An Assessment of Urbanization as it Relates to Caries Prevalence and its Determinants in Children in Copan, Honduras

by

Michael Boyd Damgaard

Department of Global Health
Duke University

Date:_____

Approved:

_____
Dennis Clements, Supervisor

_____
MarthaAnn Keels

_____
Christopher Woods

Thesis submitted in partial fulfillment of
the requirements for the degree Master of Science
in the Department of Global Health in the Graduate School
of Duke University

2012

ABSTRACT

An Assessment of Urbanization as it Relates to Caries Prevalence and its Determinants in Children in Copan, Honduras

by

Michael Boyd Damgaard

Department of Global Health
Duke University

Date:_____
Approved:

_____
Dennis Clements, Supervisor

_____
MarthaAnn Keels

_____
Christopher Woods

An abstract of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the Department of Global Health in the Graduate School of Duke University

2012

Abstract

Objective: To determine if a significant association exists between urbanization and dental caries prevalence, and whether or not similar relationships occur between community type and principal determinants of youth oral health in children ages 2 to 12 in the region of Copan, Honduras.

Methods: The investigator conducted a cross-sectional two-part interview with each participant. First, a survey was administered to the parent to collect information surrounding dental caries determinants. Second, the investigator performed a brief examination of child dentition to determine the number of existing caries. Data was collected from two separate patient populations: an urban sample of children within Copan Ruinas, and an indigenous sample from 15 surrounding rural villages.

Results: Samples consisted of 203 individuals from the urban population and 221 from the rural. While there was no visible association between caries prevalence and urbanization, teeth brushing, parent education, and sugar intake demonstrated highly significant correlations ($P<0.01$). Mean DMFT Score for the combined samples was 5.15.

Conclusion: There is a clear need for dental interventions both in urban and rural communities in Copan, Honduras. Sugar consumption is likely contributing to increased caries prevalence in the urban community. Other factors such as water fluoridation could be influencing DMFT scores in Copan's more rural villages.

Dedication

I would like to dedicate this thesis to my mother, father, and loving grandmothers.

Contents

List of Tables

List of Figures

Acknowledgements

I would like to express my deepest gratitude to Dr. Dennis Clements, my advisor, for believing in me and this thesis. He found me a second home in Copan Ruinas and helped me cultivate a strong desire to serve Latin communities that I am sure will stay with me for the rest of my life. I would also like to thank Dr. MarthaAnn Keels for opening the doors of her practice and encouraging me to learn all I can about the child dentition.

Special thanks to my in field contacts Dra. Maradiaga and Dra. Sandoval for their enthusiasm and willingness to aid me throughout my Honduran adventure. Dr. Christopher Woods, thank you for welcoming me to the Duke Global Health Institute and motivating me to take this project in whatever direction inspired me. Thanks again to Sarah Martin and Lysa Mackeen for their patience in guiding me through the thesis process, as well as Melissa Aquino and Larry Park for statistics help. Finally, I would like to express my appreciation to Carlos Andino Welchez and Jose Luis Escalante for taking me under their wing and making me part of their Honduran “manada de lobos”.

1. Background

1.1 Global Burden of Oral Disease

Despite great improvements in the oral health of populations throughout many parts of the world, global problems still persist. Oral diseases such as tooth decay, periodontal disease, oral mucosal lesions, oropharyngeal cancers, and dental trauma constitute major public health problems worldwide. Poor oral health conditions such as these have a profound impact on health and the general quality of life (See Figure 1).

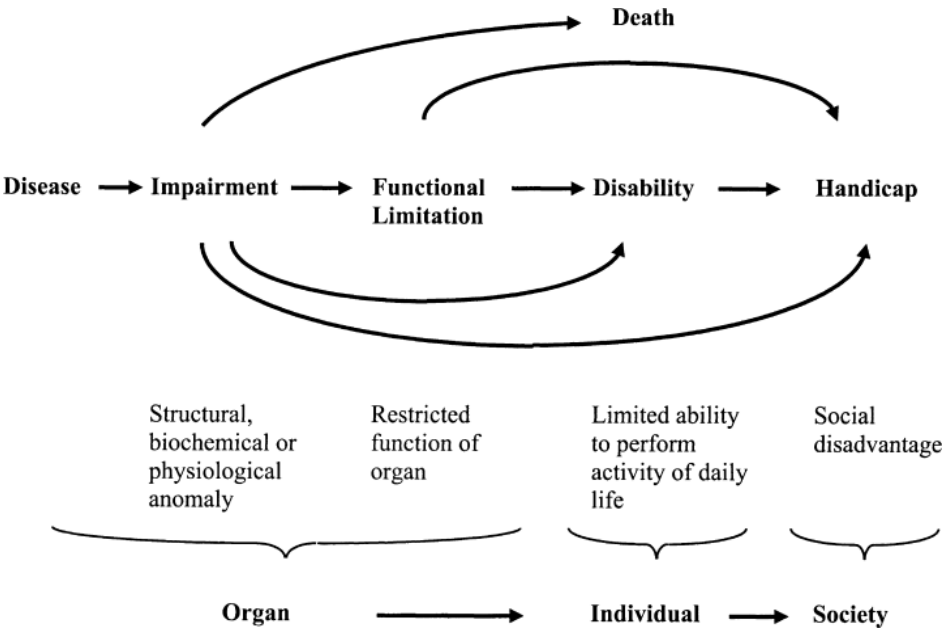


Figure 1: Locker's Model of Oral Health (Locker, 1988)

Like many health related issues, the burden of oral disease is greatest in high poverty and rural areas, particularly in less developed countries. While Central America has made great progress in public health over the past few decades, the dental health in many regions has not yet matched the first world. In several countries, utilization and access to dental treatment services is suboptimal and has been so for some time.

Additional problems include poor oral health awareness and lack of prevention methods on a national scale. This has generated a need for significant improvements within the field of dentistry in Latin America during the coming years.

1.2 Dental Disease in Honduras

Oral diseases and caries prevalence in Latin America are vastly underreported. Limited research has resulted in low data returns on oral health status. For Honduras in particular, the literature for dental services and oral diseases are very limited. Dental services provided by the Honduran government for the public sector have been experiencing great difficulty in alleviating its country's need. According to the Pan American Health Organization in a 1998 health analysis and trends summary, the National Ministry of Public Health for Honduras had a mere 34 local oral health clinics and 84 health centers in its dental subsector (PAHO, 2001). Their services were almost entirely curative, providing minimal preventive procedures affordable by the public.

For that year there were approximately 1.68 dentists per 10,000 persons, a ratio that did not have the capacity to meet the oral health care needs of a growing Honduran population (PAHO, 2001). By 2007 the country's population was estimated at 7.5 million with 60.2% of households living beneath the poverty line (PAHO, 2009). The majority of government health expenditures and private funding was being directed towards more primary care oriented services, leaving the majority of dental health issues unaddressed

and poorly resourced. With limited national capital to allocate to growing oral health need, the public sector for dental services lacked the capacity to serve its population.

2. Introduction

Existing literature on dental care throughout Central America strongly supports the proposed need for increased oral disease treatment and related research in the near future. The Pan American Health Organization and World Health Organization have published the majority of countrywide statistics regarding caries and oral disease prevalence in Honduras during the late 1990s and early 2000s. Additional data is needed in order to provide a more recent assessment of caries prevalence in Honduras over the past decade, especially in children.

