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PUT YOUR MONEY WHERE YOUR MOUTH IS: REFORMING ORGANIZED
DENTISTRY TO ADDRESS PERSISTENT ORAL HEALTH DISPARITIES IN THE U.S.

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April 26, 2019



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Submitted in partial fulfillment of the requirements for a Bachelors of Arts degree with a major
in Public Policy Analysis/Biology

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Constant conflict roils the health care landscape.

Era 1 is the era of professional dominance.

Era 2 is the era of accountability and market theory.

Let era 3 be the moral era.

Era 1 enthusiasts will find that prescription abrasive.

Era 2 devotees will find it naive.

But the discord is not helping clinicians, communities, or patients.

Without a new moral ethos, there will be no winners.

--Donald Berwick¹

¹ Donald M. Berwick, “Era 3 for Medicine and Health Care,” *JAMA* 315, no. 13 (2016): 1330, <https://doi.org/10.1001/jama.2016.1509>.

CHAPTER ONE: INTRODUCTION

Research Background & Questions

Oral health is an increasingly important, but often overlooked issue of public health and well-being. Indeed, many health professionals cite that “the mouth is a mirror of the body;”² yet it has been misguidedly separated from the rest of the body throughout history. This overt separation has effectively contributed to the insidious healthcare divide, or what Mary Otto describes as the “confounding bifurcation of the teeth and rest of the body” that continues to fuel the oral health crisis in America.³ In 2000, when U.S. Surgeon General David Satcher called oral health diseases a “silent epidemic,”⁴ the dire need to address these issues came to the forefront; however, due to the prolonged, existing framework of commoditized dental care,⁵ oral health needs are largely unmet, allowing poor oral health outcomes to percolate through the fragmented healthcare system.

In response to raised awareness from the Surgeon General’s report on Oral Health, the dental therapist movement came into existence to combat deepening trends in oral health disparities,⁶ which are distinct differences in oral health outcomes that are closely linked to social, economic, and/or environmental disadvantage. Dental therapists are mid-level providers who are trained to provide a designated scope of prevention and early-intervention services, and

² “Oral Health: Insights Into Your Overall Health,” WebMD, accessed October 13, 2018.

<https://www.webmd.com/oral-health/features/oral-overall-health>.

³ “Mouthful of Shame: The Scandalous State of U.S. Dental Care,” Undark, accessed November 6, 2018.

<https://undark.org/article/dental-care-us-teeth-review/>.

⁴ “Oral Health in America: A Report of the Surgeon General (Executive Summary),” National Institute of Dental and Craniofacial Research,” accessed October 14, 2018. <https://www.nidcr.nih.gov/research/data-statistics/surgeon-general>.

⁵ “The Devastating Effects of Dental Inequality in America,” The New Republic, accessed October 15, 2018.

<https://newrepublic.com/article/142368/devastating-effects-dental-inequality-america>.

⁶ David A. Nash and Ron J. Nagel, “A Brief History and Current Status of a Dental Therapy Initiative in the United States,” *Journal of Dental Education* 69, no. 8 (2005): 857.

are specifically designed to work in underserved areas.⁷ Though these providers have gained some attention in the U.S., many state dental boards, dental associations, and others with a vested interest in maintaining the status quo have stymied legislative efforts to authorize the dental therapist profession,⁸ and in turn, perpetuate the damaging infrastructure of dentists ascending the oral health field.

Thesis Roadmap

In this thesis, I will employ a problem-solving approach to examine oral health disparities in the United States by first (1) identifying principal determinants underlying oral health disparities using biological and social science inquiry, and (2) generating an appropriate solution to effectively alleviate these disparities. The following primary research questions will broadly guide topics discussed in subsequent chapters:

1. How do the mouth and body function as an integrated system in biological and social contexts?
2. What role does the medical-dental divide play in access to oral health care and oral health outcomes?
3. What outcomes can be expected from licensing dental therapists in California?

I will discuss these research questions in two-fold. In the problem identification and examination phase, I will begin by discussing the biological implications of oral health diseases, followed by the public policy implications underlying persistent oral health disparities in the U.S. In doing so, I will highlight principal, interrelated determinants fueling the social

⁷ Albert Yee, Kristen McGlaston, and Robert Restuccia, “How Dental Therapists Can Address the Social and Racial Disparities in Access to Care,” *American Journal of Public Health* 107, no.1 (2017): 28–29, <https://doi.org/10.2105/AJPH.2016.303641>.

⁸ Jay W. Friedman and Kavita R. Mathu-Muju, “Dental Therapists: Improving Access to Oral Health Care for Underserved Children,” *American Journal of Public Health* 104, no. 6 (2014): 1005. <https://doi.org/10.2105/AJPH.2014.301895>.

stratification of oral health outcomes. In the solution phase, I will introduce dental therapy as an effective public health intervention that addresses the aforementioned determinants to alleviate oral health disparities and their respective social impact. This will be supplemented with case study analyses and an established preponderance of evidence to support the viability of dental therapists, which in turn, will frame policy recommendations around reforming the dental workforce model in California. Essentially, each phase of this analysis will tackle the broad bandwidth of achieving oral health equity through a multidisciplinary approach.

The entirety of this thesis is meant to be both informative and accessible to the general public in efforts to increase oral health literacy at large. The policy recommendations, however, are more specifically targeted towards relevant policymakers, dental professionals, advocacy groups, community health workers, and stakeholders interested in expanding the dental workforce in California.

Methodology

During my thesis research, I employed a mixed-methods approach to integrate a breadth of quantitative and qualitative findings through primary and secondary research. I utilized the following resources to synthesize information across scientific and social-scientific disciplines in my secondary research:

- Scholarly, peer-reviewed scientific research and review articles obtained from academic search engines & databases (i.e. Google Scholar, Jscholar, Science Direct, Springer Link, Sage Research Methods)
- Grey literature (i.e. health policy issue briefs, official memos, access reports, presentations)

- Social commentary from newspaper articles, magazines, podcasts (i.e. The Wendell Potter Report), and books (i.e. *Teeth: The Story of Beauty, Inequality, and the Struggle*)
- Publicly accessible web sources and databases

In addition to findings retrieved from my secondary research, I conducted primary research comprised of semi-structured interviews and field observations. During the interview phase, I conducted 10 semi-structured phone interviews and one in person interview at varying lengths with oral health topic leaders and advocates, dentists, dental therapists, dental therapy students, as well as people involved in dental therapy legislation in Alaska and Minnesota (Appendix A.). I recruited my interlocutors by directly reaching out to them via email, followed by snowball sampling. These interviews provided qualitative background information, evidence, and attitudes to contextualize the science and public health policy elements of my research, and further supported the process of triangulation underlying my methodologies.

Moreover, I conducted field observations at a local non-profit organization *Uncommon Good* located in Claremont, CA during my public health affairs internship in the fall semester of 2018. As a health education and outreach intern, I was tasked with serving a large clientele of low-income communities, who were primarily Latino, by connecting them to dental services and oral health educational materials. During this internship, I conducted fieldwork to observe the barriers to oral health care among vulnerable populations, and gain both knowledge and context regarding the oral health community in southern California. I attended oral health advisory and coalition meetings in the Inland Empire and downtown Los Angeles, as well as the Oral Health Innovation Forum: Children's Oral health as an Issue of Equity, Social Justice, and Human Rights (an interprofessional dental conference held at UCLA's School of Dentistry), through which I connected with a group of individuals with diverse expertise (i.e. public policy, social

service, public health, dentistry, non-profit, philanthropy). These field observations, connections, and experiences have been integral in furthering my understanding of the oral health needs in California, and equipping me with the intellectual authority to conduct this research.

It is important to note that there are several limitations to my methodologies discussed thus far, mainly due to time constraints. This thesis comprises a diverse range of literatures from multiple disciplines, thus, my analysis largely draws from extrapolations, especially in regard to policy recommendations. My recommendations are suggestions for the general directions that should be considered for implementing dental therapy in California. A more focused examination of adaptability in terms of political (i.e. structural reform, bipartisan support, bureaucratic approval & understanding) and economic factors (i.e. efficiency, effectiveness, value and behavior in delivery, consumption of services, outcomes, financing) is outside the scope of this study, but would be important in developing more precise legislation and implementation strategies. This thesis is largely intended to shed light on the importance of oral health and trends towards achieving oral health equity through public awareness and understanding.

CHAPTER TWO: BIOLOGICAL IMPLICATIONS OF ORAL HEALTH

*“We have a faithful clock in our mouths...the development of our teeth begins long before birth, when we are an embryo, the size of a bean, just a few weeks old. The tooth bud ripens in the fold that becomes our jaws, and the prisms of the enamel are secreted in daily pulses. As we grow, the rhythms of time, the disruptions of traumas and transitions are documented in the striations of the enamel. The teeth contain a mineralized chronicle of growth.”*⁹

Anatomical Overview of the Teeth and Oral Cavity

The oral cavity is known as the gateway to the body not only because it is the predominant point of entry into various other body cavities, but also because it effectively mirrors the conditions of the body as a whole. From a gross anatomy perspective, the oral cavity can be broadly divided into two parts: the oral vestibule and the oral cavity proper. The oral vestibule comprises the mouth area bordered anteriorly and laterally by the lips and cheeks, and posteriorly and medially by the teeth and gums; it is essentially the space external to the teeth and gums.¹⁰ The oral cavity, on the other hand, is situated under the nasal cavities, and includes the lips, hard palate (the bony front portion of the roof of the mouth), soft palate (the muscular back portion of the roof of the mouth), retromolar trigone (the area behind the wisdom teeth), front two-thirds of the tongue, gingiva (gums), buccal mucosa (the inner lining of the lips and cheeks), and floor of the mouth under the tongue (Figure 1).¹¹

⁹ Mary Otto, *Teeth: The Story of Beauty, Inequality, and the Struggle for Oral Health in America* (New York, N.Y.: The New Press, 2016), 66.

¹⁰ “Anatomy of the Tooth,” Kenhub, accessed March 5, 2019.
<https://www.kenhub.com/en/library/anatomy/anatomy-of-the-tooth>.

¹¹ Ibid.

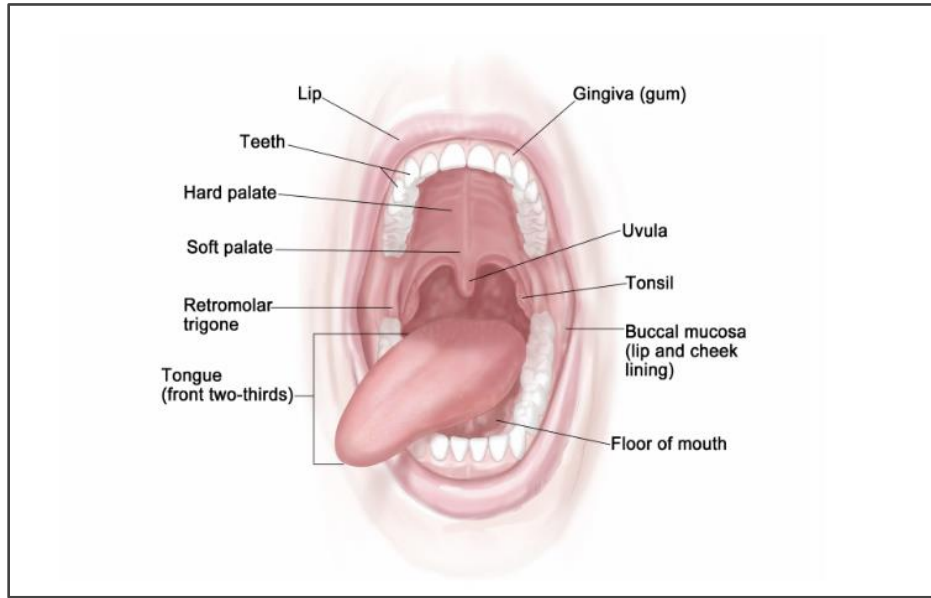


Figure 1. Anatomy of the Oral Cavity

Source: PDQ Screening and Prevention Editorial Board. Oral Cavity, Pharyngeal, and Laryngeal Cancer Prevention (PDQ®): Patient Version. 2018 July 20. In: PDQ Cancer Information Summaries [Internet]. Bethesda (MD): National Cancer Institute (US); 2002-. [Figure, Anatomy of the oral cavity...] Available from: https://www.ncbi.nlm.nih.gov/books/NBK65816/figure/CDR0000593570__131/

Muscular and bony boundaries frame this oval-shaped cavity, which contains specialized structures that work synergistically to produce fundamental functions such as initiating digestive processes, producing and modifying speech, and powering mastication (chewing).¹²

Within this highly vascularized and muscular oral cavity lie the primary and permanent dentition (i.e. baby and adult teeth). Teeth are one of the most individually complex anatomical and histological structures in the body, comprised of multiple layers of organic and inorganic matter, and paired to the maxilla (upper) and mandibular (lower) jaw structures.¹³ Each tooth contains four main parts: the *enamel*, the outer layer of the tooth and the hardest material in the body; the *dentin*, the inner layer and the main part of the tooth made of a substance harder than bone, and the largest dental tissue; the *pulp*, the soft tissue on the inside of the tooth that contains

¹² “Anatomy,” 2019.

¹³ Ibid.

blood vessels, nerves, and the ability to produce dentin; and the *root*, part of the tooth that secures it into the jaw (Figure 2).¹⁴

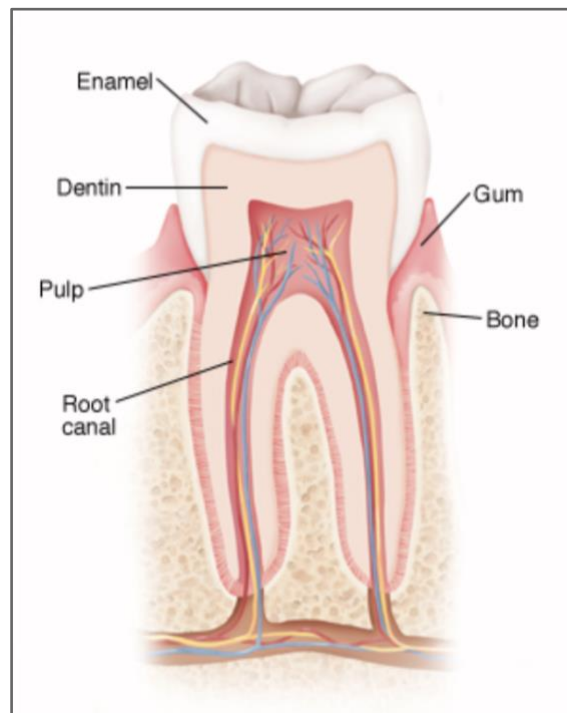


Figure 2. Anatomy of the Tooth

Source: "Default - Stanford Children's Health." Accessed March 4, 2019. <https://www.stanfordchildrens.org/en/topic/default?id=anatomy-and-development-of-the-mouth-and-teeth-90-P01872>.

The enamel, dentin, and cementum are hard tissues, while the pulp underlying this tough exterior is made of soft, non-calcified tissue.¹⁵ The functions and uses of teeth are manifold given their composition and structural morphology. The teeth are divided into four quadrants within the mouth, which lie along the fixed axes of the maxillary and mandibular jaw lines with opposing pairs arranged accordingly.¹⁶ Each quadrant contains a medial incisor, a lateral incisor, a canine,

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Ibid.

two premolars, and two to three molars.¹⁷ The main function of teeth is mastication. The incisors are used for cutting and biting, the canines for gripping, and the premolars and molars for grinding. Aside from these mechanical processes that aid in digestion, teeth are integral for giving structure and support to the face, and for producing specific pronunciation during speech production.¹⁸ Moreover, each of the aforementioned types and parts of the tooth has a specific composition of organic and inorganic matter, mineralized at varying degrees, all of which contribute to an individualized set of primary dentition, which later become the permanent dentition during the course of human development.¹⁹

A significant part of human development involves the growth and morphogenesis of teeth, a process known as *tooth eruption*.²⁰ Although teeth vary in shape, size, position, and location along the jaw lines due to hereditary and environmental factors, there is clinical documentation of the general timelines at which the primary and permanent dentition develop (Figures 3 & 4). According to the American Dental Association (ADA), at birth people usually have 20 primary teeth, which start to erupt at about six months of age and fall out at various times of childhood until about age 21, by which time 32 of the permanent teeth have usually erupted.²¹

¹⁷ Ibid.

¹⁸ Ibid.

¹⁹ “Tooth Development,” Dental Health Foundation, last modified June 25, 2010, <https://www.dentalhealth.ie/dentalhealth/teeth/development/>.

²⁰ Ibid.

²¹ “Baby Teeth Eruption Charts - American Dental Association,” accessed March 4, 2019, <https://www.mouthhealthy.org/en/az-topics/e/eruption-charts>.

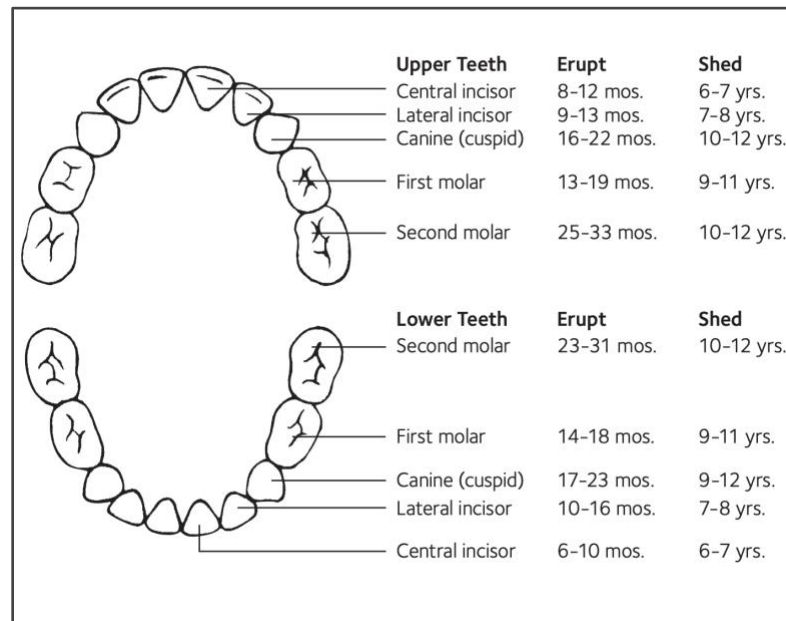


Figure 3. Baby Teeth Eruption Chart

Source: "Baby Teeth Eruption Charts - American Dental Association." Accessed March 4, 2019. <https://www.mouthhealthy.org/en/az-topics/e/eruption-charts>.

