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**Oral Healthcare Education, Equity and Policy Implementation in Rural Honduran
Communities**

Alexander J.R. Dyke

Grand Valley State University

Honors Senior Project

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A research paper submitted in conformity with the requirements
for the Frederick Meijer Honors College Senior Project

Abstract

Rural Honduras encompasses many individuals with limited access to a dental professional. Many public health studies demonstrate that dental shortage areas have more dental cavities, missing teeth, and more complex restorations that need periodic treatment. With limited access to oral health advocates, dental hygiene is undermined at home, and dental education becomes more essential. Here, we report an educational consensus and perspectives of rural Honduras through a questionnaire distributed at 13 mobile dental clinics in remote villages. To assess the effectiveness of education, the World Health Organization (WHO) has deemed two important indices in assessing trends: Community Periodontal Index of Treatment Needs (CPITN) and Decayed, Missing due to caries and Filled Teeth (DMFT). These two previous indices are reported and discussed to determine the importance of future research trends that need to be made to assess the effectiveness of future education and policy implementation. Finally, we look at barriers to dental access to analyze different forces that are detrimental to rural Hondurans to offer policy implementation to the current business model of healthcare in the nation. Eight hundred seventy-three patients who visited the clinics were screened, and 502 individuals were asked to answer the questionnaire from the set of parameters. Of the 220 participants who answered the questionnaire, every respondent deemed finding a dentist difficult, with 160 (73%) claiming they had not visited a dentist in the past two years. This demonstrated a need to increase access to the rural Honduras population of dental professionals. Of the respondents who had not seen a dentist in the past two years, the at-home hygiene education was statistically different from the 60 who had seen a dentist in the last two years, demonstrating a further need to increase education on dental cleaning within the rural area Honduras population. The indices reviewed were not sufficient to provide current statistical measures on the nation's dental health, resulting in a need to procure future research on the state of rural Honduras's dental health. Lastly, policy analysis found that educational, financial, infrastructural, technological, and accountability standards must be reviewed through changing policies to improve limited access for rural Hondurans.

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Introduction

Rural Honduras consists of just over 4 million people. Yet, this relatively large population is not afforded the same opportunities as other areas ("World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420). New York: United Nations." 2019). Water service without fluoridation is shut off at certain times to allow everyone a chance to have clean water. Families fear violence from organized crime. The job market is almost non-existent for women and children who have minimal access to education past 6th grade (Human Rights Watch 2019). These systematic inconveniences are just a tiny facet of poverty-stricken Hondurans who live in these underserved areas. The primary income for this Central American area comes from farming, tracing many traditional roots in the 1960s exportation of sugar cane. However, the deterioration of the mountain environment from what is known as shifting agriculture and the poor productivity that came about resulted in poverty for small farmers ("Honduras Agriculture, Forestry and Farming" 2021). The environmental conditions are still a very pertinent issue for the daily life of Hondurans; however, the consequential impact on the citizens is a low standard of living in the countryside. A significant concern for the general attitude is the health problems like malnutrition, environmental hazards, and poor access to seeing a healthcare professional.

Poverty-stricken Hondurans' health problems mainly stem from food productivity and agriculture, distribution, and population growth (Richard Haggerty, 2004). Instead, given a state of affairs where, for example, there is not a dramatic shortage of food but only a continuously inadequate diet, the population fails to relate infectious diseases, mental retardation, and low productivity to conditions of poor diet and lack of sanitation. Because these problems have always existed for the affected population, they tend to be accepted. Hence, Hondurans believe oral healthcare is a luxury rather than an expectation. Given the typical diet of corn, tortillas, beans, plantains, rice, coffee, and sugar cane with inadequate oral hygiene, a widespread epidemic of oral caries and diseases plagues these communities (Dodd et al., 2020).

The reality of healthcare outside of the United States and other developing countries demonstrates a need to provide more clinics, improve access and shift the focus of the low and middle-income countries (LMICs) governmental policies. These policies should implement better strategies for monitoring and tackling the crisis of healthcare. As an oral healthcare advocate, having input on fiscal implementations and the methodology of healthcare strategies is imperative to ensure that more vulnerable populations have a say in their treatment. Along the lines of policy implementation, the social and cultural framework must be considered when adapting and approaching a sensitive topic. Understanding the needs of this population must also combine an understanding of the socio-political background throughout different communities in Honduras.

The difference in lifestyle and oral health disparities was witnessed first-hand through mobile dental clinics in rural Honduran communities. I will reflect on my experiences from 2019, 2021, and 2022 to understand cultural views and note the inadequacy in oral health. As of 2022, the COVID epidemic has displayed a very different cultural shift in healthcare that I will explore. This paper will focus on Honduras's current oral healthcare model by analyzing its efficacy. In conjunction with reviewing the effectiveness, a look into the socio-political fabric for the scope of rural Hondurans will aid in a potential policy shift. This paper is designed to describe and propose alternative measures to add to the discussion on international relations. It is not intended

to propose or persuade policymakers. As there are limited data sets specifically for rural Honduras, I will also examine cross-sectional studies that can analyze markers for oral hygiene education in LMICs that resemble the rural Honduras communities.

Scope of Rural Honduras

The rural area of Honduras is defined by the geographic parts outside of towns and cities, dense with agricultural areas. Travel times to businesses, healthcare professionals, and other sectors are typically longer. Recent statistics state that 74% of the poor and 86% of the extremely poor reside in the rural areas of Honduras. Labor in these areas consists of mainly farmers or landless people: women and indigenous groups are among the poorest (“Rural Poverty in Honduras.”, 2010). The country’s population growth is among the highest in Latin America. The high birth rate has led the population to double every twenty-five years. The 1950 census counted 1,368,605 inhabitants, almost twice as many as the 1926 census. By 1974 the population had nearly doubled once again. This growth rate has remained consistent up until 2020. In 1998, Hurricane Mitch took the lives of more than 5,000 people in Honduras and caused billions of dollars in damage.

Political instability continues to trouble the country, with another military coup taking place as recently as 2009. This instability has plagued communities, especially those who rely on governmental organizations like housing, healthcare, and food. The 13 dental clinics were designed to be set up to cover much of Honduras’s rural countryside, seen in *Figure 1*, which has been adapted by the Moderate Resolution Imaging Spectroradiometer (MODIS) (NASA, 2016). The Classification and Regression Model (CART) was utilized to select from the multitude of mobile pop-up clinics to fit within the scope of the rural countryside. Clinics covered agricultural pastoral ranges, dense and sparse pine forest areas, and broadleaf forests. The population size of the villages where community centers were offered ranged greater than 150 residents but no more than 2,000 residents.

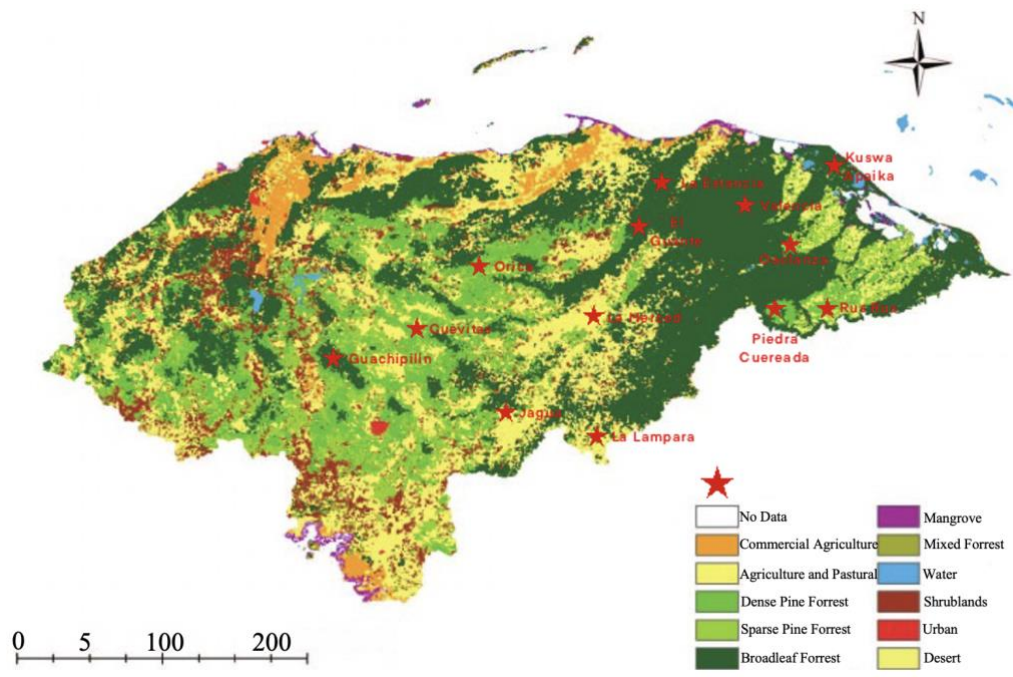


Figure 1. Land Cover Map of Honduras MODIS Imagery - 2016 CART Classification with the 13 Labeled Clinical Locations

