Prevalence of caries and malocclusion in an indigenous population in Chiapas, Mexico

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Objectives: To assess the prevalence of caries and malocclusion in Mayan Mexican adolescents, 14–20 years of age, living in Chiapas, Mexico. Methods: This was a cross-sectional, population-based, quantitative, epidemiological study. Sites were chosen to capture subjects representative of the state’s Mayan population. A total of 354 subjects were recruited. Caries experience was quantified, via visual inspection, using the Decayed, Missing and Filled Surface (DMFS) index. Malocclusion was quantified using the Index of Complexity, Outcome and Need (ICON). Results: Our data showed that 99% of the population had caries experience, with a median DMFS score of 8. Of the 99% with caries experience, over half had caries affecting more than five tooth surfaces. Thirty-seven per cent of the students had unmet orthodontic treatment need, and 46.46% presented a Class II, and 39.09% a Class III, anterior–posterior relationship. Conclusions: Less than 1% of the population had any exposure to orthodontics, demonstrating the lack of access to care. Likewise, only 1% of the population was found to have no caries experience, exhibiting a large unmet treatment need. The median DMFS score of 8 was also high in comparison with the median DMFS in the USA of 6. Our data suggest a correlation between the lack of access to care and high prevalence of caries and malocclusion in Mexican Mayans who inhabit Chiapas, Mexico.

Key words: Dental caries, epidemiology, malocclusion, dental public health

INTRODUCTION

Dental caries and malocclusion are common oral disorders among children and adolescents that affect their quality of life. Dental caries is the single most common chronic childhood disease; it is five times more common than asthma and seven times more common than hay fever.

Malocclusion refers to the abnormal relationship of the maxillary teeth to the mandibular teeth; correction of malocclusion usually involves orthodontic treatment during late childhood and adolescence. The World Health Organization (WHO) regards malocclusion as the third-highest oral-health priority.

Dental caries and malocclusion can affect self-esteem, social interactions and communication.

Several developed countries have experienced a steady reduction in dental caries. However, dental caries trends in developing countries are unclear. For instance, the lowest caries rates were found in Africa and the highest in Latin America.

In Mexico, dental caries is considered a public health problem. It is estimated that 99% of the population has had dental caries; moreover, dental caries is the main reason for extraction of teeth in patients younger than 35 years of age. The prevalence of dental caries in adolescents is higher than 70%, and the mean Decayed, Missing and Filled Teeth (DMFT) index is higher than 1.5. In a national survey, decayed teeth accounted for 90% of the index for DMFT in four states (Colima, Chiapas, Guerrero, and Yucatan). This indicates that a large unmet treatment need for caries exists in these areas since missing and filled teeth accounted for only 10% of the findings.

In terms of malocclusion, a study of Mexico City students showed that almost one-third of the teenagers studied presented occlusal anomalies leading to orthodontic treatment needs; amongst them, 43% had severe occlusal anomalies. Quantification of treatment need for orthodontic care is complex because of the psychosocial aspect of malocclusion.
Therefore, epidemiologists have developed evidence-based tools to evaluate orthodontic treatment need that aim to account for these manifold influences, including the perception of aesthetics. In general, oral diseases are considered public health problems in Latin American countries and disproportionately affect the poor and disadvantaged. Indigenous populations in Latin America are among the most disadvantaged economically and socially. Moreover, they are worse off, in terms of health, for most indicators.

According to the 2005 census, Mexico’s indigenous population numbers 12.7 million people, representing up to 13% of the national population. The majority of these indigenous populations are concentrated in the southern and south-central regions of Mexico. Almost 80% of those who speak an indigenous language live in eight of Mexico’s 31 states (Chiapas being the second largest in terms of population), and 44.2% of those who reside in indigenous municipalities are living in extreme poverty.

The region of Siltepec, with a population of 3,181, is a naturally isolated self-identified indigenous community. Chiapas is among the areas in Mexico most affected by caries during the last 27 years. The state of Chiapas and the region of Siltepec have unanswered questions in regard to the distribution of caries and malocclusion within the indigenous population. Although there are some studies on the prevalence of caries and malocclusion in Latin America and Mexico, there is a paucity of studies focusing specifically on the oral health of the indigenous populations in Mexico. This scarcity of standardised methodological studies leaves the indigenous sector of the population epidemiologically invisible. This lack of information on their oral health status is probably preventing the development of strategies for oral disease prevention and health promotion in these populations.

