Association between Caries, Obesity and Insulin Resistance in Mexican Adolescents

Juan Pablo Loyola-Rodriguez * / Carlos Villa-Chavez ** / Nuria Patiño-Marin *** / Celia Aradillas-Garcia **** / Cesar Gonzalez ***** / Esperanza de la Cruz-Mendoza ******

Aim: To determine the association among dental caries, obesity and insulin resistance in Mexican adolescents. Methods: Body Mass Index, obesity (OB) blood pressure, insulin level, insulin resistance (IR), triglycerides level, serum HDL-cholesterol (cHDL), DMFT index and salivary flow were measured. Results: Anthropometric measures showed a significant statistical difference ($p < 0.05$). Insulin level was 8.98 for healthy subjects, whereas for OB-IR group was 25.35, there was a statistical significant difference ($p < 0.05$). Triglycerides level was 88.50 for healthy subjects and 169.40 mg/dL for OB-IR; cHDL was 52.88 for healthy and 41.82 mg/dL for OB-IR group, both showed a statistically significant difference ($p < 0.05$). Salivary flow was 4.30 for healthy and for OB-IR group was 5.48 ml/min showed a significant statistical difference ($p < 0.05$). DMFT index was 3.02 for healthy and for OB-IR adolescents was 4.78, showed a significant statistical difference ($p < 0.05$). The caries component of DMFT index was 1.84 for healthy and was 3.52 for OB-IR adolescents, showed a significant statistical difference ($p < 0.05$). According to the multivariate analysis, DMFT (OR=3.10; IC95%=0.20-1.02, p=0.042) and decay (OR=3.30; IC95%=0.19-1.0, p=0.011) were associated with subjects with OB-IR. Conlusion: OB-IR Mexican adolescents showed a positive association with DMFT.

Keywords: caries, obesity, insulin resistance, children, Mexico


INTRODUCTION

Despite the efforts to diminish dental caries around the world, there are only few positive results in industrialized countries, where the population has access to primary care from early ages. Previous studies have reported high caries prevalence in Latin American countries where a great proportion of the children population remains without dental treatment. The increase in food consumption with high glycemic and caloric components (sucrose) not only causes dental caries, but it also entails obesity. Obesity is a subject of global nutritional interest, especially in childhood the obesity has more than tripled in the past 30 years, the prevalence in children aged 6 to 11 years increased from 6.5% in 1980 to 19.6% in 2008. Similar findings has been reported in adolescents, the prevalence of obesity among adolescents aged 12 to 19 years increased from 5.0% to 18.1%. The National Health and Nutrition Survey (NHANES) conducted in 2003–2006 reported an obesity prevalence of 22.1% in men and 19.9% in women in Mexican-Americans adolescents aged 12 to 19 years. These results exceed the prevalence of obesity reported in Mexico, it was reported 9.2 to 11.8% for adolescent men aged 12 to 17 and 6.8 to 10.6% for adolescent woman aged 10 to 17 years.

Insulin resistance (IR) is a metabolic state in which the physiological insulin concentrations produce an inferior physiological response. The IR is the decrease of action of this hormone in muscular, hepatic and fatty tissues, and it manifests when a determined concentration of the hormone produces a smaller biological effect. Mexico has a population with high risk of developing diabetes since levels of glucose intolerance are as high as 14.7% in a population
from 20 to 69 years old.\textsuperscript{10} When this percentage is added to
the population that already presents high levels of glucose or
are not diagnosed, it means that at least 10.7\% of the total
population in this age group have or will have diabetes mel-
литус. Based on this information, there are nearly 6.5 to 110
million diabetics in Mexico and more than 2 millions have
not been diagnosed.\textsuperscript{11} To worsen this health situation, it has
been reported that children spend more time watching tele-
vision or playing with the computer than exercising, they
spend on average 25 to 27 hours per week watching tele-
vision and 1.6 hours per week in physical activity.\textsuperscript{5,10} The prob-
ability of overweight is 4.6 times higher for those that watch
5 hours of television per day compared to those that watch
television less than 2 hours per day.\textsuperscript{1}

A recent study in elementary school reported a positive
correlation between obesity and caries experience in primary
dentition in Mexican population\textsuperscript{12} and other studies have
reported a positive association in primary and mixed denti-
tions as well.\textsuperscript{5,14} However, there has been reported an inverse
relationship between dental caries and overweight.\textsuperscript{1,15,16}

Recently, there is a report about a positive association of
proximal caries with overweight and obesity in adoles-
cents,\textsuperscript{17} but in adolescents there is a few information about
this problem health. Due to which carrying out a study with
a population of high risk to obesity, Type 2 Diabetes Mellitus,
and with a high prevalence of dental decay as the Mex-
ican is going to contribute to the knowledge of this
association. The aim of the present study was to determine
the association among caries experience and obesity-insulin
resistance in Mexican adolescents aged 12 to 18 years.