The 13 clinics that were selected included Guachipilín, Cuevitas, Jagua, La Lampara, La Merced, Orica, El Guante, La Estancia, Valencia, Oaclanza, Piedra Cuereada, Rue Rue, and Kuswa. These clinics filled the aforementioned parameters in order to assess different educational models, differential indices and a questionnaire analysis that is described in the methodology section of this paper.

Methodology of Study

This paper will examine three significant areas of study when tackling the central problem of oral healthcare in rural Honduras, including reviewing current educational practices, assessing the effectiveness before any education, and discussing dental healthcare disparities between the rural and urban areas. With health literacy and comprehension being very important for a healthy population, a patient-centered orientation for health care will also be addressed through collaboration with local hospitals. The overall approach of this paper is to analyze the current healthcare model as it relates to rural Honduras; therefore, a background investigation into a mismanaged system, political corruption based on socioeconomic classes, and the COVID-19 threat are essential for understanding direct aid and long-term solutions.

A discussion on previous and current oral hygiene treatment and education will be accomplished by analyzing rural versus urban areas through the Simplified Oral Hygiene Index of Greene and Vermillion and the Community Periodontal Index of Treatment Needs (CPITN). These indices will allow for a quantitative proportion of the dental healthcare disparities across these population sets. The data used for the CPITN stems from the World Health Organization (WHO) and will also be qualitatively assessed through my accounts in the dental clinic. Follow-up studies on patients who have gone through oral hygiene education and previous treatment from the pop-up clinics will also describe how effective different educational curriculums are deployed and understood from 2019 through 2022.

Patients were also asked to fill out a questionnaire for the 2022 dental mission trip at clinics and schools. The goal was to assess the effectiveness of education from the current model of oral hygiene instruction. This was delivered before any instruction and educational methods or before completing dental work. A translator was provided for respondents unable to read if they wished to complete the questionnaire.

Lastly, this paper will review current research and efficacy in hygiene education via mission trips, hospital initiatives, school platforms, and governmental policies via the Healthcare Equality Index (HEI) provided by the Human Rights Campaign. This index is vast, with parameters that will allow a direct view of current and future models. By adopting other LMIC research, we can depict what policies may look like with relative certainty. There are limitations to this that will be discussed in greater detail.

Current Healthcare Model and Its Limitations

As global health challenges are increasingly addressed by nongovernmental organizations (NGOs), understanding how care recipients with low literacy levels perceive a change in the development process can provide better service delivery and community empowerment. Given this increase, most would believe that nongovernmental professionals treat rural populations with a patient-centered and holistic understanding of how low health literacy levels can impact health outcomes. Unfortunately, that is not the case. In a global context, transformative dialogues about the disease and public health concerns have remained largely unaddressed, similar to the unchanged climate around education, poverty, and social inequality.

Healthcare in Honduras operates through two central systems: a private and a public infrastructure and is only officially accessed by only 60 % of the population and is primarily limited and concentrated in urban centers (Johnson 2010). The country essentially reserves the private system for the wealthy elite and those with private insurers and an economic class representing roughly 10% of the population ("Summary Findings of Honduras Threshold Program Endline Evaluation Report" 2020). The public system comprises two other institutions: the Ministry of Health and the Honduran Social Security Institute. The Ministry of Health allows anyone to have access, although only about half of the population uses it regularly (Bermúdez-Madriz et al., 2011). Meanwhile, the Honduran Social Security Institute only covers 40% of individuals with employment, totaling around 18% of the population. Between these two healthcare systems, about 17% of the population does not have routine access to healthcare, and even less have routine access to dental care. The dental and health sector are intertwined when discussing Honduras policies and financial institutions.

Honduras is the second poorest country in Central America, and malnutrition is especially problematic. In rural Honduras, 48% of the population suffers from malnutrition, and 10% of infants are born underweight due to this. Half of children ages 2-6 suffer from anemia (Borgen Project, n.d.). Adequate nutrition is essential to preserving the general state of health, especially in older adults, allowing them to maintain sufficient independence to live in the community and avoid institutionalization. Malnutrition has been related to a decline in general functional status and bone mass decrease, immune dysfunction, delayed post-surgery recovery, high hospitalization and readmission rates, and increased mortality (Haboubi 2010). With a higher rate of malnutrition occurring in these rural areas, many people are forced to function with limited to almost zero mastication. With or without dentures, a lack of teeth limits the ability to chew and swallow essential nutrients from vegetables and fruit in adults and those from more disadvantaged social groups seen in rural Honduras (Nowjack-Raymer and Sheiham 2007).

In 2013, the National Health Model was approved to emphasize primary health care. The Directorate-General of Human Resources Development is accountable for health worker development. In 2013, the country had 10.0 physicians, 3.8 nurses, and 0.3 dentists per 1,000 population. In 2015, health services administration was decentralized in 82 cities across 15 departments, covering a population of just under 1,500,000. The National Health Model (NHM) has guided the implementation of 500 primary health care teams serving rural and remote areas of the country. The teams, each consisting of a physician, a nurse, and a health promoter, prioritize communities living in extreme poverty, environmentally vulnerable conditions, and violent situations ("Country Report: Honduras" 2018). By 2016, 367 teams were already working

in the field and serving 1.5 million people, promoting qualitative improvements in their attitudes and habits. In 2014, the Ministry of Health created the Information Management Unit, ensuring that information is accurate, timely, and appropriate for health planning, organization, direction, control, and evaluation.

The new model has encouraged a diversity of participating sectors and entities, with a clear separation of the system's functions. However, there are still improvements to this model that need to be made. An improved organizational structure for social security is important, which runs the national public health system. It was created in 1959 and has seen minor changes since then. To aid in promoting the restructuring, WHO has deemed that creating a health oversight agency and designation of the Honduran Social Security Institute (IHSS) as the insurer of the national health system must be put into place. However, this system has been not only mismanaged, but has seen embezzlement through three administrations (“Esposas de Exfuncionarios Del IHSS Dirigían Red de Testaferros” 2014). The most recent administration of the IHSS was in 2014, which relied on a series of fronts. These fronts that had been identified in the investigation totaled 325 million lempiras, or US\$14 million. A report the following year determined that the likely result of this fraud caused 3,000 unnecessary deaths (“Cerva de Tres Mil Personas Han Muerto Por Descalabro En El IHSS” 2015). Political corruption plagues the current system, with many sectors of healthcare severely impacted and unable to provide care to citizens of Honduras. A more practical application of the model also requires further improvement of public health service management and more remarkable human resource development. Efforts are being made to promote and strengthen multisectoral partnerships and generate evidence for the Health in All Policies approach, especially concerning non-communicable diseases and injuries due to external causes. Further development of national capacity and competencies for measuring equity and inequalities in health is also necessary, as is effective implementation of the human rights and gender/ethnic equality approaches.

With a very low capita of dentists per person, access for the Honduran people is minimal. There are four dental schools that residents of Honduras can attend, with two being public governmental schools with no tuition and two Catholic schools. Dental school is six years, with the seventh year requiring community dental service. Once a student has graduated, their employment opportunities are to work in private practice, a government health clinic, an NGO, or a private company. The Minister of Health has not had a position open for a new graduate for the past two years, and there is currently a surplus of unemployed dentists. So, while there is a great need for dental care, the country lacks employment opportunities for these new graduates. This still is prevalent in both urban and rural areas of Honduras. Rural areas are impacted much harder by employment opportunities, even with the new model of healthcare (Tepe and Tepe 2017).