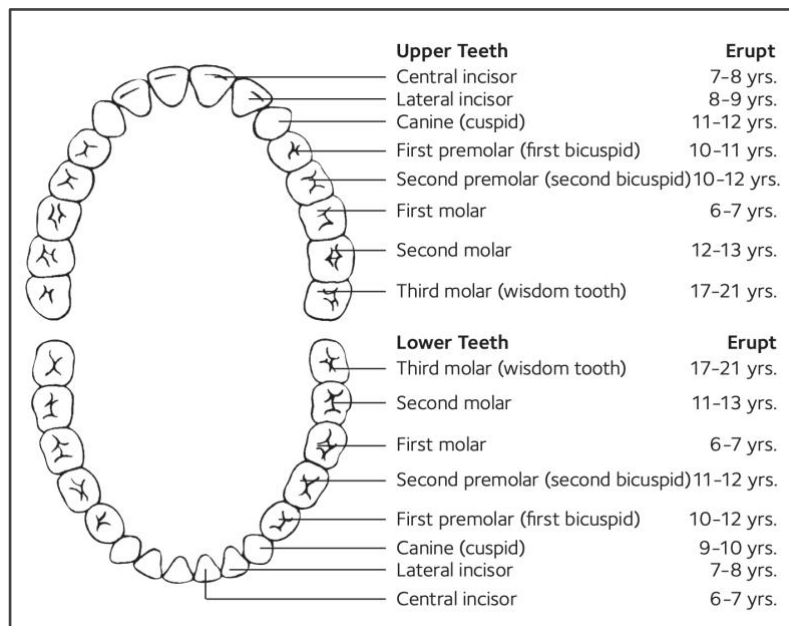


Figure 4. Permanent Teeth Eruption Chart

Source: "Baby Teeth Eruption Charts - American Dental Association." Accessed March 4, 2019. <https://www.mouthhealthy.org/en/az-topics/e/eruption-charts>.

During this developmental process, primary teeth play an integral role in helping children with basic tasks such as chewing things and pronouncing words. More notably, these primary teeth aid in fundamentally shaping the successive development of permanent teeth. It is a common misconception that caring for primary teeth is not important because they will eventually fall out and be replaced; however, healthy primary teeth are actually the underlying placeholders of permanent teeth that guide them into their appropriate positions (Figure 5).²² The neglect of primary teeth can result in numerous issues, including dental caries (tooth decay), the most chronic dental disease affecting children throughout the U.S.²³ Numerous longitudinal studies state that children who experienced tooth decay in their primary teeth are more susceptible to having tooth decay in their permanent teeth than children who maintained healthy primary teeth.^{24,25} Indeed, it is crucial to maintain good oral health from an early age because tooth decay in young children can quickly lead to pain and infection that must be treated quickly in order to guide the permanent successors, avoid crowding and misalignment of the incoming dentition,²⁶ and prevent the spread of infection to other parts of the body, which can be fatal.²⁷

²² “Primary Teeth,” Dental Health Foundation, last modified August 22, 2002, <https://www.dentalhealth.ie/dentalhealth/teeth/primaryteeth/>.

²³ Regina M. Benjamin, “Oral Health: The Silent Epidemic,” *Public Health Reports* 125, no. 2 (2010): 158.

²⁴ Y Li et al. “Predicting Caries in Permanent Teeth from Caries in Primary Teeth: An Eight-Year Cohort Study,” *Journal of Dental Research* 81, no. 8 (2002): 561–66, <https://doi.org/10.1177/154405910208100812>.

²⁵ C. T. Dülgergil et al., “Do the More Caries in Early Primary Dentition Indicate the More Caries in Permanent Dentition? Results of a 5-Years Follow-up Study in Rural-District,” *Journal of International Society of Preventive and Community Dentistry* 2, no. 2 (2012): 48, <https://doi.org/10.4103/2231-0762.109364>.

²⁶ “Primary Teeth,” Dental Health Foundation.

²⁷ EK Amponsah and P Donkor, “Life-Threatening Oro-Facial Infections,” *Ghana Medical Journal* 41, no. 1 (2007): 33–36.

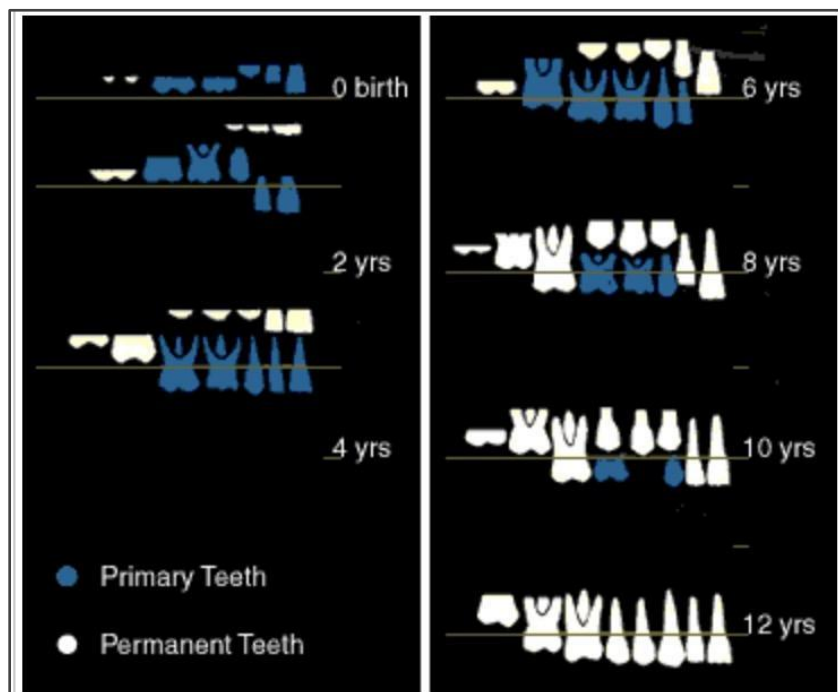


Figure 5. Tooth Eruption Chart of Primary and Permanent Teeth Over Time

Source: Dental Health Foundation, "Primary Teeth," Dental Health Foundation, August 22, 2002, <https://www.dentalhealth.ie/dentalhealth/teeth/primaryteeth/>.

Introduction to the Oral Microbiome

The complex, anatomical features of the oral cavity comprised of various glands, nerves, vessels, bony structures, and teeth provide the necessary structural and physiological conditions to create a conducive site for housing various microorganisms. This type of microenvironment determined by factors such as genes, diet, and environment, specific to each individual, contains a personalized amalgam of different bacterial, viral, and fungal species known as the *oral microbiome*, a term coined by Nobel prize laureate Joshua Lederberg to signify "the ecological community of commensal, symbiotic, and pathogenic microorganisms that literally share our body space and have been all but ignored as determinants of health and disease."²⁸ Indeed, this

²⁸ "'Ome Sweet 'Omics-- A Genealogical Treasury of Words," The Scientist Magazine, accessed April 11, 2019, <https://www.the-scientist.com/commentary/ome-sweet-omics---a-genealogical-treasury-of-words-54889>.

extremely complex, species-rich, heterogenous ecological system, compared to other sites of the human microbiota, is unique in that it is readily accessible, and often the first point of entry for pathogens that are channeled into the respiratory and digestive tracts, making it a valuable locus for investigating its role in oral and systemic diseases.

Since its conception in 2008, the Human Microbiome Project (HMP) has pioneered the investigation of various sites of the human microbiota, including the oral cavity, nasal cavity, skin, gastrointestinal tract, and urogenital tract. Advancement in studies of oral microbial communities has been revolutionized by metagenomic and metatranscriptomic approaches, moving from culture techniques, gel-based technologies, and DNA microarrays to 16S rRNA gene sequencing and next-generation sequencing (NGS) platforms.²⁹ The use of microbial *metagenomic* and *metatranscriptomic sequencing analyses* of these sites has allowed researchers to determine what species (genetic composition) inhabit these oral microenvironments, and how to assess what they are doing (actively transcribed genes) respectively.³⁰ Indeed, the establishment of this robust HMP project has refined bioinformatic techniques significantly, spurring an abundance of ongoing research that provides valuable insight into the relationship between microbiota and its impact on human health, with one of the strongest identified variables of association being ethnic/racial background.³¹

Regarding its role in the examination of the oral cavity, HMP developed a comprehensive oral microbiome database by employing Human Oral Microbe Identification using Next-Generation Sequencing (HOMINGS). The advantages of HOMINGS are that it is computationally efficient, reproducible, and rapidly identifies the majority of the oral

²⁹ Krishnan et al., “A Practical Guide to the Oral Microbiome and Its Relation to Health and Disease,” *Oral Diseases* 23, no. 3 (2017): 276–86.

³⁰ Ibid.

³¹ Ibid.

microbiome at the species level, which is currently 700 predominant bacterial species inhabiting human oral cavity.³² In addition to HOMINGS, other modern methods of identification include, whole genome shotgun metagenome sequencing, which allows for an entire DNA (genome) of a single microbial culture or a complex microbial population to be sequenced to generate reference genomes,³³ and micron-scale biogeography, which combines sequencing data with spectral fluorescence imaging to analyze the spatial structure of the microbial systems at play.³⁴ All of the aforementioned methodologies have introduced groundbreaking ways to examine hundreds of microorganisms that have evolved and inhabited the micro-niches of the oral cavity over time; however, effectively interpreting this massive volume of generated data remains a challenge, particularly in clinical contexts.

Acquisition & Development of the Oral Microbiome

The resident microflora occupying the oral microbiome has coevolved and coexisted in humans as highly organized communities that essentially create an “internal architecture to optimize nutrient absorption, waste removal and overall survival,”³⁵ sustaining a largely symbiotic relationship over millions of years.³⁶ Indeed, this highly selective process of colonization led to the integration of the microbiome with the complex, multicellular eukaryotic human body, giving rise to the superorganism, or *holobiont*.³⁷ In addition to the mutual adaptation and functional integration of the holobiont, which confers benefits for both the host

³² Ibid.

³³ Ibid.

³⁴ Jessica L. Mark Welch et al., “Biogeography of a Human Oral Microbiome at the Micron Scale,” *Proceedings of the National Academy of Sciences* 113, no. 6 (2016): 791–800, <https://doi.org/10.1073/pnas.1522149113>.

³⁵ Gerald P Curatola. “Oral Microbiome Homeostasis: The New Frontier in Oral Care Therapies,” *Journal of Dentistry Oral Disorders and Therapy* 1, no. 1 (2013): 1-3.

³⁶ Mogens Kilian, “The Oral Microbiome – Friend or Foe?” *European Journal of Oral Sciences* 126, no.1 (2018): 5–12.

³⁷ Mogens Kilian et al., “The Oral Microbiome – an Update for Oral Healthcare Professionals,” *British Dental Journal* 221, no. 10 (November 2016): 657.

and the acquired microbes, a highly diverse oral microbiome “cover[ing] the full spectrum of acidogenic, aciduric, inflammatory, and anti-inflammatory properties”³⁸ is a remarkable benefit of evolution.

The oral microbiome of an individual evolves from the initial bacterial acquisition during prenatal development, and continues through different stages of bacterial colonization throughout the course of maturation. Recent studies show plausible associations between the mother’s oral microbiome and intrauterine infection that may cause adverse pregnancy outcomes.^{39,40} Researchers suggest that during pregnancy, cultivable microorganisms may reach the amniotic fluid via transient *bacteremia* (bacteria present in the bloodstream for a short period before being cleared from the body),⁴¹ especially in the presence of oral diseases such as gingivitis or periodontitis,⁴² suggesting that these conditions are risk factors for preterm birth and low birth weight babies,^{43,44,45} and increased predisposition to *preeclampsia* (high blood pressure during pregnancy).^{46,47,48} Thus, the integration of oral screenings and/or oral treatments should be

³⁸ Ibid.

³⁹ S Corbella et al., “Periodontal disease as a risk factor for adverse pregnancy outcomes: a systematic review and meta-analysis of case-control studies,” *Odontology*, no. 100 (2011): 232–240.

⁴⁰ Yann Fardini et al., “Transmission of Diverse Oral Bacteria to Murine Placenta: Evidence for the Oral Microbiome as a Potential Source of Intrauterine Infection,” *Infection and Immunity* 78, no. 4 (April 1, 2010): 1789–96.

⁴¹ Benedita Sampaio-Maia et al., “Acquisition and Maturation of Oral Microbiome throughout Childhood: An Update,” *Dental Research Journal* 11, no. 3 (2014): 291–301.

⁴² Anuradha Basavaraju et al., “Variations in the Oral Anaerobic Microbial Flora in Relation to Pregnancy,” *Journal of Clinical and Diagnostic Research : JCDR* 6, no. 9 (2012): 1489–91, <https://doi.org/10.7860/JCDR/2012/4609.2540>.

⁴³ E Ercan et al., “Evaluation of periodontal pathogens in amniotic fluid and the role of periodontal disease in preterm birth and low birth weight,” *Acta Odontologica Scandinavica*, no. 1 (2012): 1–7.

⁴⁴ Naira Roland Matevosyan et al., “Periodontal disease and perinatal outcomes,” *Archives of Gynecology and Obstetrics* 283, (2011): 675–686.

⁴⁵ I Gomes-Filho et al., “Exposure measurement in the association between periodontal disease and prematurity/low birth weight,” *Journal of Clinical Periodontology* 34, (2007): 957–963.

⁴⁶ KA Boggess et al., “Maternal periodontal disease is associated with an increased risk for preeclampsia,” *Obstetrics and Gynecology* 101, (2003): 227–231.

⁴⁷ LO Cota et al., “Association between maternal periodontitis and an increased risk of preeclampsia,” *Journal of Periodontology* 77, (2006): 2063–2069.

⁴⁸ S Barak et al., “Evidence of periopathogenic microorganisms in placentas of women with preeclampsia,” *Journal of Periodontology* 78, (2007): 670–676.

a concern for dental and medical professionals when addressing preconception and pregnancy care.

During and after birth, newborns come into contact with numerous microorganisms out of which only a subgroup carries the ability to permanently colonize the baby's oral microbiome.⁴⁹ The exposure to this particular set of initial colonizers, a significant number of which are of maternal origin,⁵⁰ is determined by the type of delivery and the successive environments that the baby encounters. This is evidenced in studies stating "babies born by vaginal birth have similar bacterial communities to the mother's vaginal bacterial communities, predominantly *Lactobacillus*, *Prevotella*, and *Sneathia* species, while babies born by Cesarean section (dystocic) have bacterial communities similar to those present in the mother's skin, predominantly *Staphylococcus*, *Corynebacterium*, and *Propionibacterium* species."⁵¹ The importance of mode of delivery as a determinant for microbial acquisition is further supported by studies that claim vaginally born infants showed higher taxonomic diversity at three months of age,⁵² and *Streptococcus mutans* being acquired almost 1 year earlier in infants delivered by Caesarean section compared with infants who were vaginally delivered.⁵³ Following delivery from the birth canal, the baby's mouth will be exposed to even more microorganisms from the outside world through breathing, breastfeeding, contact with parents and medical staff, leading to the permanent colonization of the oral cavity in the postpartum period.⁵⁴ It is important to note that the method of feeding (breastfeeding or infant formula) may also affect the infant's oral

⁴⁹ Sampaio-Maia et al., 2014.

⁵⁰ Ibid.

⁵¹ Ibid.

⁵² P. Lif Holgersson et al., "Mode of birth delivery affects oral microbiota in infants." *Journal of Dental Research* 90, (2011): 1183–1188, doi: 10.1177/0022034511418973.

⁵³ Y Li et al., "Mode of delivery and other maternal factors influence the acquisition of *Streptococcus mutans* in infants," *Journal of Dental Research*. 84, (2005): 806–811, doi: 10.1177/154405910508400905.

⁵⁴ Sampaio-Maia et al., 2014.

microbiome significantly; for example, three-month-old breast-fed infants contain oral lactobacilli with antimicrobial properties that are not found in formula-fed infants.^{55,56} Within just twenty-four hours of life, the baby has been exposed to a plethora of conditions, allowing for the pioneer organisms to establish themselves in the oral cavity, and subsequently promote changes in the environment through production and excretion of metabolites, which often potentiate the growth of other species.⁵⁷ Indeed, the growth and metabolism of these pioneer microbes change local environmental factors such as redox potential, pH, coaggregation, and availability of nutrients, “thereby enabling more fastidious organisms to colonize after them.”⁵⁸ This process seemingly conditions the baby’s system for future microbial colonizations, leading to complex, stable ecosystems in adulthood.^{59,60} Therefore, the preliminary microbial exposure to diverse microorganisms with both pathogenic and protective properties, make it a critical foundation for future development of the adult oral microbiota.

As the baby grows, the microbial communities evolve accordingly. By five months, infants show a distinct oral microbiota from the mother, due to environmental exposure that occurs in the first months of life, particularly through the ingestion of food, proximal contact with people and animals, hygiene habits/routines, and so forth.⁶¹ In this phase, infants show fewer oral microorganisms than their parents, but exhibit greater microbial diversity.⁶² With the

⁵⁵ PL Holgerson et al., “Oral microbial profile discriminates breast-fed from formula-fed infants,” *Journal of Pediatric Gastroenterology and Nutrition* 56, (2013): 127–136, doi: 10.1097/MPG.0b013e31826f2bc6.

⁵⁵ Nelly Romani Vestman et al., “Characterization and *in vitro* properties of oral lactobacilli in breastfed infants,” *BMC Microbiology*, 13 (2013): 193, doi: 10.1186/1471-2180-13-193.

⁵⁶ Ibid.

⁵⁷ Sampaio-Maia et al., 2014

⁵⁸ K Krishnan et al. “A Practical Guide to the Oral Microbiome and Its Relation to Health and Disease,” *Oral Diseases* 23, no. 3 (2017): 276–86.

