

# **Impact of Childhood Obesity on Oral Health**

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THESIS

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This thesis is dedicated to my family.

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## TABLE OF CONTENTS

<u>CHAPTER</u>		<u>PAGE</u>
1. INTRODUCTION		
1.1 Background	õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ	1
1.2 Hypotheses	õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ	2
1.3 Specific Aims	õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ	2
1.4 Significance	õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ	3
2. REVIEW OF LITERATURE		
2.1 Obesity	õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ .	4
2.2 Obesity Linked to Systemic Disease	õ õ õ õ õ õ õ õ õ	5
2.3 Oral Health and General Health	õ õ õ õ õ õ õ õ õ õ	6
2.4 Oral Health and Obesity	õ õ õ õ õ õ õ õ õ õ	8
2.5 Childhood Obesity	õ õ õ õ õ õ õ õ õ õ	9
2.6 Childhood Obesity and Oral Health	õ õ õ õ õ õ õ õ õ õ	10
3. METHODOLOGY		
3.1 Study Design	õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ .	16
3.2 Enrollment of subjects	õ õ õ õ õ õ õ õ õ ..õ õ õ	16
3.3 Oral Examination	õ õ .õ õ õ õ õ õ õ .õ õ õ	18
3.3.1 Recording Caries Experience	õ õ õ õ õ õ õ õ õ õ õ ..	18
3.3.2 Recording Plaque Index	õ õ õ õ õ õ õ õ õ õ õ ..	19
3.3.3 Recording Gingival Index	õ õ õ õ õ õ õ õ õ õ õ ..	20
3.4 Compensation	õ õ .õ õ õ õ õ õ õ õ õ	21
3.5 Statistical Analysis	õ õ õ õ õ õ õ õ õ õ õ ..	21
3.6 IRB Approval	õ õ õ õ õ õ õ õ õ õ õ ..	22
4. RESULTS		
4.1 Demographics	õ õ õ õ õ õ õ õ õ õ .õ õ õ õ õ õ õ ...	23
4.2 Oral Examination	õ õ õ õ õ õ õ õ õ õ õ ..	26
4.2.1 Dental Caries Experience	õ õ õ õ õ õ õ õ õ õ õ ..	27
4.2.2 Dental Plaque	õ õ õ õ õ õ õ õ õ õ õ ..	31
4.2.3 Gingival Health	õ õ õ õ õ õ õ õ õ õ õ ..	31
5. DISCUSSION		
5.1 Findings of this study	õ õ õ õ õ õ õ õ õ õ õ õ õ	35
5.1.1 Study Population	õ õ õ õ õ õ õ õ õ õ õ õ .	36
5.1.2 Utilization of BMI percentile	õ õ õ õ õ õ õ õ õ õ õ	37
5.1.3 Mixed Dentition	õ õ õ õ õ õ õ õ õ õ õ ...	38
5.1.4 Radiographic Examination	õ õ õ õ õ õ õ õ õ õ õ ...	40
5.1.5 Plaque Index	õ õ õ õ õ õ õ õ õ õ õ ...	41
5.2 Limitations of this Study	õ õ õ õ õ õ õ õ õ õ õ õ	42
5.3 Future Research	õ õ õ õ õ õ õ õ õ õ õ ...	42

## TABLE OF CONTENTS (continued)

	<u>PAGE</u>
6. CONCLUSION                    õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ .	44
CITED LITERATURE            õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ .õ õ	45
APPENDICES	
APPENDIX A                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ ..	53
APPENDIX B                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ ..	56
APPENDIX C                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ ..	59
APPENDIX D                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ ..	60
APPENDIX E                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ ..	61
APPENDIX F                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ	62
APPENDIX G                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ .	63
APPENDIX H                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ .	68
APPENDIX I                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ .	70
APPENDIX J                õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ õ	73
 VITA            õ .	 76

## LIST OF TABLES

<u>TABLE</u>	<u>PAGE</u>
I. DEMOGRAPHIC CHARACTERISTICS OF HEALTHY-WEIGHT AND OBESE CHILDREN IN THE STUDY	õ õ õ õ õ .. 24
II. DENTAL CARIES EXPERIENCE IN HEALTHY-WEIGHT CHILDREN	õ õ õ õ õ .. 28
III. DENTAL CARIES EXPERIENCE IN OBESE CHILDREN	õ õ õ õ õ .. 29
IV. DENTAL CARIES EXPERIENCE IN OBESE CHILDREN COMPARED TO HEALTHY-WEIGHT CHILDREN	õ õ õ õ õ .. 29
V. REGRESSION ANALYSIS OF BMI, GROUP MEMBERSHIP (HEALTHY-WEIGHT OR OBESE) AND RECRUITMENT SOURCE ON CARIES EXPERIENCE (DFT+DFT PER TOOTH)	õ õ õ õ õ .. 30
VI. CARIES EXPERIENCE (DFT+DFT PER TOOTH) FOR OBESE AND HEALTHY-WEIGHT CHILDREN BY RECRUITMENT SOURCE	õ õ õ õ õ .. 30
VII. PLAQUE INDEX AND GINGIVAL INDEX FOR HEALTHY-WEIGHT CHILDREN	õ õ õ õ õ .. 32
VIII. PLAQUE INDEX AND GINGIVAL INDEX FOR OBESE CHILDREN	õ õ õ õ õ .. 33
IX. PLAQUE INDEX AND GINGIVAL INDEX IN OBESE CHILDREN COMPARED TO HEALTHY-WEIGHT CHILDREN	õ õ õ õ õ .. 34

## LIST OF FIGURES

<u>FIGURE</u>		<u>PAGE</u>
1.	Flowchart of the Impact of Childhood Obesity on Oral Health Study	15

## **LIST OF ABBREVIATIONS**

AIDS	Acquired Immune Deficiency Syndrome
BMI	Body Mass Index
CDC	Centers for Disease Control
DF	Decayed-Filled
DFT	Decayed-Filled-Teeth
DMFT	Decayed-Missing-Filled-Teeth
DMFS	Decayed-Missing-Filled-Surfaces
DXA	Dual-energy X-ray Absorptiometry
HIV	Human Immunodeficiency Virus
IRB	Institutional Review Board
NHANES	National Health and Nutrition Examination Survey
NIDDKD	National Institute of Diabetes and Digestive Kidney Diseases
NIH	National Institutes for Health
UIC	University of Illinois at Chicago
SD	Standard Deviation
SES	Socioeconomic Status
VPI	Visible Plaque Index
WHO	World Health Organization



## Summary

Childhood obesity is reaching epidemic proportions in the United States and worldwide. Both obesity and poor oral health may increase a person's risk for systemic disease and poor dietary habits may be one of the factors linking both multifactorial conditions together. Studies have investigated the association between obesity and dental caries, the results have been contradictory. This cross-sectional pilot study in children aged 8-12 tests the hypothesis that obese children have poorer oral health compared to healthy-weight children. To measure oral health, decayed and filled teeth (dft+DFT) scores, gingival index and plaque index was examined in 20 obese and 20 healthy-weight children. It represents part of a larger cross-sectional study that compared the oral health conditions, salivary characteristics, and dietary habits between obese and healthy weight 8-12 years old children. The results of the oral examination found no differences in caries experience, plaque or gingival scores between the two groups. However, BMI was inversely correlated with caries experience. Among the children recruited outside of the UIC dental school, the obese children had significantly lower caries experience. The larger study examining the dietary habits and properties of saliva could find additional differences between the groups and offer some insights as to why this inverse relationship may exist.

# 1. INTRODUCTION

## 1.1 Background

Childhood obesity is on the rise throughout the world, especially in developed countries. Childhood caries remains one of the most common chronic diseases in children. A growing body of research has explored the links between obesity and caries in children. In just the last three years the number of published studies on this topic has almost doubled. While these studies aimed to relate childhood caries and childhood obesity, the interaction between these two diseases is not a simple cause and effect relationship. Both diseases are multifactorial in nature and involve an interaction between genetics, metabolism, culture, environment, behavior and socioeconomic factors. The interplay of these multifactorial interactions may be one of the reasons there are conflicting results amongst the research. Some studies have shown that obese children have more caries (Willerhausen *et al.*, 2004, 2007a, 2007b; Hilgers *et al.*, 2006; Bailleul-Forestier *et al.*, 2007; Alm *et al.*, 2008, 2011; Gerdin *et al.*, 2008; Sharma *et al.*, 2009; Modeer *et al.*, 2010; Vazquez-Nava *et al.*, 2010; Trikaliotis *et al.*, 2011). Several studies have shown no association between childhood obesity and caries (Tuomi 1989; Chen *et al.*, 1998; Macek and Mitola 2006; Moreira *et al.*, 2006; Kopycka-Kedzierawski *et al.*, 2007; Pinto *et al.*, 2007; Granville-Garcia *et al.*, 2008; Hong *et al.*, 2008; Sheller *et al.*, 2009; Jugensen *et al.*, 2009; Tramini *et al.*, 2009; Jamelli *et al.*, 2010; Costacurta *et al.*, 2011; De Mello *et al.*, 2011; Sadeghi *et al.*, 2011).

While caries is one component of oral health, it alone does not reflect overall oral health. Overall oral health also includes but is not limited to, oral hygiene status, gingival health and periodontal health. These concepts will be further explored in the literature review.

The current pilot study represents the clinical component of a larger parent study that investigates the impact of childhood obesity on oral health of children 8-12 years old. The clinical oral examination performed included not only caries experience, but also various factors closely associated with oral health.

## 1.2 **Hypotheses**

The hypotheses tested were as follows.

Compared to healthy-weight children 8-12 years old:

1. The obese children will have higher dft+DFT scores.
2. The obese children will have higher plaque index.
3. The obese children will have higher gingival index.

## 1.3 **Specific Aims**

This study sought to assess the oral health conditions of twenty obese and twenty healthy-weight children 8-12 years old. Through clinical oral examinations, the caries experience, oral hygiene and gingival health of children were evaluated, recorded and compared. Caries experience was determined using the scores for decayed and filled teeth scores for primary (dft), permanent (DFT), and primary and permanent teeth combined (dft+DFT). Oral hygiene was

assessed by the presence or absence of plaque using a plaque index. Gingival health was assessed by measuring the amount of gingival inflammation present using a gingival index. The differences between the two groups of children were compared.

#### 1.4 **Significance**

Exploring the relationship between childhood obesity and dental disease helps us understand each of the diseases individually and also how they relate to one another. Finding these relationships are important for furthering health promotion and prevention strategies.

## 2. REVIEW OF LITERATURE

### 2.1 Obesity

Obesity is an abnormal or excessive accumulation and storage of fat in the body. It has been labeled a chronic disease due to the roles that the active fat cells play in inflammation and immunity (Bray, 2004). The WHO (World Health Organization) defines obesity in adults as a body mass index (BMI) greater than 30. BMI is defined as weight in kilograms divided by height in meters squared ( $\text{kg/m}^2$ ). Obesity results from a positive energy balance. Multiple environmental factors significantly affect energy balance and weight regulation (Nicklas *et al.*, 2001). The WHO reports that globally there has been an increase in energy-dense foods that are high in fat, salt and sugars but low in vitamins, minerals and other macronutrients (WHO, 2011). As the population experiences a rise in affluence, it tends to change their selection of foods. In general it leads to an increase in animal fat and protein, with a reduction in complex carbohydrates and a reciprocal increase in refined sugar intakes (Solomons, 2007). This combined with a decrease in physical activity due to an increasingly sedentary lifestyle contributes to the energy imbalance that leads to obesity. Solomons (2007) even goes as far as to say we need to insist upon a broader and more comprehensive definition of malnutrition that includes the various grades of overweight and obesity. Obesity results from complex interaction of genetic, metabolic, cultural, environmental, socioeconomic and behavioral factors (Malik, *et al.*, 2006).

