mmol 2 CaCl, 2.2 mmol (KH) 34PO, 0.5 mol acetic acid with a pH of approximately 4.4 was used. The purpose of the demineralization and remineralization cycle in vitro is to evaluate the effectiveness of fluoride-containing compounds to protect the demineralized enamel against acid [14]. The process used in this study was to use a standard formula to simulate oral conditions in which acidic substances and the activity of cariogenic bacteria cause demineralization of tooth enamel and cause primary caries (White Spot Lesion).

1) Due to the lack of studies on the effect of fluoride-containing mouthwash on microhardness of deciduous enamel compared to studies that have examined the effect of fluoride varnish and toothpaste, it is suggested that future studies further investigate the effect of mouthwash with different brands and concentrations on microhardness. Enamel deciduous teeth.

2) Due to the laboratory nature of the study, it is suggested that future studies on primary caries lesions in clinical conditions be reviewed to eliminate the problem of complete reconstruction of oral conditions.

3) It is suggested that future studies be conducted on a larger number of samples.

4- Conclusion

The results of Spearman correlation coefficient between dmft and BMI in girls were 0.16 which was not statistically significant ($p < 0.05$) but in boys it was 0.43 which was statistically significant ($p < 0.05$). Also, the results of student T test showed that there is no significant difference between boys and girls in terms of BMI, but there is a significant difference in terms of dmft, in which the mean dmft in boys is higher than girls ($p < 0.05$). The average dmft index is high and a program should be considered to control and prevent tooth decay in students. Also, contradictory results were obtained regarding the relationship between dmft and BMI, which can be explained by the fact that although the relationship between dental caries and pediatric development has been proposed by some primary and population-based studies, but due to multifactorial caries and obesity, the relationship. It is complex between the two because it depends on many factors such as age, sex, race and other environmental, genetic, behavioral and social factors. Proposing the expression of limitations in any research helps researchers to identify barriers and shortcomings with an open mind and accurate cognitive research. In this study, there were some limitations that are mentioned. One of the limitations of this study is its cross-sectional nature. In this type of study, the relationship between different variables is exploratory and therefore the cause-and-effect relationship cannot be deduced from the results of this study. Another limitation is the lack of information on eating habits that can cause obesity and dental caries. In this research, like any other human research, the living environment, social and economic conditions of individuals are among the factors affecting the research results, so caution should be exercised in generalizing it to the whole society. It is suggested to conduct longitudinal studies to discover the cause-and-effect relationship. It is suggested that a prospective study be performed on nutritional behaviors and its relationship with caries and obesity. According to the molecular dynamics simulation results the mechanical performance of lithium disilicate is close to the natural dental materials which is suitable for teeth restorations. Also, the alteration of density and materials properties were evaluated by MDs techniques. Also, changes in density and properties of restorative materials due to temperature were measured and investigated with the help of molecular dynamics method.

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