⁵⁹ Sampaio-Maia, “Acquisition.”

⁶⁰ MM Gronlund et al., “Fecal microflora in healthy infants born by different methods of delivery: Permanent changes in intestinal flora after cesarean delivery,” *Pediatric Gastroenterology and Nutrition* 28, (1999):19–25.

⁶¹ Ibid.

⁶² Kimberly D Cephas et al. “Comparative analysis of salivary bacterial microbiome diversity in edentulous infants and their mothers or primary care givers using pyrosequencing,” *PloS one* 6, (2011): 235.

eruption of the first teeth, a new ecological shift takes place in the oral environment due to the emergence of new adhesion surfaces, also known as the “window of infectivity.”⁶³ Recent studies evaluating the oral microbial population in children aged three to twelve years suggest that the entire population of the tooth-bound bacteria, and not just a small number of specific pathogenic bacteria, influences the development of caries (dental cavities).^{64,65,66,67} Additionally, studies examining the presence of caries-causing bacteria in children lacking teeth show that soft tissues may be a reservoir for oral pathogenic microorganisms.⁶⁸ Based on evidence of microbial migration and adhesion patterns relevant to *pathogenesis* (development of diseases), it is crucial that maintaining proper oral hygiene practices should begin prior to tooth eruption and continue throughout the course of life.

By three years of age, the salivary microbiome is duly complex, but continually adapts to changes in the oral cavity as primary teeth are replaced with deciduous, mixed, or permanent adult dentition, which significantly alters the oral microbial environment.^{69,70} During this time, the oral microbiome evolves accordingly by increasing in microbial load and decreasing in diversity that leads to the eventual formation of a complex, more stable microbial community.⁷¹ In addition to genotypic factors influencing the vertical transmission of microbes from mother to

⁶³ PW Caufield et al. “Initial acquisition of mutans streptococci by infants: Evidence for a discrete window of infectivity,” *Journal of Dental Research* 72, (1993): 37–45.

⁶⁴ Z Ling et al. “Analysis of oral microbiota in children with dental caries by PCR-DGGE and barcoded pyrosequencing,” *Microbial Ecology* 60, (2010):677–90..

⁶⁵ Sotira Gizani et al. “Distribution of selected cariogenic bacteria in five different intra-oral habitats in young children,” *International Journal of Pediatric Dentistry* 19, (2009):193–200.

⁶⁶ JA Aas et al. “Bacteria of dental caries in primary and permanent teeth in children and young adults,” *Journal of Clinical Microbiology* 46, (2008):1407–17.

⁶⁷ M Mantzourani et al. “The isolation of bifidobacteria from occlusal carious lesions in children and adults,” *Caries Research* 43, (2009):308–13.

⁶⁸ Ibid.

⁶⁹ W Crielaard et al. “Exploring the oral microbiota of children at various developmental stages of their dentition in the relation to their oral health,” *BMC Med Genomics* 4, (2011):22.

⁷⁰ X Xu et al. “Oral cavity contains distinct niches with dynamic microbial communities,” *Environmental Microbiology* 17, (2015): 699–710.

⁷¹ Sampaio-Maia et al., 2014.

child, horizontal transmission from proximal relationships and the environment can influence the composition of the child's oral microbiome.^{72,73} Indeed, the selective acquisition of microbes since birth is an essential process determined by hereditary factors and environmental exposure to specific physical, chemical, and biological conditions that allow for the assemblage of the host-specific oral microbiome. Based on this evidence, it is crucial for healthcare providers to emphasize the importance of practicing proper oral hygiene practices from as early as conception. In doing so, patients and their families can be well equipped with the knowledge and resources to maintain a healthy oral microbiome, which is especially important for pregnant women who are duly involved in influencing offspring microbiota. This preventive approach can then effectively set up positive oral health outcomes for successive generations.

The Oral Microbiome's Role in Pathogenesis

Throughout the process of microbial acquisition and development, the oral microbiome evolves and adapts to internal and external stressors leading up to the eventual formation of a complex, more stable microbial community.⁷⁴ The developed oral microbiome can be further classified into two different but synergetic components: the core microbiome and the variable microbiome.⁷⁵ The core microbiome is "shared among all individuals and is comprised of the predominant species that exist under healthy conditions at different sites of the body," while the

⁷² S Domejean et al., "Horizontal transmission of mutans streptococci in children," *Journal of Dental Research* 89, (2010): 51–5..

⁷³ B Kohler B et al., "Longitudinal study of intrafamilial mutans streptococci ribotypes," *European Journal of Oral Science* 111, (2003): 383–9.

⁷⁴ Sampaio-Maia et al., 2014.

⁷⁵ MF Zarco et al., "The Oral Microbiome in Health and Disease and the Potential Impact on Personalized Dental Medicine," *Oral Diseases* 18, no. 2 (March 2012): 109–20.

variable microbiome is “exclusive to the individual and has evolved in response to unique lifestyle, and phenotypic and genotypic determinants (Figure 6).”^{76,77,78}

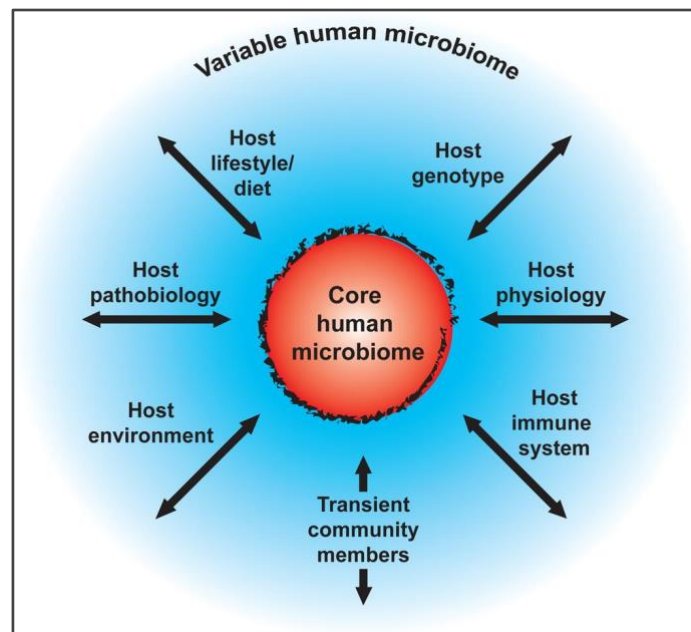


Figure 6. Conceptual Map of the Human Microbiome

Source: Peter J. Turnbaugh et al., “The Human Microbiome Project,” *Nature* 449, no. 7164 (October 18, 2007): 804–10, <https://doi.org/10.1038/nature06244>.

In order to understand the mechanistic role of the oral microbiota in pathogenesis, it is important to analyze the characteristics and dynamics of the microflora occupying the various niches of the oral cavity, including the hard, solid surfaces of teeth, and the soft, shedding tissue of the oral mucosa.⁷⁹ Genomic sequencing data from a study surveying the 11 predominant microbial habitats in the oral cavity, including the hard palate, tongue dorsum, saliva, palatine

⁷⁶ Peter J Turnbaugh et al., “The human microbiome project: a strategy to understand the microbial components of the human genetic and metabolic landscape and how they contribute to normal physiology and predisposition to disease,” *Nature* 449, (2007): 804–810.

⁷⁷ Ibid.

⁷⁸ Egjia Zaura et al., “Defining the healthy “core microbiome” of oral microbial communities,” *BMC Microbiology* 259, (2009): 12.

⁷⁹ Ibid.

tonsils, throat, buccal mucosa, keratinized gingiva, supragingival plaque, subgingival plaque, dentures, and lips show different core microorganisms when sampled from more than 200 healthy people.⁸⁰ This indicates that specific microflora gravitate towards surfaces within the oral cavity that provide respective, optimal conditions and nutrients, allowing them to thrive.⁸¹ Although individuals can share microbiota at similar sites of the body, there are varying differences in species composition, diversity, and magnitude at the cellular level that can be as “inimitable to the individual as is the fingerprint.”⁸² This is evidenced by the distinct composition of microflora that not only occupy different regional niches of the oral cavity, but also contribute to the formulation of the salivary and gingival crevicular fluid (GCF) microbiotas, as well as those of *oral biofilms*, which are complex colonies of microorganisms occupying hard and mucosal surfaces in the oral cavity such as dental plaque.⁸³ Indeed, resident microbes comprising these different media contribute to the maintenance of dynamic equilibrium within the oral cavity. For example, saliva and GCF provide nutrients for microbial growth and contain components with antimicrobial, and both pro- and anti-inflammatory activities.⁸⁴ The saliva in particular not only supplies numerous glycoproteins, minerals, and enzymes that help maintain a conducive climate for biofilms to flourish, but also continuously works to detach and modulate layers of plaque.^{85,86} Moreover, the saliva provides the necessary nutrients to protect tooth enamel and antibodies that defend the oral cavity and the rest of the body from

⁸⁰ G Jia et al., “The Oral Microbiota – a Mechanistic Role for Systemic Diseases,” *BDJ* 224, no. 6 (March 23, 2018): 447–55.

⁸¹ M Avila et al., “The oral microbiota: living with a permanent guest,” *DNA Cell Biology* 28, (2009): 7.

⁸² L Dethlefsen et al., “An ecological and evolutionary perspective on human-microbe mutualism and disease,” *Nature* 449, (2007): 811–818.

⁸³ TF Flemmig et al., “Control of oral biofilms,” *Periodontol* 55, (2000): 9–15.

⁸⁴ M Kilian et al., “The Oral Microbiome – an Update for Oral Healthcare Professionals,” *British Dental Journal* 221, (2016): 657–66

⁸⁵ Ibid.

⁸⁶ AV Nieuw Amerongen et al., “Saliva – the defender of the oral cavity,” *Oral Diseases* 8, (2002): 12–22.

infection.^{87,88} Thus, microflora occupying different media and surfaces within the oral cavity regulate oral biofilms and environmental conditions through homeostatic control, and effectively serve as *biomarkers* (measurable indicators of some biological state or condition) of pathogenesis.^{89,90}

Harboring over 700 identified microbial species, the oral cavity depends on these diverse microorganisms to adhere to the aforementioned microenvironments and form highly regulated, structurally and functionally organized communities,⁹¹ which are capable of displaying “significant tropisms in their respective environments”⁹² in order to achieve ecological balance. The key to maintaining balance within this diverse microbiome is for microorganisms to essentially practice commensalism within itself and mutualism with its host.^{93,94,95} This harmonious relationship allows microbes to flourish at no expense to their co-habitants while maintaining biodiversity within the oral cavity;⁹⁶ however, after this homeostatic, ecological balance is achieved, there can be contributing endogenous and exogenous factors that perturb this dynamic equilibrium, causing a shift in balance towards a pathogenic state through a process known as *pleomorphism*, “which is the ability of bacteria to alter their shape or size in response

⁸⁷ Ibid.

⁸⁸ S. Filoche et al., “Oral biofilms: emerging concepts in microbial ecology,” *Journal of Dental Research* 89, (2010): 8–18.

⁸⁹ Lihong Guo et al., “Salivary biomarkers for caries risk assessment,” *J. Calif. Dent. Assoc* 41, (2013): 107.

⁹⁰ MW Hall et al., “Inter-Personal Diversity and Temporal Dynamics of Dental, Tongue, and Salivary Microbiota in the Healthy Oral Cavity,” *Npj Biofilms and Microbiomes* 3, (2017): 1.

⁹¹ M Kilian et al., “The Oral Microbiome – an Update for Oral Healthcare Professionals,” *British Dental Journal* 221, no. 10 (2016): 657–66.

⁹² DL Mager et al., “Distribution of selected bacterial species on intraoral surfaces,” *J Clin Periodontol* 30, (2003): 644–6.

⁹³ J Ruby et al., “Nature of symbiosis in oral disease,” *J Dent Res* 86, (2007): 8–11

⁹⁴ Zaura et al., “Defining the healthy “core microbiome” of oral microbial communities,” *BMC Microbiol* 259, (2009): 12.

⁹⁵ Filoche et al., 2010.

⁹⁶ Zarco et al., 2012.

to environmental conditions.”⁹⁷ These ecological shifts towards pathogenesis can be a result of interrelated changes in (1) host-microbe interactions, (2) the relative abundance of pathogenic bacteria, and (3) the acquisition of virulence factors.⁹⁸ Thus, changes in this dynamic equilibrium, shifting from mutualistic to parasitic, commensal to opportunistic, symbiotic to dysbiotic allow pathogenic bacteria to flourish while beneficial bacteria diminish; as a result, the host becomes infected or prone to infection, which in turn, provides the necessary means for diseases to manifest.

There are numerous mechanisms that may be responsible for initiating this perturbed balance in the oral microbiome, including but not limited to: poor oral hygiene that is responsible for the accumulation of pathogenic bacteria within biofilms,⁹⁹ compromised immune systems that fail to effectively regulate inflammatory responses between the oral microbiome and the host,^{100,101} and genotypic makeup, which is responsible for the level of microbial diversity and cellular mechanisms that may be more or less susceptible to pathogenesis. In order to elucidate the dynamic nature of homeostatic control that lies in a continuum between the host’s oral microbiome and the external environment, it is necessary to consider both the endogenous and exogenous factors at play. Much of the aforementioned knowledge of oral microbial activity focuses on the endogenous, genotypic factors within the oral cavity; however, exogenous factors, which may also contribute to social determinants of oral health are increasingly important in

⁹⁷ HM Joshi et al., “Nutrition induce pleomorphism and budding mode of reproduction in *Deinococcus radiodurans*,” *BMC Research Notes* 2, (2009): 123.

⁹⁸ NB Parahitiyawa et al., “Exploring the oral bacterial flora: current status and future directions,” *Oral Diseases* 16, (2010): 10.

⁹⁹ Filoche et al., 2010.

¹⁰⁰ Ahmed S Sultan et al., “The Oral Microbiome: A Lesson in Coexistence,” *PLOS Pathogens* 14, no. 1, (2018): 1006719, doi.org/10.1371/journal.ppat.1006719.

¹⁰¹ Jonathan H. Badger et al., “The Human Genome, Microbiomes, and Disease,” in *Metagenomics of the Human Body*, ed. Karen E. Nelson (New York, NY: Springer New York, 2011), 1–14, https://doi.org/10.1007/978-1-4419-7089-3_1.

understanding susceptibilities to pathogenesis. Some well-researched exogenous factors include, diet, tobacco smoking, alcohol consumption, antibiotic/antimicrobial use, and socioeconomic status, each of which will be discussed individually and recurringly in the following sections.¹⁰²

The relationship between poor dietary consumption and susceptibility to tooth decay has been extensively studied over the years, especially since the advent of industrialization in the mid 1850s, which has made processed sugar and flour both prevalent and accessible, effectively shifting the oral microbial community to a disease-associated configuration.¹⁰³ The biological implications of this shift are rooted in the development of dental caries (cavities), which occur due to the dissolution of tooth structures by acid-producing oral bacteria derived from the fermentation of dietary carbohydrates.¹⁰⁴ When the fermentation process is enhanced by excess ingestion of sugar, the saliva loses its buffering capacity, and constant reductions on the pH lead to the erosion of the enamel, cementum and dentin.¹⁰⁵ Under these conditions, the oral microbiota seems to shift in favor of acidogenic (acid producing) and aciduric (acid tolerant) cariogenic bacteria,¹⁰⁶ such as increased colonization of *Streptococcus mutans*,¹⁰⁷ the predominantly identified biomarker of dental caries, among other microorganisms.^{108,109,110} Indeed, this dramatic dietary shift in composition, magnitude, and frequency towards processed food consumption in modern-day lifestyles is directly associated with the increased incidence of

¹⁰² Jia et al., 2018.

¹⁰³ CJ Adler et.al., “Sequencing ancient calcified dental plaque shows changes in oral microbiota with dietary shifts of the Neolithic and Industrial revolutions,” *Nature Genetics* 45, (2013): 450–455.

¹⁰⁴ N Takahashi et al., “Critical reviews in oral biology & medicine: the role of bacteria in the caries process: ecological perspectives,” *J Dent Res* 90, (2011): 294-303, doi: 10.1177/0022034510379602.

¹⁰⁵ Ibid.

¹⁰⁶ JS McLean, “Advancements toward a systems level understanding of the human oral microbiome,” *Front Cell Infect Microbiol* 4, (2014):98.

¹⁰⁷ Ibid.

¹⁰⁸ J He et al., “The Oral Microbiome Diversity and Its Relation to Human Diseases,” *Folia Microbiologica* 60 no. 1, (2015): 69–80.

¹⁰⁹ Jia et al., 2018.

¹¹⁰ Andres Gomez et al., “The Oral Microbiome of Children: Development, Disease, and Implications Beyond Oral Health,” *Microbial Ecology* 73 no. 2, (2017):492–503.

oral diseases in population health.^{111,112} In a similar regard to unhealthy diet, the use of alcohol and tobacco products can have an adverse effects on the oral microbiota and overall oral health. Several studies suggest that there is an association between heavy alcohol consumption and cigarette smoking to increased rates of oral and pharyngeal cancers.^{113,114,115} From a biological perspective there is plausible evidence to support this claim in that possible changes in cellular mechanisms generated from smoking and drinking can alter the oral microbial ecology by “increasing the acidity of saliva, depleting oxygen, influencing oral bacterial adherence to mucosal surfaces, impairing host immunity,”^{116,117} and converting “ethanol to acetaldehyde,” which is a known carcinogen.^{118,119}

The use of antibiotics are another factor that influence pathogenic oral microbial activity. Not only are antibiotics extensively used to directly kill certain bacteria, but they are also used to inhibit their growth and influence bacterial growth curves at varying levels and patterns. Many studies report that antibiotics such as azithromycin, amoxicillin clindamycin and ciprofloxacin affect the amount and diversity of oral microbes.^{120,121} Additionally, there is reported data

¹¹¹ Massimo Costalonga et al., The Oral Microbiome and the Immunobiology of Periodontal Disease and Caries,” *Immunology Letters* 162 no.2, (2014):22–38.

¹¹² D Locker, “The burden of oral disorders in a population of older adults,” *Community Dental Health* 9 no.2, (1992):109-124.