This does not stop many mission trips from foreign dentists to provide aid in these rural communities. While access is limited, it is even more sparse in rural areas, and fewer dentists are willing to be hired. Requirements for visiting dentists include registering with the Ministry of Health prior to working in Honduras by supplying a copy of the dentist's graduation credentials; they must work under the supervision of a licensed Honduran dentist. Honduran dentists who practice outside of their own business are limited to working only 6 hours per day. Of the host of procedures, dental prophylaxis, extractions, and amalgam restorations are typically provided at

public dental clinics. Crowns, bridges, composite restorations, endodontics, and implants are only supplied in private settings where the price is considerably higher. Their cost is similar to that of the United States, while Hondurans' gross national income per capita is US\$1,649 ("United Nations Data: Honduras" 2021). Toothpaste is widely available in stores, markets, and even sold by vendors in the aisles of local buses. Fluoride varnish is rarely used, and toothpaste with higher fluoride levels is unavailable. Systemic fluoride via water, salt, or milk is unavailable (Milner, Trevor 1998). Education about dental care is done primarily through the marketing efforts of Colgate-Palmolive, which supplies some schools with posters, pamphlets, coloring books, brushes, and paste. The Bright Smiles, Bright Futures (BSBF) delivers certain initiatives that focuses mainly on schools. Their partnerships with local influencers and embedded curriculum creates humanitarian efforts within LMIC's. Smaller education platforms typically arise from mission trips and local humanitarian efforts. The effectiveness of Colgate BSBF initiatives on the rural Honduras communities has not been studied other than from Colgate global reports. However, these global reports do not specify the Honduras statistics. Hence, there is more importance on the current oral health education on the rural Honduras population. The BSBF offers instructional methods using selected kits for students in Honduras. These are typically donated to different community centers, churches and schools. There is currently no data provided on the quantity donated to rural Honduras. The question remains if Colgate initiatives are sufficient. Since we only look at the adult population in the questionnaire, there is a significant limitation as our sample does not attribute recent efforts within the school systems. Colgate does offer mobile vans in urban Honduras, but there is no data signifying the use of mobile vans for educational purposes in the rural countryside.

A significant limitation to these pop-up dental clinics is limited supplies (Vashishtha et al., 2014). Triaging measures, or the initial exam, are typically the most challenging restriction dental professionals face in these mobile dental clinics. Most citizens will have their dental work done in community centers or churches throughout the rural areas. These typically do not have any power, so generators must be brought in to support any electrical machinery, including handpieces, x-ray technology, and lights. These are integral pieces for dental cleanings and procedures, but sometimes the terrain can eliminate the possibility that people get the proper treatment. Another crucial boundary is the water supply in some villages'. Clean water is a commodity that many do not have direct access to. In the dental setting, sanitized water is essential in open areas since it is a direct passageway into the digestive system, and many diseases can stem from unsafe water. Sterile water is also necessary for sanitization measures of dental instruments.

The need for infrastructure with safe water, high-vac systems, and safe dental irrigation is critical to providing the rural Honduran communities access to safe dental care. These mobile clinics typically bring in a plethora of suitcases with handpieces and extraction tools, parts of x-ray machines that are set up when dental staff arrive at the location, bulky autoclaves, and more than 100 gallons of clean water that must be locked up due to shortages. Dental professionals are there to help, and not having the essential fundamental tools can lead to more harm than good. Infrastructure that supports these needs would allow dentist to perform more procedures, ensure periodic treatment follow-ups, and promote a higher quality of care for rural citizens.

The Science of Dental Caries

Dental caries, or dental cavities, occur over time due to acidogenic shock, poor hygiene, and resident microbiota. The loss of tooth substances (enamel and dentin) is caused by acid production resulting from the bacterial metabolism of sugars. We all have bacteria that generally accumulate on our teeth; however, a shift in the balance of our normal microbiota due to the repeated acid cycles of frequent sugar intake causes dental carries (Kleinberg 2002). These bacteria live in dental plaque, which can cause oral diseases like cavities. Once these reach the inner part of the tooth, called dentin, it runs much more rampant. The amalgamation of bacteria and the innate inflammatory response around the gingiva leads to increased gingival crevicular fluid (GCF), an exudate of periodontal cells (Silva-Boghossian et al., 2013). The GCF provides nutrients that encourage the growth of obligate and proteolytic anaerobes, present in dental caries and oral disease (Rugg-Gunn 2013). The early stages are often without symptoms, but advanced stages of dental caries may lead to pain, infections, abscesses, or even sepsis (Sheiham 2005).

Maintaining balanced levels is crucial by proper at-home hygiene, regular dental check-ups, and preventative measures. Since dental caries develop from metabolized sugars, food is an essential factor in understanding causation. Many sugar-sweetened beverages, including fruit-based and milk-based sweetened drinks and 100% fruit juices, are a primary source of free sugars and confectionery, cakes, biscuits, sweetened cereals, and sweet desserts, sucrose, honey, syrups, and preserves (Moynihan and Kelly 2014). While farming and agriculture are the main economic driving forces for rural Honduras, rarely can they access these essential nutrients grown locally due to their state of finance.

An association between dental caries and undernutrition in children has been reported in some low- and middle-income countries; however, whether this is cause or effect, or both, remains to be determined (“World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420). New York: United Nations.” 2019). The World Health Organization has laid out founding principles to which many LMICs should respond and implement as a result of this epidemic. These include taxation on sugar-sweetened beverages and foods with high free sugar content; implementing clear nutrition labeling; regulation on the advertising and the marketing of food and drinks that have high free sugars; improving how schools or public institutions regulate the sale of foods and beverages; prioritizing awareness and access to clean water.

When dental caries go too far, periodontal health, including gums, teeth mobility, and calculus, is a cause for concern. These indicate anaerobic periodontal infection, leading to full tooth loss without repair. This can be pretty common in areas where the community periodontal index is exceptionally high (Gjermeo 1994). The importance of public health on examining the needs of dental professionals, access, and education is imperative to stop periodontal diseases.

Clinical Questionnaire

The questionnaire was designed to assess current dental education and the correlation to access within the defined population group. Analyzing the relationship between rural Hondurans' existing dental understanding and the ability to visit a dental professional is essential to evaluate reinforcement practices offered. The data also dictates the current epidemic faced by Hondurans

as supplemental to the CPITN from the World Health Organization, as previously discussed. Lastly, it aims to test the hypothesis that malnutrition is a dominant cause for families within the socioeconomic background that the clinics served.

220 respondents filled in at least half of the questionnaire which had visited one of the 13 pop-up mobile dental clinics in rural Honduras. The 13 clinics are displayed in *Figure X*. The questionnaire was offered before any dental work, dental education, or oral products provided. Of the 220 respondents, 98 participants could not read the questionnaire, and a translator was offered. 61 respondents could not write, and two evaluators confirmed the responses to limit communication issues or biases. The questionnaire was filled out and collected without any information about the patient documented. The questions asked on the questionnaire can be found in Appendix A. A wide range of respondent demographics was utilized to gather as much information about rural Honduras populations. The only strict parameters set were anyone older than 21, who were residents near the clinic they attended.

Results of the Questionnaire

Of the 873 patients who visited the clinic, 502 individuals met the requirements to aid in the questionnaire. Of the 502 patients who fit the parameters, 9% also arrived from urban areas looking for more affordable care or had previously visited the clinic and trusted the doctors (N=45). Furthermore, of the 457 who were asked to participate, 48% did participate (N=220). This sample size adequately resembles the population, with almost half of the participants willing to answer the questionnaire.

Questions 1, 1. A, 2, and 2. A was aimed to gather a baseline on the population's oral health practices at home. Questions 1 and 1.A. demonstrated that the average Honduran who visited the clinic brushed their teeth 1.3 times per week (N = 220) and flossed 0.03 times per week (N = 220). Of the reported participants, 5% brush their teeth at least twice a day (N =11), and around 15% said they brush once per day (N=15). 50% of the participants reported that they do not brush their teeth within a week (N=108).