2.1 Caries Prevalence in Honduran Children

The documentation of caries, or the common dental cavity, is defined by a painful infection that causes the demineralization and destruction of a tooth's organic tissues (i.e. enamel, dentin, cementum). It is vital to dental research because it is the most frequently used indicator for poor oral health. PAHO has collected a number of small-scale studies on caries prevalence in younger age groups of Honduran children. In 2002 they compiled existing data and extrapolated an estimate that between 50-70% of Honduran children had 3 or more teeth with dental caries (PAHO, 2002). This high prevalence of child dental caries failed to meet the oral health goal set by WHO for the year 2000 which sought to lower the national mean to fewer than 3.0 caries per child below 12 years of age (Bönecker & Cleaton-Jones, 2003).

2.1.1 DMFT Score and Measuring Tooth Decay

The global health community has enlisted a variety of methods to accurately assess caries prevalence on a more comparative international scale. Perhaps the most comprehensive and widely used standardized measurement for oral disease in medical literature is the DMFT (Decayed Missing Filled Teeth Prevalence) score. While explained in greater depth later, DMFT score is used to quantify the number of teeth that have been affected by tooth decay in a particular individual. WHO published a World Oral Health Report in 2003 as well as a bulletin in 2005 that illustrates how DMFT scores help identify existing oral health problems globally (See Figure 2).

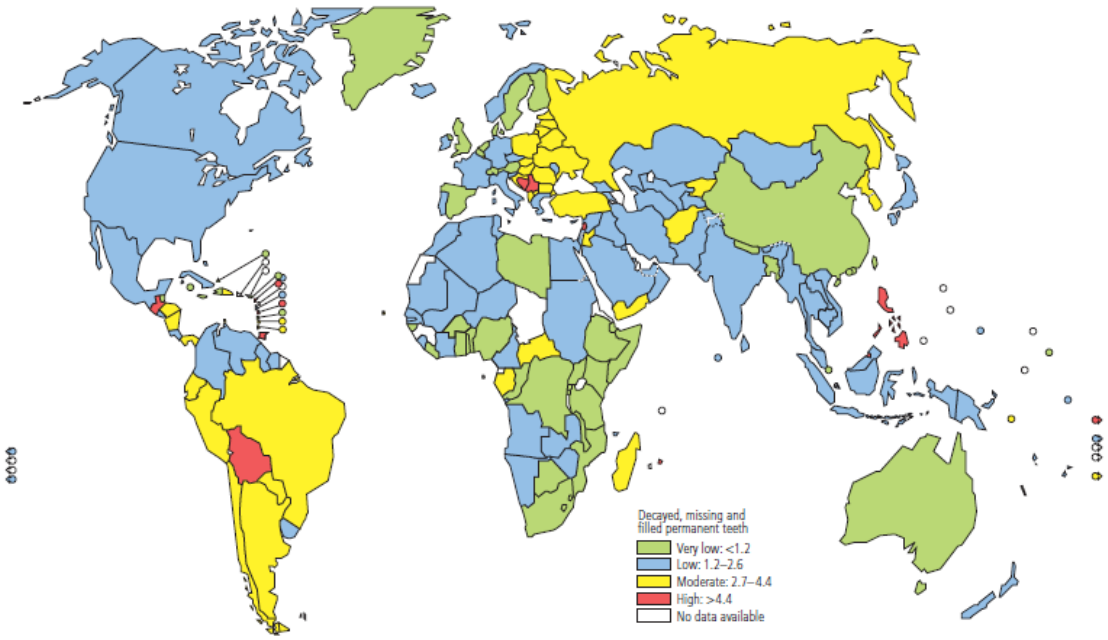


Figure 2: Dental Caries Levels (DMFT) of 12-Year-Old Children Worldwide (Petersen et al., 2005)

2.1.2 Urbanization

Urbanization has traditionally been viewed as strong determinant for a variety of different health outcomes. Rural areas have often been associated with poverty and access issues, both of which can have a profound impact on wellness. Poverty also exists in urban environments, making urbanization an interesting point of study for researchers who wish to better understand its effects on a population's health for a specific area. The effects of urbanization on caries prevalence have been documented, but there are few studies that examine its relation to caries-causing factors (Maupomé, 1998). By increasing awareness of how urbanization relates to caries determinants, we can better comprehend how the changing dynamics (e.g. dietary exposure) of different sample settings can influence oral health.

2.1.3 Dietary Determinants

Diet continues to be cited as a primary determinant for dental caries and subsequent oral disease outcomes in all parts of the world (Fontana et al., 2011), (Kaste, et al., 1996). Diets high in sugar and high in acidic pH levels are known to increase caries incidence through demineralization. Young children with developing dentition are especially vulnerable (Chainani-Wu, 2011). Candy (e.g. lollipops, gum) and sugary beverage (e.g. soda, juice) consumption can serve as effective indicators of caries

incidence. The lack of fluoride in a community water source is also a nutritional risk factor for caries (Jones & Worthington, 2000).

2.1.4 Socioeconomic and Hygienic Determinants

Researchers have identified socioeconomic inequalities as indicators for measuring the potential of varying levels of oral disease within certain societal groups. These inequalities can affect the ability to purchase oral hygiene supplies such as toothbrushes as well as larger dental treatment access and payment issues (Chaffin, 2003). The inability to mechanically remove the plaque of the teeth with a toothbrush and floss increases its accumulation and subsequently raises the risk of dental caries. The ability to treat existing caries is also compromised without access to dental treatment. Without dental supplies, caries prevention through consistent hygienic practices cannot be realized. Therefore it is important that we understand how socioeconomic and behavioral characteristics can lead to certain oral health outcomes over extended periods of time.

2.1.5 Oral Health Literacy

Literacy has been shown to have a distinct relationship to health outcomes within a community (DeWalt, et al., 2004). Health literacy represents the ability to understand and follow information to achieve better health and well-being. Higher

literacy levels have been linked to greater utilization of preventive and treatment measures as well as fewer hospitalizations and disease incidence. Oral health literacy also mimics this trend. In children, it is the literacy of the caregiver that contributes to the oral health of its child (Miller et al., 2010). Since literacy is gained through education, this highlights parent schooling as a possible focal point for determining oral health outcomes in respective children.

3. Methods

This qualitative study utilized a brief dental assessment of the number of caries in the children of the underserved populations of Copán, Honduras, both inside the municipality of Copan Ruinas, and from surrounding indigenous communities. Extensive interview data from their parents was then collected from a close-ended survey. The study was conducted over a 3-month period during the fall of 2012.

3.1 Study Design

A cross sectional study was conducted on 424 children and their parents. The participants were approached and asked if they would like to take part in a study on local child dental health and nutrition. Child subjects were between the ages of 2 and 12 in order to qualify to participate, and were accompanied by a parent or guardian over the age of 16. The age range 2 – 12 was selected because it represents a crucial time in child dental development where primary teeth are erupting and later shed for permanent dentition. A minimum age of 16 was set for the guardian to help ensure accuracy in survey responses. 203 participants were selected from within the city limits to represent an urban sample while 221 participants were chosen from 15 surrounding indigenous communities in order to generate a rural sample.

3.1.1 Field Site Selection

The municipality of Copán Ruinas, Honduras was selected as the field site for the study for several reasons. Duke University has been sending medical brigades comprised of both faculty and students to rural regions of Honduras annually over the course of the last decade. Field contacts were readily available through faculty members to help assist in reaching indigenous populations in need of medical interventions.

Copan Ruinas also allowed for a unique approach in the comparison of caries prevalence in urban vs. rural settings. The city is home to a large amount of tourism due to local Mayan ruins and its convenient travel location on the Guatemalan border. Its urban environment and touristic atmosphere suggest a sample population that may be subject to a variety of first world nutritional influences that may directly affect caries prevalence. Additionally, the city of Copan Ruinas is surrounded by over a hundred different indigenous communities, many of which are easily accessible from the city. As a whole, Copan Ruinas was an optimal destination to conduct a study that investigated urbanization as a determinant of caries prevalence.