During the past 20 years there has been a dramatic increase in obesity in the United States. In 2009, only Colorado and the District of Columbia had a prevalence of obesity less than 20% (CDC, 2011). Results from the 2005-2006 National Health and Nutrition Examination Survey (NHANES), indicate that an estimated 34.3 percent of U.S. adults 20 years and older are obese and 5.9 percent are extremely obese (CDC, 2011).

## 2.2 **Obesity linked to systemic disease**

Obesity is linked to numerous systemic health problems. Some of obesity's direct effects on general health include altered blood pressure, insulin resistance, dyslipidemia (Kopelman, 2007) and a state of low-grade inflammation (Falagas and Kompoti, 2006). A systematic review and meta-analysis by Guh, et al., 2009, examined 20 co-morbidities of overweight and obesity. They included: cancer (kidney, colorectal, prostate, ovarian, uterine/endometrial, esophageal, pancreatic, and post-menopausal breast), type II diabetes, cardiovascular disease risk (hypertension, coronary artery disease, congestive heart failure, pulmonary embolism, stroke, dyslipidaemia), gallbladder disease, chronic back pain, osteoarthritis, asthma, and sleep apnea. They found associations with all the examined co-morbidities except for esophageal and prostate cancer.

According to Kopelman, 2007, 85% of hypertension is associated with a BMI of >25+ (which is overweight according to the CDC (2011)). He also states, 90% of type II diabetics have a BMI >23+.

Reproductive health can also be affected by obesity. In women 6% of primary infertility is associated with obesity. In men, obesity has been linked to impotency and infertility (Kopelman 2007). Overweight and obese pregnant women are at an increased risk of preterm birth (McDonald et al., 2010). Overweight and obesity in mothers did not prevent low birth weights in their children (McDonald et al., 2010). An association between maternal obesity and increased risk of a range of structural anomalies was identified by Stothard *et al.*, 2009, in a systemic review and meta-analysis.

Therefore, obesity not only affects a person's overall health, but can be life-threatening.

### 2.3 **Oral Health and General Health**

The oral cavity is the host to a variety of bacteria. The amount and types of bacteria present are influenced by many factors such as the integrity of the soft-tissues, oral hygiene, saliva, diet and the host's immune and inflammatory responses (Migliorati and Madrid, 2007). Poor oral health may lead to oral diseases and conditions including, dental caries, gingivitis, periodontal disease, halitosis and tooth-loss. Certain medications or conditions can lead to alterations in the composition and amount of saliva. The change in the amount and/or composition of saliva can disrupt the natural balance of the bacteria and can also lead to oral diseases.

Some of the links between poor oral health and systemic disease are well known and have been studied extensively and others links are beginning to

emerge. Endocarditis is one example of a systemic disease that can be caused by oral bacteria. Dental procedures that manipulate gingival tissues can cause a transient bacteremia. The circulating bacteria then colonize damaged endocardium or heart valves, leading to infective endocarditis. In the case of HIV/AIDS, many manifestations present in the oral cavity such as, oral candidiasis, Kaposi's sarcoma, necrotizing ulcerative gingivitis and/or periodontitis and hairy leukoplakia.

Periodontal disease is considered a chronic inflammatory disease initiated by dental plaque biofilm and perpetuated by a deregulated immune response (Suvan *et al.*, 2011). Periodontal disease has been linked to several systemic diseases and conditions. A systematic review and meta-analysis by Humphrey *et al.*, in 2008 concluded that, periodontal disease is a risk factor or marker for coronary heart disease (CHD) that is independent of traditional CHD risk factors, including socioeconomic status. The effects periodontal disease in pregnant women has also been studied. A meta-analysis by Matevosyan in 2011, reviewed original research published between 1998 and 2010 and concluded that, maternal periodontal disease has strong associations with preeclampsia and prematurity. A systematic review by Cambrone *et al.*, 2011 found evidence to support the hypothesis that periodontitis is associated with the risk of preterm births and/or low birth weight children. Treatment of periodontal disease during pregnancy may reduce preterm and low birth weight incidence (George *et al.*, 2011). The interaction between diabetes and periodontal disease has also been investigated. Type II diabetes mellitus is considered a risk factor for periodontitis



(Chavarry et al., 2009). A Cochrane Systematic Review by Simpson et al. (2010) found that, %there is some evidence of improvement in metabolic control in people with diabetes, after treating periodontal disease.+

Continued research is needed to investigate the relationship between oral health and systemic conditions.

#### 2.4 **Obesity and Oral Health**

Due to the inflammatory nature of both obesity and periodontal disease, links between these two chronic diseases are being investigated. Using NHANES III data, Wood et al. (2003) concluded that body composition was correlated with periodontal disease. The study reinforced the concept that, %periodontal disease and certain obesity related systemic illnesses are related, with abnormal fat metabolism possibly being an important factor.+ Several studies have found that obesity and metabolic syndrome may be risk factors for periodontal disease (Saito *et al.*, 2001; Linden *et al.*, 2007; Saito and Shimazaki, 2007; Shimazaki *et al.*, 2007). A systematic review found a positive association of overweight and obese adults with presence of periodontitis, although the magnitude of the association remained unclear (Suvan *et al.*, 2011). A 2010 study by Timonen et al., examined metabolic syndrome, periodontal disease and dental caries. They found a weak association between metabolic syndrome, periodontal disease and dental caries. Most of the research in adults focuses on the relationship between obesity and periodontal disease while in children it focuses on the relationship between obesity and dental caries. Further

examination of childhood obesity and oral health is discussed in the following sections.

## 2.5 **Childhood Obesity**

Like in adults, obesity in children is calculated using the BMI values. BMI is defined as weight in kilograms divided by height in meters squared ( $\text{kg/m}^2$ ). However, children are not considered obese by a set cutoff in BMI. A child's BMI is computed then charted on a BMI-for-age growth chart developed by the CDC (Center for Disease Control) to determine their BMI percentile. The BMI percentile shows how a child's BMI compares to other children of the same age and sex (Appendix C, D). The categories are underweight (<5th percentile), healthy weight (5th to 85th percentile), overweight (85th to 94th percentile), and obese (>95th percentile).

The 2009-2010 NHANES data indicate that an estimated 17% of children and adolescents aged 2-19 years are obese (Ogden *et al.*, 2012). Obese children are more likely to have high blood pressure and high cholesterol, which are both risk factors for cardiovascular disease (Freedman *et al.*, 2007). They have also been found to have increased risk of impaired glucose tolerance, insulin resistance and type-2 diabetes (Whitlock *et al.*, 2005). In addition, obese children are reported to have breathing problems (Han *et al.*, 2010; Sutherland, 2008), joint and musculoskeletal discomfort (Han *et al.*, 2010; Taylor *et al.*, 2006), and gastro-intestinal disturbances (Whitlock *et al.*, 2005; Han *et al.*, 2010). Very often, they may have lower levels of self-esteem (Strauss, 2000). There is

also evidence indicating that obese children have accelerated linear growth, due to high body fat content affecting hormonal metabolism and growth (Stovitz *et al.*, 2008 & Slyper, 1998). Overweight and obese children are more likely to be obese in adulthood, bringing with it the increased systemic risks (Serdula *et al.*, 1993; Whitaker *et al.*, 1997).

## 2.6 **Childhood Obesity and Oral Health**

The effect of childhood obesity on oral health has been explored. One of the first studies on this subject was from Tuomi in 1989. This relationship continues to be explored with the number of published studies on this topic almost doubling in the last 3 years.

When picturing the driving cause of obesity, overindulging on energy-dense highly refined food choices and sweetened beverages comes to mind. The relationship between frequent consumption of refined carbohydrates and dental caries is well established (Petersen, 2003; Marshall *et al.*, 2007). Considering dietary similarities, it seems logical that obese children would have more dental caries. Given that increased levels of inflammation are found in both obesity and periodontal disease, it seems logical that obese children would have increased risk for periodontal disease. Therefore, it seems logical that obese children would have poor oral health (Enwonwu, 2010). However both of these diseases are much more complex. Studies have been conducted to examine the relationship between these two diseases. A study by Marshall *et al.* (2007) found that caries and obesity coexist in children of low socioeconomic status. A

prediction study by Tuomi (1989) found that obesity alone was not a good indicator for predicting caries. However, when earlier obesity was combined with earlier caries experience, the accuracy of predicting caries in first and second permanent molars increased. Tuomi offered an explanation for this relationship as, % incorrect diet predicts both obesity and caries, but obesity develops more rapidly than caries+ (Tuomi, 1989).

Studies have attempted to demonstrate a relationship between dental caries and body-mass-index in children. Several European studies have shown that children with higher BMI have higher caries rate. Willerhausen *et al.* conducted three studies (2007a, 2007b, 2004) conducted on German school children ages 6-11 found a significant correlation between BMI and caries frequency. Alm *et al.* (2008) reported that overweight and obese Swedish children at age 15 had more proximal caries than normal-weight children. A longitudinal study by Alm *et al.* (2011) that included this same group of children, found that obese children had higher caries prevalence at age 15 and 20. Gerdin *et al.* (2008) conducted a cohort study, also in Swedish children, found a weak association between overweight children and caries prevalence. Bailleul-Forestier *et al.* (2007) concluded that severely obese children ages 12-18 in France were more likely to have caries than non-obese children. A cross-sectional study of 8-12 year old children in India by Sharma and Hedge (2009) found a higher prevalence of caries in overweight and obese children as compared to the normal weight children; however the highest mean value for caries was found in the underweight group. Trakaliotis *et al.* (2011), in a study

of Greek pre-school children, found that overweight children were at a higher risk for dental caries; although, they did not find a differences in caries levels between the obese group and the other BMI categories. Another study conducted on pre-school children in Mexico (Vazquez-Nava et al., 2009) also found obesity to be associated with dental caries in the primary dentition.

While European studies found that increased BMI is related to an increased caries experience, the data obtained from US studies are controversial. One study from the United States has found that children with increased BMI had a higher caries risk. Their study examined children aged 8-11 that participated in the %Smile Kentucky+program through the University of Louisville Dental School and found an elevated BMI was associated with an increased risk of permanent molar interproximal caries (Hilgers *et al.*, 2006b). However, additional studies conducted in the United States have not shown an association between increased BMI percentile and increased dental caries (Macek and Mitola, 2006; Pinto *et al.*, 2007; Kopycka-Kedezierawski *et al.*, 2008; Hong *et al.*, 2008; Sheller *et al.*, 2009) . Two of the five studies investigated children younger than age six (Hong *et al.*, 2008; Sheller *et al.*, 2009) and found no association. Three of US studies, while concluding there was no association between increased BMI and dental caries , actually found the obese children older than 6 had a decreased rate of caries (Kopycka-Kedezierawski *et al.*, 2008; Macek and Mitola, 2006; Pinto *et al.*, 2007). A study by Werner *et al.*, 2012, found contrary results. A %smaller proportion of obese and overweight children presented with primary tooth caries than underweight/healthy weight children+

and obesity and dental caries in the permanent dentition at initial and recall visits were not associated+ (Werner *et al.*, 2012).