¹¹³ Soo Choi et al., “Effect of Cigarette Smoking and Alcohol Consumption in the Aetiology of Cancer of the Oral Cavity, Pharynx and Larynx,” *International Journal of Epidemiology* 20 no. 4, (1991):878–85.

¹¹⁴ Helmut K Seitz et al., “Alcohol Metabolism and Cancer Risk,” *Alcohol Research & Health* 30 no.1 (2007):38.

¹¹⁵ Daniel M Saman. “A Review of the Epidemiology of Oral and Pharyngeal Carcinoma: Update,” *Head & Neck Oncology* 4 no.1, (2012): 1.

¹¹⁶ Aplana Kanwar et al., “Long term effect of tobacco on resting whole mouth salivary flow rate and pH: An institutional based comparative study,” *Eur J Gen Dent* 2, (2013): 296–299.

¹¹⁷ I Brook, “The impact of smoking on oral and nasopharyngeal bacterial flora,” *J Dent* 90, (2011): 704–710.

¹¹⁸ J Ahn et al., “Oral microbiome and oral and gastrointestinal cancer risk,” *Cancer Causes Control* 23, (2012): 399–404.

¹¹⁹ Anne Marie Lynge Pedersen. 2015. *Oral Infections and General Health: From Molecule to Chairside*. New York, NY: Springer Berlin Heidelberg.

¹²⁰ Egija Zaura et al., “Same exposure but two radically different responses to antibiotics: resilience of the salivary microbiome versus long-term microbial shifts in faeces,” *American Society for Microbiology* 6, (2015): 1693–1708.

¹²¹ SR Abeles et al., “Microbial diversity in individuals and their household contacts following typical antibiotic courses,” *Microbiome* 4,(2016): 39–51.

revealing that oral microbiome functions such as microbe metabolic activity, microbial gene expression and protein synthesis were “drastically changed as a direct consequence of antibiotic treatments,” perhaps through mechanisms that damage and/or destruct the bacterial cells and consequently decrease their enzymatic activity.¹²² Several factors of antibiotic intervention that may impact changes in the oral microbiota depend not only on the chemical nature of the antibiotic used to treat specific infections, but also on the type of administration, duration and dose, as well as the level of resistance that each microbiota develops.¹²³ Thus, the use of antibiotics and antimicrobial drug interventions may indeed adversely impact both the biodiversity and functional aspects of the oral microbiota.

Among the previously discussed factors affecting oral health, socioeconomic status (SES) is an important exogenous factor that should not be neglected. Socioeconomic status is largely viewed as a social determinant of health, however, there is ongoing research that examines its biological implications as well. A study conducted by *Belstrom et al.* reports that the differences in SES are reflected by the bacterial profiles of saliva. In the high SES group, *Megasphaera micronuciformis*, *Veillonella atypical*, *Veillonella parvula*, *Rothia mucilaginosa*, *Prevotella histicola*, *Fusobacterium periodontium*, *Granulicatella adiacens* and *Tannerella forsythia* were abundant, while *Aggregatibacter segnis*, *Achromobacter xylosoxidans* and *Neisseria cluster ii* were abundant in the low SES group, showing a distinct difference in biodiversity.¹²⁴ Moreover, *Miller et al.* believe that the oral microbiome might vary considerably over time because of SES and the phenomenon of reducing oral microbial diversity was disproportionately prevalent in

¹²² Z Ling Z et al., “Impacts of infection with different toxigenic *Clostridium difficile* strains on faecal microbiota in children,” *Sci Rep* 4,(2014): 7485.

¹²³ M Ferrer et al., “Antibiotic use and microbiome function,” *Biochem Pharmacol* 134, (2017):114–126.

¹²⁴ D Belstrom et al., “Bacterial profiles of saliva in relation to diet, lifestyle factors, and socioeconomic status,” *J Oral Microbiol* 6, (2014) 1–9.

low-SES neighborhoods.¹²⁵ These studies suggest that increased species-associated biodiversity among high SES groups, which is largely shaped by factors such as income, educational attainment, health literacy, hygiene habits, dietary patterns, and accessibility to healthcare services, may indeed be a predominant indicator of better oral health.

There is a multifactorial basis to understanding how the oral microbiota changes in response to the interdependent effects of stimuli. The previous sections discuss the influence of exogenous factors such as diet, nutrition, lifestyle, and SES in maintaining symbiosis in the oral cavity based on a breadth of scientific dental literature that examines strong significance among these variables; however, there are still limitations to these studies in establishing causal evidence. Thus, it is important to note that though the cellular mechanisms influenced by these factors and conditions may be difficult to examine, there is still well-established evidence of their downstream effects upon disease processes that manifest at localized and systemic levels, which will be discussed in the following sections.

A perturbed balance in the dynamic relationship between the host's oral microbiome and the environment can result in numerous oral and even systemic diseases, suggesting that the oral microbiota plays a mechanistic role in influencing pathogenesis. This is evidenced by the previously discussed modern metagenomic and metatranscriptomic techniques, as well as clinical metadata, which reveal that in addition to interspecies collaborations, antagonisms provoked by host-specific and environmental stimuli can increase the virulence and pathogenic potential of opportunistic bacteria. The most prominent oral health diseases that develop as a result of a dysbiotic microbiome are dental caries and periodontal diseases (including periapical

¹²⁵ GE Miller et al., "Lower neighborhood socioeconomic status associated with reduced diversity of the colonic microbiota in healthy adults," *Plos One* 11, (2016): 148952–148969.

periodontitis and gingivitis).¹²⁶ Indeed, when these diseases manifest, their associated bacteria can grow to “markedly higher proportions than under healthy conditions, where they are normally minor and innocuous components in the biofilm.”¹²⁷ However, these diseases may not remain isolated to the oral cavity. Over time, these localized systemic infections stemming from the circulation of pathogenic bacteria in oral biofilms, hard and soft tissue crevices, or periodontal pockets of surrounding tissue in bone and fascia of the oral cavity, can metastasize from the local site into the bloodstream. There are several hypotheses regarding immune mechanisms that underlie this pathogenic infiltration including, genetic predispositions, systemic inflammation due to increased circulating cytokines and mediators, direct infection of blood vessels by bacteria, and cross-reactivity (molecular mimicry) between bacterial antigens and self-antigens,^{128,129} which may potentiate infections in a variety of body systems, including heart valves, brain, spleen, pancreas, liver, and bone.¹³⁰

The associations between cariogenic and periodontopathic bacteria and systemic diseases have been the subject of numerous studies that examine cardiovascular, respiratory, immune, neuropathic, metabolic, osteopathic, endocrine, and obstetric complications. There is ample literature that suggests that there is a strong bidirectional relationship between diabetes and periodontal disease, meaning the bacteria involved in periodontal disease jeopardizes the body’s

¹²⁶ He et al., 2015.

¹²⁷ Jia et al., 2018.

¹²⁸ GJ Seymour et al., “Relationship between periodontal infections and systemic disease,” *Clin Microbiol Infect* 13, (2007): 3–10.

¹²⁹ Jorgen Slots et al., “New views on periodontal microbiota in special patient categories,” *J Clin Periodontol* 18, (1991): 411–420.

¹³⁰ Scannapieco, 2013.

control of glycemic levels leading to whole-body insulin resistance.^{131,132,133} Additionally, periodontal pathogens can signal excessive amounts of antigens, endotoxins, cytokines, and C-reactive proteins that also contribute to cardiovascular complications such as lipid deposition, smooth muscle proliferation, and platelet aggregation, which effectively make their way into arteries and result in atherothrombosis (formation of arterial blood clots).¹³⁴ This persistent inflammatory response is a plausible mechanism for not only the underlying pathology of diabetes and cardiovascular diseases (i.e. atherosclerosis, coronary heart disease, cerebrovascular disease, peripheral artery disease), but also rheumatoid arthritis, renal and liver disease, and cancer.¹³⁵ Regarding the role of cariogenic bacteria in pathogenesis, it is evident that caries are not only an indicator of poor oral health due to the resultant effects of tooth decay and demineralization, but also a determinant for patients with chronic conditions such as obesity, diabetes, and cleft palate syndrome who are often claimed to be caries prone.¹³⁶ In addition to the more well-known diseases associated with oral health infections mentioned previously, there is increasing evidence derived from modern methodologies that identify systemic effects resultant of oral microbial dysbiosis, including gastrointestinal system diseases like irritable bowel syndrome and stomach ulcers, nervous system diseases like Alzheimer's and stroke, immune system diseases such as HIV infection, respiratory diseases like pneumonia and peripheral vascular disease,¹³⁷ all of which have respective uncertainties in immune cellular mechanisms.

¹³¹ BL Pihlstrom BL et al., "Periodontal Diseases," *Lancet* 366, (2015): 1809–1820.

¹³² LC Kuo et al., "Associations between periodontal diseases and systemic diseases: a review of the inter-relationships and interactions with diabetes, respiratory disease, cardiovascular diseases and osteoporosis," *Publ Health* 122, (2008): 17.

¹³³ RC Williams et al., (2008). The potential impact of periodontal disease on general health: a consensus view. *Curr Med Res Opin*, Informa UK Ltd. 24: 1635–1643.

¹³⁴ Kuo et al., 2008.

¹³⁵ *Oral Infections and General Health*, 2015.

¹³⁶ Anon. 2015. *Oral Infections and General Health: From Molecule to Chairside*. New York, NY: Springer Berlin Heidelberg.

¹³⁷ Jia et al., 2018.

All of this evidence strongly supports that the oral microbiota reflects oral and systemic conditions within the body, sufficiently making the oral cavity a mirror to overall health.

Brushing Up on Oral Hygiene Practices

The oral microbiota plays a mechanistic role as a liaison in disease processes, effectively linking the changes in microbial activity among site-specific niches in the oral cavity to local and systemic pathways. Indeed, this increasing scientific base at the cellular level precisely supports that maintaining oral microbial symbiosis is key to sustaining good oral health, and inextricably, overall health.

Good oral health can be largely achieved through preventive practices, such as maintaining a healthy oral hygiene routine, eating a healthy diet, and being self-aware of early detection, treatment, and management of oral health problems. In an ideal world where oral equity exists, every person would have access to preventive and restorative dental services, fluoridated drinking water, affordable nutrient-dense foods, a toothbrush and floss in hand, and healthy oral hygiene practices instilled from an early age; however, millions of people continue to suffer from oral diseases largely due to the lack of accessible dental coverage and education around *oral health literacy*, or “the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate oral health decisions.”¹³⁸ This often leads to adverse effects upon their general health and quality of life. In efforts to increase oral health literacy and oral health promoting behaviors across populations, the following sections will briefly summarize preventive, age-relevant oral hygiene practices.

¹³⁸ “Health Literacy in Dentistry,” accessed April 3, 2019, <https://www.ada.org/en/public-programs/health-literacy-in-dentistry>.

Oral Care During Pregnancy

Pregnancy induces significant hormonal changes associated with oral health sensitivity and dysregulation, thus, maintaining good oral hygiene may help reduce the risk of adverse pregnancy outcomes such as premature births and other infant complications during placental and fetal development.¹³⁹ During this time, the teeth and gums need special attention as it has been evidenced that women notice changes such as severe swelling, inflammation, and bleeding, often referred to as pregnancy gingivitis. Pregnancy gingivitis commonly occurs at the front of the mouth, mimicking symptoms of gingivitis, but the underlying causes may differ due to the changes in hormone levels, which may enhance bacterial growth and alter host immune responses. Other oral health problems accompanying pregnancy may include granulomas (benign tumors involving blood vessels), tooth erosion related to morning sickness, dry mouth, and excess saliva production.¹⁴⁰ The following section will address recommended practices for pregnancy-related oral care.

Pregnant mothers and women considering pregnancy should visit a dentist and/or periodontist (gum specialist) for a checkup during and prior to becoming pregnant to discuss a specific treatment plan that distinguishes what medications (i.e. dental anesthetics, pain medications and antibiotics), procedures (i.e. X-rays, extractions, surgeries), and practices are safe and effective in reducing oral health problems that accompany pregnancy. Moreover, common at-home oral care practices should include: avoiding chronic internal and external stressors, regularly brushing teeth twice a day for at least two minutes with fluoridated

¹³⁹ Basavaraju et al., 2012.

¹⁴⁰ “Oral Health Through Pregnancy: Dental Health for Women | Colgate,” accessed April 20, 2019, <https://www.colgate.com/en-us/oral-health/life-stages/oral-care-during-pregnancy>.

toothpaste, flossing daily, using an antibacterial mouthwash to destroy gingivitis-related bacteria, eating a balanced, nutritious diet with plenty of protein, calcium and vitamins A, C and D, and drinking plenty of water to avoid dry mouth.¹⁴¹

Infant and Baby Oral Care [birth to 24 months]

Because most babies do not start developing teeth until they are around six months old, standard dental procedures like brushing and flossing are not initially required for infants; however, it is important to practice good oral hygiene through other means because infants are highly susceptible to tooth decay and oral pain.¹⁴² Moreover, temporary baby teeth are integral in influencing the health and proper alignment of permanent teeth.

During the period of teeth eruption among infants' oral cavities, parents and caregivers should be aware of oral health concerns related to teething, baby bottle tooth decay (also known as early childhood dental caries), and the unhealthy use of pacifiers. When the teething process occurs, normally between three and nine months, infants may experience symptoms of decreased sleeping, excessive biting or gnawing, rubbing of the ear or cheek area, loss of appetite, profuse drooling, swollen gum tissue, continuous rubbing of eyes, cheeks or ears, and a general sense of restlessness and irritability. Moreover, the common use of baby bottles is strongly associated with tooth decay due to frequent exposure to sugary liquids (including milk, baby formula, and fruit juices) that coat and erode the enamel of baby teeth leading to dental cavities. Similarly, pacifiers can introduce unhealthy bacteria into the infants' mouths if not cleaned and

¹⁴¹ Ibid.

¹⁴² "Oral Care for Babies: Brushing, Flossing, and Cavities | Colgate," accessed April 20, 2019, <https://www.colgate.com/en-us/oral-health/life-stages/infant-oral-care>.

administered properly.¹⁴³ The following section will address recommended practices for oral care relevant to infants and babies.

Prior to teeth eruption, infants should be given the appropriate amount of exposure to fluoride to strengthen their tooth enamel early on. In many municipal water supplies, the right amount of fluoride is distributed in water systems at a community-wide basis, but should be confirmed by calling one's local water district. If the local water supply does not contain any (or enough) fluoride, pediatricians or dentists can prescribe fluoride drops or fluoride supplements for infants if deemed necessary. In addition to administering fluoride, it is necessary to wipe the gums of infants after feedings with a clean gauze square, washcloth, or terry cloth finger cot to get rid of lingering bacteria and sugar particles. For reasons addressed earlier, infants should not fall asleep with bottles containing any sugary liquids overnight, nor should they be nursed continuously. Instead, they should be given bottles filled with water or a thoroughly cleaned (not dipped in any sugary liquids) pacifier with ventilation holes made of flexible, non-toxic material, which is large enough to not be swallowed.¹⁴⁴

The American Dental Association and the American Academy of Pediatric Dentistry recommend that a child's first dental appointment should be scheduled shortly after their first tooth erupts, no later than age one to two.¹⁴⁵ In doing so, parents or caregivers can provide children a *dental home*, or "an ongoing relationship between the dentist and the patient, inclusive of all aspects of oral health care delivered in a comprehensive, continuously accessible,

¹⁴³ Ibid.

¹⁴⁴ Ibid.

¹⁴⁵ "When to Take a Child to a Dentist for the First Time," accessed April 20, 2019, <https://www.colgate.com/en-us/oral-health/life-stages/childrens-oral-care/when-to-take-a-child-to-a-dentist-for-the-first-time-0113>.

coordinated, and family-centered way,”¹⁴⁶ to institute a lifetime of good oral health from an early age. Indeed, establishing a good dental home can address anticipatory guidance around preventive, acute, and comprehensive oral health care, and can include referral to dental specialists when appropriate, assuming that one has access to such services.¹⁴⁷

As infants’ teeth develop, it is necessary to brush them at least two to three times a day with a soft-bristled toothbrush and water. Toothpaste is not recommended until a child reaches the age of two. Once the child reaches the appropriate age, they should be taught to use only a pea-sized amount of fluoride toothpaste and avoid swallowing it. Infants who may have begun teething during this time should be treated with patience and eased of their discomfort by gently rubbing their gums with a clean finger, an infant gum massager or a wet gauze pad, and be given a clean teething ring for chewing if necessary.¹⁴⁸

Children’s Oral Care [2 to 12 years]

Dental caries (cavities) is the most common chronic disease in children; it is about five times as common as asthma and seven times as common as hay fever.¹⁴⁹ Therefore, parents and caregivers should cautiously monitor the incidence of cavities among their children, which may be linked to poor choices in snacking and dietary habits provided at home or school. As children’s baby teeth grow and evolve, they become susceptible to the same conditions and damage that adult teeth face, making it a very crucial period for maintaining good oral health. Other concerns that may arise during this time are signs of teeth crowding, and if that is the case,

¹⁴⁶ “Definition of a Dental Home,” accessed April 21, 2019, <https://www.aapd.org/research/oral-health-policies--recommendations/Dental-Home/>.

¹⁴⁷ Ibid.

¹⁴⁸ “Oral Care for Babies.”

¹⁴⁹ Benjamin, “Oral Health: The Silent Epidemic,” 158.

dental professionals can provide preventative or interventional treatment as necessary during bi-annual checkups.¹⁵⁰ The key concern during this period of development is to establish good, sustainable, routine oral hygiene practices so that children are more likely to engage in healthy hygiene habits throughout their life. The following section will address recommended practices for children's oral care.