3.1.2 Survey Characteristics

A survey was administered to determine four primary data types from the participant's parent or guardian. These four data types included: the participant and parent/guardian's demographic information, the child's diet in sugar containing candy

and non-water beverage products, dental treatment and hygienic history, and socioeconomic information (Zelaya, 2005). The main objective of the survey was to collect variable data for factors that are commonly associated with dental caries.

3.1.3 Dental Assessment and DMFT

Following the survey, each child participant was examined for an assessment of the number of caries, missing teeth, and a subsequent DMFT score. The investigator was trained by a board-certified pediatric dentist prior to the study to ensure accurate identification of dental caries. Teeth that were determined to have clinically defined dental decay or removed as a result of caries would each contribute a score of 1 to the child's DMFT. Since dental fillings are resource costly and largely inaccessible even in some of the most well established clinics in Copan, Honduras, no fillings were recorded in any of the participants. Simplified, DMFT scores in this study consisted of the sum of the number of decayed or extracted teeth.

3.2 Data Analysis

The independent variable of interest in this study was a categorical assessment of whether or not the child resided in an urban vs. rural living environment. Separating the populations into these 2 distinct sample types helped eliminate confounding related to access to treatment and dietary influences that would have otherwise been encountered

had the two populations been combined and a different independent variable was investigated.

Several dependent variables were investigated to see how they might be associated with children residing in a rural vs. urban environment. Urbanization and its relationship to DMFT score were of the greatest interest, as high DMFT is directly indicative of caries prevalence and oral disease burden. Other dependent variables included exposure to sweets and sugary beverages and access to extractions by a health care professional. Socioeconomic and hygiene variables such as a the level of school completed by the participants' parents, family size, and number of times a child brushes per day were also explored.

3.2.1 Data Coding

Data was compiled using FileMaker Pro 11 to administer the survey and store responses in a program-specific data file. This file was later converted to an Excel spreadsheet that was then imported into Stata IC 12 where multiple variables were generated. Pearson's chi-squared tests were predominantly used to calculate the bivariate association between the two independent groups and several categorical variables. Prevalence odds ratios and 95% confidence intervals were then calculated accordingly. DMFT Scores were calculated as a continuous variable and age groups were separated into an ordinal variable type (see Figure 3).

4. Results

4.1 Description of Study Populations

Table 1 shows demographic characteristics for the sample while distinguishing between the rural and urban samples. Distribution between gender, age, and whether or not the child attends school appears even between the two groups. It is possible that a number of participants who reported "no" in regards to school attendance may have been too young to enroll. The state-mandated public school curriculum in Honduran closely mimics those of North America, with first graders enrolling at age 6.

Table 1: Sample Demographic Characteristics (N=424)

		Urban		Rural		Total (N=424)	
Variable		**N**	**%**	**n**	**%**	**N**	**%**
Population Size		**203**	**47.9%**	**221**	**52.1%**		
Gender	**Male**	**113**	**55.7%**	**119**	**53.8%**	**232**	**54.7%**
	Female	**90**	**44.3%**	**102**	**46.2%**	**192**	**55.3%**
Age	**2**	**4**	**2.0%**	**3**	**1.4%**	**7**	**1.7%**
	3	**11**	**5.4%**	**17**	**7.7%**	**28**	**6.6%**
	4	**20**	**9.9%**	**18**	**8.1%**	**38**	**9.0%**
	5	**29**	**14.3%**	**26**	**11.8%**	**55**	**13.0%**
	6	**36**	**17.7%**	**33**	**14.9%**	**69**	**16.3%**
	7	**29**	**14.3%**	**33**	**14.9%**	**62**	**14.6%**
	8	**24**	**11.8%**	**21**	**9.5%**	**45**	**10.6%**
	9	**23**	**11.3%**	**22**	**10.0%**	**45**	**10.6%**
	10	**15**	**7.4%**	**13**	**5.9%**	**28**	**6.6%**
	11	**20**	**9.9%**	**8**	**3.6%**	**28**	**6.6%**
	12	**10**	**4.9%**	**9**	**4.1%**	**19**	**4.5%**
Attends School or Kindergarten	**Yes**	**143**	**70.4%**	**137**	**62.0%**	**280**	**6.6%**
	No	**60**	**29.6%**	**84**	**38.0%**	**144**	**34.0%**

4.2 Associations between Urbanization and DMFT Scores

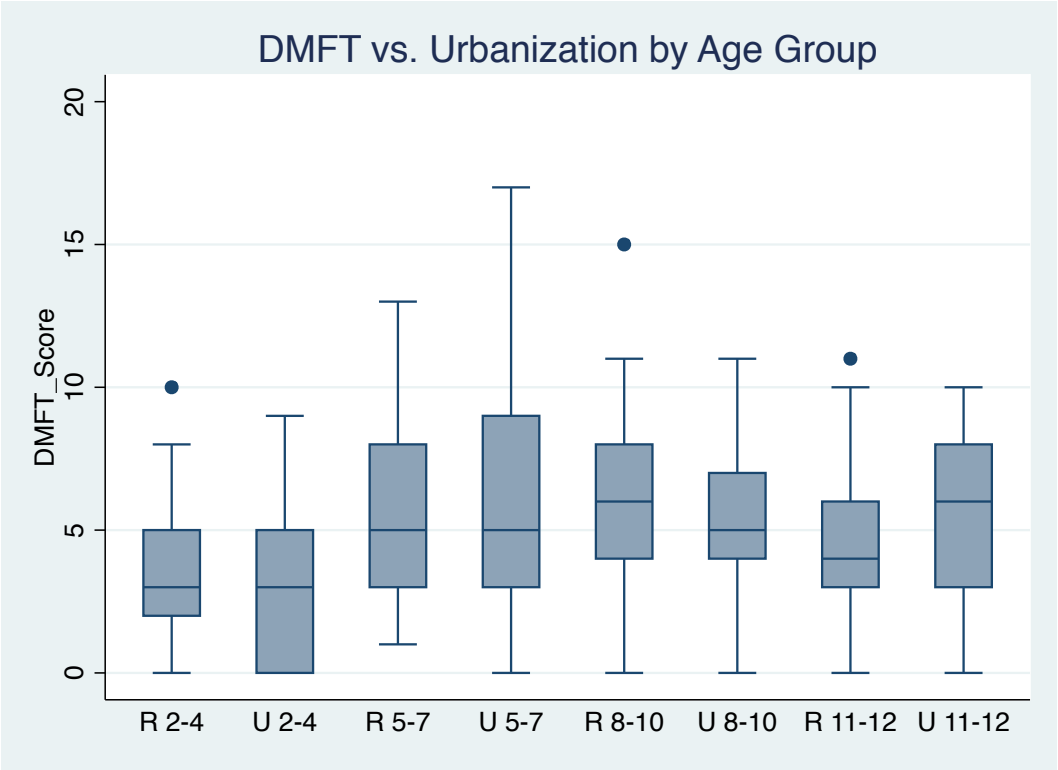
When overall DMFT score is tested against urbanization the association is highly insignificant (P=0.758, see Table 2). There is no evidence supporting the hypothesis that the participant's community has a statistically viable relation to caries prevalence. The urban and rural samples have a mean DMFT Score of 5.21 and 5.10, respectively. Together they combine for an overall mean DMFT of 5.15.