Questions 3, 3. A, and 4 tackle the educational considerations of the respondent population. By asking about the recommended number of times they should brush, we can extrapolate the population's overall knowledge of dental health. Of the 220 respondents, just 40% believed that they currently know or had been educated on the recommended quantity to brush per day (N=88). Furthermore, of the 88 respondents, 65% reported that it is recommended to brush two times per day (N=57), while 35% reported once per day (N=31). Of the 31 respondents who answered twice per day, 100% of the individuals had previously visited the clinic or had had access to a dentist in the past two years.

To assess the effectiveness of the education at the clinic for returning patients and respondents who have seen a dentist in the last two years, an F-test and a Students T-test was run. The two groups included returning patients / recent dental visits (N=60) and new patients / not recent dentist visits (N=160). When the two groups responded to how many times is recommended for them to brush their teeth per day, the F-test result (*Table 1*) demonstrated that the variance of the two populations is unequal ($F=6.61$, $p<0.005$); therefore, we fail to reject that the null hypothesis, that there is no difference, and assume that there is difference between the two

groups. This demonstrates that those who have visited a dentist recently answer how many times they should brush differently than those who are new patients or haven't seen a dentist recently.

Table 1: F-Test Two-Sample for Variances for Responses on Brushing

	<i>New Pt. and >2 years</i>	<i>Returning Pt. and <2 years</i>
Mean	1.025	1.9
Variance	0.829559748	0.125423729
Observations	160	60
df	159	59
F	6.614057454	
P(F<=f) one-tail	1.0932E-13	
F Critical one-tail	1.45323194	

*** If $F > F_{critical}$, we fail to reject the null hypothesis and accept the alternative. In this case, we reject the null and accept that there is a difference in the variances.*

Since we failed to reject that the two groups have equal variances, the Students T-Test with differing variances is performed (*Table 2*) with a two-tailed p-value is used. New patients and those who have not seen a dentist in less than two years reported that the recommended quantity to brush was less (M=1.025, SD=0.9108) than returning patients and those that have seen a dentist in the past two years in general, $t = -10.25$, $p < 0.005$. Since we reject the null hypothesis, we assume there is a statistical difference between these two groups. This means that patients who have visited a dentist recently are more likely to answer the correct number of times they should brush when compared to those who haven't seen a dentist for less than two years or haven't visited a clinic.

Table 2: t-Test: Two-Sample Assuming Unequal Variances for Responses on Brushing

	<i>New Pt. and >2 years</i>	<i>Returning Pt. and <2 years</i>
Mean	1.025	1.9
Variance	0.829559748	0.125423729
Observations	160	60
Hypothesized Mean Difference	0	
df	218	
t Stat	-10.25858022	
P(T<=t) two-tail	2.11659E-20	
t Critical two-tail	1.970905601	

*** If $T < -T_{critical}$ we reject the null hypothesis and accept that there is a statistical difference between the two groups.*

The same groups were also analyzed for their responses on the recommended times to floss each day. When the two groups responded to how many times is recommended for them to floss per day, the F-test result (*Table 3*) demonstrated that the variance of the two populations are unequal ($F=5.55$, $p<0.005$), therefore we fail to reject that the null hypothesis, that there is no difference, and assume that there is difference between the two groups. Much like we saw with the answers for brushing, the patients who have been to a dentist recently answer differently than those who haven't been to a dentist within the past two years.

Table 3: F-Test Two-Sample for Variances for Responses on Flossing

	<i>New Pt. and >2 years</i>	<i>Returning Pt. and <2 years</i>
Mean	0.803704821	0.969329499
Variance	0.157253885	0.028351439
Observations	161	61
df	160	60
F	5.54659278	
P(F<=f) one-tail	4.66415E-12	
F Critical one-tail	1.449016707	

*** If $F > F_{critical}$, we fail to reject the null hypothesis and accept the alternative. In this case, we reject the null and accept that there is a difference in the variances.*

As seen with the responses on brushing, we ran a Students T-Test to determine if these two groups are statistically different. New patients and those who have not seen a dentist in less than two years reported that the recommended quantity to floss each day was also less ($M=0.806$, $SD=0.396$) than returning patients and those that have seen a dentist in the past two years in general, $t = -4.99$, $p<0.005$. Since we reject the null hypothesis, we assume there is a statistical difference between these two groups. This means those returning to the clinic or have seen a dental professional within two years answer more accurately on the number of times to floss than those who have not seen a dentist or visited a clinic in the past two years.

Table 4: t-Test: Two-Sample Assuming Unequal Variances for Responses on Flossing

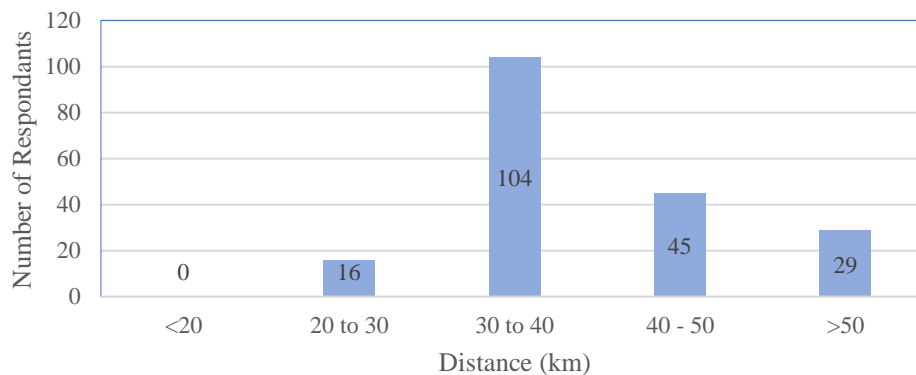
	<i>New Pt. and >2 years</i>	<i>Returning Pt. and <2 years</i>
Mean	0.80625	0.983333333
Variance	0.157193396	0.016666667
Observations	160	60
Hypothesized Mean Difference	0	
df	215	
t Stat	-4.98828962	
P(T<=t) two-tail	1.25487E-06	
t Critical two-tail	1.971059122	

Question 5, 6, 7, 8, 10, 11, and 12 focuses on the respondent’s access to dental professionals and oral care products. 24% of the respondents reported visiting a dentist once in the last two years (N=53), while 3% (N=7) reported visiting a dentist at least twice in two years. 73% of respondents had not visited a dentist in the last two years (N=160).

For returning patients, the most common reason for coming back to the clinic that was for free oral care products or education (68%, N=11) while pain was the second most common reason for coming back (47%, N=8). The least common reason for returning to the clinic was for a check-up for both returning patients (N=1) and new patients (N=1). Of the new patients, the most common reason for coming to the clinic was pain (78%, N=158), followed by free oral hygiene products and education (21%, N=40).

Every respondent that visited 1 of the 13 clinics reported that finding a dentist was hard (N=220). The values for the distance from a dental professional are typically varied, and in certain clinics dental professionals can be closer or farther. Based on the typical distances seen within the TWD report, respondents were placed into 5 groups: Less than 20km, 20 to 30km, 30 to 40 km, 40-50 km, >50km. The average distance a respondent would need to travel to have access to a dentist was reported to be 39.5 km (N=146). Some participants were unaware of how far they would need to travel due to never thinking they could afford going to a dentist (N=74). *Figure 2* describes the distribution across the respondents.

Figure 2: Distance Rural Hondurans Have to Travel to See a Dental Professional



As dental professionals are seemingly far from most respondents, an analysis of the distance from which they get their dental and oral health supplies was asked. Of the 189 responses, the average distance was 8.13km, with 92% of participants stating that they get their dental supplies from their local community center or through donations. The other 8% described that they receive oral health supplies from stores, on transportation systems like buses, hospitals, and dentists or do not purchase/use them.