METHOD AND MATERIALS

A cross-sectional study was carried out in oral medicine
clinic of the Faculty of Dentistry and in the Laboratory of
Hormones and Nuclear Medicine of the Faculty of Medi-
cine, both at San Luis Potosí University, Mexico. The cli-
cal research committee approved the study in accordance
with the ethical guidelines of the declaration of Helsinki
(version 2008).

Parents of children completed a standardized health ques-
tionnaire that included information about pediatrics and oral
evaluations and an informed voluntary written consent from
parents was obtained prior to clinical examinations. Anthro-
metric measures, arterial pressure, and blood and saliva
samples were included for each patient as well. The selec-
tion of the subjects were carried out by using the following
criteria: 1) Inclusion criteria: Group A. subjects with
absence of OB-IR, age between 12 and 18 years old, and
presence of permanent teeth were included. Group B.
patients with diagnosis of obesity and insulin resistance
(OB-IR), subjects from12 and 18 years old, and presence of
permanent teeth were included. 2) Exclusion criteria for
both groups were as follows: patients affected by diabetes
mellitus and subjects with evident genetic disorders.
3) Elimination criteria: technical incapacity to establish the
diagnosis of obesity and insulin resistance and to evaluate
the variables included in the study.

From a total of 350 evaluated individuals, 100 subjects
that fulfill the selection criteria were selected and divided
into two groups. Group A: 50 healthy subjects without OB-
IR and Group B: 50 patients with diagnosis of OB-IR. The
study was blinded for obesity and insulin resistance diag-
noses. A 10 milliliter of peripheral blood was taken and cen-
trifuged 3,500 rpm/10 min; then, serum was separated and
stored at -80°C until experimental procedures. Determina-
tion of plasma glucose levels, serum HDL-cholesterol
c(HDL) and triglycerides were measured by using a Hitachi
902 automatic analyzer (Roche Diagnostics, Japan). Deter-
mination of insulin was carried out by quimioluminiscence
(QLA) (IMMULITE 1000 analyzer DPC, Los Angeles, CA,
USA). Insulin resistance degree was determined by the
homeostatic model assessment.\textsuperscript{14} Scores ordinarily range
from 0 to 15, higher scores indicated an insulin resistance,
which was calculated as the product of the fasting plasma
insulin level (in micromunts per milliliter) and the fasting glu-
cose level (in millimoles/l) divided by 22.5.

Anthropometric measures

Height was measured with the participants standing with-
out shoes by using a stadiometer, and was recorded to the
nearest half centimeter. Weight was measured by a digital
scale, with the participants wearing light clothing or under-
wear, and was recorded to the nearest 100 g. Waist-Hip-
Ratio was defined as follows: waist circumference was
measured at the narrowest part between the lower rib and the
iliac crest (the natural waist) or, in case of an indeterminable
waist narrowing, halfway between the lower rip and the iliac
crest, and was recorded to the nearest half centimeter. Body
Mass Index (BMI) was calculated as weight in kilograms
divided by the square of height in meters and was rounded
to the nearest tenth. The index of hip and waist was calcul-
ated dividing the waist circumference by the hip measure, a
value up to 0.9 in men and 0.8 in women was associated
with higher incidence of insulin resistance.\textsuperscript{19}

Overweight and obesity

Obesity and overweight status were defined based on
the age and sex-specific 2000 CDC growth charts for the
United States.\textsuperscript{20} Obesity was defined as at or above the 95th
percentile of BMI for age and sex; overweight was defined as
at or above the 85th percentile and less than 95th percentile
of BMI for age and sex. Normal weight was defined as less
than 85 percentile of BMI for age and sex.