This inverse relationship has been documented outside of the US. A lower caries index in overweight children ages 7 - 11 was also found in a 4-year longitudinal study of Mexican children (Sanchez-Perez *et al.*, 2009).

Additional studies outside of the US have found no association between dental caries and obesity (Chen *et al.*, 1998; Moreira *et al.*, 2006; Granville-Garcia *et al.*, 2008; DeMello *et al.*, 2011; Costacurta *et al.*, 2011; Sadeghi *et al.*, 2011; Jamelli *et al.*, 2010; Jurgensen and Petersen, 2009; Tramini *et al.*, 2009).

On the contrary, children that are underweight have been reported to be at risk for dental caries as compared to overweight and obese children in developing countries (Narksawat *et al.*, 2009;; Benzian *et al.*, 2011). Even in developed countries, when examining children with severe early childhood caries treated under general anesthesia, most of the children are underweight (Cameron *et al.*, 2006; Sheller *et al.*, 2009). An article by Enowonwu, 2010 actually compares the conditions of underweight and obesity and presents the idea that both groups are suffering from malnutrition. This malnutrition, caused by under-consumption of nutritious food, can result in changes in the oral health (Enowonwu, 2010).

Based on a systematic review published in 2006 (Kantovitz *et al.*, 2006), the authors decided that only three studies providing a high level of evidence. Of the studies examined there were conflicting findings. Given the controversial

nature of the findings more studies are indicated as well as more systematic reviews as more research emerges.

In addition to caries, childhood obesity may be associated with other diseases in the oral cavity. Positive associations between obesity and periodontal disease in adults have been reported (as described above). This association has also been described in the pediatric population (Reeves *et al.*, 2006). However, a systematic review of the literature by Katz and Bimstein in 2011, calls for more research due to the limited numbers of studies on this topic.

Modeer, *et al.* (2010) attempted to include other aspects of oral health by examining not only caries, but also plaque accumulation, gingival inflammation, and flow rate of saliva. They found that the obese subjects had a higher number of decayed surfaces, plaque accumulation and gingival inflammation but no association between caries experience was found between the groups and stimulated saliva flow rate was reduced in the obese group.

A couple of studies have examined tooth eruption and obesity. It is suggested that the hormonal changes in overweight and obese children could accelerate tooth eruption (Hilgers *et al.*, 2006a; Sanchez-Perez *et al.*, 2009).

Given the limited evidence exploring childhood obesity and overall oral health, our pilot study examined not only caries experience but also oral hygiene and gingival health. It was part of a larger study that also investigated the dietary habits, salivary flow rate and microbiological properties of saliva (Figure 1).

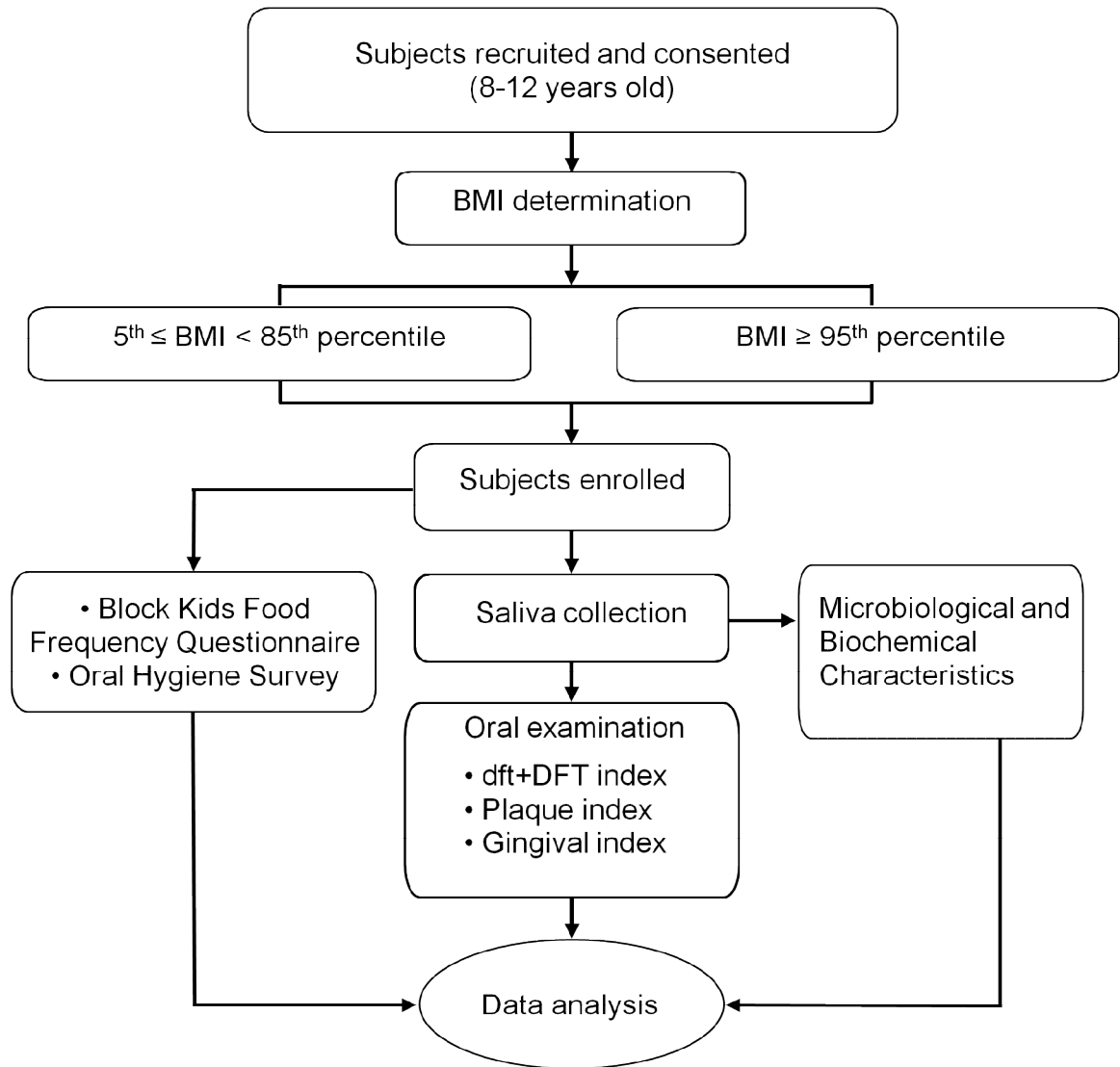


Figure 1: Flowchart of the Impact of Childhood Obesity on Oral Health Study



### **3. MATERIALS AND METHODS**

#### **3.1 Study Design**

This cross-sectional study compared the decayed and filled teeth (DFT+dft), gingival index and plaque index between 20 obese and 20 healthy weight children aged 8-12. This study was a part of a larger study approved by the Institution Review Board of the University of Illinois at Chicago titled "The Impact of Childhood Obesity on Oral Health," research protocol # 2009-0702 (Appendix A, B).

#### **3.2 Enrollment of Subjects**

Children of all genders and races were recruited for this study. BMI was determined by  $BMI = [weight \text{ in pounds} / (height \text{ in inches} \times height \text{ in inches})] \times 703$ . The BMI percentile ranking of the children was determined in accordance with the BMI-for-age growth chart by the Center for Disease Control and Prevention (CDC, 2005; Appendix C, D). The BMI percentile compares a child's BMI to other children of the same age and sex. The categories are underweight (<5th percentile), healthy-weight (5th to 85th percentile), overweight (85th to 94th percentile), and obese (>95th percentile). The child was qualified for the study if they were considered healthy-weight (control group) or obese. Inclusion criteria were children 8-12 years of age who were cooperative and willing to come for one visit at UIC College of Dentistry for approximately one and a half hours. The children had to qualify in either the obese or healthy-weight group. Children that

were underweight or overweight did not qualify for the study. Exclusion criteria included: children taking any prescribed medication; children with any systemic illness; those suffering from xerostomia or children with orthodontic appliances.

We first recruited subjects from the UIC community with flyers (Appendix E) on bulletin boards and web announcements, but the response was low. We then recruited from the UIC Wellness Clinic, Obesity Clinic and pediatric dentistry clinics. The questionnaires were only offered in English. The study was conducted at the UIC College of Dentistry, Department of Pediatric Dentistry. Children were screened in one of two ways. Parents could respond to the advertisement via phone. They were asked age, sex, medical history, height and weight of the child (Appendix F). Children attending the pre-doctoral and post-doctoral clinics in the department of Pediatric Dentistry were also recruited. The same information was obtained. A preliminary BMI percentile was determined to see if they were in one of the two groups. If it was likely that they qualified for the study they were given an appointment to complete the study. For the children that were recruited from the dental school, appointments were given that day if convenient for the parent, child and examiner.

On the day of their appointment, consent and assent forms were completed by the parent and child respectively (Appendix G and H). The height and weight of the children was measured with the child in light clothing and without shoes. The children were weighed using a Tanita® C-400 scale that weighed to the nearest tenth of a pound. Height was determined using the

stadiometer of a Health-o-Meter scale to the nearest ¼ inch. BMI percentile was calculated to verify that they qualified in the obese or healthy-weight group.

As a part of the larger study, a non-stimulated whole saliva sample was collected from the children and transported to the laboratory for further analysis. The examining dentist took the child to the clinic to perform the clinical examination while the parent completed a questionnaire on demographics and oral hygiene habits (Appendix I). The parents also completed the Block Kids Food Frequency questionnaire as a part of the larger study.

### 3.3 **Oral Examination**

All oral examinations were completed in the Pediatric Dentistry Clinics by a calibrated dentist. When the principle examiner (Briney) was not available, two additional examiners participated in data collection. All three were calibrated prior to the examinations. A standard dental examination mirror, a Number 5 dental explorer and Williamsqperiodontal probe were used during the examination. Data was recorded on the Clinical Examination Form (Appendix J).

#### 3.3.1 **Recording Caries Experience**

The teeth present were recorded by circling the corresponding numbers or letters on the clinical examination form (Appendix J). Teeth that were not present or missing were indicated with an %+in the corresponding box. A tooth was considered having decay if a primary lesion or recurrent decay was present. Only cavitated lesions were recorded. Non-cavitated white spot lesions were

observed but not recorded. A letter %D+ was placed in the corresponding box to indicate a tooth with decay. If a filling or sealant was present an %F+ was recorded for that tooth. Zeros %D+ were recorded for each sound tooth. A score of 1 was assigned for each tooth that had either a %D+, %F+, or %DF+ recorded. The maximum score assigned per tooth was a 1. The df score, DF score and df+DF score was calculated

### 3.3.2 **Recording Plaque Index**

The method of O'Leary (1972) was used for the plaque index. The presence of plaque was disclosed using a solution (2Tone by Young Dental Manufacturing). It was placed on the teeth using a saturated cotton-tipped applicator. A light swiping motion on the buccal and lingual surfaces of the maxillary and mandibular teeth ensured that all surfaces were covered. Water was placed in the child's mouth. The excess solution and water was suctioned out of the child's mouth with slow speed evacuation.