During this critical period of dental development, children gain baby teeth, and subsequently begin to lose them around the age of six years. This mixed dentition now occupying their oral cavities brings specific concerns. Parents and caregivers should advise children to gently wiggle their loose baby teeth until they fall out on their own to minimize pain and associated bleeding. Additionally, it is important to establish an effective brushing and flossing routine that may adapt and evolve as the child grows. Flossing should begin when a child has two teeth that are touching, which normally occurs around two years of age. At age of two, children can likely hold a baby toothbrush (i.e. small, soft-bristle toothbrush) but may lack the manual dexterity to actually brush effectively, so they should be adequately supported when cleaning their teeth twice a day, especially before bedtime. By age seven or eight, children may want to brush independently with a bigger toothbrush, so it is best to allow them to transition into this phase, given that they are brushing their teeth well without additional support. As the child grows, it is recommended that their toothbrush be thrown out every three months, or when it starts to look worn out and the bristles are no longer straight. Flossing on the other hand, may not be acquired as quickly during child development. Indeed, it is not likely that children will be able

¹⁵⁰ "What Parents Should Know About Mouthwash for Children | Colgate," accessed April 24, 2019, <https://www.colgate.com/en-us/oral-health/life-stages/childrens-oral-care>.

to effectively floss until about age nine or ten, so they should again be given adequate support, assistance, or the provision of easier flossing tools such as dental flosser or floss picks.¹⁵¹

Children should be receiving dental checkups every six months to ensure adequate preventive and restorative care that address oral health issues, especially dental cavities, as well as referrals to orthodontists when deemed necessary. Many of the same treatment and evaluation options that adults have are also available to kids including x-rays, dental sealants (thin plastic coatings applied to the grooves on the chewing surfaces of the back teeth to protect them from dental caries), fluoride and orthodontic treatments, and pulpectomies (procedure involving the removal of an infected or diseased pulp from the tooth to avoid extraction).¹⁵²

Teen Oral Care

In this stage of pubescence and maturation, profound hormonal and developmental changes occur, affecting physical, mental, and oral health, all of which are inextricably tied in nature. Thus, teenagers can be expected to have orthodontic and wisdom teeth issues as their permanent dentition settles into their developing jaws. It is important to note that in addition to such significant overall body changes, teenagers are still be susceptible to dental cavities, which are related to poor diet and consumption of tobacco and alcohol products.¹⁵³ The following section will address recommended practices for teen-related oral care.

Up until this point in development, teenagers should continue engaging in the aforementioned oral hygiene habits that were hopefully introduced in early childhood. If they still have difficulty adhering to these practices, patients and caregivers should engage in

¹⁵¹ Ibid.

¹⁵² Ibid.

¹⁵³ “Oral Care for Teenagers: Braces, Wisdom Teeth | Colgate,” accessed April 20, 2019, <https://www.colgate.com/en-us/oral-health/life-stages/teen-oral-care>.

conversations that address the importance of oral hygiene, which helps in alleviating dental cavities, stained or discolored teeth, and bad breath. Moreover, it is important to provide oral healthcare supplies (i.e. soft toothbrushes, fluoridated toothpaste, flossing products) and nutritious foods at home so that healthy oral hygiene habits can be reinforced over time. Other concerns for parents and caregivers should be to monitor their teens for excessive consumption of sugary beverages (i.e. sodas, sports and energy drinks, juices) and processed foods, and/or use of alcohol, tobacco products, and oral piercings. If teens are engaging such unhealthy substance use or actions, it is important to have constructive conversations with them, which can come from a dental provider, family member, teacher, or some other trusted person. In doing so, they can convey the evident concerns of carcinogens and toxins in tobacco products, which can cause various types of cancer, gum disease, bad breath, tooth discoloration and a diminished sense of smell and appetite; and the adverse effects that oral piercings can have on the health of the tongue, lips, cheeks and uvula leading to speech impairment, fractured teeth and gingival recession if not maintained properly, all of which may help in changing their behaviors towards more positive habits.¹⁵⁴

Adult Oral Care

Maintaining healthy habits can become more difficult during the aging process as the body deteriorates while risk factors and stressors increase; therefore, it is critical to maintain a healthy, consistent oral hygiene routine early on and throughout adulthood to decrease the likelihood of developing oral health issues. This means that adults should be brushing twice a day with fluoride toothpaste to remove dental plaque (sticky film on teeth), which is the primary

¹⁵⁴ Ibid.

cause of tooth decay and inflamed gums, and flossing daily between teeth and under the gum line for similar reasons of removing plaque before it hardens into tartar. Some common oral health symptoms that arise among adults are dry mouth (common side-effect of medications) and teeth sensitivity (due to enamel loss).¹⁵⁵

Moreover, during this period of development, adults are especially susceptible to periodontal diseases, which usually manifest after the age of 35, but may be sooner due to poor oral hygiene practices. Therefore, it is critical that adults see a dental provider, a dentist or periodontist, every six months to discuss oral health conditions that may arise while maintaining a good oral hygiene routine at home. Indeed, preventive maintenance throughout adulthood is a principal concern, however, when prevention does not suffice, restorative or surgical care is necessary to re-establish structure and function to teeth that are damaged, infected, or missing through procedures such as dental fillings, crowns and/or bridges, dental implants, root canals, or tooth extractions.¹⁵⁶

Oral Hygiene Maintenance Throughout Life

At any point in human development, the teeth and gums are susceptible to decay, recession, and inflammation. Thus, it is crucial for every person to understand the impact of oral health issues, and practice good oral hygiene techniques to effectively prevent the two leading causes of poor oral health: dental caries and periodontal diseases. Alleviating the burden of these prevalent diseases should begin with the “understanding that tooth loss is often the result of disease or injury, rather than an inevitable consequence of aging.”¹⁵⁷ Moreover, this assumption

¹⁵⁵ “Oral Care for Adults: Brushing, Flossing, Cavities | Colgate,” accessed April 20, 2019, <https://www.colgate.com/en-us/oral-health/life-stages/adult-oral-care>.

¹⁵⁶ Ibid.

¹⁵⁷ Benjamin, “Oral Health,” 159.

of oral health literacy should not fall solely on patients, but rather should be the responsibility of both patients and frontline clinicians (i.e. dentists, dental hygienists, dental assistants) to detect oral health conditions during checkups. At the clinical level, dental providers should offer comprehensive preventive and restorative dental care, including oral cancer screenings, as well as oral hygiene instruction (i.e. proper tooth brushing and flossing techniques, promotion of healthy dietary and lifestyle habits).^{158,159} At the patient level, it is important that people of all ages adhere to the treatment plans and recommendations provided by dental providers, and implement necessary lifestyle changes accordingly. By shifting the paradigm towards prevention, the burden of oral health disease can be distributed among patients and providers alike to avoid victim-blaming,¹⁶⁰ which in turn, may set up successive generations for positive oral health outcomes.

¹⁵⁸ “Dental Caries.” Accessed March 27, 2019. <https://www.ada.org/en/member-center/member-benefits/practice-resources/dental-practice-parameters/dental-caries>.

¹⁵⁹ Stephen Birch et al. “Prevention in Practice – a Summary,” *BMC Oral Health* 15, no. 1 (September 15, 2015): 12.

¹⁶⁰ Richard Geddie Watt. “From Victim Blaming to Upstream Action: Tackling the Social Determinants of Oral Health Inequalities,” *Community Dentistry and Oral Epidemiology* 35, no. 1 (2007): 1–11. <https://doi.org/10.1111/j.1600-0528.2007.00348.x>.

CHAPTER THREE: PUBLIC POLICY IMPLICATIONS OF ORAL HEALTH

“Doctors are doctors, and dentists are dentists, and never the twain shall meet. Whether you have health insurance is one thing, whether you have dental insurance is another. Your doctor doesn’t ask you if you’re flossing, and your dentist doesn’t ask you if you’re exercising.”¹⁶¹

Medical and Dental Divide of the U.S. Healthcare Delivery System

Background

The medical-dental divide is a critical determinant of oral health inequality in the United States. This divide dates back to hundreds of years ago when the lack of integration in professional development laid the foundation for what is now known as organized medicine and dentistry. Historically, the medical profession has not embraced dentistry as a component of healthcare. In fact, before the 1800’s, barbers used to also perform dental procedures and extractions,¹⁶² making the barber-surgeon ties to the dental profession perceived as “more of a trade than a healing art” compared to medical professions.¹⁶³ These separate origins were mirrored in the educational system as dentistry was not recognized during the conception of medical schools, leading to the independent establishment of the first dental school in 1840.¹⁶⁴ Since then, all aspects of dentistry (i.e. education, training, financing, workforce, accreditation & licensure, scope of practice, and delivery systems) in the U.S. evolved separately from medicine for hundreds of years, solidifying its artificial division in the healthcare system. As a result, this divergent healthcare system has not only effectively separated the mouth from the body, but it has also created a hierarchy where medicine reigns over all aspects of priority and utilization of

¹⁶¹ Julie Beck, “Why Dentistry Is Separate From Medicine,” *The Atlantic*, March 9, 2017, <https://www.theatlantic.com/health/archive/2017/03/why-dentistry-is-separated-from-medicine/518979/>.

¹⁶² John Titor, “History of Dentistry: From Barber-Surgeons to Dentists,” *History Daily*, accessed April 19, 2019, <https://historydaily.org/history-dentistry-barber-surgeons-dentists>.

¹⁶³ Otto, *Teeth*, 58.

¹⁶⁴ Elizabeth A. Mertz, “The Dental–Medical Divide,” *Health Affairs* 35, no. 12 (December 1, 2016): 2168, <https://doi.org/10.1377/hlthaff.2016.0886>.

healthcare services; this largely carves out oral health from insurance coverage, medical records, payment systems, health literacy, diagnostic practices, spheres of operation, and even structural policy reform.

The artificial medical-dental divide is pervasive in all areas of the privatized market of the U.S. healthcare system and poses significant challenges to improving population health at large, given that oral health and general health are inextricably linked. One case that precisely illustrates the downstream effects of this artificial divide is Dr. Gayathri Subramanian's accounts of treating a patient named James, a middle-aged man working multiple odd jobs who was diagnosed with tongue cancer, but intentionally delayed his need for eighteen tooth extractions before radiation treatment because he could not afford it.¹⁶⁵ She states that this artificial divide forced her patient to prioritize care based on affordability rather than need, leading to the irreversible risk of osteoradionecrosis (bone death due to radiation), and subsequent development of a "fungal infection in his mouth—a fallout of an immune system compromised by chemotherapy and radiation treatment."¹⁶⁶ Throughout the treatment process, there was no standard of care that required dental referral and clearance, nor any provisions to offer urgent oral health care services for this low-income patient who delayed dental care initially only to develop a more serious, painful and incurable disease. This case clearly shows the way in which the medical-dental divide funnels adverse health outcomes, and further supports Otto's argument that the infrastructure of existing divergent care systems are built upon a model of "entitlement to care," which is essentially a large-scale social issue that is insufficiently solved with private means.¹⁶⁷

¹⁶⁵ Gayathri Subramanian, "Bridging the Divide Between Dental and Medical Care," *Health Affairs* 35, no. 12 (December 1, 2016): 2338, <https://doi.org/10.1377/hlthaff.2016.0763>.

¹⁶⁶ Ibid.

¹⁶⁷ Otto, *Teeth.*, 119.

The following sections will illustrate how the medical-dental divide has been systematically funneled through the U.S. healthcare system since its professional development into education and practice, insurance coverage, and delivery systems, all of which has effectively sustained oral health disparities.

Education & Practice

The separate establishment of medical and dental schools has effectively trained physicians and dentists to view the mouth and body as distinct entities. Indeed, oral health education has been historically excluded from medical school curricula, leaving medical students with little to no training about examining patients' mouths for oral health conditions or referring them to dental providers.¹⁶⁸ This carries over to the frontline of healthcare delivery, which is largely driven by primary care medical professionals (i.e. include primary care physicians, nurse practitioners, behavioral care providers, pharmacists, physician assistants, and registered nurses) who rarely provide patients with proper oral care.¹⁶⁹ Similarly, dental schools produce clinicians who are well-versed in oral health, but have a more limited perspective on overall health. Few dental students are equipped to examine a patient holistically by taking their vital signs, evaluating their risk of heart disease or stroke (among other conditions), or spotting early symptoms of disease beyond the oral cavity;¹⁷⁰ this evidently translates into dental settings where general dentists rarely have the intention or equipment to prioritize any diagnostic concerns. Despite a growing body of clinical and evidence-based knowledge around oral-systemic

¹⁶⁸ Sang E. Park et al., "The Impact of Integrating Oral Health Education into a Medical Curriculum," *Medical Principles and Practice* 26, no. 1 (2017): 61, <https://doi.org/10.1159/000452275>.

¹⁶⁹ Ibid.

¹⁷⁰ "It's Time to Break down the Wall between Dentistry and Medicine," STAT, July 17, 2017, <https://www.statnews.com/2017/07/17/dentistry-medicine-division/>.

linkages, this blatant separation in the education, training, and practice of physicians and dentists poses dire consequences in terms of diagnoses, which can often be delayed,¹⁷¹ ignored, or inaccurate, leading to especially poor oral health outcomes among those who are least likely to receive any medical attention, let alone dental care. Clearly, there is a rift in the worlds of medicine and dentistry, which effectively percolates into every aspect of the healthcare system.

Insurance Coverage

One of the biggest consequences of this divergent system is inaccessibility to comprehensive, quality healthcare, which is largely determined by insurance coverage plans. In the 1960s and 1970s, most consumers assumed costs of dental services through direct out-of-pocket payments, in contrast to medical costs, which were characterized by “insurable risk,” meaning medical diseases were worthy of insurance because they could lead to “major loss, infrequent, unwanted, and beyond individual control.”¹⁷² Oral diseases, on the other hand, were not considered to have these characteristics of insurable risk, especially when seen in isolation, because they were perceived as “unlikely to be catastrophic.”¹⁷³ Thus, dental benefit systems were purposefully not modeled after medical plans; instead, they were introduced as a prepaid benefit plan to incentivize people to seek care, making the major sources of financing dental care as out-of-pocket payments, followed by private insurance payments.¹⁷⁴ Indeed, dental benefits were not really structured as insurance against anything, but rather as a down payment on preventive services. The great paradox is that there is increasing clinical evidence to support that

¹⁷¹ “Eliminating the Medical/Dental Care Divide | The Actuary Magazine,” accessed April 23, 2019, <https://theactuarymagazine.org/eliminating-medical-dental-care-divide/>.

¹⁷² Mertz, “The Dental–Medical Divide,” 2170.

¹⁷³ *Ibid.*, 2171.

¹⁷⁴ Julie Farmer et al., “Towards an Understanding of the Structural Determinants of Oral Health Inequalities: A Comparative Analysis between Canada and the United States,” *SSM - Population Health* 2 (December 1, 2016): 226–36. <https://doi.org/10.1016/j.ssmph.2016.03.009>.

oral diseases should not be seen in isolation (as addressed in chapter two) because they can potentiate fatal, systemic effects, leading to large-scale expenses and leaving those who are of the utmost need as the least likely to receive care.

Though there have been several attempts to reform the U.S. healthcare delivery model over time, President Obama's enactment of the Patient Protection and Affordable Care Act (ACA) introduced an unprecedented, robust, comprehensive healthcare reform in 2010 in efforts to combat the "complex crisis characterized by inadequate access for some and high costs for everyone."¹⁷⁵ The ACA established several novel criteria, including, but not limited to: individual insurance mandates, employer mandates, the expansion of public programs, the establishment of state and federal insurance exchanges, financial reforms (premiums, cost-sharing subsidies), and the provision of ten essential health benefits among qualifying health benefit plans.¹⁷⁶ With the introduction of these criteria, the ACA has made a strong attempt to remedy the problem of America's uninsured by seemingly expanding public and private insurance options; however, consistent with the bifurcation of the mouth and the body, it has failed to uphold dental coverage to same standards as medical coverage. Generally, the three methods of purchasing dental coverage on ACA's marketplaces include¹⁷⁷:

1. An *embedded dental plan* within qualified health plans (one premium for one combined medical and dental policy).
2. A *bundled plan* (one premium for separate medical and dental policies).

¹⁷⁵ Thomas S. Bodenheimer and Kevin Grumbach, *Understanding Health Policy: A Clinical Approach* (New York City: McGraw-Hill Companies, 2009), 15.

¹⁷⁶ "Summary of the Affordable Care Act," *Kaiser Family Foundation*, last modified April 25, 2013, <https://www.kff.org/health-reform/fact-sheet/summary-of-the-affordable-care-act>.

¹⁷⁷ Mertz, "The Dental–Medical Divide," 2170.

3. A *stand-alone dental plan* purchased alongside a qualified health plan (two premiums for separate medical and dental policies).

Because the individual mandate does not apply to stand-alone plans, and the costs can be considerably less, these plans predominate, perpetuating the divide between coverage options.¹⁷⁸

The exception to this insufficient dental coverage is that children under Medicaid and the Children’s Health Insurance Program (CHIP) are guaranteed comprehensive dental coverage regardless what state they reside in because pediatric dental services are deemed an “essential health benefit.”¹⁷⁹ Although this legislation has made some progress to expand access to dental care among low-income children, it does not establish how the federal government should mandate these dental benefit provisions, resulting in considerable variance among states to implement it into ACA’s marketplace.¹⁸⁰ On the other hand, the situation is even more dire for adult populations on Medicaid because dental coverage for adults is not an essential benefit; thus, health plans that qualify to sell coverage on the ACA marketplace exchanges do not need to provide dental care for adults. Without this federal provision, a majority of states (32) offer little to no dental benefits for adults under Medicaid. Indeed, states typically cut out adult dental services in Medicaid when facing budget pressures, which is especially evident among the four states with virtually no dental coverage.¹⁸¹

This convoluted structure of dental coverage essentially amounts to a system of commoditized dental care, leaving many individuals and families with no provision or knowledge to assume dental benefits, nor any incentive to voluntarily purchase them. As a result,

¹⁷⁸ Ibid.

¹⁷⁹ “Summary of the Affordable Care Act.”

¹⁸⁰ “FAQ: Pediatric Oral Health Services in the Affordable Care Act,” accessed April 22, 2019, <https://www.cdhp.org/resources/165-faq-pediatric-oral-health-services-in-the-affordable-care-act>.

¹⁸¹ Ibid.

dental care is underutilized and underprioritized across populations, and further compounds the effects of poor oral health outcomes among disadvantaged and underserved communities.