Blood pressure

Blood pressure (BP) was measured in a seated position
after at least 5 min rest with a Dinamap semiautomatic oscil-
lometric recorder. A cuff of suitable size was applied to
the participant’s upper arm (the arm not used for blood collec-
tion), which was supported by a table at heart level. BP was
measured with a standard mercury sphygmomanometer
using the first and fifth Korotkoff sounds, to the nearest 2
mmHg. The normal value of BP was 100/60 up to 120/80,
values over 130/90 mmHg were indicative of hypertension.
**Saliva sampling**

Paraffin-stimulated whole saliva from subjects was sampled over a 5-min period in a sterilized propylene tube; this procedure was carried out consistently in the morning (9-10 am) to minimize the circadian rhythm effects, 2 h after the previous meal. The quantification of the salivary flow was determined by dividing the whole saliva sample (in milliliters) between harvesting time, pH was estimated by a potentiometer (Orion 720A, Boston, MA, the USA) for its calibration buffers pH 4 and 7 were used. The buffer capacity was measured by Checkbuf Decay Risk Checker CR-20 kit in agreement to the specifications of the manufacturer (Morita Co., Kyoto, Japan). The salivary secretion was determined according to the following parameters: more than 5.0 milliliter (sufficient) from 3.5 to 5.0 milliliter (moderate) and less than 3.5 milliliter (low). The salvia buffer capacity was analyzed under the following parameters: pH up to 5.8 (high), 4.8 to 5.8 (moderate) and < 4.8 (low).

**Dental Caries Index**

The WHO caries diagnostic criteria were used for determining the permanent tooth DMFT index (decayed, missing and filled tooth surfaces).

**Statistical analysis**

Before starting the study, two examiners were calibrated in all variables with an expert in dental caries through Kappa test. All variables are expressed as mean, standard deviation, and range. Shapiro-Wilks, Levine and Brown Forsythe tests were used to determine the distribution of variables. The non-parametric Mann Whitney U test was used to compare continuous variables and χ² of Mantel-Haenszel test was used to compare categorical variables. A binary logistic regression multivariate analysis was carried out to estimate the association among DMFT, decay, and pH of saliva. The diagnosis of obesity and insulin resistance was established as a dichotomous dependent variable. The independent variables were DMFT, decay and pH of saliva. All statistical test were carried out by JMP program version 8.0 and Statview version 4.0 (both for SAS Institute, USA), statistical significance was set at p<0.05.

**RESULTS**

Before starting the study, two examiners were calibrated in all variables with an expert in each variable by using the intraclass correlation coefficient, obtaining 0.98 as result. From 100 selected subjects, 50 were healthy and 50 were diagnosed with obesity and insulin resistance (OB-IR). The healthy subjects 29 women (58%) and 21 men (42%) had a mean age of 13.08±1.06 years old and it was reported a familial antecedents (FA) of diabetes mellitus in 31 (62%). The age distribution of OB-IR group, 27 (54%) were women and 23 (46%) were men, with a mean of 13.0±1.17 years old, reported FA of Mellitus Diabetes in 42 (84%) and a frequency of Insulin Resistance Syndrome (IRS) of 9 (18%). A statistically significant difference was observed for FA (p = 0.0132) and for IRS (p = 0.0017) between groups.

Table 1, depicts the comparisons of the anthropometric measures between groups, most variables showed a significant statistical difference between groups (p < 0.05). However, there was no statistical difference when comparing groups (p > 0.05) about age.

In Table 2, insulin level of 9.0 is reported in healthy subjects, whereas for the patients with OB-IR was 25.4, obtaining significant statistical difference (p < 0.05). The systolic arterial pressure showed an average of 109.3 in the healthy group and for OB-IR group was 114.3 mm Hg, there was a statistical significant difference (p < 0.05). In the variable triglycerides an average of 88.5 was obtained for healthy subjects and 169.4 mg/dL in patients with OB-IR, cHDL displayed a mean of 52.8 for control group and 41.8 mg/dL for OB-IR group; both variables were statistically significant when groups were compared (p < 0.05). The systolic arterial pressure showed a significant statistical difference (p < 0.05) between groups as well. The variables cholesterol, glucose and diastolic arterial pressure did not observe statistically significant differences when groups were compared (p > 0.05).