On the clinical examination form (Appendix J), the teeth present were recorded by circling the corresponding letter or number. Teeth that were not present or missing were indicated with an %X+ in the corresponding boxes. The presence or absence of stained plaque along the gingival margin was recorded for four areas of each tooth: mesial-buccal, facial, distal-buccal and lingual. A score of 0 was given for absence of stained plaque and a score of 1 for presence of stained plaque for each surface. The number of surfaces with stained plaque

were counted and recorded. The number of teeth present were counted and recorded.

### 3.3.3 **Recording Gingival Index**

For determining gingival index, a modified method of Loe and Silness (1963) was used. Six teeth were selected for examination to determine gingival inflammation. The preferred teeth to examine were #3, 9, 12, 19, 25, 28 or the corresponding primary tooth. If one of the preferred teeth was not present, or if the primary tooth had class II mobility or more, an adjacent tooth was selected and was indicated on the exam sheet (Appendix J). A Williamsqprobe was gently inserted 1 mm inside the free gingival margin and was swept along the entire margin at a depth of 1mm. A gingival score was recorded for four surfaces of each tooth: mesial-buccal, facial, distal-buccal and lingual.

Each surface was given score of 0-3:

0= Normal healthy gingival . no stained plaque present, no bleeding.

1= Mild inflammation . presence of stained plaque but no bleeding.

2= Moderate inflammation . presence of stained present and bleeding on probing.

3= Severe inflammation . marked redness and edema of the gingival tissue that has ulceration and tendency to spontaneous bleed.

### 3.4 **Compensation**

Upon completing the study, the family was compensated \$25 for their time. If a child or parent did not complete the study the family was compensated \$10 for their time.

### 3.5 **Statistical Analysis**

Data analysis was completed using the statistical software package SPSS, version 16.0 (SPSS, Chicago, IL). The obese group was then compared to the healthy-weight group for all analyses. Chi-square tests compared categorical data between the groups. The independent samples *t*-test was used to analyze the differences in means for the continuous data of age and BMI.

The dft and DFT score as well as the number of primary teeth and the number of permanent teeth were entered into SPSS. To control for the number of teeth present, ratios were then calculated: decayed or filled primary teeth, decayed or filled permanent teeth and total decayed or filled teeth, whether primary or permanent. Group differences were compared via *t*-test.

The number of surfaces that had stained plaque was entered for the plaque index. The number of surfaces was then converted to a ratio by dividing by the total number of teeth present. Group differences were compared via *t*-test.

Gingival index was entered as the total score. It was divided by 24 (the total number of surfaces) for the ratio score. Group differences were compared via *t*-test.

Linear regression analysis of dft+DFT per tooth was used to determine if recruitment source explained the variance in decay rates independently of the grouping variable.

### 3.6 **IRB Approval**

This study was a part of a larger study approved by the Institution Review Board of the University of Illinois at Chicago titled, "The Impact of Childhood Obesity on Oral Health," research protocol #2009-0702 (Appendix A).

## 4. RESULTS

Approximately 60 children aged 8-12, were recruited for the study. Forty were qualified and were included in the study. These included 20 obese and 20 healthy-weight children. The children that were not included either did not meet inclusion criteria, failed to show up on the day of the appointment, or the parents did not speak English. Only one child began the study and did not complete the clinical portion of the exam. Three children that had asthma were included in the study. Two were taking the medication Singulair (montelukast, a leukotriene receptor antagonist). One concern of children taking prescription medications was the side effect of xerostomia. However, the latter is not a reported side effect of Singulair.

### 4.1 **Demographics**

Demographic information for the obese and healthy-weight children is shown in Table I. The mean age for both groups was 10 years. No difference in age between the two groups was found using independent samples *t*-test.

The mean BMI in the healthy weight group was 18. The mean BMI in the obese group was 26. BMI between the groups was different using the independent samples *t*-test.



TABLE I		
DEMOGRAPHIC CHARACTERISTICS OF HEALTHY-WEIGHT AND OBESE CHILDREN IN THE STUDY		
	Healthy (20)	Obese (20)
<b>Age<sup>b</sup></b>		
	10(2)	10(1)
<b>BMI<sup>b,c</sup></b>		
	18(1)	26(4)
<b>Gender<sup>a</sup></b>		
Male	45% (9)	65% (13)
Female	55% (11)	35% (7)
	<b>100% (20)</b>	<b>100% (20)</b>
<b>Race and Ethnicity<sup>a</sup></b>		
Hispanic	32% (6)	42% (8)
African American	58% (11)	42% (8)
White, Non-Hispanic	5% (1)	5% (1)
Other	5% (1)	11% (2)
	<b>100% (19)</b>	<b>100% (19)</b>
<b>Parental Income<sup>a</sup></b>		
Below 20K	63% (12)	53% (10)
Between 20K-50K	26% (5)	37%(7)
Above 50K	11% (2)	11% (2)
	<b>100% (19)</b>	<b>100% (19)</b>
<b>Parental Education<sup>a</sup></b>		
Less than High School	11% (2)	11% (2)
High School Graduate	32% (6)	21% (4)
Some College	26%(5)	37% (7)
College Graduate	32% (6)	32% (6)
	<b>100% (19)</b>	<b>100% (19)</b>
<b>Recruitment Source<sup>a</sup></b>		
Dental Clinic	55% (11)	50% (10)
Non-dental Clinic	45% (9)	50% (10)
	<b>100% (20)</b>	<b>100% (20)</b>

a = Chi Square ; b = Independent Samples *t*-test; c = *p*<.001

As shown in Table I, the majority of the healthy weight group of children were female (55%, 11 children). The majority of the obese group of children was male (65%, 13 children). However, differences in gender were not significant (Chi Square analysis).

Among the study children, the majority of the healthy-weight children were African American (58%, 11 children) followed by Hispanic (32%, 6 children) and white, non-Hispanic (5%, 1 child). One parent reported %other+(5%). The group of obese children had equal numbers of African American and Hispanic children (42%, 8 children). One child in the obese group was white, non-Hispanic (5%). Two parents reported %other+(11%). Two parents, one in each group, chose not to report race and ethnicity. There were no differences between the groups for race and ethnicity using Chi Square analysis.

In both groups, the reported income for the majority of parents was below \$20,000 (63% of healthy weight group and 53% of the obese group). An income of \$20,000 - \$50, 000 was reported in 26% of the healthy weight group and 37% of the obese group. An income above \$50,000 was reported the least, with only 11% in each group. One parent in each group did not report income. There were no differences in the groups (Chi Square analysis). Overall the group was of a low socioeconomic status.

For parental education, the percent of parents having less than a high school education was 11% in both groups. The percent of parents having a high school education was 32% in the healthy weight group and 21% in the obese group. Some college education was reported to be 26% in the healthy weight

group and 37% in the obese group. A parent being a college graduate was 32% in both groups. Two parents, one in each group, chose not report educational level. There were no differences between the groups in educational level (Chi Square analysis). Overall the parents were not college graduates.

Efforts were made to recruit from the UIC community, outside of the College of Dentistry. Response rates were low so recruitment was expanded to include the pediatric dental clinics. This resulted in about half of the children being recruited from the dental clinics and half recruited from outside of the dental clinics (non-dental clinics). The healthy-weight and obese groups did not differ in the recruitment source (Chi Square analysis).

Overall, the only difference in demographic data between the healthy-weight and obese group was BMI.

#### 4.2 **Oral Examination**

As described in the methods section, the oral examination included recording of caries experience, plaque index and gingival index. For the oral examination, Briney was the principle examiner. Two other examiners helped conduct the exams when the principle examiner was not available. All examiners were calibrated prior to the study. Using Cohen's kappa for caries and fillings, the examiners' reliability was 1.0. The inter-rater reliability was 0.91 and 1.0 using Kendall's tau-b for the plaque and gingival indexes, respectively.

#### 4.2.1 **Dental Caries Experience**

Caries experience was recorded using the decayed-filled teeth score for primary (dft) and permanent teeth (DFT), Table II, III and IV. In the healthy weight group, 14 children were of a mixed dentition and 6 children had a permanent dentition. The mean decayed-filled score for primary teeth (dft) per tooth was .48 (.34). The mean decayed-filled score for permanent teeth (DFT) per tooth was .24(.11). The mean decayed-filled score primary teeth and permanent teeth combined (dft+DFT) per tooth was .30(.13). In the obese group 18 children were of a mixed dentition and 2 children had a permanent dentition. The mean dft per tooth was .41(.33), the mean DFT per tooth was .19(.11) and the mean dft+DFT per tooth was .24(.14). There were no differences in mean dft+DFT per tooth scores between the healthy-weight and obese groups (independent samples *t*-test). When BMI was evaluated as a continuous variable, rather than a grouping variable, it was inversely correlated with dft+DFT per tooth score ( $r = -.46$ ,  $p < .01$ ,  $n = 40$ ). As BMI increased the dental caries experience decreased. Recruitment source, group membership (healthy-weight or obese), and BMI were regressed on dft+DFT per tooth. Recruitment source and group membership were not found to be predictors of dft+DFT per tooth, however, BMI was a predictor dental caries experience (Table V).

TABLE II							
DENTAL CARIES EXPERIENCE IN HEALTHY-WEIGHT CHILDREN							
	# of prim. teeth	#of perm. teeth	dft	DFT	dft per tooth	DFT per tooth	dft+DFT per tooth
1	12	12	0	4	0.00	0.33	0.17
2	7	16	6	5	0.86	0.31	0.48
3	12	12	3	4	0.25	0.33	0.29
4	0	28	0	5	---	0.18	0.18
5	12	12	3	3	0.25	0.25	0.25
6	8	11	4	2	0.50	0.18	0.32
7	12	12	6	1	0.50	0.08	0.29
8	0	26	0	3	---	0.12	0.12
9	3	16	0	1	0.00	0.06	0.05
10	0	28	0	9	---	0.32	0.32
11	0	28	0	12	---	0.43	0.43
12	8	17	6	4	0.75	0.24	0.40
13	0	28	0	11	---	0.39	0.39
14	12	12	8	4	0.67	0.33	0.50
15	7	14	6	2	0.86	0.14	0.38
16	7	15	7	4	1.00	0.27	0.50
17	14	9	6	1	0.43	0.11	0.30
18	6	13	4	4	0.67	0.31	0.42
19	1	23	0	4	0.00	0.17	0.17
20	0	31	0	9	---	0.29	0.29

TABLE III							
DENTAL CARIES EXPERIENCE IN OBESE CHILDREN							
	#of prim. teeth	#of perm. teeth	dft	DFT	dft per tooth	DFT per tooth	dft+DFT per tooth
1	7	16	4	4	0.57	0.25	0.35
2	12	12	0	0	0.00	0.00	0.00
3	6	18	0	2	0.00	0.11	0.08
4	1	21	1	4	1.00	0.19	0.23
5	14	10	4	2	0.29	0.20	0.25
6	10	14	7	1	0.70	0.07	0.33
7	12	11	7	4	0.58	0.36	0.48
8	3	20	3	4	1.00	0.20	0.30
9	4	20	1	4	0.25	0.20	0.21
10	11	12	5	4	0.45	0.33	0.39
11	12	12	0	4	0.00	0.33	0.17
12	5	18	0	4	0.00	0.22	0.17
13	0	25	0	3	---	0.12	0.12
14	12	12	0	0	0.00	0.00	0.00
15	12	12	3	0	0.25	0.00	0.13
16	4	18	2	2	0.50	0.11	0.18
17	8	14	5	4	0.63	0.29	0.41
18	11	13	8	4	0.73	0.31	0.50
19	0	28	0	6	---	0.21	0.21
20	5	18	2	4	0.40	0.22	0.26

TABLE IV			
DENTAL CARIES EXPERIENCE IN OBESE CHILDREN COMPARED TO HEALTHY-WEIGHT CHILDREN			
	Healthy (n=20)	Obese (n=20)	Significance
<b>Caries Experience</b>			
<i>dft per tooth</i>	.48 (.34) <sup>+</sup>	.41 (.33) <sup>++</sup>	<i>p</i> >.1
<i>DFT per tooth</i>	.24 (.11)	.19 (.11)	<i>p</i> >.1
<i>dft+DFT per tooth</i>	.30 (.13)	.24 (.14)	<i>p</i> >.05

Standard deviation is in parentheses; + N=14; ++ N=18

<b>TABLE V</b>				
<b>REGRESSION ANALYSIS OF BMI, GROUP MEMBERSHIP (HEALTHY-WEIGHT OR OBESE) AND RECRUITMENT SOURCE ON CARIES EXPERIENCE (DFT+DFT PER TOOTH)</b>				
	Unstandardized Coefficients			
	<b>B</b>	<b>Std. Error</b>	<b>t</b>	<b>Sig.</b>
BMI	-.020	.008	-2.567	.015
Group Membership	.091	.074	1.227	.228
Recruitment Source	.029	.042	.691	.494

Table VI displays the mean scores of dft+DFT per tooth, compared by group and recruitment source. Healthy-weight and obese children recruited from the dental clinics had similar caries experience (dft+DFT per tooth). In children recruited outside of the dental school, obese children had significantly lower dft+DFT per tooth (independent samples *t*-test;  $p < .02$ ).