Table 2: Comparison of DMFT Score against Urbanization

Variable	Urban		Rural		Overall
DMFT Score	**n**	**%**	**n**	**%**	
0	**16**	**7.9%**	**9**	**4.1%**	
1 – 3	**48**	**23.6%**	**64**	**29%**	
4 – 6	**73**	**36%**	**74**	**33.4%**	
7- 9	**42**	**20.7%**	**53**	**24%**	
10+	**24**	**11.8%**	**21**	**9.5%**	
Mean	**5.21**		**5.10**		**5.15**
p-value					**0.758**

Figure 3 helps illustrate the relationship between urbanization and caries prevalence when stratified by age group. The box plot does not show that there is any notable difference in the number of caries observed based on the age of the child and sample type. Rather both groups demonstrate higher caries numbers in age groups 5-7 and 8-10 where primary teeth have reached peak exposure time to caries-causing factors before beginning to shed for permanent dentition.

Figure 3: DMFT vs. Urbanization by Age Group (R = Rural, U = Urban)



4.3 Associations between Urbanization and Sugar Intake

Table 3 reveals that exposure to 3 of the 4 candy types were significantly correlated to higher consumption in children living in the city limits of Copan Ruinas as opposed to a local indigenous village. Sugar cane did not follow this trend. With a p-value of 0.884, it can be inferred that access to this type of candy is likely not indicative of whether or not a child was residing in an urbanized environment. Lollipops in particular displayed the greatest exposure levels within the urban setting with over 61% (OR = 2.95) of participants citing having eaten at least one within the last month from the time of survey administration.

Table 3: Crude Association of Urbanization and Candy Consumption

		Urban Sample		Rural Sample		Prevalence Odds Ratio	Confidence Interval	p-value
Variable	**N**	**n**	**%**	**n**	**%**	**Rural = 1.00 (ref)**		
Consumed Hard Candy								
Yes	**288**	**161**	**55.9%**	**127**	**44.1%**	**2.84**	**1.845 – 4.363**	**0.000***
No	**136**	**42**	**30.9%**	**94**	**69.1%**			
Consumed Lollipops								
Yes	**207**	**127**	**61.4%**	**80**	**38.6%**	**2.95**	**1.985 – 4.369**	**0.000***
No	**217**	**76**	**35%**	**141**	**65%**			
Consumed Gum								
Yes	**180**	**111**	**61.7%**	**69**	**38.3%**	**2.66**	**1.789 – 3.949**	**0.000***
No	**243**	**92**	**37.9%**	**151**	**62.1%**			
Consumed Sugar Cane								
Yes	**74**	**36**	**48.6%**	**38**	**51.4%**	**1.04**	**0.630 – 1.710**	**0.884**
No	**350**	**167**	**47.7%**	**183**	**52.3%**			***p<0.01**

Tests on beverage consumption showed significantly higher levels of consumption exposure for juice and soda in the urban sample (See Table 4). Coffee remained independent of urbanization. A common drink type, its consumption was

roughly 50% for both groups. Soda exposure was extremely prevalent within the urban sample compared to the rural group; where residents had 6.31 times the odds of consumption (P=0.000).

Table 4: Crude Association of Urbanization and Sugary Beverage Consumption

		Urban Sample		Rural Sample		Prevalence Odds Ratio	Confidence Intervals	p-value
Variable	**N**	**n**	**%**	**n**	**%**	**Rural = 1.00 (ref)**		
Consumed Coffee with Sugar								
Yes	**343**	**163**	**47.5%**	**180**	**52.5%**	**0.93**	**0.573 – 1.503**	**0.763**
No	**81**	**40**	**49.4%**	**41**	**50.6%**			
Consumed Juice								
Yes	**268**	**150**	**56%**	**118**	**44%**	**2.47**	**1.641 – 3.718**	**0.000***
No	**156**	**53**	**34%**	**103**	**66%**			
Consumed Soda								
Yes	**186**	**134**	**72%**	**52**	**28%**	**6.31**	**4.128 – 9.649**	**0.000***
No	**238**	**69**	**29%**	**169**	**71%**			***p<0.01**

4.4 Associations between Urbanization and Treatment and Prevention Practices

Unlike teeth brushing, treatment-seeking behavior failed to distinguish a significant association with urban characteristics. Extremely low in both groups, less than 13% of total parents surveyed had reported taking their child to a dental health professional for the extraction of a decayed tooth. Daily brushing was highly significant (P=0.000), with 80% of total children having reported daily brushing habits among the urban population (OR = 8.17).

Table 5: Crude Association of Urbanization vs. Treatment and Preventive Practices

		Urban Sample		Rural Sample		Prevalence Odds Ratio	Confidence Intervals	p-value
Variable	**N**	**n**	**%**	**n**	**%**	**Rural = 1.00 (ref)**		
Received Dental Treatment								
Yes	**48**	**29**	**60.4%**	**19**	**39.6%**	**1.77**	**0.966 – 3.248**	**0.065**
No	**376**	**174**	**46.3%**	**202**	**53.7%**			
Brushes Teeth Daily								
Yes	**135**	**108**	**80%**	**27**	**20%**	**8.17**	**5.026 – 13.271**	**0.000***
No	**289**	**95**	**32.9%**	**194**	**67.1%**			***p<0.01**

4.5 Associations between Urbanization, Parent Education, and Household Size

The standard for household family size was set at 5 based on a study conducted on Honduran men who felt that 3 children plus a spouse would be most ideal from a socioeconomic standpoint (Remez, 1999). The variable was not significant, however. Its p-value was measured to be 0.152, dismissing any evidence of a possible correlation between urbanization and family size. Results differed greatly in education (P=0.000), suggesting that a parent's completion of grade school might be significantly more likely to occur in an urban family than a household from a more traditional rural area.

Table 6: Crude Association of Urbanization vs. Parent Education and Household Size

		Urban Sample		Rural Sample		Prevalence Odds Ratio	Confidence Intervals	p-value
Variable	**N**	**n**	**%**	**n**	**%**			
1+ Parent(s) completed grade school								
Yes	**235**	**132**	**56.2%**	**103**	**43.8%**	**2.13**	**1.441 – 3.148**	**0.000***
No	**189**	**71**	**37.6%**	**118**	**62.4%**			
House size > 5								
Yes	**159**	**69**	**43.4%**	**90**	**56.6%**	**0.75**	**0.505 – 1.112**	**0.152**
No	**265**	**134**	**50.6%**	**131**	**49.4%**			***p<0.01**

5. Discussion

5.1 Principal Findings

5.1.1 Caries Prevalence as it Relates to Urbanization

An association between DMFT scores and whether the individual lived in a rural village versus the larger, more developed town of Copan Ruinas is not evident from this study. It cannot be concluded with confidence that urbanization has a direct impact on whether or not a child from the municipality will be more likely to exhibit greater levels of caries prevalence than his or her rural counterpart. This is an intriguing finding when considering that several of the determinants in the study scored highly significant for a particular sample. Hard candy, lollipop, gum, juice, and soda exposure all support a positive correlation with increased caries prevalence in the urban community.

While significant sugar and acid exposure levels help to explain high caries prevalence experienced by the urban group, they do not account for the relatively high mean of 5.10 DMFT expressed in the rural sample. While poor dental hygiene and low levels of parent education provide possible reasons for high caries prevalence in the rural group, the sample is still lacking a strong association with a determinant that has a direct physical impact on caries formation. The most logical explanation for this imbalance in DMFT scores and determinant association is that there are other important factors playing substantial roles in caries incidence for the rural sample that have not been explored by this study.

5.1.2 Water Fluoridation

Nutrition and dietary intake are arguably one of the greatest determinants of oral health. It is highly probable that a common source of nourishment not observed in this study, such as water, is acting upon DMFT. Ideal fluoride levels in water help support the remineralization of the tooth surface to help counter the early development stages of caries (Newbrun 1989). Excessive or insufficient levels increase the vulnerability of teeth to infection and decay (Jones & Worthington, 2000).