**Table 1. Comparison anthropometric measures of the adolescents in the study groups.**

<table>
<thead>
<tr>
<th></th>
<th>Healthy n=50</th>
<th>OB-IR n=50</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>13.1±1.1</td>
<td>12.0-15.0</td>
<td>13.0±1.2</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>46.9±8.0</td>
<td>31.5-62.0</td>
<td>68.8±23</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.6±0.1</td>
<td>1.4-1.8</td>
<td>1.6±0.1</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19.1±2.2</td>
<td>15.7-23.7</td>
<td>29.2±3.1</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>73.5±7.2</td>
<td>52.0-86.0</td>
<td>97.4±8.9</td>
</tr>
<tr>
<td>Hip (cm)</td>
<td>84.8±7.3</td>
<td>65.0-96.0</td>
<td>104.7±8.8</td>
</tr>
<tr>
<td>WHR (cm)</td>
<td>0.9±0.1</td>
<td>0.8-1.0</td>
<td>0.9±0.1</td>
</tr>
</tbody>
</table>

SD: standard deviation; kg: kilograms; m: meter; cm: centimeter; kg/m²: weight in kilograms divided between height in meters to the square; BMI: Body Mass Index; WHR: Waist-Hip-Ratio; Statistical test used: Mann-Whitney U.

**Table 2. Comparison of insulin, glucose, cholesterol, triglycerides, HDL, arterial pressure (systolic and diastolic) of the adolescents groups.**

<table>
<thead>
<tr>
<th></th>
<th>Healthy n=50</th>
<th>OB-IR n=50</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin (µU/mL)</td>
<td>9.0±3.0</td>
<td>2.0-14.0</td>
<td>25.4±10.0</td>
</tr>
<tr>
<td>Glucose (mg/dL)</td>
<td>88.2±9.2</td>
<td>65.0-108.0</td>
<td>89.2±9.8</td>
</tr>
<tr>
<td>Triglycerides (mg/dL)</td>
<td>88.5±33.4</td>
<td>39.0-198.0</td>
<td>169.4±174.6</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>52.88±14.85</td>
<td>24.0-111.0</td>
<td>41.8±8.7</td>
</tr>
<tr>
<td>Systolic (mmHg)</td>
<td>109.3±12.66</td>
<td>80.0-150.0</td>
<td>143.5±10.5</td>
</tr>
<tr>
<td>Diastolic (mmHg)</td>
<td>71.00±9.74</td>
<td>60.0-110.0</td>
<td>73.5±7.4</td>
</tr>
</tbody>
</table>

SD: Standard deviation; cHDL: Cholesterol together with HD lipoproteins; µU/mL: micro international units divided between milliliters; mg/dL: milligrams divided between deciliters; mmHg: millimeters of mercury; Statistical test used: Mann-Whitney U.
Several studies have considered saliva as a vehicle to diagnose factors associated to dental decay. In this study, several traits of saliva were included, salivary flow, pH, and buffer capacity as main risk factors. Nevertheless, some of them such as salivary flow are influenced by the age, weight, method used and collaboration of the patient, which affects the obtained results. In the present report salivary flow was higher in OB-IR patients, which suggests a better protection against dental caries by salivary clearance of bacterial factors against caries.

**DISCUSSION**

Most reports about the association of decay dental-obsesity have been carried out in children population. In Mexico, there are reports of a high frequency of obesity in children population, it could be explained due to sport programs in elementary schools does not exist and the little that exists, it could be explained due to sport programs in the prevention is not carried out in most Latin American countries. In Mexico decay prevalence of 91.6% in urban areas and 54.4% in countryside has been reported. In the present study, dental decay prevalence was 74% in healthy adolescents and 84% in OB-IR adolescents, when DMFT index was detached and each component was evaluated separately, it could be observed that decay and missing teeth components showed a significant statistical difference. These results suggest that in adolescent population of high risk to IR and DM, there is evidence of a positive association between the obesity and dental decay. The results agree with other studies in which it was determined a positive association between dental decay and obesity. Since in Mexico there is just a report about dental decay experience in adolescent population (4.04 ± 3.90), it is difficult to make comparatives analysis with this study mainly due to sample size. However, this study showed that caries experience in the healthy group was very similar (4.58 ± 3.43), but OB-IR adolescents showed a higher caries experience (6.08 ± 5.06) in similar age population. Independently of comparisons, it is important to mention that the dental decay continues being an oral health problem in Mexico.