Delivery System

Due to the persistent medical-dental divide and lack of structural integration between these fields, the model of dental care delivery has remained isolated and relatively unchanged over the years, operating in essentially two distinct parts: the *private delivery system* and the *safety net*. Indeed, there is little integration of either sector with wider health care services, and the two systems function almost completely separately; they use different financing systems, serve different clientele, and provide care in different settings.¹⁸² In the private delivery system, care is usually provided in small, private dental offices and financed primarily through employer-based or privately purchased dental plans and out-of-pocket payments, while the safety net is made up of a diverse and fragmented group of providers who are financed primarily through Medicaid and the Children's Health Insurance Program (CHIP), other government programs, private grants, as well as out-of-pocket payments.¹⁸³ The private delivery system and safety net have operated separately for quite some time because private dentists are concerned about low-reimbursements rates (which are usually below overhead costs), administrative burden, and high no-show rates among Medicaid patients.¹⁸⁴ In efforts to combat this issue more recently, some

¹⁸² Read "Advancing Oral Health in America" at NAP.Edu, accessed April 2, 2019, <https://doi.org/10.17226/13086>.

¹⁸³ Ibid.

¹⁸⁴ Elizabeth Hinton, Julia Paradise Published: Mar 17, and 2016, "Access to Dental Care in Medicaid: Spotlight on Nonelderly Adults," *The Henry J. Kaiser Family Foundation* (blog), March 17, 2016, <https://www.kff.org/medicaid/issue-brief/access-to-dental-care-in-medicaid-spotlight-on-nonelderly-adults/>.

states legislatures, like California, have increased reimbursement fees to incentivize private dentists to accept patients with Medicaid.¹⁸⁵

The two-tier system of dental care delivery has been largely maintained in the current infrastructure; as a result, “dentistry’s professional isolation and control via self-regulation has undoubtedly contributed to dominance in the political sphere, which—ample evidence suggests—has been used primarily to preserve the status quo of the lucrative fee-for-service solo practice.”¹⁸⁶ The concerted efforts to maintain this highly-conserved monopoly of dental care has been historically upheld by organized dentistry (i.e. the tripartite of the American Dental Association at the local, state and national levels) who claim that “professional training of a dentist is not only the sole indicator of oral health care quality but, indeed, the only one necessary.”¹⁸⁷ Thus, the structural conditions of the medical-dental divide has been further established by this culture of isolation among organized dentistry, leading to widespread oral health consequences. Given the nature of this fragmented system, an effective healthcare reform would work to integrate this large-scale divide by bridging the gaps that have allowed consequential oral health disparities to persist.

Because the separation of medicine and dentistry has been deeply embedded into the structural conditions of the U.S. healthcare system, oral health has been largely removed, and overlooked in all aspects of healthcare. The following sections will discuss how this divergent healthcare system, in addition to various other determinants, has silenced oral health issues across multiple levels, and effectively enabled oral health disparities to persist.

¹⁸⁵ “Higher Reimbursement Rates in Effect for Medi-Cal Dental Program,” California Dental Association, accessed April 25, 2019, <https://www.cda.org/news-events/higher-reimbursement-rates-in-effect-for-medi-cal-dental-program>.

¹⁸⁶ Mertz, “The Dental–Medical Divide,” 2172.

¹⁸⁷ Ibid.

The Silent Epidemic: Oral Health Disease

“What amounts to ‘a silent epidemic’ of oral diseases is affecting our most vulnerable citizens—poor children, the elderly and many members of racial and ethnic minority groups.”¹⁸⁸

The oral health of status of Americans has significantly improved since the mid-20th century. For example, untreated dental caries among children and adolescents aged 6–19 years has declined more than 70%, from 55% in 1971–1974 to 16% in 2007–2010.¹⁸⁹ This is largely attributable to the discovery and implementation of community water fluoridation, which has reduced the prevalence of dental caries and gingivitis in communities with and without fluoridated water through the diffusion of fluoridated water in the bottling and processing of foods and beverages, and widespread use of fluoride toothpaste.¹⁹⁰ Indeed, community water fluoridation has proven to be one of the greatest achievements in improving population oral health because it is equitable, both cost-effective and cost-saving, and reaches all residents of designated communities independent of individual behavior.¹⁹¹

Even with the introduction of water fluoridation and tremendous advances in dental technology, research, basic dentals services are still out of reach for many; indeed, only those who are directly assuming the benefits of oral health progress are less susceptible to tooth decay, which has effectively led to deepening trends in oral health disparities throughout the country. This is evidenced in the U.S. Surgeon General’s Report on Oral Health, a broad, comprehensive assessment of the nation’s oral health landscape that not only drew attention to the sweeping improvements made upon oral health conditions up until that time, but also acknowledged that

¹⁸⁸ “Oral Health in America: A Report of the Surgeon General (Executive Summary).”

¹⁸⁹ National Center for Health Statistics (US), *Health, United States, 2013: With Special Feature on Prescription Drugs*, Health, United States (Hyattsville (MD): National Center for Health Statistics (US), 2014), <http://www.ncbi.nlm.nih.gov/books/NBK209224/>.

¹⁹⁰ “Achievements in Public Health, 1900-1999: Fluoridation of Drinking Water to Prevent Dental Caries,” accessed April 21, 2019, <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4841a1.htm>.

¹⁹¹ Ibid.

“not everyone is experiencing the same degree of improvement.”¹⁹² The major themes of the report include the inextricable nature of the mouth and body, the need to address the implications of oral health beyond just healthy teeth, and a call to action for effective, preventative measures to meet the oral health needs of certain populations.¹⁹³ This report is largely considered the premier (and only) evaluation of oral health at a national scale, which gave voice to historically silenced oral health issues in society, and led to the formation of the National Oral Health Plan and efforts by the U.S. Department of Health and Human Services to include oral health in formulating national objectives for improving the overall health of all Americans.¹⁹⁴

The Surgeon General’s report brought increased awareness and significant changes around oral health issues since its release, however, to this day, the two largely preventable diseases, dental caries and periodontal disease, remain the biggest threats to oral health,¹⁹⁵ disproportionately affecting vulnerable populations, such as children, the elderly, and racial/ethnic minority populations.^{196,197} Therefore, societal progress in oral health has been made in some regards, but not in addressing the large-scale unmet needs of oral health that allow these disparities to persist. The following section will discuss these how the silencing of oral health not only applies to the burden of oral health diseases, but also to the silencing of unmet needs among vulnerable populations in California.

¹⁹² “Oral Health in America: A Report of the Surgeon General (Executive Summary).”

¹⁹³ Ibid.

¹⁹⁴ Oral Health,” Healthy People 2020, accessed November 9, 2018. <https://www.healthypeople.gov/2020/topics-objectives/topic/oral-health/objectives>

¹⁹⁵ Benjamin, “Oral Health,” 159.

¹⁹⁶ Dena J Fischer et al. “Oral Health Disparities: A Perspective From the National Institute of Dental and Craniofacial Research,” *American Journal of Public Health* 107, no. 1 (June 2017): 36–38. <https://doi.org/10.2105/AJPH.2016.303622>.

Unmet Needs of Oral Health

The overall oral health status among Americans has improved with the advent of community water fluoridation and various advances in dental technology, yet oral health disparities persist among vulnerable populations throughout the country, and is especially evident in California. Consider the following statistics as a snapshot of California's oral health disparities:

- **Children:** Tooth decay is the most common chronic condition experienced by children. In California, 54% of kindergarteners and 70% of third graders have experienced dental caries, and nearly $\frac{1}{3}$ of children have untreated tooth decay. Children of color and poor children experience greater instances of dental disease than their white, more affluent counterparts.¹⁹⁸
- **Pregnant Women:** There is a critical need for pregnant women to get oral health care to prevent adverse pregnancy outcomes. In California, only 42.1% of California women had a dental visit during pregnancy in 2012. Poor oral health and low access to care is more common among low-income women, black women, women with lower education levels, and women enrolled in Medi-Cal or no insured at all.¹⁹⁹
- **Adults:** Traditionally underserved adults also do not get the oral health care they need. Racial and ethnic minorities, people with less than a high school education and those with annual incomes under \$25,000 are least likely to visit a dentist.²⁰⁰
- **Seniors:** While data for California seniors are not readily available, nationally, 47.2% of U.S. adults have some form of periodontal disease. In adults aged 65 and older, 70.1% have periodontal disease. Periodontal Disease is higher in men than women, and greatest among Mexican Americans and Non-Hispanic blacks, and those with less than a high school education.²⁰¹

¹⁹⁸ Madhurima Gadgil et al., "Status of Oral Health in California: Oral Disease Burden and Prevention 2017," n.d., 69.

¹⁹⁹ Ibid.

²⁰⁰ Ibid.

²⁰¹ "Disparities in Oral Health | Division of Oral Health | CDC," December 14, 2018, https://www.cdc.gov/oralhealth/oral_health_disparities/index.htm.

- Children and Adults with Special Health Care Needs/Disabilities: The prevalence of unmet oral health care needs is almost twice as likely for those with special health care needs (SHCN). Low-income (under 200% FPL) children and adolescents with SHCN are 4 times more likely to have an unmet oral health care needs than children and adolescents with SHCN in families with incomes at or above 400% FPL. Black and Hispanic children with SHCN are more likely to have unmet oral health care needs than their white counterparts.^{202,203,204}
- Community-wide Fluoridation: 64% of California’s population receives fluoridated water from their community drinking water system, far short of the federal Healthy People 2020 target of 79.6 percent.²⁰⁵
- Dental-related Emergency Visits: The number and rate of visits to the emergency department for dental-related problems has increased substantially from 44,516 (in 2005) to 70,385 (in 2011) in California. A large proportion of these patients are uninsured and those covered by Medicaid.²⁰⁶

These are just a few out of many alarming statistics in California that illustrate how poor oral health is notably evident among vulnerable populations across all age demographics identified as having distinct or overlapping characteristics such as: racial/ethnic minority, pregnant, disabled and/or special needs status, homeless, unemployed, low socioeconomic status, and low educational attainment.²⁰⁷

²⁰² Angelia M. Paschal et al., “Unmet Needs for Dental Care in Children with Special Health Care Needs,” *Preventive Medicine Reports* 3 (2016): 62–67, <https://doi.org/10.1016/j.pmedr.2015.11.013>.

²⁰³ “ASTDD | Children with Special Health Care Needs,” accessed April 19, 2019, <https://www.astdd.org/children-with-special-health-care-needs/>.

²⁰⁴ “All Publications | National Maternal and Child Oral Health Resource Center,” accessed April 19, 2019, <https://www.mchoralhealth.org/publications/list.php>.

²⁰⁵ Ibid.

²⁰⁶ Rampa et al., “Trends in Dental-Related Emergency Department Visits in the State of California from 2005 to 2011,” *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology* 122, no. 4 (2016): 426, <https://doi.org/10.1016/j.oooo.2016.05.003>.

²⁰⁷ Institute of Medicine and National Research Council, *Improving Access to Oral Health Care for Vulnerable and Underserved Populations* (Washington, DC: The National Academies Press, 2011), <https://doi.org/10.17226/13116>.

Indeed, substantial proportions of California's populations suffer a disproportionate burden of oral disease and impairment because their needs are unmet. The unmet oral health needs fueling these oral health disparities are largely due to (1) unaffordable dental coverage and the (2) inaccessible dental providers. The issues of unaffordable dental coverage have been addressed previously; thus, the focus will shift towards the issue of inaccessible dental providers in the following sections.

More than 35,000 dentists were licensed to practice in California in 2012, representing about 15.6% of the total number of dentists nationwide, which is higher than in any other state.²⁰⁸ Clearly, the issue is not in terms of the quantity of inaccessible dental providers, but rather about their composition and distribution throughout the state. The simple fact is that the current dental workforce (i.e. dentists, dental auxiliaries, and other support staff involved in the provision of oral health care)²⁰⁹ does not have the capacity to meet the oral health needs of California's vulnerable populations. In order to assess this displacement, it is important to look at where dentists are distributed, who they are serving, and whose needs they mirror. Some ways to measure these components are by examining the following factors:

1. *Dental Health Shortage Professional Areas (DHPSA):*

Federal regulations stipulate that in order to be considered a DHSPA, an area must have a population-to-provider ratio of at least 5,000 to 1 (4,000 to 1 if there are unusually high needs in the community). Based on the current data, this means that approximately 10,635 dental practitioners are needed to remove DHPSA designations throughout California.²¹⁰ This data not

²⁰⁸ Nadereh Pourat and Moonkyung Kate Choi, "Trends in the Supply of Dentists in California," n.d., 5.

²⁰⁹ Eric S. Solomon, "Dental Workforce," *Dental Clinics of North America* 53, no. 3 (2009): 435, <https://doi.org/10.1016/j.cden.2009.03.012>.

²¹⁰ "Dental Care Health Professional Shortage Areas (HPSAs)," *The Henry J. Kaiser Family Foundation* (blog), February 13, 2019, <https://www.kff.org/other/state-indicator/dental-care-health-professional-shortage-areas-hpsas/>.

only reveals that 1,193,697 people are living in areas with dental shortages, but also shows that there is an exceedingly large burden placed on providers who may not have the capacity to address such a magnitude of needs, and patients who may face socioeconomic barriers (i.e. cannot afford insurance or afford to miss pay from their jobs for a while dental visit).

2. Number of dental providers enrolled in Medi-Cal:

There are currently more than 13 million individuals enrolled in Medi-Cal,²¹¹ which has steadily increased from 2009, when there were only 6.8 million people enrolled.²¹² A state audit conducted in 2012 found that 27, nearly half, of California’s counties had either no dental providers willing to accept new Medi-Cal patients or had an insufficient number of dental providers willing to accept new Medi-Cal patients.^{213,214} Moreover, a 2015 rate review by the state auditor showed a 12.6% decrease in rendering providers (individuals who provide care) and a 14.5% decrease in billing providers since 2008.²¹⁵ This data suggests that there are not enough providers to accommodate for increasing numbers of enrollees in Medi-Cal over time.

3. Diversity of the dental providers:

According to the California Department of Public Health’s State Burden Report, nearly 50% of dentists and 63% of dental hygienists in California are Caucasian/White/European or Middle Eastern, whereas dentists and dental hygienists who identify as African-American/Black/African, Latino/Hispanic, Indian/Native-American/Alaska-native or native-

²¹¹“Medi-Cal Managed Care Enrollment Reports,” accessed April 22, 2019, <https://www.dhcs.ca.gov/dataandstats/reports/Pages/MMCDMonthlyEnrollment.aspx>.

²¹²“2013 Edition — Medi-Cal Facts and Figures,” *California Health Care Foundation* (blog), accessed April 22, 2019, <https://www.chcf.org/publication/2013-edition-medi-cal-facts-figures/>.

²¹³“California State Auditor - Our Publications,” accessed April 22, 2019, <https://www.auditor.ca.gov/reports>.

²¹⁴“2009 Edition — Medi-Cal Facts and Figures,” *California Health Care Foundation* (blog), accessed April 22, 2019, <https://www.chcf.org/publication/2009-edition-medi-cal-facts-figures/>.

²¹⁵ California Department of Health Care Services, “*Medi-Cal Dental Services Rate Review*,” accessed April 22, 2019, http://www.dhcs.ca.gov/Documents/2015_Dental-Services-Rate-Review.pdf.

Hawaiian/Pacific-Islander make up less than 10% of the workforce.²¹⁶ Among these providers, the predominant language spoken is English, followed by Spanish. It is evident that dentists and dental hygienists are overwhelmingly white, while the majority of the state's populations is not. Clearly, this composition of the dental does not mirror the needs of a population as diverse as California's, and further compounds racial, linguistic, and cultural barriers for racial/ethnic minority populations, who are disproportionately affected by poor oral health, to access providers.

These measures delineate that California's unmet oral health needs are heavily due to lack of an adequate dental workforce capacity to meet the needs of its underserved and disadvantaged populations. Indeed, the aforementioned data shows that dental providers are not providing care for those who need it the most due to issues of distribution and composition. As a result of leaving these pervasive issues unaddressed, oral health equity is far from the current reality as vulnerable populations are compounded by numerous barriers of accessing dental providers and services. The following section will further contextualize this recurring discussion around persistent oral health disparities by drawing attention to the social determinants of oral health.

Social Determinants of Oral Health

Despite being a wealthy, well-developed, global superpower, the U.S. remains markedly behind other developed countries in its failure to provide comprehensive oral health care for all of its citizens. As a result, the roots of oral health inequity strongly grasp onto this fragmented system that largely prioritizes affluent, privileged populations over disadvantaged and

²¹⁶ Madhurima Gadgil et al., "Status of Oral Health in California: Oral Disease Burden and Prevention 2017," n.d., 55-56.

underserved communities. To gain a more nuanced understanding about how this occurs, it is important to examine how the social determinants of oral health can function as a principal domain in perpetuating oral health disparities, which essentially lead to socially stratified oral health outcomes.

Given the inextricable oral-systemic linkages in influencing population health, the following discussion will broadly adapt public health theories around health equity, health disparities, structural inequities, and social determinants of general health to oral health (aside from oral health-specific factors).

It is becoming increasingly recognized that in order to improve population health, the trajectory of health governance should trend towards prioritizing social justice in health.²¹⁷ In other words, the goal is *health equity*, or “the attainment of the highest level of health for all people, requires valuing everyone equally with focused and ongoing societal efforts to address avoidable inequalities, historical and contemporary injustices, and the elimination of health and health care disparities.”²¹⁸ In order to understand how to eliminate these disparities effectively, it is important to consider its underlying causal factors, which include social determinants of health and structural inequities. Indeed, the factors that strengthen and influence health disparities are determined by *structural inequities*, “personal, interpersonal, institutional, and systemic drivers—such as, racism, sexism, classism, ableism, xenophobia, and homophobia—that make those identities salient to the fair distribution of health opportunities and outcomes,” and *social determinants of health*, which refer to “both specific features of and pathways by which societal

²¹⁷ Braveman, P. & Gruskin, S. (2003). Defining equity in health. *Journal of Epidemiology and Community Health*, 57, 254-258.

²¹⁸ “Disparities,” Healthy People 2020, accessed February 9, 2019.