Discussion

The recommended number of times to brush teeth is twice per day, as reported by the American Dental Association (ADA) (Worthington et al. 2019). The ADA also recommends that people floss interproximal surfaces once per day to remove any debris not cleared by brushing. A Kelton Global survey study in 2020, which analyzed these similar parameters, found that the United States average ranges between 65% to 70% of people who regularly brush their teeth twice a day (“The State of America’s Oral Health Report” 2022). When comparing the global average, around 67% of people brush their teeth at least two times a day (“Global Healthy Thinking Report: 2021 Oral Health Awareness Survey” 2021). However, as reported from the questionnaire, rural Honduras is well below these self-reported values. Only 5% reported brushing their teeth at least twice a day, which explains why rampant carries are detected across this population and are much more common among individuals.

Visiting a dental professional, whether for treatment, a check-up, or cleaning, is essential for detecting how well someone is doing on their brushing and flossing. It is beneficial to detect abnormalities like cavities or oral health diseases, but it also helps educate patients on proper at-home oral hygiene. With only 27% of the sample size reporting that they had visited a dental professional at least once, within the past two years, there is cause for concern about how often this population sees someone who can detect oral health issues. The public health concern of rural Honduras is that individuals are just not receiving essential updates on their oral hygiene. This leads patients down a slippery slope, where they lose their dentition over time to the point of no return. Problems with chewing, speaking, and body image could potentially plague this community regarding their teeth.

73% of the sample size have been unable to see a dentist within the past two years, indicating that limited access is a potential problem. The available mobile pop-up clinics are limited and act as a bandage to the problem, with most participants reporting pain as the primary reason for visiting. Many patients can go into the mobile clinics for oral health products like toothbrushes and toothpaste, yet only those who have previously had work done at the clinic select that as the primary reason to visit the dentist.

New patients almost strictly reported problems with pain. Patients' education is inadequate, with short-term treatment plans due to the inability to see a local dentist for follow-up visits. Dental prosthetics like dentures are widely unavailable at these pop-up clinics, with the older population unable to chew solid foods like vegetables and fruits. These essential nutrients limit the quality of life, and patients cannot relate the infectious disease of dental cavities to other health problems. More complex treatments, like crowns, bridges, and root canals, require more materials and future visits than the pop-up clinics can provide. Most patients cannot have this treatment without a permanent dentist in their area. While the participants reported that the closest dentist is too far from where they live, performing these at mobile clinics would not be feasible as patients cannot finish their treatment after visiting the clinic.

All participants reported that finding a dentist was very difficult. Considering that patients would need to travel an average of 39.5 km, or 25 miles, this is hardly achievable for this population. The environmental terrain limits travel, with dirt roads that the Honduras Department of Transportation has not touched since the early 1950s. The seasonal climate also determines when

someone from this area can travel, with many tropical storms rolling in and halting access to some communities. Hurricane Mitch also destroyed the vitality of particular communities and disrupted some transportation routes that would aid in the passage into or out of poverty-stricken areas.

The economic burden on families to pay for travel and time away from working seems like it should be minuscule. However, the average rural Honduran family makes roughly US\$255 per month (Global Living Wage Coalition 2020). The financial situation does not favor well for many Hondurans who are doing informal or farming jobs with no minimum wage value, where the estimated living wage per month is US\$277 for rural communities. Since the average rural Honduran makes less than what is estimated to be the minimum to get by, paying for dental visits or treatment seems unbearable. When discussing this with people of rural Honduras, the cultural context has become very evident. Many households see dentistry as a luxury. The questionnaire indicates several reasons why finding and maintaining visits to a dentist is hard. The most significant reasons for this sample population were travel access and financial situations resulting in an inability to find a dental professional.

Access to dental products is also vital for proper oral hygiene. The ADA reports that toothpaste should contain fluoride and systemic fluoride in water to aid in cavity prevention. According to most manufacturers, toothbrushes should last around 3-4 months for bristles to reach important areas of the tooth, gums and to eliminate bacterial build-up on the head of the brush itself (“Toothbrush Care, Cleaning and Replacement”, 2006). Therefore, people need to have access to these important hygiene products. However, many patients have to wait for donation centers or travel between 8km and upwards of 30km to find dental supplies. Of the 8% of respondents who reported that they do not get their oral hygiene products from community centers or donations, the most common method was when they traveled into the city. Many rural Hondurans only travel into the city when it is essential, so if an individual runs out of supplies, they may have to wait months before getting more dental items. The questionnaire did not expand on how often they buy these items; however, future research should be done to assess how the population receives dental hygiene products.

Limitations to the Questionnaire

An apparent limitation was the inability of some participants to read the questionnaire. However, a translator was provided to read verbatim. The translator's influence must be taken into account. However, there was no prompt after or before. In these situations, the translator would read, the respondent would answer, and the recorder would confer with the translator about what the respondent had said and record the value. Having two individuals to help translate and record limited the bias of the questionnaire. 38 respondents who could not read the questionnaire had accepted a translator and recorder for assistance. The questionnaire was offered before treatment or education to assess their current understanding before attending the clinic that day. However, many of those visiting the clinic were in pain due to concurrent infection, which could bias their results. We informed all participants that this questionnaire was entirely optional.

Regarding education, patients who had visited the clinic previously or a dental professional were aware of how often they should brush and floss. Most of those who had not visited the clinic was unaware of how often to brush and floss. However, the questionnaire did not indicate the technique and a quality measure of those returning. This is a significant factor when discussing oral hygiene education, as one could know the quantity, but without the proper technique, it could be inadequate.

Question 10 described the distances from which the sample traveled to see a dental professional. As a statistical measure, this was difficult to categorize into groups; however, the range of data was high. The lowest value recorded was 20km, and the highest was 90km. Some participants also recorded their value as “*here*,” which was the mobile pop-up clinic. The question intended to see how far one would have to travel to see a dentist who was permanently there rather than at a pop-up clinic. This question then must have confused some of the sample, which had fewer participants due to this error.

Community Periodontal Index (CPI) in Rural Honduras Communities

The Community Periodontal Index (CPI) utilizes three key indicators when discussing community oral health (Suresh and Muthukumar 2009). A designed CPI-probe, or WHO-probe, measures periodontal pockets, bleeding, and calculus. For adults aged 20 or over, the mouth is divided into six sections called sextants. These sextants are scored and examined to measure a tooth and the surrounding gum down to the sulcus. As it approaches the root's surface, the probe measurement is recorded. Individuals are then put into six groups based on criteria and treatment needs, as seen in Table 5 (Cutress, Ainamo, and Sardo-Infirri 1987).

Table 5: Criteria for the CPITN Codes and Corresponding Treatment Needs of Individuals

Codes	Criteria	Treatment Needs
0	No signs of disease (Healthy periodontal tissue)	No need for periodontal treatment
1	Gingival Bleeding	Improvement on personal oral hygiene
2	Presence of supra or subgingival calculus	Need for scaling, need for improved personal hygiene
3	Pathological pocket of 4-5mm	Need for BOTH scaling and root planning, need for improved personal hygiene
4	Pathological pocket of 6mm or more	Complex treatment i.e. deep scaling, root planning and surgical procedures
x	Only one or no teeth are present within a sextant	Cause of concern on occlusion

The codes can illustrate both an individual's treatment needs and a particular community's treatment needs. The most critical codes for severe periodontal health are 3, 4, and X. A community that averages within the higher values demonstrates a greater need for dental intervention, education, and clinicians. For health services planning, the data can offer an essential foundation for approximating overall population requirements regarding treatment types and clinicians' needs for treating periodontal diseases. When CPI is used to assess the

treatment needs for financial and clinical intuitions, the indices are the Community Index of Periodontal Treatment Needs (CPITN). The Pan American Health Organization (PAHO) plays a crucial role in providing health data, like CPITN, and additional critical metrics in Honduras and other Latin American areas.

Critical indicators of periodontal health that are not measured when using CPI include gingival recession, tooth mobility, and intensity of inflammation. Individuals are assigned to one of four treatment need categories determined from their CPI scores. One metric that supplements the CPITN is the Decayed, Missing due to caries, and Filled Teeth (DMFT). The DMFT score indicates the development of dental caries and further reflects the deterioration of oral hygiene through the population aged 12 and under. A value can be given based on summing how many teeth are decayed, restored, and missing, demonstrating the importance of treatment being carried out. For example, if an individual has one tooth that is decayed and needs treatment, two teeth are planned to be restored, and three teeth are missing, then the individual DMFT score is 6. By averaging out the population's mean score of the youth's dental health, public health institutions may utilize this information to understand trends and future practices to lower the population's overall score. Together with the DMFT scores and CPI codes, a comparison of treatment needs of the Honduras population with other populations can be made.