The municipality of Copan Ruinas have been working with local Peace Corp volunteers over the past decade to help establish improved filtration systems and more stable fluoride levels for water within the city. This helps dismiss the possibility that an absence of fluoride is affecting children in the urban population. It is not unlikely, however, that there are varying degrees of water fluoridation between the fifteen rural communities, where residents rely heavily upon local rivers and wells. Low fluoride could account for a considerable increase in caries prevalence observed in the rural sample and warrants additional research in the region.

5.1.3 Associating between Urbanization and Sugar Consumption

There are several ways in which urbanization might influence the consumption of sugar products in this study. Exposure to the marketing of candy products and drinks containing sugar in Copan Ruinas is virtually unavoidable to the local resident. Shops

displaying hundreds of assorted candies are situated in close proximity to the grade school, readily available to children on their daily commute. Tourism, one of Copan Ruinas' primary sources of income, may also account for sugar product exposure in the urban group. Brand name gaseous beverages and candies are common in most stores and restaurants and enjoy a consumer base comprised of both travelers and locals. Coca-Cola products were first introduced in Honduras in the 1930s, and have since heavily diffused into resident consumption. Three Liter bottles are a popular purchase for adults who take them home to share with family.

Unlike the city, rural areas in Copan appear to be dramatically less exposed to these sugar products. Small privately owned stores cannot afford to stock them due to a highly limited market in more indigenous local economies. Price is likely contributing to lack of exposure along with inaccessibility. Participants appear to be more likely to take part in the consumption of more readily available goods. Coffee with sugar seems to be the most common substitute for water in rural communities. It cannot be associated with urbanization due to its extreme prevalence in Honduran households everywhere. As one of the chief exports of Honduras, it is inexpensive and easy to acquire. It has woven its way into the nation's culture and is served in small cups to children as young as 2 years of age. Many Hondurans will continue to drink it for the rest of their lives. The popularity of coffee reflects a strong influence in sugar trends in coffee. Individuals who

add greater amounts of sweeteners to regular servings of coffee will likely experience a greater risk of caries incidence.

5.1.4 Associating Urbanization with Treatment and Socioeconomic Variables

Since 1 from each of the 2 behavioral and socioeconomic variable types displayed potential for significant correlations, it can be said that urbanization may play a role in determining whether a child has access to a toothbrush or whether their parent was able to complete grade school. Both financial and geographical factors likely play a role. Families who live too far from modernized shops or drug stores may not be able to purchase toothbrushes or toothpaste for their children, and as a result their hygienic practices suffer greatly.

Socioeconomic status is also relevant. The vast majority of literature studying job markets would likely suggest that a parent who was unable to finish grade school is at a severe disadvantage when competing for a high-paying job, especially in a third world setting. Financial constraints can easily create a trade-off scenario where purchasing a toothbrush and toothpaste for one child out of several could mean sacrificing a day or more's pay. This could easily translate to giving up food, clothing, and other basic necessities that may seemingly diminish the benefits of oral hygiene by comparison.

5.2 Limitations

5.2.1 Survey administration

Survey-based studies requiring a researcher to cross a language barrier may run the risk of acquiring inaccurate data. I consider myself to be proficient in Spanish, but there were many times when I feared a question might have been misinterpreted. For example, often times when asking a parent to report if a child had a tooth extracted, the parent would mistake the Spanish translation, "sacado" or taken out, for the shedding of a primary tooth. While this can usually be clarified by asking if a dentist was present, it's entirely possible that this error could slip by in younger children who may have only lost one or two baby teeth.

Access to treatment and treatment-seeking behavior in general can often be difficult to quantify. The act of seeking treatment usually only occurs if there is already a preexisting need for it. It is difficult to calculate whether or not there is access to health care if the individual never needed to seek care originally. To further complicate this issue, there is the proposed ideology that possessing a few dental caries is commonplace for most Hondurans and does not warrant the immediate attention of a dentist. If Hondurans do not feel there is need to visit a dentist (under conditions where it would normally be deemed necessary by professional) we are again unable to infer any information surrounding their level of accessibility.

5.2.2 Sample Bias

This type of study risks the potential for sample bias. It can take place during the survey portion of the interview. Compensation of a toothbrush and toothpaste may inadvertently cause the participant to create premeditated answers, regardless of whether he or she is responding truthfully to the proposed question. The interviewee may feel that unless his or her responses demonstrate a certain level of need, they may not be eligible for the reward. The accuracy of a response may also be compromised if a parent cross-references with their child (e.g. brushing routine) for answers of which they are unsure. Fear that certain responses may incur a negative reaction from the investigator may also provoke inaccurate data.

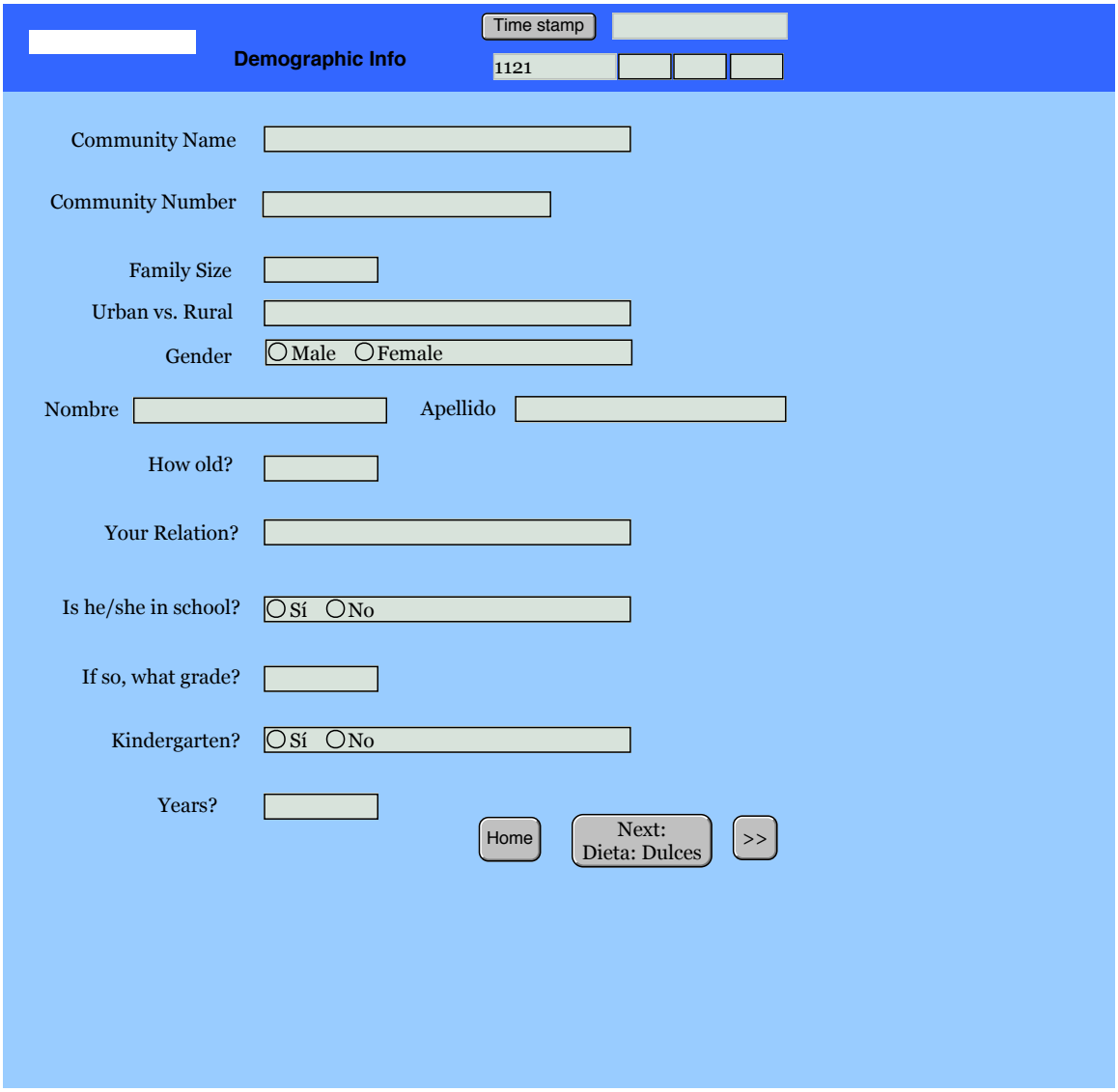
Another common problem is convenience sampling. Its non-random nature can also allow for unforeseen bias. For example, in one scenario I had been invited report to a rural school to perform my interviews. Upon reaching the school 15 child participants with suspiciously high tooth decay and overall need for compensation had been predetermined for my assessments. As a result I was forced to eliminate their data records due to potential bias.