The objective of the present study was to assess the prevalence of caries and malocclusion in an indigenous adolescent population living in the south-eastern Mexican state of Chiapas. This state has a population of around 5 million, of whom 30% are indigenous.

An understanding of the extent of caries and malocclusion in this population would help design the appropriate interventions. Without this basic assessment, inequalities cannot be addressed.

**METHODS**

This was a cross-sectional, population-based, quantitative, epidemiological study. Ethical approval was granted by the Committee for Human Research at University of California, San Francisco (UCSF) and by the University of Nuevo Leon in Mexico and was conducted in full accordance with the World Medical Association Declaration of Helsinki. Written consent, in Spanish, was obtained from the adolescents and their parents/caregivers, as well as from participants ≥ 18 years of age. Members of the research team explained the study, and its voluntary nature, thoroughly, in Spanish.

The target population of the study included subjects between 14 and 20 years of age who were attending the only high school in the town of Siltepec, Chiapas, Mexico (Table 1). Classes within the school were sampled systematically, and all students attending school and who met the inclusion criteria were examined (Table 2). We determined the indigenous status of the students; according to the Mexican National Commission for the Development of Indigenous Peoples (Spanish: Comisión Nacional para el Desarrollo de los Pueblos Indígenas, CDI), an indigenous person is defined as someone ‘living in a household whose head of the family, a spouse and/or an ascendant self-identifies and is a speaker of an indigenous language’. The dental examination consisted of an extra-oral assessment of the student’s smile and an intra-oral examination of the teeth and occlusion. The DMFS index was used to assess the presence of dental caries, and the Index of Complexity Outcome and Need (ICON) was used to assess malocclusion. No insight can be gained about the type of decay (pit/fissure or smooth surface) because the DMFS index was recorded in digital form as a single sum total of all categories without reference to the individual D/M/F categories. Occlusal antero-posterior relationship was determined according to Angle’s classification. Students with a different Angle’s classification on each side were categorised into a single class based on the predominant pattern of occlusion and/or canine relationship.

The students were examined at the schools, in a quiet classroom without external interference, under natural or artificial illumination. The examination lasted for approximately 15 minutes per student, following the WHO (2013) guidelines. No radiographs, study casts or previous written records were used. Personal data and information about orthodontic treatment were obtained directly from the students. Treatment urgency was dental examiner-determined.

**Table 1** Distribution of participants, according to age and gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age (years)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>67</td>
</tr>
<tr>
<td>Male</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>107</td>
</tr>
</tbody>
</table>
according to the status of oral disease present at the time of the dental examination. The responses were scored by the dental examiner, according to treatment urgency, as: (i) see a dentist immediately; (ii) see a dentist within 2 weeks; (iii) see a dentist at earliest convenience; or (iv) continue with routine care. Information on treatment urgency was given to participants for their benefit; however, this data was not recorded. Each participant was given a toothbrush and oral hygiene instructions. The family was informed about their child’s oral health status. All examination data were entered directly into an electronic form on a secured, encrypted, laptop and transmitted to UCSF.

The clinical examination was carried out by three examiners (M.F.O., O.R.B. and K.A.), whose ratings using the DMFS index and ICON had previously been standardised by calibration. Calibration exercises for raters of DMFS and ICON were performed using 10 casts and photographs from UCSF orthodontic clinic patients who were not participating in the study. Intra- and inter-rater reliability was assessed using 10 additional casts and photographs from UCSF orthodontic clinic patients who were not part of the calibration exercises. These records were used to test and retest each examiner at least three times, and were administered 3–4 weeks apart between retests.

Descriptive statistics, including medians, quartiles, frequencies and per cents, were calculated to summarise the general characteristics of the sampled population. Treatment severity for caries was determined as follows: DMFS = 0, no caries; DMFS = 1–5, moderate caries; and DMFS > 5, severe caries. Malocclusion severity was assessed, as described in the ICON, as treatment complexity. The significance of differences for DMFS and ICON grades between genders was assessed using the chi-square test \((P < 0.05)\). The intraclass correlation coefficient (ICC) was used to evaluate intra- and inter-examiner reliability. ICC values of 0 represent agreement equivalent to that expected by chance, whereas an ICC of 1 represents perfect agreement. All statistical analyses were performed using STATA (Stata Corp. LP, College Station, TX, USA).