<https://www.healthypeople.gov/2020/about/foundation-health-measures/Disparities>

(including cultural) conditions affect health and well-being” such as “income, education, social capital, occupation, community structure, social support, availability of health services, cultural beliefs and attitudes, and legal channels.”²¹⁹ The impacts of social determinants of health can “accumulate during a lifetime, alter health trajectories across the life course, and be transferred across generations,”²²⁰ leading to poor biological and oral-health specific, psychosocial outcomes such as “social isolation, lower wages, and loss of self-esteem.”^{221,222} Moreover, social determinants collectively interact with biological and personal determinants to shape individual biology, individual risk behaviors, environmental exposures, and access to resources that promote health. ²²³ Essentially, these interrelated factors and systems at play contribute to the process of social stratification where individuals who are divided into subgroups based on the aforementioned determinants become subject to a graded relationship between social position and health status.²²⁴ Once this process of differentiation occurs, individuals are evaluated and sorted into higher social statuses based on favorable attributes, which then determines their respective healthcare provisions and health outcomes.²²⁵

These established social gradients in health are clearly evidenced in the landmark 2008 report of the World Health Organization’s (WHO) Commission on Social Determinants of

²¹⁹Donald L Patrick et al. “Reducing Oral Health Disparities: A Focus on Social and Cultural Determinants.” *BMC Oral Health* 6, no. 1 (July 10, 2006): 4, <https://doi.org/10.1186/1472-6831-6-S1-S4>.

²²⁰ Ritu Sadana. “What can public health programs do to improve health equity?” *Public Health Rep* 128, no.3 (2013):12–20.

²²¹ “Oral Health in America: A Report of the Surgeon General (Executive Summary).”

²²² Benyamini Yael et al. “Self-Rated Oral Health as an Independent Predictor of Self-Rated General Health, Self-Esteem and Life Satisfaction,” *Social Science & Medicine* 59, no. 5 (September 1, 2004): 1109–16, <https://doi.org/10.1016/j.socscimed.2003.12.021>.

²²³ Ibid.

²²⁴ Patrick et al., 2006.

²²⁵ Ibid.

Health²²⁶ and the “The Marmot report” for the UK in 2010,²²⁷ which indicate that the “social and economic factors that determine the conditions of daily life [of individuals and groups occupying] a social hierarchy, in addition to the environment, then determine exposure to health-enhancing or health-damaging conditions in daily life (e.g., where people are born, grow, live, work, and age).”^{228,229} Furthermore, a breadth of epidemiological evidence from a diverse pool of countries and populations shows that social gradients in oral health outcomes exist as well.^{230,231} Indeed, oral health disparities that are commonly reported for “caries, chronic periodontitis, and cancers of the head and neck, as well as for receipt of preventive dental visits, sealants, tooth loss, and quality of life”^{232,233} are socially patterned across hierarchies in morbidity and mortality, mirroring patterns found in general health.^{234,235} This established universality of the social gradient underlying oral health may indeed influence adverse oral health behaviors and outcomes; however, the extent to which social stratification precipitates oral health disparities varies along the spectrum, meaning that numerous social determinants of health are related to proximal causes, “such as health-compromising behaviors,” whereas social determinants of health disparities, or the “causes of the causes” such as the “the economic, social, and physical

²²⁶ Commission on Social Determinants of Health. CSDH final report: closing the gap in a generation: health equity through action on the social determinants of health. Geneva: World Health Organization; 2008.

²²⁷ “Fair Society Healthy Lives (The Marmot Review),” Institute of Health Equity, accessed April 2 2019. <http://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review>.

²²⁸ JY Lee et al. “The ethical imperative of addressing oral health disparities: a unifying framework,” *J Dent Res.* (2014):1–7.

²²⁹ Marisol Tellez et al., “Social Determinants and Oral Health: An Update,” *Current Oral Health Reports* 1, no. 3 (September 1, 2014): 148–52. <https://doi.org/10.1007/s40496-014-0019-6>.

²³⁰ A Sheiham A et al., “Global oral health inequalities: implementation and delivery of oral health research and strategies,” *Adv Dent Res* 23 (2011): 259–67.

²³¹ R Poulton, “Association between children's experience of socioeconomic disadvantage and adult health: a life course study,” *Lancet* 360, (2002):1640–5

²³² BA Dye et al., “Oral health disparities as determined by selected healthy people 2020 oral health objectives for the United States, 2009–2010,” *NCHS Data Brief* 104, (2012): 1–8.

²³³ WM Thomson, “Social inequality in oral health,” *Community Dent Oral Epidemiol* 40 no.2, (2012): :28–32

²³⁴ W Sabbah et al, “Social gradients in oral and general health,” *J Dent Res* 86,(2007): 992–6.

²³⁵ S Macintyre S, “Understanding the social patterning of health: the role of the social sciences.” *J Public Health Med* 16, (1994):53–9.

environmental causes of sugar consumption or smoking” acting at a macro-level, are distal causes.²³⁶

Though there is no definitive, theoretical model that has been developed to explain the causal pathways and processes linking the social determinants of oral health and resultant disparities to oral health outcomes, the life course analysis framework is effective in describing how social structure and social environments influence biological, behavioral, and psychosocial oral health factors as “disadvantage accumulates or clusters at critical periods throughout development” (Figure 9).²³⁷ Another public health model that serves as an adjunct to this theoretical framework is the conceptual model established by the American Academy of Pediatrics, which displays levels of influence as function of time and the environment (Figure 10).²³⁸ These diagrams are meant to visually encapsulate how social determinants are both interrelated and intersectional²³⁹ as they operate along multiple axes of advantages and vulnerabilities, which contribute to oral health disparities at large.

²³⁶Kuh D, Ben Shlomo Y. *A life course approach to chronic disease epidemiology*. Oxford: Oxford University Press; 1997.

²³⁷ Patrick et al., 2006.

²³⁸ “*Advancing Oral Health in America*.”

²³⁹ Nancy López and Vivian L. Gadsden, “Health Inequities, Social Determinants, and Intersectionality,” *NAM Perspectives*, December 5, 2016, <https://doi.org/10.31478/201612a>.

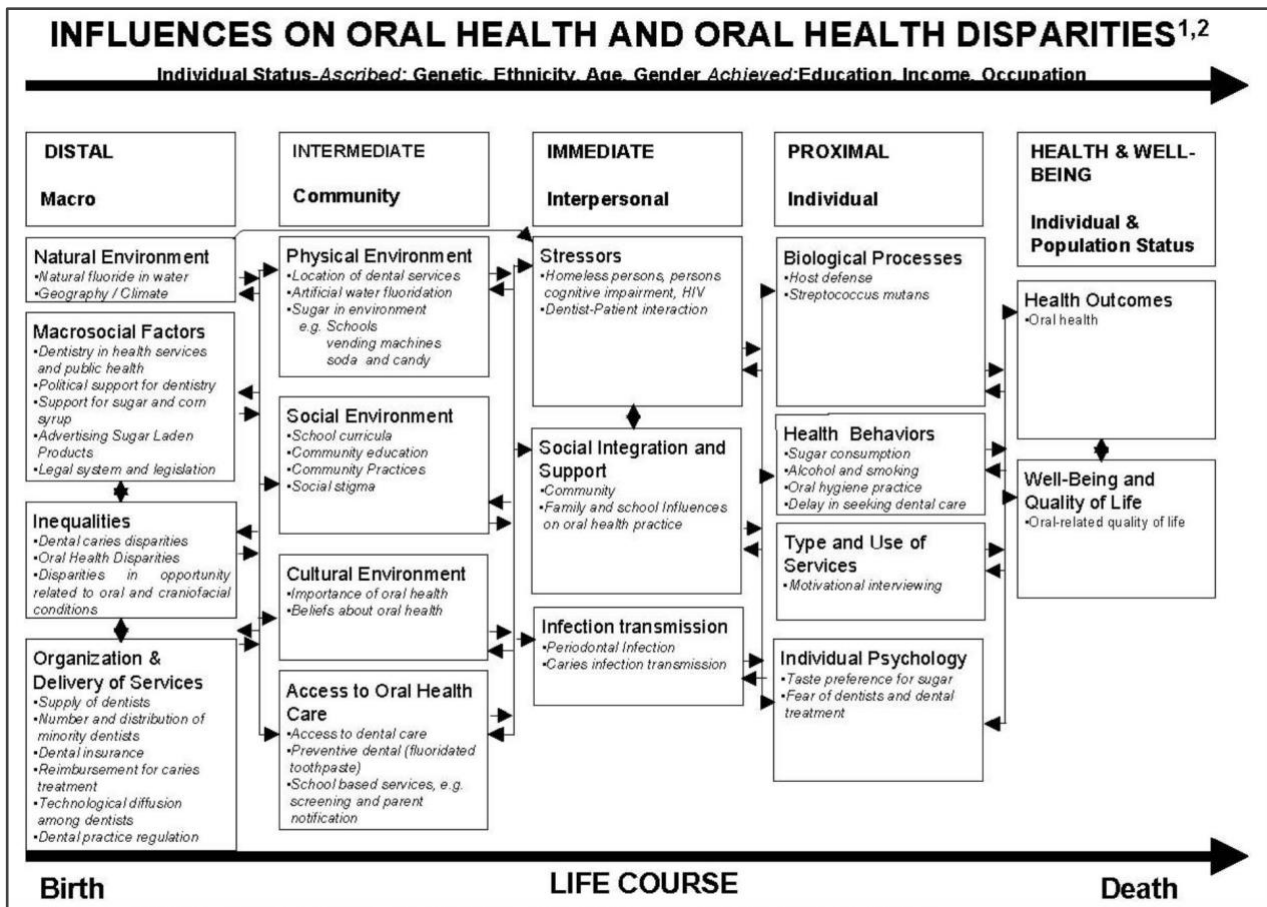


Figure 7. Life Course Analysis Model of Oral Health Disparities

Source: Patrick, Donald L., Rosanna Shuk Yin Lee, Michele Nucci, David Grembowski, Carol Zane Jolles, and Peter Milgrom. "Reducing Oral Health Disparities: A Focus on Social and Cultural Determinants." *BMC Oral Health* 6, no. 1 (2006): 4. <https://doi.org/10.1186/1472-6831-6-S1-S4>.

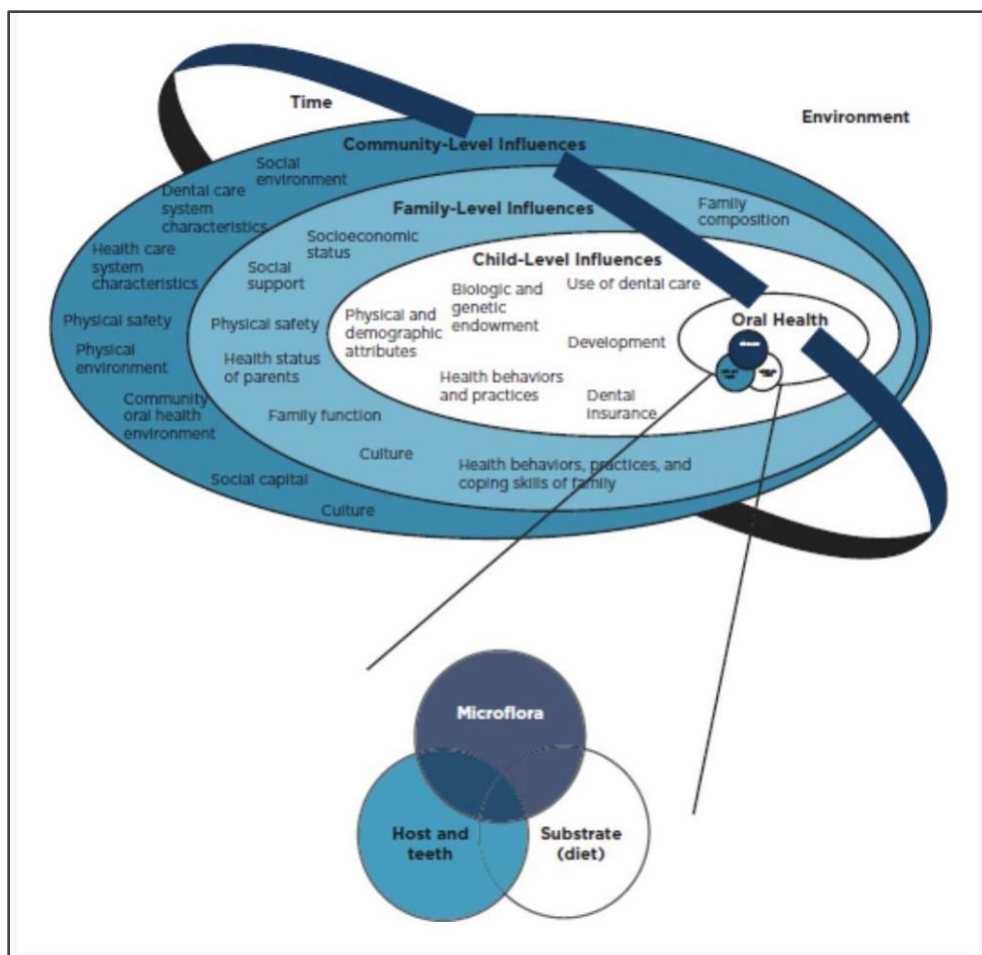


Figure 8. Conceptual Model of Level of Influences on Oral Health

Source: Institute of Medicine, *Advancing Oral Health in America*, (Washington, DC: The National Academies Press), 60.

Based on discussions of biological, social, and structural determinants thus far, it is well-established that good oral health outcomes are not uniformly attainable across all populations. Therefore, it is not surprising that even with remarkable advances in oral health, there have not been notable reductions in oral health disparities. This is further supported by the aforementioned theoretical models and frameworks on the social determinants of oral health, which not only address *what* factors are involved in this large-scale issue of oral health inequity, but also *how* they direct socially stratified oral health outcomes across populations. In other words, oral health outcomes are determined by social status; so, the lower one is in the social hierarchy, the greater likelihood that they have poor oral health.

The extent and magnitude to which social stratification precipitates oral health disparities depends on the effectiveness with which public policies can mitigate or exacerbate the effects of this social gradient in oral health, especially factors that are amenable to change such as healthcare and education. Thus, to effectively alleviate these disparities, public policy reform should focus on increasing access to dental care and oral health literacy among disadvantaged and underserved populations. It is quite evident that increasing access to dental care can lead to positive oral health outcomes; however, this conception is lesser known when it comes to understanding the importance of oral health literacy. Research shows that poor oral health literacy negatively affects oral health, and has a significant financial impact on society, making it a critical influence on health care use, health outcomes, and overall dental care costs.²⁴⁰ Indeed, poor oral health literacy is inextricably tied to poor access because individuals may not understand the importance of oral diseases and oral healthcare, or may not even know their options for accessing such care.²⁴¹ Thus, by addressing both areas of access and education around oral health, disparities fostered around various axes of social stratification from macro to micro, proximal to distal, national to state, and community to individual can be alleviated. In doing so, this would redistribute the necessary power, agency, and resources for historically socially-excluded populations to practice positive oral health behaviors such as following healthy dietary and oral hygiene habits, and accessing dental services to meet their respective needs.

Along the basis of reorienting public policy towards a social justice model to address oral health disparities, the subsequent chapters will introduce and examine the implications of a public health intervention, dental therapy, which has strong evidence of mitigating oral health disparities by increasing access to preventive dental care services and knowledge of oral health

²⁴⁰ Tellez et al., 2014.

²⁴¹ Patrick et al., 2006.

through a community-based model. It should be noted that addressing every aspect of the aforementioned determinants in mitigating oral health risks is beyond the scope of this paper; thus, more focus will be placed upon trending towards oral health equity through principal strengths identified in the dental therapy model.

CHAPTER FOUR: EXPANDING THE DENTAL WORKFORCE

The following chapters will shift towards examining a community-based, public health early-intervention model, known as dental therapy, as one solution to improve oral health outcomes by expanding the traditional dental care workforce to address oral health disparities. However, before moving into analysis of the dental therapy model, it is important to note what California's dental workforce model currently looks like in order to understand what specific issues this dental therapy intervention can address.

In California, dental care services are largely funneled through a dental workforce comprised of three primary members summarized below²⁴²:

- ***Dentists*** (1) head the dental team in and is responsible and accountable for everything that goes on in the dental office, (2) receive extensive education and training to obtain a doctor of dental surgery (DDS) or doctor of medicine in dentistry (DMD) degree, (3) and specialize radiology, or surgery; endodontics, pediatrics, periodontics, prosthodontics, anesthesiology, dentofacial orthopedics, requiring post-doctoral dental education if necessary. Moreover, they are licensed to diagnose, plan treatments, and prescribe medications that treat oral health diseases and conditions, while receiving extensive clinical training in restorative and surgical care.
- ***Dental hygienists*** serve as the preventive and periodontal specialists of the dental team. They are equipped with oral hygiene instruction knowledge and skills to prevent and detect oral disease, clean teeth, provide nonsurgical procedures (ex. fluoride treatment), and support periodontal health. Hygienists have three

²⁴² "Careers in Oral Health | CDA (California Dental Association)," accessed April 22, 2019, <https://www.cda.org/public-resources/careers-in-oral-health>.

licensing options including the registered dental hygienist (RDH), registered dental hygienists in extended functions (RDHEF) and registered dental hygienist in alternative practice (RDHAP).

- ***Dental assistants*** are adjunct members of the dental team who provide supportive duties in the office with on on-the-job training or are licensed to work chairside with dentists in two ways, including the registered dental assistant (RDA) and the registered dental assistant in extended functions (RDAEF).

Under this workforce model, dental hygienists, and assistants conduct various tasks and procedures based on the permitted level of supervision that complies with their licensing standards, all of which is overseen by the dentist. Clearly, this model heavily relies on dentists who are delegated a high degree of authority and power in streamlining dental services, which fares far better in meeting the needs of affluent clientele in private practice settings as opposed to safety net clinics comprised of a “small subset of dental providers in a hodgepodge of disparate local, state, and federal programs and policies that seek to address the needs of vulnerable populations.”²⁴³ However, the issue here is not whether this type of dental workforce can function efficiently, but whether this workforce can function effectively in serving communities who face numerous socioeconomic barriers to accessing dental services (i.e. travel time, loss of pay for missing work, childcare) and often suffer from cyclical poor oral health outcomes and behaviors. Thus, the traditional dental workforce delivery model lends itself to persistent oral health disparities because populations that need the most care often do not have access to it.