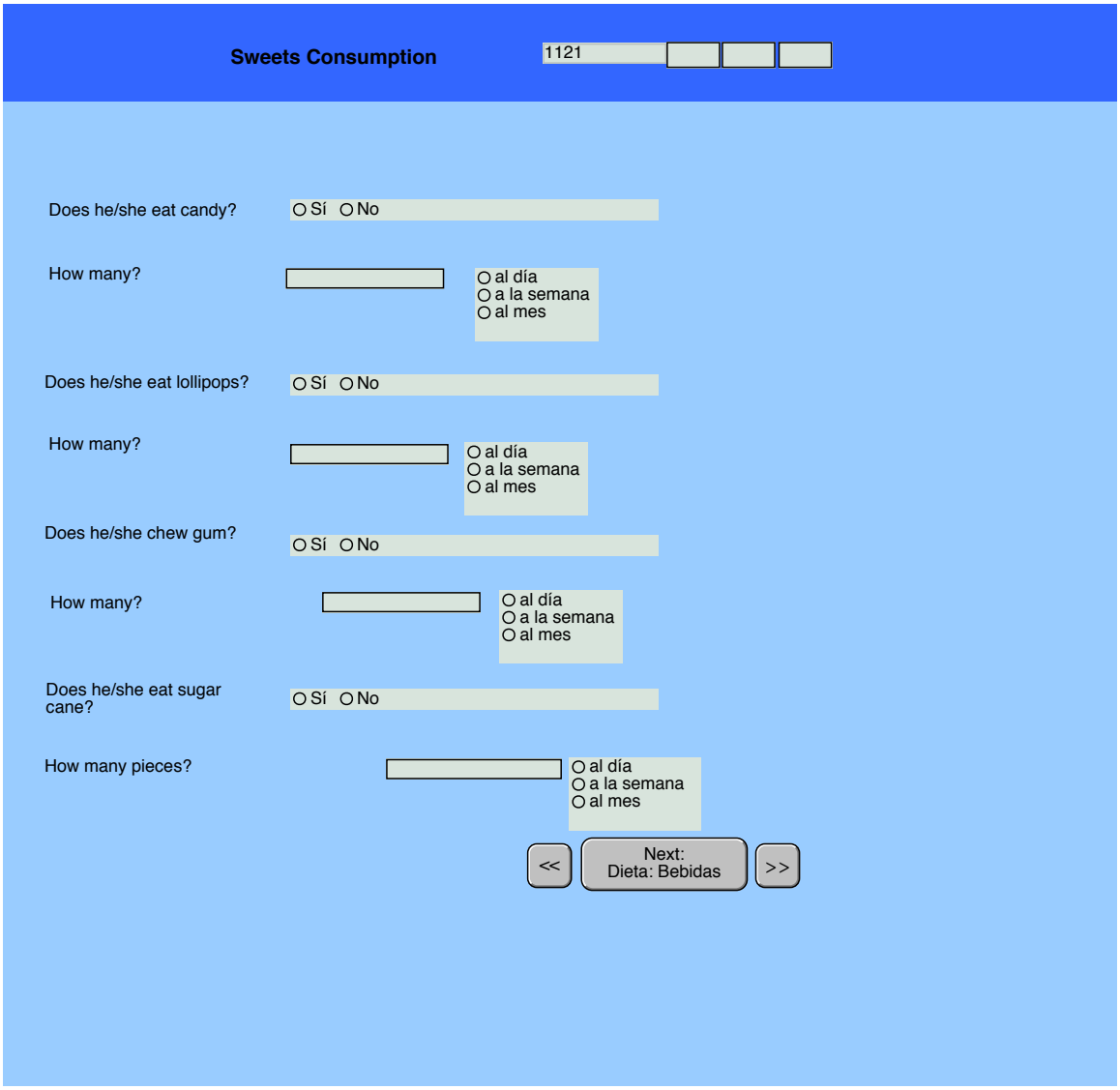
6. Conclusion

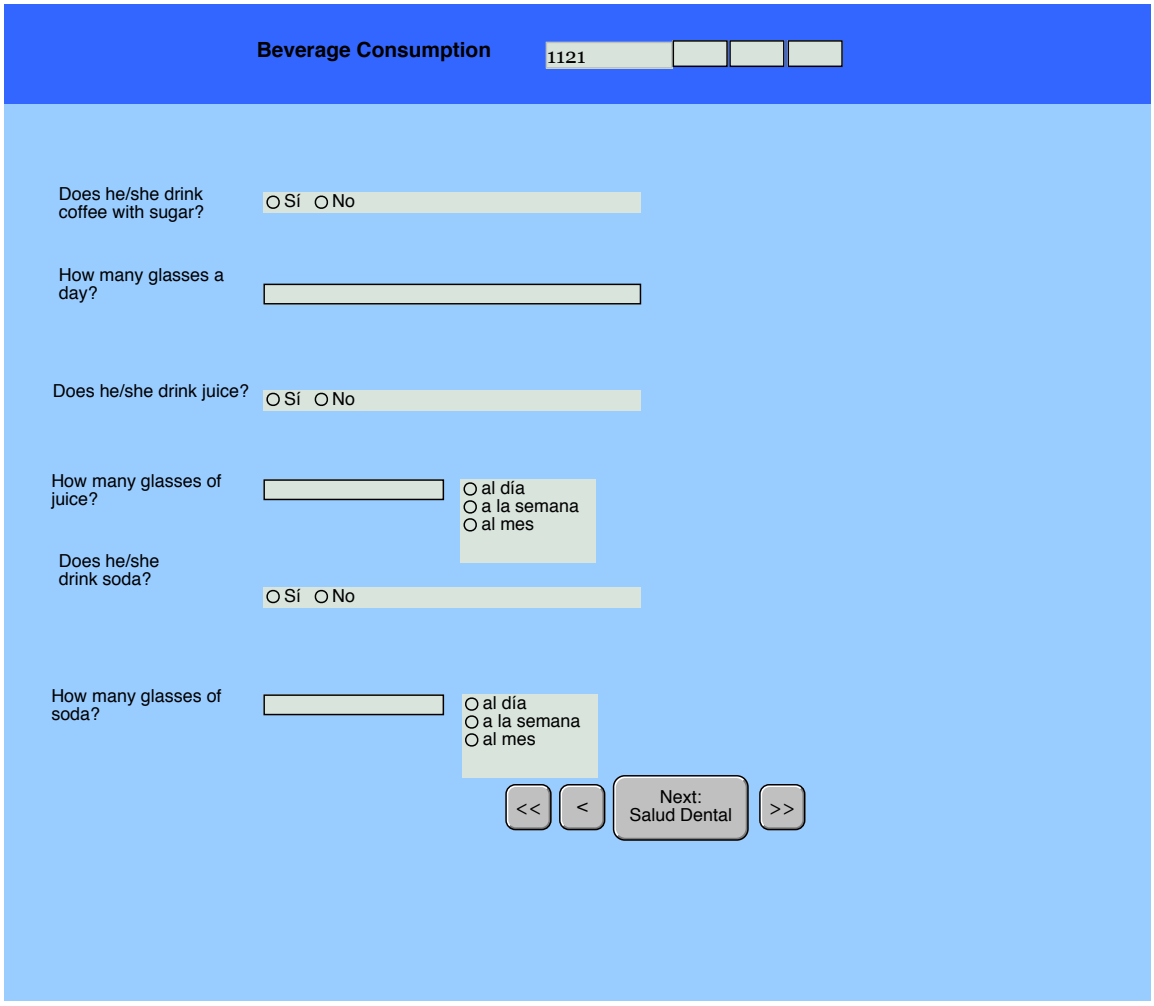
While this study was unable to identify a statistically viable association between DMFT score and urbanization, it was able to provide significantly positive correlations for sugar consumption exposure (hard candy, gum, lollipops, soda, and juice), parent education, and daily brushing habits. Additionally, this study demonstrated a mean DMFT Score of 5.15 for the combined populations. This high score supports the claim that future interventions are needed throughout Honduras to help lower mean DMFT in 12-year-old children by 2015. Since high caries prevalence does not discriminate based on urbanization in this study, both population types would benefit greatly from treatment interventions. The data collected also warrants consideration of water fluoride levels in future oral health research to help identify any influence it may have on caries risk within certain communities that rely on water from unregulated sources. Oral health education remains a top priority in third world settings. By increasing public awareness of good oral health practices, continuing to investigate the causes of caries incidence, and making additional treatment efforts, the global health community can help reduce the mean number of caries in Copan, Honduras and other regions of the developing world.