<b>TABLE VI</b>			
<b>CARIES EXPERIENCE (DFT+DFT PER TOOTH) FOR OBESE AND HEALTHY-WEIGHT CHILDREN BY RECRUITMENT SOURCE</b>			
	<b>Dental Clinic Patients</b>	<b>Non-Dental Clinic Patients</b>	<b>Total</b>
<b>Obese (20)</b>	.31 (.15) N=10	.17 (.9) N=10	<b>.24 (.14) N=20</b>
<b>Healthy (20)</b>	.31 (.13) N=11	.31 (.13) N=9	<b>.31 (.13) N=20</b>
<b>Total</b>	<b>.31 (.14) N=21</b>	<b>.24 (.13) N=19</b>	

#### 4.2.2 **Dental Plaque**

Using the O'Leary plaque index, overall the children had stained plaque present on the majority of surfaces examined (Table VII and Table VIII). The analysis of the plaque index between the groups using an independent samples *t*-test did not demonstrate any differences (Table IX). The mean plaque index per tooth for the healthy weight children was 87% (8%) and for obese children was 88% (11%).

#### 4.2.3 **Gingival Health**

For assessing gingival health, a gingival index modified from Loe and Silness (1963) was used (Table VII and Table VIII). The gingival index took into account presence or absence of plaque and bleeding. Overall the children's mean scores were less than 1.0, indicating mild gingivitis (Table IX). The healthy weight children had a mean score per tooth of .97(.10) and the obese children had a mean score per tooth of .95(.13). There were no differences between the gingival indexes of the two groups (independent samples *t*-test).



TABLE VII						
PLAQUE INDEX AND GINGIVAL INDEX FOR HEALTHY-WEIGHT CHILDREN						
	#of prim. Teeth <sup>1</sup>	#of perm. Teeth <sup>2</sup>	# of surfaces with plaque	Plaque index <sup>3</sup>	Sum of surface scores	Gingival index <sup>4</sup>
1	12	12	85	88.54	22	0.92
2	7	16	85	92.39	25	1.04
3	12	12	87	90.63	27	1.13
4	0	28	90	80.36	24	1.00
5	12	12	67	69.79	18	0.75
6	8	11	61	80.26	22	0.92
7	12	12	94	97.92	24	1.00
8	0	26	95	91.35	24	1.00
9	3	16	59	77.63	20	0.83
10	0	28	101	90.18	23	0.96
11	0	28	102	91.07	27	1.13
12	8	17	91	91.00	23	0.96
13	0	28	101	90.18	24	1.00
14	12	12	70	72.92	19	0.79
15	7	14	84	100.00	26	1.08
16	7	15	81	92.05	23	0.96
17	14	9	84	91.30	25	1.04
18	6	13	61	80.26	23	0.96
19	1	23	79	82.29	20	0.83
20	0	31	122	98.39	25	1.04

<sup>1</sup>: primary teeth; <sup>2</sup>: permanent teeth;

<sup>3</sup>: ((Number of surfaces with plaque)/(number of teeth present x 4)) x100;

<sup>4</sup>: sum of surface scores/24

TABLE VIII						
PLAQUE INDEX AND GINGIVAL INDEX FOR OBESE CHILDREN						
	#of prim. Teeth <sup>1</sup>	#of perm. Teeth <sup>2</sup>	# of surfaces with plaque	Plaque index <sup>3</sup>	Sum of surface scores	Gingival index <sup>4</sup>
1	7	16	80	86.96	22	0.92
2	12	12	90	93.75	28	1.17
3	6	18	96	100.00	25	1.04
4	1	21	82	93.18	23	0.96
5	14	10	63	65.63	21	0.88
6	10	14	83	86.46	26	1.08
7	12	11	59	64.13	16	0.67
8	3	20	84	91.30	26	1.08
9	4	20	94	97.92	26	1.08
10	11	12	84	91.30	21	0.88
11	12	12	79	82.29	20	0.83
12	5	18	81	88.04	23	0.96
13	0	25	100	100.00	24	1.00
14	12	12	84	84.50	24	1.00
15	12	12	96	100.00	25	1.04
16	4	18	59	67.05	16	0.67
17	8	14	83	94.32	22	0.92
18	11	13	80	83.33	22	0.92
19	0	28	99	88.39	20	0.83
20	5	18	90	97.83	26	1.08

<sup>1</sup>: primary teeth; <sup>2</sup>: permanent teeth;

<sup>3</sup>: ((Number of surfaces with plaque)/(number of teeth present x 4)) x100;

<sup>4</sup>: sum of surface scores/24

TABLE IX			
PLAQUE INDEX AND GINGIVAL INDEX IN OBESE CHILDREN COMPARED TO HEALTHY-WEIGHT CHILDREN			
	Healthy (n=20)	Obese (n=20)	Significance
Plaque Index	87% (8%)	88% (11%)	$p>.1$
Gingival Index	.97 (.10)	.95 (.13)	$p>.1$

## 5. DISCUSSION

### 5.1 **Findings of this Study**

This cross-sectional study compared obese and healthy weight children 8-12 years old in the mixed or permanent dentition for tooth decay, gingival index and plaque index. The hypotheses were that obese children would have: 1) higher dft/DFT scores; 2) higher plaque scores; 3) higher gingival scores. Data from this study found no differences in caries experience, plaque or gingival scores. Even though there were no differences in caries experience there was an inverse correlation between BMI and caries experience. As BMI increased, caries experience decreased.

An inverse relationship has been described in other studies conducted in the United States based on NHANES data. These studies reported that children over 6 who are overweight had decreased rates of caries (Macek and Mitola, 2006;;Kopycka-Kedzierawski *et al.*, 2007). The study conducted at an urban dental school on children ages 8-9 also found this inverse relationship (Pinto *et al.*, 2007). None of the authors offered a theory as to why decreased caries rate was observed in overweight children. Further research may find biological factors that are caries protective in overweight children. Salivary properties in overweight and obese children may be the difference. The biochemical and microbiological salivary data obtained from the participants of this study (as a part of the larger study), may offer some insights into the complex relationship of dental caries as it relates to body mass index in children.

The relationship between childhood obesity and dental plaque has not been as extensively studied. In this study we found that the children in both groups had a high level of plaque, and differences between the groups were not significant. Modeer *et al.* (2010) found a higher visible plaque index in obese children. Werner *et al.* (2010) found a marginally significant difference in plaque scores between groups of children. They found that the group of overweight children (but not the obese group) had a lower proportion of subjects with a high plaque score. While our study did not find differences in plaque score, continuing to examine the interaction of plaque and childhood obesity is important. The ability of plaque to adhere to teeth could influence the caries rate between the groups.

In addition to observing plaque accumulation, gingival health was also observed in this study. Overall the children in this study had mild gingivitis and no differences existed between the groups. This is consistent with Werner *et al.* (2012). They also used modified gingival score with a range of 0 (no gingival inflammation) to 3 (severe inflammation). Using bleeding on probing as a measure of gingival health, Modeer *et al.* (2010) found that obese children had a higher percentage of bleeding on probing.

#### 5.1.1 **Study Population**

The sample of children in this study has limitations. Initial attempts were made to recruit children outside of the dental school. However, after a low response, children were recruited from UIC Pediatric Dentistry Clinics. The

dental school traditionally serves children of a lower socioeconomic status. Reports have shown children of a lower socioeconomic status have more caries (Marshall *et al.*, 2007; Chankanka *et al.*, 2011). Furthermore, a sample recruited from a dental clinic would normally have a higher caries rate than a sample recruited elsewhere. Group differences are harder to detect if range of disease is narrow. This may have contributed to this study not finding difference in caries scores between the groups.

#### 5.1.2 **Utilization of BMI Percentile**

In this study, BMI percentile was used to categorize the children into the two study groups (healthy-weight and obese). BMI or BMI percentile has been widely used in epidemiological studies to classify obesity. While simple and cost-effective, BMI is not the most accurate because it is weight based and it does not distinguish body composition. Direct measurements of the percentage of body fat such as the dual-energy x-ray absorptiometry (DXA) scan would offer more accurate grouping of individuals as obese, but is not practical for most epidemiological studies (Costacurta *et al.*, 2011; DeMello *et al.*, 2011). One study by Costacurta *et al.* (2011) in Italy used both BMI and DXA to classify children and then observed their dental caries experience. They found that according to the BMI classification there was no significant association between increased caries and pre-obesity/obesity. When using the DXA scan results to classify the children into groups, differences were found with the pre-obese/obese children having a higher caries index than the normal weight children. The study also

demonstrated that, compared to DXA, BMI misclassified adiposity status of the pediatric population. It was suggested that differences in classification could be one of the reasons there is conflicting results reported in the literature. Even studies that used weight based measurements may have classified them differently. Some used BMI, some BMI percentile. Different cut-offs may have been used depending on the country (US uses CDC, others used their countries standards or WHO charts). BMI percentile was used in our study to classify children into healthy-weight and obese groups due to the ease and limited risk to the children.

Most studies have categorized study subjects into 4 groups: underweight, healthy-weight, overweight and obese. This study was a cross-sectional study and, while not being totally case-controlled, limitations were used to recruit an obese group and a healthy-weight group. Case controlled models have been done (Bailleul-Forestier *et al.*, 2007; Modeer *et al.*, 2010). The advantage using a case control is that groups can be compared for gender, SES and other demographic variables allowing for smaller sample sizes. By limiting the study to healthy-weight and obese, differences between overweight and underweight subjects may be overlooked.