The latest study provided by PAHO on DMFT and its possible determinants of oral health was released in 2009. The study analyzed 4,000 patients over 7 years and found a range of DMFT scores between 1.0 to 8.5 (Nishi et al. 2002) (PAHO 2010). Findings indicated that every Latin American nation DMFT categorization had a mean above 4. In comparison, the mean DMFT score for the United States is 1.2 (“Oral Health Surveillance Report: Trends in Dental Caries and Sealants, Tooth Retention, and Edentulism, United States” 2019). Honduras was on the higher end of the DMFT, with a score of 8.3 (Dr. A A Adewakun 2010). On average, the population of youth in Honduras has more decayed, restored, and missing teeth than most populations in Latin America and considerably more than that of the United States. This demonstrates a higher need for dental intervention via education and clinicians. This supports the claims of the questionnaire analysis.

When examining the Honduras CPITN, there is an indication that current treatments do not suffice for the general oral healthcare of the population. The frequency of periodontal disease has remained largely unchanged, with a frequency CPITN of 71% of one rural community having a periodontal disease frequency in 2015 and 69% of the same rural population having a periodontal disease frequency in 2018 (Oppermann et al. 2015; GALO, Ericka Elizabeth Valle et al. 2018). Both studies indicate that rural Honduras communities show a high prevalence of caries, according to WHO criteria, due to several factors. The high prevalence of caries was due to the lack of dental care available, deficiency of nutrients in their general diet, reduced hygiene leading to microbial plaque buildup, and therefore premature dental loss and functional adaptations. This corresponds to the DMFT score and the questionnaire analysis. An important distinction between these studies is the use of CPO-D indices in the GALO study in 2018 to measure the timeline of dental health. The 2018 study utilized a more comprehensive set of parameters to include CPO-D, which aids in the ability to make essential distinctions on how dental loss occurs based on long term data (Master in public health, Autonomous University of

the State of Hidalgo, Professor undergraduate oral public health and epidemiology, University Center Metropolitan Hidalgo. et al. 2018).

Unfortunately, this is the extent of critical measures when studying the epidemiological approach to oral health within Honduras. Further research must contribute to the discussion on the importance of dental needs, as this population needs more dental access and is limited in its dental hygiene education. This limitation ultimately leaves the rural Honduras populace vulnerable to oral diseases, with current efforts being hard to measure. Analysis of periodontal conditions, restorative and missing teeth is critical in adjusting the educational efforts of philanthropic groups and NGOs in these unsupported rural areas. Within this framework, adjustments to research must ultimately include a standard. The population is measured in any indices that can describe trends. This significance is critical in the future discussion of policy implementation, discussed in the following sections. These indices could provide an ideal measurement globally to understand the treatment needs that rural Hondurans require.

Patient-Centered Orientation and Health Literacy

Recently, public health initiatives have shifted focus to patient-centered care (Nelson-Brantley et al., 2020). Patient-centered care involves the partnership between individuals and their healthcare providers to help guide clinical decisions. In other words, listening to, easing anxiety, providing emotional support, respecting values, educating individuals, and empowering patients to take an active role in the care plan is critical to offering the best possible care for a patient. Relaying important messages to patients helps patient-provider relationships encourage periodic treatment (Paasche-Orlow et al., 2006).

Communication and verbiage are incredibly influential, mainly when dealing with health education. As seen in the questionnaire and indices, many rural Hondurans have limited health and dental professional access. Hence, the difficulty is anticipated in delivering adequate information about the overall health needs of the general public. While health illiteracy is a universal issue that burdens many populations and needs the attention of health care professionals, patients often obtain treatment without preventive and ample health information. Like those in Honduras that attended the dental clinics, rural regions experience this phenomenon on an elevated scale (Sookhoo 2014). Not receiving enough details on treatment or knowledge of their health conditions can result in a deficiency of preventative health for low literacy populations (Tsakos et al., 2010).

Access to health information is a primary liability when discussing preventative dentistry in rural Honduras. As a result, proposals on reworking the educational pamphlets, posters, and oral hygiene products distributed across the clinics and local hospitals were implemented. With health illiteracy having significant distinctions across urban and rural populations, redesign of this information based on patient demographics is essential for providing the best delivery. Financial sectors also see health illiteracy as a burden; however, there is no documentation on Honduras' health illiteracy. Based on the 2003 National Assessment of Adult Literacy (NAAL) data combined with 2003 expenditure data, records demonstrate that low health literacy costs the United States health care system somewhere between 106 billion and 238 billion dollars (National Assessment of Adult Literacy 2003). Extrapolating the rural communities of the United States with a higher prevalence of health illiteracy in Honduras, it is safe to assume that

empowering individuals to prevent infectious diseases and treatment is an essential factor when dealing with financial institutions and healthcare.

Health literacy policy implementation is crucial in improving the expenditure of the Honduran government on oral healthcare. One possibility of improving health literacy is working with children in schools to become advocates for individual and community oral health (St Leger, 2001). There are three challenges that most school systems face when aiding in developing health literate students: the traditional structure and function of school in Honduras, teacher's practices and skills, and the time and resources (Gavin, Megan R. 2018).

The traditional structure of schools in rural Honduras communities revolves around 'core knowledge' models. Core knowledge models revolve around guidelines describing fundamental competencies and specific knowledge that provide coherent foundations. This core knowledge is very similar to health literacy that stems from the United States (Tecce Decarlo, Mary Jean 1997). This traditional health education system is described as objective-based teachings from a textbook, with key benefits including discussing the paramount foundations of health. However, the curriculum interferes with topics of joint health and prevention. This assumes that different health issues are discussed at home; an example is describing proper oral hygiene, which assumes that it does not need to be taught within the school systems. Preventative dentistry is rarely if at all, discussed and has not been embedded in curriculums within Honduras.

The core knowledge model stems from an 'ends-means' model, where curriculum implementation results from a national or global health crisis. The ends-means model does not assume that education is more than the accumulation of facts (John Dewey, 1953; Ronald & Roskelly, 2001). A critical emphasis that educated individuals must exhibit is active learning and curating the knowledge to seek information. With limitations embedded due to objectives, incorporating other models can improve some flaws. Learning through participatory models allows children to use language to identify and build their knowledge and experiences in the world (Wallerstein, 1987). Health education is personal and relevant to every child in a classroom. Hence the experience that a present learner brings in is imperative to allowing new concepts.

A critical measurement to health awareness of a population is the health-related knowledge and understanding (HKU). In order to target and hopefully improve the HKU of young Hondurans, there is strong evidence that supports a student-centered teaching learning process. Evidence suggest that students adhere more to participatory programs, with direction from a teacher conversant in student-driven discussion and literature, rather than from a traditional top-down model of health education ("Research to Improve Implementation and Effectiveness of School Health Programmes" 1996; Bisset and Potvin 2006). The participatory model includes the partnership of teachers, school administration and students input that ultimately forms the scientific research team to for planning, implementation, and evaluating the measures to improve overall HKU. The interaction and collaboration methods can improve comprehension and proficiencies regarding evidence-based and practicable measures in the classroom (Hawe et al. 1997). Participatory education of health starts with curriculum guidelines to target fundamental concepts through progression of student objectives (Rutten and Gelius 2014). By making grouped health issues, differing literature can be presented, discussed, read and curated from

students with the instructor acting as a facilitator (Goodyear and Dudley 2015). Over the course of the curriculum, fundamental concepts can be discussed in a more engaging method than traditional top-down approaches. This method of education offers insight into the vast knowledge bank that many students are capable of displaying while keeping the topics relevant to lifestyle and cultural differences.