Appendix A

Survey




Sweets Consumption
1121
Does he/she eat candy?
Sí
No
How many?
al día
a la semana
al mes
Does he/she eat lollipops?
Sí
No
How many?
al día
a la semana
al mes
Does he/she chew gum?
Sí
No
How many?
al día
a la semana
al mes
Does he/she eat sugar cane?
Sí
No
How many pieces?
al día
a la semana
al mes
<<
Next:
Dieta: Bebidas
>>


Beverage Consumption
1121
Does he/she drink coffee with sugar?
Sí
No
How many glasses a day?
Does he/she drink juice?
Sí
No
How many glasses of juice?
al día
a la semana
al mes
Does he/she drink soda?
Sí
No
How many glasses of soda?
al día
a la semana
al mes
<<
<
Next: Salud Dental
>>

Dental Health

1121

Does he/she ever have tooth pain? ○ Sí ○ No

How often does he/she have tooth pain?
○ diariamente
○ seminalmente
○ mensualmente
○ cada año/casi nunca
○ nunca

Has he/she ever had a tooth extracted? ○ Sí ○ No

If so, how many?

Has he/she ever missed school due to tooth pain? ○ Sí ○ No

If so, how many days?

Does he/she brush with a toothbrush daily? ○ Sí ○ No

If not, have they ever brushed in the past? ○ Sí ○ No

When he/she brushes, how often do they brush each day?

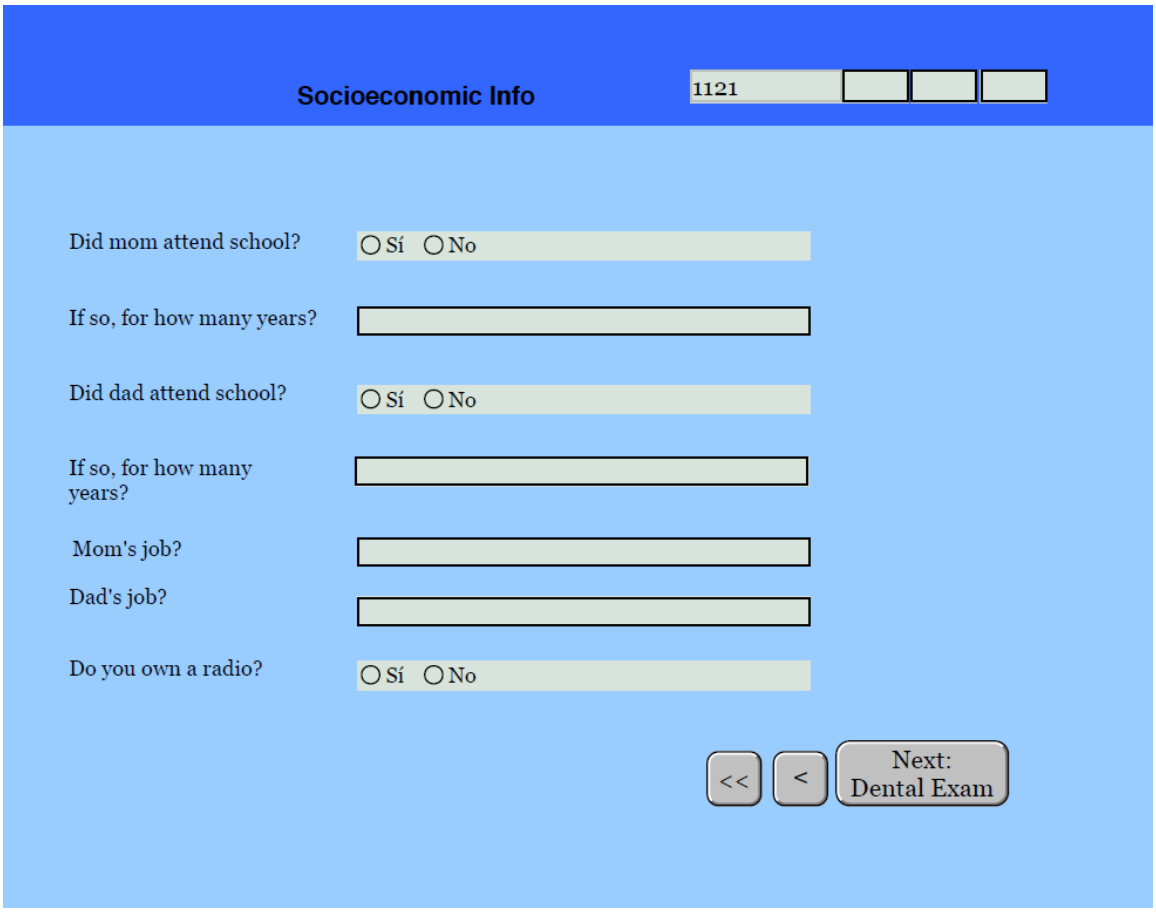
Does he/she brush with toothpaste daily? ○ Sí ○ No

When he/she brushes how often do they use toothpaste?