### 5.1.3 **Mixed Dentition**

Routinely caries experience is reported as decayed, missing, and filled surfaces or teeth. Most of the children in our study were in the mixed dentition stage, making it difficult to determine if a tooth was missing due to caries or

natural exfoliation. Therefore, missing teeth were charted but not included in the calculation for caries experience. Decayed and filled teeth were used in this study to indicate caries. Many other studies examining children with mixed dentition have made similar modifications in reporting caries experience. Using NHANES III data, Kopycka-Kedzierawski *et al.* (2008) presented dfs/DMFS scores in children aged 2-18, while Macek and Mitola (2006) presented the dft/DMFT scores. In a study examining children ages 8-9, Pinto *et al.* (2007) used only decayed surfaces to demonstrate differences in BMI and caries. Examination of Swedish children ages 4-10 by Gerdin *et al.* (2008) reported decayed-extracted-filled (def) in children up to age 6 and DFT in children aged 10-12. Three studies by Willershausen (2007a, 2007b, 2004) utilized dft/DFT scores in children aged 6-11. Again, this is an example of how methods differ between studies in this type of research. It is important to examine how caries experience is reported when comparing studies. The variety of methods used to report caries could contribute to the varying findings relating to caries to obesity in children.

It has been reported that tooth eruption in obese children progresses faster (Hilgers *et al.*, 2006a; Sanchez-Perez *et al.*, 2009). Because caries progress relatively slowly, children who have mixed dentition may have newly erupted teeth that are healthy. If obese children's teeth indeed erupt sooner, then at a given age, these children may have more permanent teeth and fewer caries. Their percentage of carious teeth would be reduced, affecting caries



experience. The effect of obesity in children on tooth eruption is another issue that has yet to be fully explored.

In spite of the above described discrepancies that arise when children of a mixed dentition are involved in caries studies, many researchers have selected this age ranges for examination (Tuomi, 1989; Willershausen et al., 2004, 2007a, 2007b; Hilgers et al., 2006b; Macek and Mitola, 2006; Kopycka-Kedzierawski *et al.*, 2007; Pinto *et al.*, 2007; Gerdin et al., 2008; Jurgensen and Petersen, 2009; Sharma and Hedge, 2009; Costacurta et al., 2011; Alm et al., 2011).

#### 5.1.4 **Radiographic Examination**

In practice, radiographs are part of a comprehensive oral examination performed on children to determine caries experience. However, in most clinical studies, radiographs are not usually performed as a part of the exam, which may lead to the under-reporting of dental caries. Like the majority of other studies, this study did not utilize radiographs as a part of the oral examination. This may cause under-reporting of dental caries. Among the studies that utilized radiographs, all reported an association of increased weight and interproximal dental caries (Hilgers *et al.*, 2006b; Alm *et al.*, 2008, 2011; Gerdin *et al.*, 2008; Modeer *et al.*, 2010), except one by Sheller *et al.* (2009). In large epidemiological studies, it is unrealistic and potentially unethical to expose children to radiation unless subsequent comprehensive dental care is provided as a part of the study. Because of the above reasons, dental radiographs were

not used to detect caries in this study. Therefore, the caries experience may have been under-reported in this study.

#### 5.1.5 **Plaque Index**

This study used the O'Leary plaque index. The O'Leary plaque index measures the presence or absence of plaque at the gingival margin. The O'Leary plaque index is a common index that is relatively easy to measure in children and relatively easy to calibrate examiners. Choosing a different plaque index that measures the amount of plaque covering the tooth would be more representative of the overall level of plaque present but may have been more difficult to measure accurately. At present, few studies have included plaque index as an oral health measure when comparing healthy-weight and obese children (Modeer *et al.*, 2010; Werner *et al.*, 2012). Modeer *et al.* (2010) used visible plaque index (VPI). They did find a higher VPI% in the obese group as compared to the control group. Werner *et al.* (2012) assessed amount of plaque present on 6 teeth and gave a score of 0 (no plaque present) to 4 (plaque covering more than two-thirds of the tooth surface). There exists no standard in reporting plaque index in this type of research. However, the choosing of an index that reflects amount of plaque versus presence or absence of plaque may be better if trying to relate plaque to caries and childhood obesity.

## **5.2 Limitations of this Study**

The small sample size was the main limitation of this study. Recruiting children from the College of Dentistry is also a limitation. However, the sample size would have been even smaller if those children would not have been included. Utilizing BMI percentile rather than a more accurate direct measurement of adiposity could be considered a limitation. However, BMI percentile is widely used not only for research purposes but also by healthcare professionals. The lack of radiographic examination could have lead to the under-reporting of caries. The choice of the O'Leary Plaque index may have also limited the results of the study. It was a measure of the presence or absence of plaque at the gingival margin rather than the amount of plaque present. The amount of plaque present may have a greater influence in this study. Despite the limitations, this study provides valuable information.

## **5.3 Future Research**

A larger sample size is necessary for this type of study. Utilizing a school system that has a range of SES and a range of caries experience would be ideal and would increase its external validity. Expanding the study to include underweight and overweight children should also be considered. Exploring the feasibility and ethic considerations of using the DXA scan may allow better classification of children into underweight, healthy weight, overweight and obese. Choosing an age group in either primary or permanent dentition would allow for more accurate measurement.

To fully explore the relationship between childhood obesity and oral health requires multiple measures of oral health. Choosing a plaque index that measures the amount of plaque may offer more insight than just the presence or absence of plaque. Going further and analyzing the plaque pH and consistency of the plaque would go even further to see if there are changes in plaque as obesity increases. That information could be helpful for determining biological changes that occur during obesity. In turn it could help explain how obesity affects oral health and vice versa. Including salivary analysis to investigate hormonal levels, cytokines, etc, could also explain some of the biological changes. Including dietary analysis and oral hygiene habits is necessary for controlling those influences.

## **6. CONCLUSION**

This cross-sectional pilot study found no differences between caries experience, plaque index or gingival index between obese and healthy-weight children ages 8-12. It did find that there was an inverse relationship between BMI and caries experience. In children recruited outside of the dental school, obese children had significantly lower caries experience. More research is needed to investigate if obese children are indeed less caries prone. Future research should include salivary analysis to understand the biological effects increased body weight on oral health. Given the prevalence of childhood obesity and dental caries, health professionals, including dentists, should be educating parents on the current dietary guidelines.

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## APPENDIX A IRB APPROVAL

### UNIVERSITY OF ILLINOIS AT CHICAGO

Office for the Protection of Research Subjects (OPRS)  
Office of the Vice Chancellor for Research (MC 672)  
203 Administrative Office Building  
1737 West Polk Street  
Chicago, Illinois 60612-7227

#### Approval Notice Initial Review (Response To Modifications)

November 24, 2009

Christine D. Wu, MS, PhD  
Pediatric Dentistry  
801 S. Paulina St., 469J Dent. Bldg.  
M/C 850  
Chicago, IL 60612  
Phone: (312) 996-7531 / Fax: (312) 996-1981

**RE: Protocol # 2009-0702**  
**"The Impact of Childhood Obesity on Oral Health"**

Dear Dr. Wu:

Your Initial Review (Response To Modifications) was reviewed and approved by the Expedited review process on November 4, 2009. You may now begin your research

Please note the following information about your approved research protocol:

**Protocol Approval Period:** November 4, 2009 - November 3, 2010

**Approved Subject Enrollment #:** 150

**Additional Determinations for Research Involving Minors:** The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Wards of the State may not be enrolled unless the IRB grants specific approval and assures inclusion of additional protections in the research required under 45CFR46.409. If you wish to enroll Wards of the State contact OPRS and refer to the tip sheet.

**Performance Sites:** UIC

**Sponsor:** Department

**PAF#:** Not Applicable

**Research Protocol(s):**

- a) "The Impact of childhood obesity on oral health," version 1, as submitted to OPRS on August 5, 2009

**Recruitment Material(s):**

- a) Telephone Script, The impact of childhood obesity on oral health, Version #1, 09/21/2009
- b) Internet announcement, The Impact of childhood obesity on oral health, Version 1.1, 09/21/09
- c) Advertisement for recruitment of subjects, Version 1.1, Impact of childhood obesity on oral

Phone: 312-996-1711

<http://www.uic.edu/depts/ovcr/oprs/>

FAX: 312-413-2929

## APPENDIX A (continued)

Page 2 of 3

health, 09/21/09

- d) Advertisement for recruitment of subjects, Version 1.1, Impact of childhood obesity on oral health, 09/21/09

**Assent(s):**

- a) The impact of childhood obesity on oral health, version 1.2, 10/21/09

**Parental Permission(s):**

- a) Impact of Childhood Obesity on Oral Health, Parental permission form, version- 1.1, 9/21/2009

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

- (3) Prospective collection of biological specimens for research purposes by noninvasive means,  
 (4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.),  
 (7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

**Please note the Review History of this submission:**

Receipt Date	Submission Type	Review Process	Review Date	Review Action
08/05/2009	Initial Review	Expedited	08/16/2009	Modifications Required
09/22/2009	Response To Modifications	Expedited	09/30/2009	Modifications Required
10/26/2009	Response To Modifications	Expedited	11/04/2009	Approved

Please remember to:

→ Use your **research protocol number** (2009-0702) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,  
**"UIC Investigator Responsibilities, Protection of Human Research Subjects"**

**Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.**

**Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.**

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 413-7323. Please send any correspondence

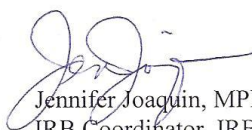
**APPENDIX A (continued)**

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Page 3 of 3

about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,



Jennifer Joaquin, MPH  
IRB Coordinator, IRB # 1  
Office for the Protection of Research Subjects

Enclosure(s):

- 1. UIC Investigator Responsibilities, Protection of Human Research Subjects**
- 2. Assent Document(s):**
  - a) The impact of childhood obesity on oral health, version 1.2, 10/21/09
- 3. Parental Permission(s):**
  - a) Impact of Childhood Obesity on Oral Health, Parental permission form, version- 1.1, 9/21/2009
- 4. Recruiting Material(s):**
  - a) Telephone Script, The impact of childhood obesity on oral health, Version #1, 09/21/2009
  - b) Internet announcement, The Impact of childhood obesity on oral health, Version 1.1, 09/21/09
  - c) Advertisement for recruitment of subjects, Version 1.1, Impact of childhood obesity on oral health, 09/21/09
  - d) Advertisement for recruitment of subjects, Version 1.1, Impact of childhood obesity on oral health, 09/21/09

cc: Indru C. Punwani, Pediatric Dentistry, M/C 850



## APPENDIX B IRB RENEWAL

### UNIVERSITY OF ILLINOIS AT CHICAGO

Office for the Protection of Research Subjects (OPRS)  
Office of the Vice Chancellor for Research (MC 672)  
203 Administrative Office Building  
1737 West Polk Street  
Chicago, Illinois 60612-7227

#### Approval Notice Continuing Review

November 17, 2010

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Chicago, IL 60612  
Phone: (312) 996-7531 / Fax: (312) 996-1981

**RE: Protocol # 2009-0702**  
**"The Impact of Childhood Obesity on Oral Health"**

Dear Dr. Wu:

Your Continuing Review was reviewed and approved by the Expedited review process on October 26, 2010. You may now continue your research.

Please note the following information about your approved research protocol:

**Protocol Approval Period:** November 4, 2010 - November 3, 2011

**Approved Subject Enrollment #:** 150 (7 enrolled to date)

**Additional Determinations for Research Involving Minors:** The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Wards of the State may not be enrolled unless the IRB grants specific approval and assures inclusion of additional protections in the research required under 45CFR46.409. If you wish to enroll Wards of the State contact OPRS and refer to the tip sheet.