### RESULTS

A total of 354 subjects, 176 (49.7%) female and 178 (50.3%) male, were examined for participation in this study. After the application of inclusion and exclusion criteria, the final sample consisted of 351 subjects, 99.2% of the original sample population.

The prevalence of caries is depicted in Figure 1. Of the 351 students, only five (1.4%) presented with no caries. The median DMFS was 8, whereas more than half of our sample had more than five affected surfaces. There were no statistically significant differences between male and female students in caries experience \((P = 0.4627)\) (Table 3). Of the total sample, 129 (37%) subjects needed orthodontic treatment. Our results showed that 119 students (34.1% of the total sample) had an easy malocclusion, according to the ICON index; 132 (37.8%) students had mild malocclusion and 45 (12.9%) students had moderate malocclusion. Difficult malocclusion was evident in 30 (8.6%) students, and 23 (6.6%) students presented with very difficult malocclusion (Figure 2). As depicted in Figure 3, 13.6% of students presented with a Class I malocclusion, 46.46% with a Class II malocclusion and 39.09% with a Class III malocclusion. There were no statistical differences between male and female students in terms of anterior–posterior occlusion \((P = 0.4484)\) (Table 4). The majority of students (60.7%) had an edge-to-edge or <1/3 coverage overbite, whereas 18% had different degrees of open bites (Figure 4). As shown in Figure 5, 50.1% of

![Figure 1](https://example.com/figure1.png)

**Figure 1.** Prevalence of dental caries, assessed using the Decayed, Missing and Filled Surface (DMFS) index.

### Table 3 Caries experience

<table>
<thead>
<tr>
<th>DMFS score</th>
<th>Male students</th>
<th>Female students</th>
<th>Total</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n)</td>
<td>%</td>
<td>(n)</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>1.12</td>
<td>3</td>
<td>1.73</td>
</tr>
<tr>
<td>1–5</td>
<td>49</td>
<td>27.53</td>
<td>39</td>
<td>22.54</td>
</tr>
<tr>
<td>&gt;5</td>
<td>127</td>
<td>71.35</td>
<td>131</td>
<td>75.72</td>
</tr>
<tr>
<td>Total</td>
<td>178</td>
<td>100</td>
<td>173</td>
<td>100</td>
</tr>
</tbody>
</table>

DMFS, Decayed, Missing, and Filled Surface index.
the students had within 2 mm of arch length discrepancy, in either spacing or crowding. 29.8% of the students had between 2.1 mm and 5 mm of crowding, whereas only 5.4 students displayed spacing between 2.1 mm and 5 mm.

In this study, the three raters exhibited a high level of inter-rater reliability; the overall Fleiss’ kappa value was 0.87 (95% CI: 0.86–0.88). For intra-rater reliability, the three raters achieved high levels of reliability. The overall weighted kappa value was 0.95 (range: 0.93–0.96) for the 10 cases that were evaluated three times, separated by 3 weeks, by each rater.

**DISCUSSION**

The present study is one of few epidemiology analyses carried out in a Mayan Mexican population.

The state of Chiapas was selected for this study because it contains the second-largest indigenous population in Mexico. Moreover, the specific site of this study was selected owing to the presence of a relatively intact, geographically isolated, indigenous population. For convenience, all students attending the single school in the area, and who met the inclusion criteria, were screened. This school is the only school of the region and takes pupils from a large geographical area.

The location inhabited by this community is consistent with that of other Latin American indigenous populations who are often relegated to less desirable lands – mountains and jungle instead of proximity to rivers and flatlands. The isolation of these communities plays a role in their ethnic homogeneity and on the narrow range of socio-economic status40.