In spite of the efforts made anywhere in the world to diminish the incidence and prevalence of dental decay, there are positive results only in the industrialized countries, but the opposite scenario is in the developing countries where the access to dental care is limited and where the culture of the prevention is not carried out in most Latin American countries. In Mexico decay prevalence of 91.6% in urban areas and 54.4% in countryside has been reported. In the present study, dental decay prevalence was 74% in healthy adolescents and 84% in OB-IR adolescents, when DMFT index was detached and each component was evaluated separately, it could be observed that decay and missing teeth components showed a significant statistical difference. These results suggest that in adolescent population of high risk to IR and DM, there is evidence of a positive association between the obesity and dental decay. The results agree with other studies in which it was determined a positive association between dental decay and obesity. Since in Mexico there is just a report about dental decay experience in adolescent population (4.04 ± 3.90), it is difficult to make comparatives analysis with this study mainly due to sample size. However, this study showed that caries experience in the healthy group was very similar (4.58 ± 3.43), but OB-IR adolescents showed a higher caries experience (6.08 ± 5.06) in similar age population. Independently of comparisons, it is important to mention that the dental decay continues being an oral health problem in Mexico.

### Table 3. Comparisons of salivary flow and pH, and DMFT index of the study groups.

<table>
<thead>
<tr>
<th>Component</th>
<th>Healthy n=50 Mean ± SD</th>
<th>Range</th>
<th>OB-IR n=50 Mean ± SD</th>
<th>Range</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin (µU/mL)</td>
<td>9.0 ± 3.0</td>
<td>2.0-14.0</td>
<td>25.4 ± 10.0</td>
<td>15.3-53.7</td>
<td>0.0001</td>
</tr>
<tr>
<td>Salivary flow (mL/min)</td>
<td>4.30 ± 2.64</td>
<td>0.90-13.7</td>
<td>5.48 ± 2.89</td>
<td>1.0-14.20</td>
<td>0.0172</td>
</tr>
<tr>
<td>pH salivary</td>
<td>7.29 ± 0.47</td>
<td>6.4-8.8</td>
<td>7.31 ± 0.33</td>
<td>6.50-7.90</td>
<td>0.4971</td>
</tr>
<tr>
<td>DMFT</td>
<td>3.02 ± 1.82</td>
<td>0.00-8.00</td>
<td>4.78 ± 3.30</td>
<td>0.00-12.00</td>
<td>0.0016</td>
</tr>
<tr>
<td>Decay</td>
<td>1.84 ± 3.35</td>
<td>0.00-14.0</td>
<td>3.52 ± 2.84</td>
<td>0.00-10.00</td>
<td>0.0008</td>
</tr>
<tr>
<td>Missing</td>
<td>0.16 ± 0.24</td>
<td>0.00-6.00</td>
<td>0.10 ± 0.70</td>
<td>0.00-1.00</td>
<td>0.7303</td>
</tr>
<tr>
<td>Filled</td>
<td>1.02 ± 1.35</td>
<td>0.00-6.00</td>
<td>1.16 ± 1.63</td>
<td>0.00-7.00</td>
<td>0.8554</td>
</tr>
</tbody>
</table>

SD: Standard deviation; mL/min: Milliliters per minute; DMFT: Decay, Missing and Filled Teeth; Statistical test used: Mann-Whitney U.
biofilm on the teeth. However, it has been reported that obesity is associated with reduced flow rate of stimulated saliva, it could be more important the saliva amount of organic and inorganic components to protect against dental caries rather than the salivary flow. Buffer capacity is an important trait of saliva, since its capacity depends to reduce pH resulting of bacterial action on sucrose substrates found in dental plaque to avoid acid attack that produces enamel demineralization. The results of the present study in both groups displayed a high buffer capacity, which is opposite to other reports that indicated that the patients with decay display an altered buffer capacity. These discrepancies can be explained by the different inclusion criteria (age, sex, weight, sample size, type of teething and used method to measure capacity buffer). The pH in general terms is an indicator of the bacterial activity, it has been described that saliva normal pH is 7 in caries-free patients, tending slightly to acidity in caries-active patients. Recent studies reported a pH mean of 6.79, the mean obtained in the present study in healthy subjects was 7.29 and for the OB-IR group was 7.31; therefore, in this study pH was not an important factor.

CONCLUSIONS
In a Mexican adolescents sample population with and without OB-IR, DMFT index showed a significant statistical difference (p < 0.05) between groups. When DMFT index was detaching into its components and evaluating each separately, it could be observed a positive association between OB-IR with decay teeth (p < 0.05). According to the multivariate analysis, DMFT (OR = 3.10; IC95% = 0.20 - 1.02, p = 0.042) and decay (OR = 3.30; IC95% = 0.19 - 1.0, p = 0.011) were associated with subjects with obesity and insulin resistance.

REFERENCES