**Performance Sites:** UIC

**Sponsor:** Department

**PAF#:** Not Applicable

**Research Protocol(s):**

- a) Impact of childhood obesity on oral health, Version 1.3, 03/02/2010

**Recruitment Material(s):**

- a) Internet announcement, The Impact of childhood obesity on oral health, Version 1.2, 01/20/2010
- b) Telephone Script, The impact of childhood obesity on oral health, Version #1.2, 04/16/2010
- c) Flyer for recruitment of subjects, Version 1.4, 08/13/2010

Phone: 312-996-1711

<http://www.uic.edu/depts/ovcr/oprs/>

FAX: 312-413-2929

## APPENDIX B (continued)

Page 2 of 3

d) Email Notice- The Impact of childhood obesity on oral health, Version 1.2 08/13/10

**Assent(s):**

a) The impact of childhood obesity on oral health, Version 1.3, 01/20/2010

**Parental Permission(s):**

a) Impact of Childhood Obesity on Oral Health, Parental permission form, version- 1.2, 8/13/2010

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

- (3) Prospective collection of biological specimens for research purposes by noninvasive means.,
- (4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.),
- (7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

**Please note the Review History of this submission:**

Receipt Date	Submission Type	Review Process	Review Date	Review Action
10/13/2010	Continuing Review	Expedited	10/26/2010	Approved

Please remember to:

→ Use your **research protocol number** (2009-0702) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,  
"UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

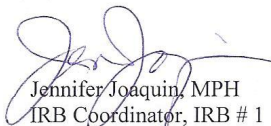
Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

**APPENDIX B (continued)**

Page 3 of 3

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 413-7323. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,



Jennifer Joaquin, MPH  
IRB Coordinator, IRB # 1  
Office for the Protection of Research Subjects

Enclosure(s):

- 1. UIC Investigator Responsibilities, Protection of Human Research Subjects**
- 2. Assent Document(s):**
  - a) The impact of childhood obesity on oral health, Version 1.3, 01/20/2010
- 3. Parental Permission(s):**
  - a) Impact of Childhood Obesity on Oral Health, Parental permission form, version- 1.2, 8/13/2010
- 4. Recruiting Material(s):**
  - a) Internet announcement, The Impact of childhood obesity on oral health, Version 1.2, 01/20/2010
  - b) Telephone Script, The impact of childhood obesity on oral health, Version #1.2, 04/16/2010
  - c) Flyer for recruitment of subjects, Version 1.4, 08/13/2010
  - d) Email Notice- The Impact of childhood obesity on oral health, Version 1.2 08/13/10

cc: Philip Marucha, Associate Dean for Research, M/C 621

## APPENDIX C

### CDC BMI PERCENTILE-FOR-AGE FOR BOYS

**2 to 20 years: Boys**  
**Body mass index-for-age percentiles**

NAME \_\_\_\_\_

RECORD # \_\_\_\_\_

[illegible]

Published May 30, 2000 (modified 10/16/00).  
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).  
<http://www.cdc.gov/growthcharts>



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## APPENDIX D

### CDC BMI PERCENTILE-FOR-AGE FOR GIRLS

### 2 to 20 years: Girls

### Body mass index-for-age percentiles

NAME \_\_\_\_\_

RECORD #

[illegible]

Published May 30, 2000 (modified 10/16/00).  
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).  
<http://www.cdc.gov/growthcharts>



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Call: (312) 355-1610, or  
Email: [codobstudy10@uic.edu](mailto:codobstudy10@uic.edu)

## APPENDIX F RECRUITMENT FORM

Appointment Date \_\_\_\_\_

Subject Number \_\_\_\_\_

Appointment Clinician \_\_\_\_\_

### The Impact of Childhood Obesity on Oral Health Study UIC College of Dentistry, Pediatrics Department

1. Parent/Guardian Name \_\_\_\_\_

Patient Name \_\_\_\_\_

2. Phone Number \_\_\_\_\_

3. Is your child between 8-12 years of age? ☐ Yes ☐ No

If yes, how old is your child?

☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 124. Does your child currently take any prescribed medication? ☐ Yes ☐ No5. Does your child have any systemic illnesses? ☐ Yes ☐ No6. Is your child suffering from any special or syndromic conditions? ☐ Yes ☐ No7. What is the gender of your child? ☐ Female ☐ Male

8. What is your child's ethnicity? \_\_\_\_\_

☐ White ☐ Black ☐ Hispanic ☐ Asian ☐ American Indian ☐ Other

9. What is your child's weight? \_\_\_\_\_

10. What is your child's height? \_\_\_\_\_

11. Calculated Body Mass Index (BMI) \_\_\_\_\_

12. BMI-for-Age Percentile \_\_\_\_\_

13. Is the child qualified for this study? ☐ Yes ☐ NoCompensation to subject: ☐ Yes ☐ No

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Name of Interviewer: \_\_\_\_\_



## APPENDIX G CONSENT

### University of Illinois at Chicago Parental Permission for Participating in Research “Impact of Childhood Obesity on Oral Health”

#### Why is my child being asked?

Your child is being asked to be a subject in a research study on impact of childhood obesity on oral health. Childhood obesity has alarmingly increased in the past two decades, and is a topic of interest for many researchers in health related field including dental care. This study is being conducted at Department of Pediatric Dentistry, College of Dentistry at the University of Illinois at Chicago (UIC). The Principal Investigator is Dr. Christine D. Wu, Department of Pediatrics Dentistry, UIC. Your child has been asked to participate in the research because you responded to our flyer/advertisement and your child may be eligible to participate. Please read this form and ask any questions you may have before agreeing to allow your child to participate in the research study.

Your child's participation in this research is voluntary. Your decision whether or not to allow your child to participate will not affect your child's or your current or future relations with the University or with the College of Dentistry. If you decide to allow your child to participate, your child is free to withdraw at any time without affecting that relationship.

#### Why is this research being done?

Obesity is a growing health concern in children and adults. It is a condition resulting from excessive storage of fat in the body which may impair general health. Increase intake of sugary food, fatty diet and reduced physical activity are contributing factors for obesity. Childhood obesity has alarmingly increased in the past two decades, and is topic of interest for many researchers in health related field including dental care. Oral health is an important component of the general health. Poor oral health may lead to dental decay, bad breath, pain, tooth loss and sometimes systemic diseases. Both obesity and poor oral health can lead to possible health risks in the long term.

#### What is the purpose of this research?

Impact of Childhood Obesity on Oral Health  
Parental permission form version- 1.1  
3/15/2012  
Page 1 of 5



## APPENDIX G (continued)

The purpose of this research is to find out if childhood obesity affects oral health in children between ages 8 -12 years old.

### What procedures are involved?

If you agree to allow your child to be in this research, we would ask your child to do the following things:

Approximately 150 participants will be enrolled in this study at UIC College of Dentistry. Your child will come to College of Dentistry only one time during this study. An oral exam will be done to see if your child is qualified for the study. The height and weight of your child will be measured on the standard scale. The waist measurement will be also recorded. Then, spit sample will be collected. Your child will be asked to tilt his/her head on one side and drool for 5 minutes. This spit sample will be collected in the collecting tube and transported to the laboratory for further study. Dental plaque is a soft deposit that accumulates on the teeth. Plaque index is a measure of the amount of plaque on the tooth surface. After spit collection, plaque index will be measured. Your child will be asked to chew on a food coloring tablet which will color the plaque and then the plaque index can be recorded. A clinical oral exam will be performed to check overall gums condition—and to record the number of decayed, filled and missing teeth. Gums are known as gingiva. GI is used to determine the health of gingival tissue. The Gingival Index (GI) will be measured. A blunt dental probe is moved around the gingival margins and then depending upon the presence or absence of bleeding, the readings are recorded. Finally, you will be asked to fill out two questionnaires. These questionnaires will mainly include information about your child's oral habits, living condition and the diet which he/she eats regularly. The estimated time for this visit will be approximately one hour and 30 minutes. No medical or dental treatment will be provided if any cavities or other oral health conditions are identified in the examination. The result of oral examination will be given to you at the end of the study.

### What are the potential risks and discomforts?

As no invasive procedures are used in this study, there is no risk involved. We will be collecting the saliva sample by asking your child to tilt his/her head and drool. Although very unlikely, drooling might cause slight discomfort to some children.

### Are there benefits to taking part in the research?

There are no direct benefits to you or your child.

## APPENDIX G (Continued)

### **Will I be told about new information that may affect my decision to allow my child to participate?**

This is a one visit study. During the course of the study, you will be informed of any significant new findings (either good or bad), such as changes in the risks or benefits resulting from participation in the research or new alternatives to participation, that might cause you to change your mind about allowing your child to continue in the study. If new information is provided to you, your consent to allow your child to continue participating in this study will be re-obtained.

### **What about privacy and confidentiality?**

The persons who will have knowledge about your child's involvement in this study will be limited to members of the research team, and, if appropriate, your child's physicians and nurses. No information about your child, or provided by you or your child during the research will be disclosed to others without your written permission, except:

- If necessary to protect your child's rights or welfare (for example, if your child is injured and need emergency care or when the UIC Institutional Review Board monitors the research or consent process); or
- If required by law.

Your child's information will only be identified by a numeric code and your child's name will not be included in the data. Two lists will be assembled for this study: one list links your child's name and contact information with his/ her numeric code and another list will be of your child's study data identified only by the assigned numeric code. When the results of the research are published or discussed in conferences, no information will be included that would reveal your identity. All data will be stored in a locked file cabinet in a secure room.

### **What if my child is injured as a result of his/her participation?**

This is a minimal risk study. In the event of injury related to this research, treatment will be available through the UIC Medical Center. However, you or your third party payer, if any, will be responsible for payment of this treatment. There is no compensation and/or payment for such medical treatment from the UIC Medical Center for such injury except as may be required of the University by law.

If you feel you have been injured, you may contact Principal Investigator Dr. Christine D.Wu at 312-355-1990

### **What are the costs for participating in this research?**

There is no cost for participating in this research.

### **Will I be reimbursed for any of my expenses or paid for my child's participation in this research?**

## APPENDIX G (Continued)

Yes, you will be paid \$25 in cash at the end of the visit if your child qualifies and completes the study. If not qualified on the initial exam you will be paid \$10.

### **Can my child withdraw or be removed from the study?**

Your child's participation in this research is VOLUNTARY. If you choose not to allow your child to participate, that will not affect you or your child's relationship with UIC or your right to health care or other services to which you and your child are otherwise entitled. If you decide to allow your child to participate, you are free to withdraw your consent and discontinue your child's participation at any time without affecting your future care at UIC. You will be only paid if you complete the visit.

The investigator may withdraw your child from participating in this research without your consent if circumstances arise which warrant doing so. The decision may be made to protect your child's health and safety. The investigators or Dr. Wu will inform you as soon as possible when this happens.

### **Whom should I contact if I have questions?**

The Principal Investigator of this study is Dr. Christine Wu and co investigator is Dr. Marilia Montero-Fayad. You may ask any questions you have now. If you have questions later, you may contact the researchers at: 312-355-1990.

### **What are my child's rights as a research subject?**

If you feel you have not been treated appropriately according to the descriptions in this form, or you have any questions about your rights as a research subject, you may call the Office for the Protection of Research Subjects (OPRS) at 312-996-1711 (local) or 1-866-789-6215 (toll-free) or e-mail OPRS at [uicirb@uic.edu](mailto:uicirb@uic.edu).