If not, have they ever used toothpaste in the past? ○ Sí ○ No

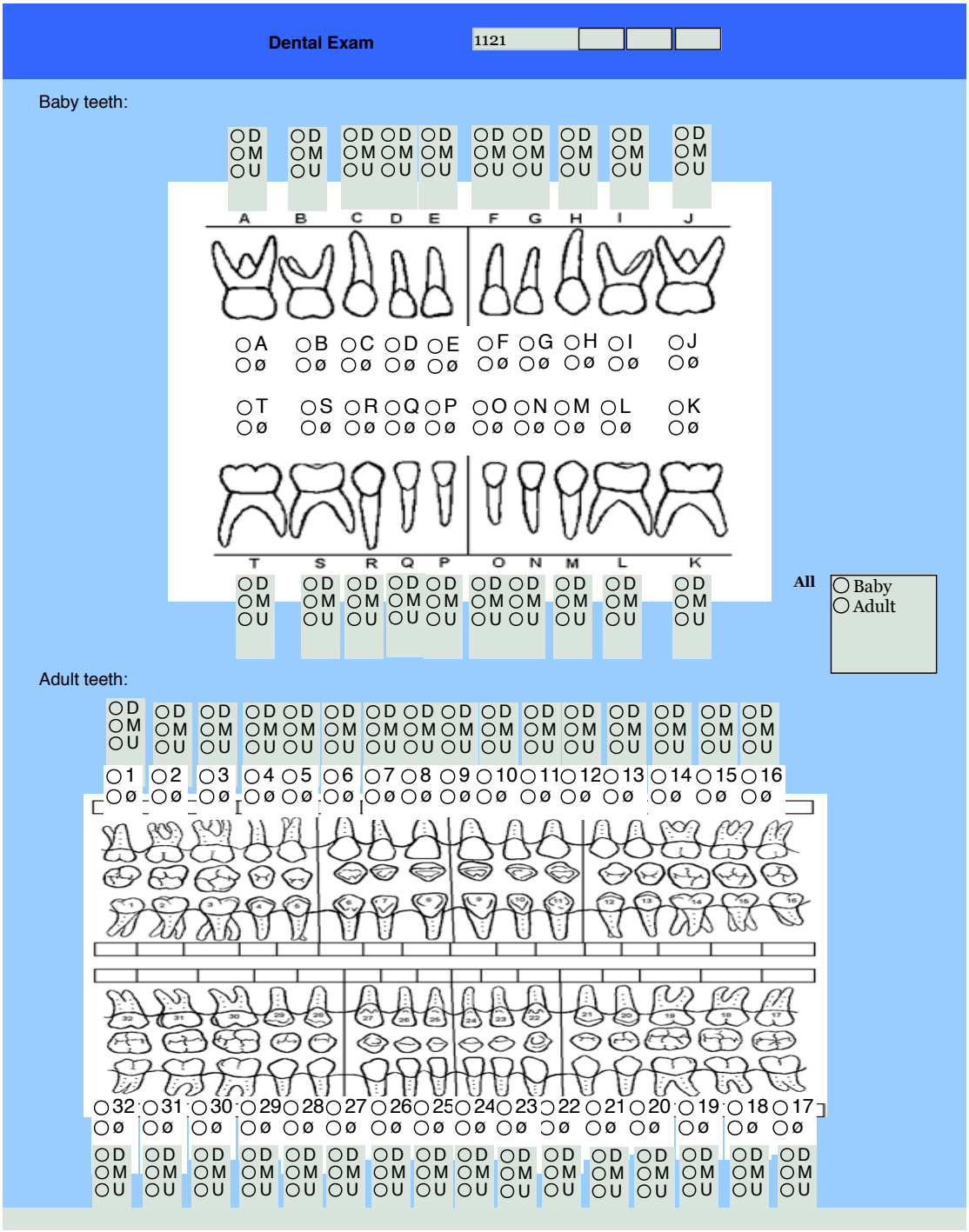
If he/she does not brush daily, why not?

<< < Next: Informacion Socioeconomica >>


Socioeconomic Info
1121
Did mom attend school?
Sí
No
If so, for how many years?
Did dad attend school?
Sí
No
If so, for how many years?
Mom's job?
Dad's job?
Do you own a radio?
Sí
No
<<
<
Next: Dental Exam

Appendix B

Dental Exam



References

Bönecker M. & Peter C. (2003). “Trends in dental cares in Latin American and Caribbean 5-6- and 11-13- year-old children: a systematic review.” *Community Dentistry and Oral Epidemiology,* 13 (2).

Bratthall, D. (2000). “Introducing the *Significant Caries Index* together with a proposal for a new oral health goal for 12-year-olds”. *International Dental Journal*, 50: 378-384.

Carberry, F. J. (2009). "Collaborative approach to dental care provision in resource poor Honduran community". *New York state dental journal*, 75 (3): 34.

Chaffin, J (2003). "Public health model for dental specialty MEDRETE". *Military medicine*, 168 (11): 885.

Chainani-Wu, N. (2011). "Diet and prevention of oral cancer: strategies for clinical practice". *The Journal of the American Dental Association*, 142 (2): 166.

DeWalt, et al. (2004). “Literacy and Health Outcomes A Systematic Review of the Literature.” *J Gen Intern Med,* 19: 1228-1239.

Fontana M., et al. (2011). “Identification of caries risk factors in toddlers”. *Journal of Dental Research*, 90 (2): 209-214.

Jones, C.M. Worthington, H. (2000). “Water fluoridation, poverty and tooth decay in 12-year-old children”. *Journal of Dentistry,* 28 (8): 389–393.

Kaste, L. M., et al. (1996). "Coronal caries in the primary and permanent dentition of children and adolescents 1-17 years of age: United States, 1988-1991". Division of Epidemiology and Oral Disease Prevention, National Institute of Dental Research, National Institutes of Health, Bethesda.

Lee, G. and Carrington, M., 2007. "Tackling heart disease and poverty". *Nursing & Health Sciences*, 9: 290–294. Preventative Cardiology, Baker Heart Research Institute, Melbourne, Australia.

Locker, D. (1988). Measuring oral health: a conceptual framework. *Community Dent Health*, 5: 3 – 18.

Maupomé, G. (1998). "An introspective qualitative report on dietary patterns and elevated levels of dental decay in a deprived urban population in northern Mexico". *ASDC Journal of Dentistry for Children*, 65 (4): 276 – 285.

Miller, et al. (2010). "Impact of Caregiver Literacy on Children's Oral Health Outcomes". *Pediatrics*, 126 (1).

Molyneux, L., Preston, A. J. (2007). "Promoting oral health: the use of salt fluoridation to prevent dental caries". *British Dental Journal*, 202 (639).

Newbrun, E. (1989). "The Effectiveness of Water Fluoridation". *Journal of Public Health Dentistry*, 49 (5): 279 – 289.

Nishi, M., Stjernswärd, J., Carlsson, P., Bratthall, D. (2002). "Caries experience of some countries and areas expressed by the *Significant Caries Index*". The WHO Collaborating Center.

Pan American Health Organization. (2001). “Health Situation Analysis and Trends Summary”. Washington, D.C.: *PAHO*.

Pan American Health Organization. (2002). “La salud en las Américas, edición de 2002”. Washington, D.C. *PAHO.*

Pan American Health Organization. (2009). “Health System Profile Honduras, Central America: Monitoring and Analysis of Health Systems Change/Reform”. Washington, D.C.: *PAHO*.

Remez, L. (1999). “In Honduras, Men Now Have an Average of Five children, but Consider a Family of Three to be Ideal”. *International Family Planning Perspectives*, 25 (3): 154-156.

World Health Organization. (2001). “How to calculate the *Significant Caries Index* (SiC Index)”. WHO Collaborating Center. <http://www.whocollab.od.mah.se/expl/significant.pdf>.

Zelaya, I (2005). "Anxiety and dental fears among Honduran school children". *Revista latinoamericana de psicología*, 37 (3): 461.