The structuring of school-based curricula across all grades that Honduras allows can contribute an effort to bettering the overall oral health of the population. Rural areas are affected severely, where the basis of oral check-ups must be advocated. By reading, writing, and talking about a particular issue, a profound change in confidence about literacy and access can contribute to a more educated populace's importance of oral health in these poverty-stricken communities (Auerbach, 1992). Participatory education is a method where students are allowed to determine their curriculum to incorporate their learning goals into their activities while promoting involvement in democratic decision-making. The purpose of participatory education is to help groups learn to use reflections on their everyday experiences to analyze the social-political context in which they live and develop a sense that they can work effectively to change that context (Castelloe and Watson 1999). Health education through this model can increase overall health literacy and tackle the problem of oral health education. A change in an educational approach increases health literacy, encompassing the current ideal of patient-centered care.

The cultural notation that rural Honduras has displayed demonstrates that participatory education within school systems can increase health literacy rates and a comprehensive restructuring of health in school systems. While there are no direct studies correlating participatory models within rural Honduras with health literacy, there is a clear indication that health literacy and knowledge of proper at-home oral hygiene must be taught. In addition, this method must be taught early and not just through philanthropic efforts and NGOs. By embedding this in standard education, the prevalence of dental caries could potentially decrease. The number of periodic check-up visits to a general dentist can increase, and a lower DMFT score may be seen.

Obstacles of Dental Access

Limitations that arise from access to care are detrimental to communities, typically negated by social, cultural, geographical, and economic factors. These four disparities contribute the most when considering why rural Hondurans are not receiving the care they need (Sudore et al., 2006; Derose, Gresenz, and Ringel, 2011). The crossroads between access to healthcare and limited health literacy describes why individuals are not seen periodically. Many countries, including Honduras, rely heavily on unmaintainable philanthropy and NGOs for a subset of healthcare needs. The absence of foundational capacity and technologies that many industrialized countries benefit from are not transient across LMICs.

The significant social detriment of healthcare is interconnected with cultural, geographical, and economic factors. In Honduras, rural farmers are often located hours away from a primary care doctor, a specialist, and other treatment services needed to support more complex diseases or continual follow-up visits. Network care and telehealth have become more common in industrialized societies due to the COVID epidemic (Suran, 2022). However, like no to little power areas, the structural framework does not benefit from connecting to a provider or specialist. One solution would be to retrofit power upgrades and wireless connections and improve electronic communication between these rural areas and specialists. Most local hospitals

spread throughout the countryside of Honduras are ill-equipped to deal with special cases and complex procedures. By building a sustainable foundation to support digital telehealth or networking outside of a confined region, access to health professionals drastically improves (Al Knawy et al., 2022). As many rural citizens are geographically separated due to social means, like farming and the inability to use much of their allotted financial capita towards dental care, access to a dental professional is even more limited. Local hospitals are much like urgent care settings, and many patients will go to these hospitals for dental problems (Susan Tuz, 2005). As these medical staffs are not specialized in dealing with dental cases, many of these hospitals resort to practices that are not beneficial for patients to follow proper oral hygiene and periodic check-ups. The cultural outlook on dental services is for pain, not for the luxury of cleanings or scheduled examinations. Over time, the development of how individuals view dental problems creates a stigma around evaluations of their dental health. By not following preventative practices and only seeking treatment when there is something wrong, rural Hondurans develop more dental problems in the long run (Mueller, 1993).

The challenge remains essentially the same in providing access virtually and in person: how can healthcare combine both investment and innovation to conform to a business model of policy changes. Many innovations have failed to live up to the heightened expectations of creating a healthy populace (Xie & Or, 2017). Consumer-focused improvements in healthcare delivery typically set the goals of being more effective, convenient, and less costly. These goals help provide individuals with greater control over personal healthcare expenditure. At the same time, a service provider can deliver a cheaper cost and accommodate its members by being more user-friendly. Technological improvements are also an innovative field that businesses part-take in that affects consumers. New pharmaceuticals, diagnostic techniques, and medical devices can provide better treatment and care that is less expensive, troublesome, and agonizing for severe health conditions.

Overall, the business model of healthcare is fragmented. Almost all healthcare facilities in Honduras are independent, where pharmaceutical, biotechnology, and medical device companies are made of hundreds of small firms. These industries are considered horizontally and vertically integrated (Heeringa et al., 2020). Horizontal integration refers to the increase of their supply with the increase in consumer needs of the supply chain to generate wealth. Vertical integration results from the fragmented industry; however, it focuses on specific conditions within one roof and results in healthier individuals. Rural Honduras is remarkable in that it offers very little vertical integration within its economy. Minor vertical integration means that patients are more burdened by coordinating their care with different providers and specialists (Carmenate Milian et al., 2017). Rural Honduras typically sees healthcare under local outreach centers that are general practices and offers very few specialties. Not incorporating more focused specialties has increased costs by not improving patients' health.

Furthermore, vertical integration reduces the likelihood that an individual's care will fall between the cracks of different medical disciplines. As outlined by these innovations, barriers to healthcare affect rural Honduras. These innovations may increase efficacy by managing five forces that impact healthcare by managing specific forces.

Managing the Forces Impacting Healthcare Access for Rural Honduras

Government programs can provide both aid in the access to healthcare and hinder it. Forces that impact access to healthcare, extending to dental health, include public policy, technology, patient and consumers, funding, and accountability. For example, Honduras government regulation of Poverty Reduction Strategy (PRS) was introduced in 2001. The implementation of this strategy has implied increased participation by the population and allocation of resources obtained by foreign debt settlement to the poorest municipalities (“Honduras: Poverty Reduction Strategy Paper Progress Report” 2005). Since implementation, the country has provided investment mainly into human capital, increasing overall wages and attributing nearly 30% of human capital to health sectors. This benefits Hondurans by providing more work and incorporating citizens into healthcare systems. However, the Honduran government has also implemented policy changes through the National Human Resources for Health Board (CONARHUS). CONARHUS is a political and technical agency at the national level in the health sector responsible for coordinating policies, plans, programs, and projects to manage human resources development in the industry. However, the latest delegation was in 2015 and resulted in the suspension of several new specialty hospitals that focuses on cardiopulmonary and oral health procedures (Eduardo Benjamin Puertas 2015). This inability of a government delegation to fund regulations results in public policy issues detrimental to healthcare. Inventors and policy writers need to recognize the extensive network of regulations that supports a particular improvement. Voters and public servants typically punish delegates more for underregulating than for tightening the approval process, even if doing so postpone a promising innovation (Daniel B. Rodriguez 1994).

Rural Honduras suffers due to infrastructural challenges (Jones et al., 2013). This challenge is particularly concerning for managing the forces of limited access to healthcare. Considering the business model of healthcare and as medical technology advances, considering when to implement or adopt an innovation is critically important. If an investor or innovator implements technology too early, the infrastructure needed to support the invention may not yet exist. The implementation of improper infrastructure was demonstrated when Honduras implemented a centralizing health service delivery due to the 2009 coup that arose due to mismanagement of governmental financial institutions (Zarychta, 2020). The idea of consolidating healthcare within the current governmental organization of Honduras did not support the vastness and infrastructural capabilities of the rural populations. However, if companies and components of an innovation wait too long to implement, then competitive advantages in markets may have passed. This is in all healthcare markets through the concurrent business model of healthcare administration.

Consumers in healthcare are also patients. Therefore, the empowered individual in patient-centered orientation is a vital force in innovation. Internal interest groups and associations are common in the United States but less common in Honduras. For example, there are more philanthropy and NGOs in Honduras, but fewer internal organizations like the American Cancer Society exist (Zarychta, 2020). As this is an essential financial sector for improving innovations regarding patient health, Honduras displays less overall economic force for innovative technological improvements. Consumers spend tremendous amounts of money on health care services across the globe (“Global Spending on Health: Weathering the Storm” 2018). By improving patient-centered care, arming individuals with knowledge of health systems and

treatments can significantly enhance the adoption of innovations (Canhão, H., Zejnilovic, L., and Oliveira, P. 2017).