### **Remember:**

Your child's participation in this research is voluntary. Your decision whether or not to allow your child to participate will not affect your current or future relations with the University. If you decide to allow your child to participate, your child is free to withdraw at any time without affecting that relationship.

You will be given a copy of this form for your information and to keep for your records.

### **Signature of Subject or Legally Authorized Representative**

I have read (or someone has read to me) the above information. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I agree to participate in this research. I have been given a copy of this form.



**APPENDIX G (Continued)**

---

Signature

---

Date

---

Printed Name

---

Signature of parent or guardian

---

Date (must be same as subject's)

---

Printed name of parent or guardian

---

Signature of Researcher

---

Date (must be same as subject's)

---

Printed name of Researcher

## APPENDIX H ASSENT

### University of Illinois at Chicago **ASSENT TO PARTICIPATE IN RESEARCH**

“The impact of childhood obesity on oral health”

1. My name is Lynse Briney. I am responsible for making this study work smoothly.
2. We are asking you to take part in a research study because we are trying to learn more about increase in weight (obesity) and conditions like bad breath, tooth pain, cavities and loss of teeth.
3. If you agree to be in this study, we will look into your mouth and see if you have any dental problems. If you get to do this study then we will collect your spit by asking you to tilt your head to one side and let the spit flow out of your mouth. We will collect that spit in the tube and examine it further for our study. Also we will measure how tall you are and your weight and your waist.
4. The method we are going to use to gather spit is simple and easy and will not cause you any kind of pain.
5. You will get a free oral exam. Your mouth will be looked at so that you know what is your oral health condition. By getting involved in this research you will help us to study the relation of overweight and poor oral health.
6. Please talk this over with your parents before you decide whether or not you want to be a part of this study. We will also ask your parents to give their permission for you to take part in this study. But even if your parents say “yes” you can still decide not to do this.
7. If you don't want to be in this study, you don't have to participate. Remember, being in this study is up to you and no one will be upset if you don't want to get involved or even if you change your mind later and want to stop.
8. You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can call me at 312-355-1610 or ask me later during the study.

**APPENDIX H (Continued)**

9. Signing your name at the bottom means that you agree to be in this study. You and your parents will be given a copy of this form after you have signed it.

---

Name of Subject

---

Date

---

Signature

---

Age

---

Grade in School

## APPENDIX I ORAL HYGIENE SURVEY

ID: \_\_\_\_\_

Date \_\_\_\_\_

### “The Impact of Childhood Obesity on Oral Health”

#### Survey Questionnaire

**1. How many times does your child brush his/her teeth?**

- a. More than once a day
- b. Once a day
- c. Not every day
- d. Never

**2. Does your child use mouthwash?**

- a. More than once a day
- b. Once a day
- c. Not every day
- d. Never - if you checked this option skip question number 3.

**3. What type of mouthwash does your child use?**

- a. Scope
- b. Listerine
- c. Act
- d. Fluorigard
- e. Other \_\_\_\_\_

**4. Do your child's gums bleed while brushing his/her teeth?**

- a. Always
- b. Frequently (more than 3 times a week)
- c. Occasionally (once or twice a week)
- d. Rarely (once or less every two weeks)
- e. Never

**5. Does your child have bad breath during the day?**

- a. Always
- b. Frequently (more than 3 times a week)
- c. Occasionally (once or twice a week)
- d. Rarely (once or less every two weeks)
- e. Never

**6. Does your child complain of toothache?**

- a. Always
- b. Frequently (more than 3 times a week)
- c. Occasionally (once or twice a week)
- d. Rarely (once or less every two weeks)
- e. Never

The impact of childhood obesity on oral health.  
Version 1.2 04/16/2010

**APPENDIX I (Continued)**

**7. When was the last time your child visited a dentist for his/her oral exam?**

- a. Within the last 6 months
- b. Within the last year
- c. More than a year ago
- d. My child has never visited the dentist before this

**8. Does your child watch TV/computer?**

- a. More than 6 hours per day
- b. 3-6 hours per day
- c. Less than 3 hours per day
- d. Not at all

**9. Does your child exercise/play sports?**

- a. Everyday
- b. Frequently (more than 3 times a week)
- c. Occasionally (once or twice a week)
- d. Rarely (once or less every two weeks)
- e. Never

**10. How many times a day does your child drink juice /soda or eat snacks in between meals?**

- a. 1-2 times
- b. 3-4 times
- c. More than 4 times

**11. Does your child chew gum?**

- a. More than once a day
- b. once a day
- c. Not every day
- d. Never

**12. If your child chews gum, what type of chewing gum does he/she chew?**

- a. Sugar-added chewing gum
- b. Sugar-free chewing gum
- c. Both

**13. Does your child eat dried fruits?**

- a. More than once a day
- b. once a day
- c. Not every day
- d. Never

**14. If your child eats dried fruits, which one does he/she eat most?**

- a. Dried plums (Prunes)
- b. Raisins
- c. Banana chips
- d. Almonds and Cashews



**APPENDIX I (Continued)**

**15. What is your annual income?**

- a. Below 20K
- b. Between 20K- 50K
- c. Above 50K

**16. What is the highest level of education you (Parent/guardian) have received?**

- a. Less than High school
- b. High school graduate
- c. Some college
- d. College graduate

**17. What is your ethnicity?**

- a. White non-hispanic
- b. Hispanic
- c. African-american
- d. Asian
- e. Other

## APPENDIX J CLINICAL EXAMINATION FORM

Patient ID number : \_\_\_\_\_

Examiners Initials : \_\_\_\_\_

### df-t/DF-T score

- Record the number of decayed and filled teeth in both the primary and permanent dentition. If a tooth has decay (primary lesion or recurrent decay) or a filling it gets a score of 1.
- No tooth can score greater than a 1. If a tooth has a restoration and decay it still only scores a 1.
- Only cavitated lesions score a 1. Non-cavitated white spot lesions are observed but not recorded.
- Sealants should be counted as filled.

Step One: Circle the teeth present.

Step Two: X-out any box in which there is not a tooth present

Step Three: Mark a "D" or "F" or "DF" in each box corresponding with the tooth

Step Four: Enter a "0" in the box to indicate a sound tooth.

Step Five: count the df-t and enter – remember even a df scores a 1.

Step Six: count the DF-T and enter – remember even a DF scores a 1.

Step Seven: Add the df-t + DF-T and enter.

2	3	4/A	5/B	6/C	7/D	8/E	9/F	10/G	11/H	12/I	13/J	14	15

31	30	29/T	28/S	27/R	26/Q	25/P	24/O	23/N	22/M	21/L	20/K	19	18

df=

DF=

df+DF=

## APPENDIX J (Continued)

Patient ID number : \_\_\_\_\_  
 Examiners Initials : \_\_\_\_\_

### O'Leary Plaque Index

- Plaque index is taken for all teeth present.
- 4 surfaces on each tooth:
  - M= mesial-buccal
  - F= Facial
  - D=distal-buccal
  - L=Lingual
- Plaque is only scored if it is along the gingival margin.
  - 0= no plaque present at that surface along the gingival margin
  - 1= plaque is present at the gingival margin – any amount of plaque
- Expressed as a percentage. Add all plaque containing surfaces then divide by four times the number of teeth examined. Then multiply by 100.

Step one: Disclose the patient

Step two: Circle the teeth present.

Step three: X-out any box in which there is not a tooth present

Step four: Record the 4 readings for each tooth – 3 in the box designated for DFM and 1 in the box for L.

Step five: Calculate the plaque index

2	3	4/A	5/B	6/C	7/D	8/E	9/F	10/G	11/H	12/I	13/J	14	15
DFM	DFM	DFM	DFM	DFM	DFM	DFM	MFD	MFD	MFD	MFD	MFD	MFD	MFD
L	L	L	L	L	L	L	L	L	L	L	L	L	L

L	L	L	L	L	L	L	L	L	L	L	L	L	L
DFM	DFM	DFM	DFM	DFM	DFM	DFM	MFD	MFD	MFD	MFD	MFD	MFD	MFD
31	30	29/T	28/S	27/R	26/Q	25/P	24/O	23/N	22/M	21/L	20/K	19	18

Number of surfaces with plaque:

X 100 =

Number of teeth examined:

X 4

## APPENDIX J (Continued)

Patient ID number : \_\_\_\_\_  
 Examiners Initials : \_\_\_\_\_

**Silness and Loe Gingival Index**

- Six teeth are selected to evaluate gingival index. The preferred teeth are #3, 9, 12, 19, 25, 28.
- If the primary tooth is present instead of the permanent tooth select that tooth and indicate on the form.
- If the primary tooth has class 2 mobility or more, select an adjacent tooth and indicate the tooth number in the box.
- Each tooth selected is measured on 4 surfaces:
  - D=distal-facial papillae
  - F=Facial margin
  - M=mesio-facial papillae
  - L=entire lingual gingival margin
- A probe is gently inserted just inside of the free gingival approximately 1 mm (not to the base of the pocket). It should be swept along the entire surface to determine the presence or absence of bleeding.
- Each surface is given a score of 0-3:
  - 0= Normal healthy gingival –no plaque present, no bleeding.
  - 1= Mild inflammation –plaque present but no bleeding.
  - 2= Moderate inflammation – Plaque present and bleeding on probing.
  - 3= Severe inflammation – marked redness and edema. Ulceration and tendency to spontaneous bleed.
- The index is calculated by adding all of the readings and divide by the number of surfaces (24).

Step One: indicate the teeth used for the gingival index by circling the number being used or by writing in the tooth number selected. Must select 6 teeth.

Step Two: Run the probe through the sulcus at a depth of 1 mm using the perio probe.

Step Three: Record each of the 4 surfaces for the tooth

Step Four: Repeat for all 6 teeth selected

Step Five: Calculate the Gingival index

Tooth: 3					Tooth: 9 / F					Tooth: 12 / I				
D	F	M	L		D	F	M	L		D	F	M	L	

Tooth: 19					Tooth: 25 / P					Tooth: 28 / S				
D	F	M	L		D	F	M	L		D	F	M	L	

Sum of all Scores:

	/ 24 =	
--	--------	--

## **VITA**

**NAME:** Lynse J. Briney

**EDUCATION:** B.S., Biology, Iowa State University, Ames, IA, 2001

D.D.S., University of Illinois at Chicago, Chicago, IL, 2005

Certificate, General Practice Residency, Advocate Illinois  
Masonic Medical Center, Chicago, IL 2006

Certificate, Pediatric Dentistry, University of Illinois at  
Chicago, Chicago, IL, 2011

**HONORS:** Omicron Kappa Upsilon, inductee, 2005

Chicago Dental Society , HPSC Scholarship Recipient,  
2005

Omicron Kappa Upsilon, Lina Tharp Award, 2004

Omicron Kappa Upsilon, Outstanding Sophomore Award,  
2004

Clopper Memorial Foundation Scholarship Recipient, 2003

Omicron Kappa Upsilon, Outstanding Freshman Award,  
2003

Alliance of the Chicago Dental Society Scholarship, 2003

**PROFESSIONAL** American Dental Association  
**MEMBERSHIPS:** Illinois State Dental Association  
Chicago Dental Association  
American Academy of Pediatric Dentistry  
American Board of Pediatric Dentistry, candidate