The Mames population is one of the largest indigenous groups directly descended from the Mayan people. They occupy the highlands and jungles of the Chiapas region and extend into Guatemala’s Western Highlands, forming a continuum of territory, culture and linguistics41. There are numerous indigenous populations in Mexico, which are known to be dissimilar in appearance, behaviour and genetics. Therefore, the ability to extrapolate the results of this study to other, possibly disparate, groups is limited. However, insights gained here may incrementally add to the body of knowledge of these groups.

Even though this population has access to government-sponsored public clinics, the Mames group still retain their indigenous traditional remedies, languages and mythology. A remarkable 85% of the population has less than a middle school level of education. In addition, 55.7% of Mames households report not having a consistent income41.

Previous studies have shown a high prevalence of oral disorders in areas of social inequalities, such as the area in which the present study was conducted.
The prevalence of caries observed in this population was extremely high. With 99% of the population having caries and a median DMFS score of 8, the severe caries experience and the large unmet treatment need is evident. Several studies of rural Mexican communities have shown a varying prevalence of caries, ranging from 43% to 100%. It is notable that not all of these studies used the same caries index. Our results showed no statistical differences between male and female students; this is in contrast to other studies on Mexican adolescents that showed a higher prevalence of caries in female subjects.

Access to government-sponsored dental care is limited (Siltepec, Chiapas, Mexico). The town has one dentist. There are no other clinics available in the area and the closest clinic is 6 hours away by car. Car ownership in this area is rare.

The expansion of roadways may be a contributor to caries experience, as is the increase in access to junk foods and poor diets, which are a departure from the traditional sources of nutrition. After all, Mexico is now the country with the second-highest soft drink consumption worldwide.

The patterns of beverage intake are complex. Although associated with caries presence, there are other variables related to the relationship between diet, sugars and carious lesions that need further elucidation.

Moreover, the increased accessibility of decay-inducing food items often accompanies the process of increasing access to potable water in these remote communities. For this reason, further studies are warranted to elucidate the contributing social factors to the heavy burden of caries in this indigenous population.

Potential limitations of this study include a lack of recording treatment urgency and limitations of the DMFS index, including measuring the severity of active decay.

Approximately one-third of students were considered in need of orthodontic treatment, but <1% had any orthodontic treatment experience. Of particular note is that more than 15% of the students presented with a difficult or very difficult type of malocclusion. This may be a result of the high prevalence of Angle’s Class III malocclusion that was observed in this sample. One limitation of Angle’s classification is that it does not incorporate vertical and transverse abnormalities. However, it is a universally accepted system that is reliable and that minimises examiner subjectivity. In our study, almost 40% of the students presented with a Class III malocclusion. This is much higher than the prevalence in other populations, as evidenced by a recent systematic review that showed Class III malocclusion prevalence worldwide ranging from 0% to 26.7%. Latinos living in the USA, self-described as Mexican or of Mexican descent, showed a prevalence of Class III malocclusion of 8–9%.

Class III relationship is most often cited as being an inherited trait. Human studies support an autosomal-dominant mode of inheritance of the Class III phenotype. The ethnical homogeneity of the Mames population, together with the inherited trait of the Class III malocclusion, could partially explain our findings.

Angle’s Class II malocclusion was also high in this population, at 46%. Class II malocclusion in other ethnic groups, including Latinos, ranges from 16% to 22%. Low socio-economic status, caries experience, premature loss of deciduous teeth and prolonged digit or lip sucking habits, might increase susceptibility to Class II malocclusion, as seen in this population.

Furthermore, changes from a hard diet to a soft diet may constitute an important aetiologic factor for the increased prevalence of Class II malocclusion. This is probably because of a decrease in dental attrition and a lack of compensatory tooth mesial migration associated with softer diets.

We identified no differences in the anterior–posterior relationship between male and female students (Table 4).

CONCLUSIONS

The high prevalence of caries and malocclusion, observed in Mames adolescents, reflects the social inequality that is present in this community. The high prevalence of caries in this population could explain, in part, the high prevalence of Class II and Class III malocclusion. Early loss of primary molars from caries may lead to non-Class I molar relationships. As a result of the very high prevalence of caries within this group, no statistically significant relationships can be inferred between caries and malocclusion.

Although health indicators have improved over the years among indigenous population groups, our results indicate that oral health inequalities still persist among indigenous populations in Mexico.
Acknowledgements

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Conflict of interest

There are no conflicts of interest.

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