Accountability results from consumers and delegates who want long-term safety and cost-effective strategies for tackling problems. Responsibility largely accounts for regulatory agencies put into effect. The Ministry of Health governs the sector and provides the regulatory agencies and the Sanitary Regulation Agency (ARSA). ARSA functions similarly to the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) in the United States. This accreditation for hospitals and healthcare providers enables citizens to feel more comfortable visiting clinics accredited under the law. However, Honduras institutions that the ARSA and supplemental agencies accredit still have fundamental liability flaws (Carmenate Milian et al., 2017). ARSA-approved sites were found to have almost zero correlation between mortality rates in hospitals that have been approved and those that have not been approved. Liability insurances typically focus on if a treatment process was in accordance rather than improvements on current systems inpatient health (Smith and Institute of Medicine (U.S.) 2013). With strict requirements from agencies, innovators must still recognize the importance of accountability.

The health sector's multifaceted system of reimbursements is complex due to government and private insurers' part in the funding. For example, a government agency and the insurer must approve a novel product or new service, and most critically, the pricing, before any investments occur. The perception of an invention's cost further regulates how much reimbursement is issued, which may differ from a patient's opinion. Furthermore, the collective body of different insurers may disagree upon specific pricing. As central healthcare systems have been determined to undermine the infrastructure of rural Honduras, there is a notable complication with decentralization. Citizens do not see more value in innovation with a long-term cost impact, for example, an obesity reduction treatment, due to a higher turnover rate of consumers paying private insurers (Davis, 2004). In addition, doctors are also factored into the health sector's funding system as they are in a position to endorse different products to patients. Honduras doctors are typically paid a flat salary from the organization or network. However, they receive monetary payments if performing a procedure in which they utilize an innovation from the service offering the product (Chayes, 2017).

Legislation Changes

These barriers that impact healthcare describe an insightful overview of how approaches could be made to change policy. Healthcare autonomy does not lie in a business model nor centralized power, as indicated in the previous discussion on agencies and insurers impacting Honduras access to healthcare. However, utilizing all forces demonstrates a few crucial needs that policymakers may benefit from managing.

Apart from educational curricula requirements, infrastructural and human capital must also be contributed to the discussion on the nation's healthcare policy. An example of rural engagement follows similar protocols from the European rural referral programs. The rural referral hospital designation was implemented after determining that governmental-run local hospitals lacked an inpatient rate-setting policy that did not sufficiently account for extended patient populations and heightened infrastructure budgets due to spatial reasoning. These rural hospitals received a lower standard payment rate than urban hospitals; the patient classification system used to determine

payment did not adequately account for differences in severity. The hospital wage index reflected relative wage levels with no occupational mix adjustment. Honduras is another example of government accounting for local rural hospitals and clinical care settings that do not fund the severity of the patient populace. By enacting a different prospective payment system to adjust for similar payment rates to hospitals identified in these rural areas, there is reason to believe that an improved ability to account for differences in patient severity to serve rural citizens. The 436 rural health centers and 1,078 Health Centers with Physician and Dentistry (CESAR) would also benefit from less rigorous geographic reclassification criteria. Reclassification would result in higher share payments than small urban and 16 area hospitals that do not receive as many severe cases (Richard Haggerty, 2004) (Carmenate Milian et al., 2017). The adjustment would adequately relieve the funding stress described in the funding forces discussion.

Given the few dental clinics and schools that offer dental services in Honduras, the foundational structure of remote areas that dentists must work in is far from practical. By designating infrastructural funding to support geographically isolated individuals, there would be a higher chance of success for practices to open and offer clinical assistance to the respective groups. Through missionary trips, philanthropic groups, and NGOs, Honduras also denotes rural healthcare as practical means of access. However, the limited reimbursement of national citizens remains primarily undermined. Incentive Payment Programs for dentists have shown efficient matriculation into low dental areas.

An example is the Health Professional Shortage Areas (HPSA) in the United States, which has offered physicians, dentists, and other healthcare workers bonuses for working in these shortage locations since 1987 (HRSA, 2012a). Under section 1833m of the Social Security Act, financial institutions can award these bonuses to individuals; however, in Honduras, higher taxation could potentially impede the ability of citizens to reach out about their health to save their accumulated wealth. This would need further indication on funding reallocation and potential aids in practitioner choice based on maldistribution of physicians. However, establishing a similar loan forgiveness program could offer higher access once improved infrastructural changes occur. Changing perspectives on accountability of rural regions is incredibly important for cultural responses to healthcare literacy. By adjusting for patient outcomes over the procedure process, better outcomes result in more patients understanding the complexity of their treatment plans. This can encourage rural citizens to deem the importance of their health and improve the population's perception of funding and taxation of a system that ultimately needs improvements. Accountability force marks an important acquisition into funding policy and governmental policy changes.

Concluding Remarks

Questionnaire analysis has aided in discussing rural Hondurans' outlooks and educational levels regarding oral health care and at-home hygiene. As an important marker for a community's health, further research must be allocated to understand the population's actual values of the CPITN and DMFT indices. Furthermore, continuous research and updates can adjust for communal health and follow growing trends in oral health education. Within our school systems, curricula embedded as part of the teaching for grade schools must stress the importance of patient-centered care. This compassion for empowering the youth of rural Honduras can improve the longevity of severe health conditions and oral health discrepancies seen in the questionnaire and indices values. NGOs and missionary work are beneficial; however, periodic improvement must take time and practice within the school systems of Honduras. Health care policy remains largely up for debate on the future of Honduras. By improving the overall access for these rural populations in shortage areas, increased patient care, health literacy, and funding can be demanded from the populace. The dental health policies are intertwined within the primary healthcare system, and further decentralization is essential. That said, policy implementation can be just as effective, seen in the discussion on legislative changes.

Appendix A – Questionnaire

English

Please fill out the questionnaire to your knowledge. This will be used to help dental care education in the future. If you have any questions, please talk to Alexander Dyke (Dental Assistant).

1. How often do you brush your teeth each day? _____
 - a. If not every day, how often do you brush your teeth each week? _____
2. How often do you floss your teeth each day? _____
 - a. If not every day, how often do you floss your teeth each week? _____
3. Has someone informed you on the recommended times you brush your teeth per day? _____
 - a. If so how many times is encouraged for you to brush your teeth? _____
4. What is the recommended times to floss your teeth each day? _____
5. How many times have you visited a dentist in the last 2 years excluding today? _____
6. Have you been to our clinic previously? _____
7. Would you say finding a dentist when you have a problem is easy or hard? _____
8. Why did you visit our clinic today? _____
9. On average, how many meals do you eat in one day? _____
10. Where is the closest dentist from where you live? This does not include this clinic. _____
11. Where do you get your materials for medicine, health products or oral healthcare products?
12. How far do you have to travel to the location where you receive these materials?

Spanish

Por favor complete el cuestionario a su conocimiento. Esto se utilizará para ayudar a la educación sobre el cuidado dental para el futuro. Si tiene alguna pregunta, hable con Alexander Dyke (asistente dental).

1. ¿Con qué frecuencia se cepilla los dientes todos los días? _____
 - a. Si no todos los días, ¿con qué frecuencia se cepilla los dientes cada semana? _____
2. ¿Con qué frecuencia usa hilo dental todos los días? _____
 - a. Si no todos los días, ¿con qué frecuencia usa hilo dental cada semana? _____
3. ¿Alguien le ha informado sobre los tiempos recomendados para cepillarse los dientes al día? _____
 - a. Si es así, ¿cuántas veces se recomienda que se cepille los dientes? _____
4. ¿Cuál es el horario recomendado para usar hilo dental todos los días? _____
5. ¿Cuántas veces ha visitado a un dentista en los últimos 2 años excluyendo hoy? _____
6. ¿Ha estado anteriormente en nuestra clínica? _____
7. ¿Diría que encontrar un dentista cuando tiene un problema es fácil o difícil? _____
8. ¿Por qué visitó nuestra clínica hoy? _____
9. En promedio, ¿cuántas comidas hace en un día? _____
10. ¿Dónde está el dentista más cercano de donde vives? _____
11. ¿De dónde obtiene sus materiales para medicamentos, productos sanitarios o productos para el cuidado de la salud bucal?
12. ¿Qué distancia tiene que viajar para ir al lugar donde recibe estos materiales?

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