In addition to this formal system of clinical care, there is an emerging, less-formal system that recognizes the important role community providers can play in providing oral health disease

²⁴³ Burton Edelstein, “The Dental Safety Net, Its Workforce, and Policy Recommendations for Its Enhancement,” *Journal of Public Health Dentistry* 70, no. s1 (2010): S32–39, <https://doi.org/10.1111/j.1752-7325.2010.00176.x>.

prevention and education services to families. This system acknowledges that many people learn better, and thus are more likely to adopt healthy behaviors, when they are in more comfortable settings within a community. Indeed, in California, this community-based system has been recognized in some capacity among community health workers, home-visitors,²⁴⁴ and Head Start providers, who are providing culturally competent oral health education in places, such as schools, community centers, homes, Head Start Centers, and other early learning sites.²⁴⁵ Although this community-based model is increasing access to oral health care among low-income families, it is largely unsustained, and does little to provide clinical care directly.²⁴⁶

Among current models of dental care delivery in California, private practices and safety net clinics lack community-based competencies, while community-based preventive and education systems lack clinical competencies. Since these structurally embedded dental care delivery systems are difficult to change, reforming more proximal factors, such as the dental workforce, can effectively merge the gaps in cultural and clinical competencies to produce more optimal oral health outcomes overall. More specifically, incorporating mid-level providers known as dental therapists, can meet the primary needs of achieving oral health equity by (1) reducing barriers to accessible dental providers and services, (2) alleviating the burden of oral health diseases among vulnerable populations, (3) and improving oral health behaviors by increasing oral health literacy. The following domestic case study analyses examining dental therapy in Alaska and Minnesota will be used to support the aforementioned claims, and

²⁴⁴ “Healthy Mouth, Healthy Start: Improving Oral Health for Young Children and Families Through Early Childhood Home Visiting – The Children’s Partnership,” accessed April 26, 2019, <https://www.childrenspartnership.org/research/healthy-mouth-healthy-start-improving-oral-health-young-children-families-early-childhood-home-visiting/>.

²⁴⁵ “Head Start Program Performance Standards Related to Oral Health | ECLKC,” accessed April 22, 2019, <https://eclkc.ohs.acf.hhs.gov/oral-health/article/head-start-program-performance-standards-related-oral-health>.

²⁴⁶ Jenny Kattlove, Interview.

essentially shape policy recommendations for introducing this dental workforce innovation in California.

Dental Therapy Movement

Oral health workforce models and care delivery systems have evolved since the conception of the dental profession; however, the current infrastructure largely fails to meet the oral health needs of millions of Americans. As a result of large-scale assessments, evaluations, and overwhelming dissatisfaction regarding the lack of dental coverage among certain populations, the movement to integrate dental therapists into the dental workforce gained traction. Dental therapists are the seemingly equivalent counterpart of nurse practitioners and physician assistants in the medical field. Their scope of practice is under the jurisdiction of a dentist where they can be tasked with educating patients about oral health and prevention, performing dental evaluations, and conducting procedures such as fluoride treatments, teeth cleanings, simple extractions, and placing dental sealants and fillings.²⁴⁷ Dental therapists also have accredited skills that allow them to do certain dental procedures in specified settings outside of a traditional dental office.²⁴⁸ This flexibility allows dental therapists to participate in a variety of community-based settings such as safety net dental clinics, and effectively breaks down barriers of inaccessibility and vulnerability (Figure 9). Moreover, dental therapists have been well-established providers internationally in more than 54 countries such as Canada, New Zealand and Australia, and domestically state-wide or on tribal lands in Alaska, Oregon,

²⁴⁷ “Dental Therapists Can Improve Access to Dental Care for Underserved Communities,” Families USA, accessed November 28, 2016, <https://familiesusa.org/product/dental-therapists-can-improve-access-dental-care-underserved-communities>.

²⁴⁸ Tony Yang et al., “Dental Therapists: A Solution to a Shortage of Dentists in Underserved Communities?” *Public Health Reports* 132, no. 3 (May 1, 2017): 286. <https://doi.org/10.1177/0033354917698114>.

Washington, Arizona, Maine, Minnesota, Vermont, and most recently Michigan, making it the eighth state to authorize dental therapy.²⁴⁹

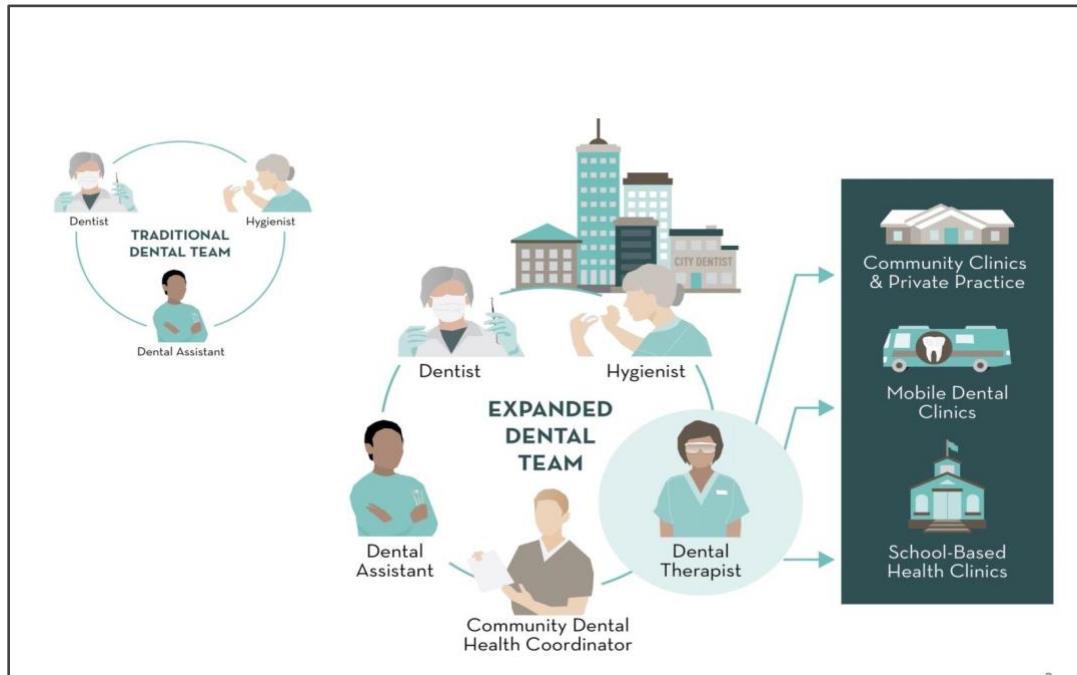


Figure 9. Expanding the Traditional Dental Team to Include Dental Therapists.

Source: Community Catalyst Advocacy Workshop Presentation Slides

Numerous studies cite evidence of the successful establishment of dental therapists in narrowing the distance between providers and patients, which effectively alleviates a large-scale oral health disparity regarding access to care.²⁵⁰ A robust monograph released by Kellogg Foundation reviewing 1100 documents from 54 countries utilizing dental therapists concluded that “they improve access to care for children and provide quality care with effective results.”²⁵¹ A further review of international programs stated that “dental therapists practicing in

²⁴⁹ “States Expand the Use of Dental Therapy,” accessed April 4, 2019, <http://pew.org/2cWiqgc>.

²⁵⁰ Sarah Shoffstall-Cone and Mary Williard, “Alaska Dental Health Aide Program,” *International Journal of Circumpolar Health* 72 (August 2013): 1, <https://doi.org/10.3402/ijch.v72i0.21198>.

²⁵¹ David Nash et al., “A Review of the Global Literature on Dental Therapists,” *Community Dentistry and Oral Epidemiology* 42 (2014): 1-10, <https://onlinelibrary.wiley.com/doi/full/10.1111/cdoe.12052>.

schools are a cost-effective model of caring for children.”²⁵² Moreover, a systematic review of 23 articles from six industrialized nations determined that “dental therapists safely and competently perform the limited set of irreversible procedures that fall within their scope of practice.”²⁵³

Opposition from Organized Dentistry

Clearly, there is ample documentation of evidence-based research that supports the effective integration of dental therapists into the dental workforce throughout the world.

So why is the U.S. far behind other developed nations in incorporating this dental workforce model? Over several decades, much of the strong opposition against dental therapy has been upheld by organized dentistry who assert that dental therapists are unqualified providers delivering “second-tier or inferior care,”²⁵⁴ while others are concerned about cost-effectiveness, professional competence, and the adverse effects of distributing these mid-level providers upon dentists’ income and practices.²⁵⁵ These baseless claims by many dentists and professional dental associations have arose time and time again during legislative efforts to introduce dental therapy in the U.S. As a result, this extreme opposition to the inclusion of dental therapists in the dental workforce has essentially evolved into a highly controversial and politically charged topic.

Dr. Frank Catalanotto, a pediatric dentist by training and strong proponent of the dental therapy movement, notes that the public generally does not know what dental associations do behind the scenes; but, the actuality is that organized dentistry is very wealthy, powerful, and deliberately strategizes how to garner unified opposition against dental therapy from dentists,

²⁵² Kavitha Mathu-Muju et al., “Oral Health Care for Children in Countries Using Dental Therapists in Public, School-Based Programs, Contrasted with that of the United States, Using Dentists in a Private Practice Model,” *American Journal of Public Health* 103, no. 9 (September 2013): 8, doi. 10.2105/AJPH.2013.301251.

²⁵³ E. Phillips and H.L. Shaefer, “Dental Therapists: Evidence of Technical Competence,” *Journal of Dental Research* 92, no. 7 (July 2013): 14, doi:10.1177/0022034513484333.

²⁵⁴ Friedman and Mathu, “Dental Therapists,” 1006.

²⁵⁵ *Ibid.*, 1005.

while keeping the benefits of the movement outside of the public eye by rolling out negative PR campaigns.²⁵⁶ He recounts a personal incidence of dealing with the “buzzsaw of the American Dental Association and the Florida Dental Association” who tried to fire him during his relatively novel attempt to set up community-based dental clinic affiliations when he was a former dean at the University of Florida’s School of Dentistry back in 1995. At the time, Dr. Catalanotto’s intent was to allow dental students to directly serve the community; however, the associations strongly objected to having dental students work in safety net clinics like federally qualified health centers (FQHCs) because they feared business competition for dentists, which infuriated him because “these were patients who were simply not being seen.”²⁵⁷ Since then, Dr. Catalanotto has become heavily involved in the training, advocacy, and research efforts of the dental therapy movement. From these experiences, he communicates some revealing insight into the roots of organized dentistry’s strong pushback against dental therapy:

I am convinced that the fight against dental therapy is coming from the leadership. People who want to keep their jobs as elected officers of these associations because of all of the perks they get. Organized dentistry is losing some membership with the millennial generation and this is a way to show the membership that they are fighting for them as dentists instead of fighting for good healthcare...the reality is that what really wins this for them is their PAC [political action committee] dollars. Every legislator for the most part has a dentist once or twice a year where that legislator is a captive person in that dentist chair... and they have a highly organized PAC system with lots of money that they give to forward elections. We as advocates don’t and can’t do that, so the facts almost don’t make a difference. Unfortunately, there are lots of legislators who respond to PAC dollars, and there are others who will sit and listen to good data, and understand what we are saying, and believe us when we say it when and we show them the reports and that’s the group o we try to work with.²⁵⁸

²⁵⁶ Wendell Potter and Joey Rettino, “Dental Therapy with Dr. Frank Catalanotto, *The Potter Report*, podcast audio, Jan 10, 2019, <http://wendellpotter.com/tag/dental-care/>.

²⁵⁷ Ibid.

²⁵⁸ Ibid.

Despite facts, research, and evidence around dental therapy, it is evidently the shocking effects of organized dentistry that has historically kept this workforce innovation from being implemented throughout the country. The following sections will examine two case studies of dental therapy in Minnesota and Alaska, states that frontlined the dental therapy movement in spite of opposition by organized dentistry.

CHAPTER FIVE: CASE STUDIES

The dental therapy model is currently utilized in Minnesota and the tribal health system in Alaska. Although these regional models are not exactly the same, they share common themes of dental therapy that have been adapted to meet the needs of their respective communities. Each case study will cover specific adaptations of dental therapy in terms of legislative background, education and training, program infrastructure, supervision, scope of practice, and evidence of implemented practices. Ultimately, the purpose of this section is to present the narrative and research evidence of each dental therapy model, and drawn upon their strengths to inform its adaptability in California.

The Case Study: Dental Therapy in Alaska's Tribal Communities

Program Overview

As a part of a community-driven, tribal-led approach to increasing access to dental care among Alaska's underserved populations, the Alaska Native Tribal Health Consortium (ANTHC), in collaboration with tribal health organizations, began the Alaska Dental Health Aide Therapist Initiative in 2003 modeled after the dental therapy program that began in New Zealand in 1921.²⁵⁹ Since the successful establishment of the dental therapist workforce in 2004, Dental Health Aide Therapists (ADTEP's) have proven to provide culturally appropriate oral health education and routine dental services within the scope of their training among Alaska Native communities to which they are deployed following their accreditation. ADTEPs provide preventive and restorative dental care to children and other underserved populations in some of Alaska's most remote communities in efforts to reduce high levels of cavities and among other

²⁵⁹ Nash et al., 2014.

prevalent oral health issues.²⁶⁰ Indeed, ADTEPs are effectively extending care to locations where there has been a historic shortage of dentists, and effectively save tribal communities millions of dollars on medical and transport expenditures to dental care hub clinics.²⁶¹

Legislative Background

Due to significant socio-demographic, lifestyle, and geographic barriers, Alaska Native populations have long endured poor oral health issues largely due to inaccessible dental providers. Knowing that Alaska's dental capacity to meet the overwhelming oral health needs among these communities was not adequate, Dr. Tom Bornstein, a pediatric dentist, spearheaded a movement to expand oral health care access for Alaska Natives in 1999. He did so by drafting a paper that not only outlined the dire oral health needs among Alaska Natives and American Indians, but also offered dental therapy as an effective solution to address these issues; he then presented this paper to the Alaska Tribal Health Organization board of directors who were so moved by the paper that they asked the Indian Health Services (IHS) director at the time, Geanine Tucker, to bring dental therapy into the tribal health system.²⁶² Through collaborative efforts, they decided that the easiest way to do bring dental therapy to Alaska was by using the preexisting Community Health Aide Program.²⁶³

From there, Dr. Ron Nagel was tasked with writing the standards and procedures of adopting dental therapy into this program.²⁶⁴ Because there was no established dental therapy

²⁶⁰ "Oral Health Outcomes for Alaska Native Communities Served by Dental Therapists Better Than for Those Without, Study Finds," *Rasmuson Foundation* (blog), accessed April 2, 2019, <https://www.rasmuson.org/news/oral-health-outcomes-for-alaska-native-communities-served-by-dental-therapists-better-than-for-those-without-study-finds/>.

²⁶¹ "Dental Health Aides Therapists: ANTHC's Tribal Solution for Alaska's Dental Care Crisis | Alaska Native Tribal Health Consortium," accessed April 2, 2019, <https://anthc.org/news/dental-health-aides-therapists-anthcs-tribal-solution-for-alaskas-dental-care-crisis/>.

²⁶² Dr. Williard, Interview.

²⁶³ "Alaska Community Health Aides - Home Page," accessed April 22, 2019, <http://www.akchap.org/html/home-page.html>.

²⁶⁴ Ibid.

curriculum in a U.S.-based education program at the time, Dr. Nagel arranged financial support from grants and with the continued from the Alaska Native Tribal Health Consortium, sent six students to the be trained at New Zealand's University of Otago dental therapy program in 2003.^{265,266} This cohort was succeeded by more students in following years who returned to Alaska with intensive didactic and clinical training where they spent three months with a supervising dentist (under their direct supervision), providing patient services in hub clinics.²⁶⁷ Indeed, it was the concerted efforts among IHS, ANTHC, and the aforementioned dentists that led to the establishment of Dental Health Aide Therapists (DHATs) in Alaska's native communities. This seemingly smooth process of streamlining dental therapists into the community, however, came with strong opposition from none other than organized dentistry. Indeed, the American Dental Association and the Alaska Board of Dentistry instituted a lawsuit against the state of Alaska, the ANTHC, and the eight DHATs in Alaska at the time for an injunction on the program, and charged the state with failing to enforce the provisions of the dental practice act. ^{268,269} However, this lawsuit did not move forward because the DHAT program was implemented under the tribal health system, which has sovereign authority and self-regulation in health services, and therefore, was completely legal under federal law according to the Attorney General. Although the lawsuit was dropped for not having any substantial grounds, the efforts of organized dentistry to divert public attention towards their baseless claims persisted according to Dr. Willard:

I think the dental associations can really stop opposing something that is evidence-based and has a proven track record here in the U.S now. I've had to struggle to keep this program open because even though they dropped their lawsuit, they didn't

²⁶⁵ Ibid.

²⁶⁶ Stephanie Woods, Interview.

²⁶⁷ Ibid.

²⁶⁸ Dr. Willard, Interview.

²⁶⁹ "New or Expanded Oral Health Workforce Models in the U.S.," n.d., 64.

stop intimidating funders and things like that to keep them from helping us out. You know with the millions they've spent on opposing dental therapy, I could have spent on training thousands of dental therapists and solved the problem by now... To me, it's just immoral what they've done and what they continue to do. It's not like they've ever came out and tried to provide care to people who aren't receiving care. That's the reason why we need dental therapy, because dentistry was just not doing it.²⁷⁰

Over time, the DHAT education program has been sustained by various dental therapy advocates within the tribal health system, and has effectively evolved into a well-established program with pre-clinic and clinical sites in Bethel and Anchorage, Alaska.

Education & Scope of Practice

Dental Health Aide Therapists who are recruited from Alaskan Native communities, are funneled into the two-year Alaska Dental Therapy (ADTEP) Educational Program offered in partnership between ANTHC the Iñisagvik College through which they complete approximately 3,000 hours of training as well as a preceptorship consisting of a minimum of 400 hours.²⁷¹ This training prepares them to provide dental education, prevention, and urgent and routine restorative care. During the preceptorship, the supervising dentist gains a close understanding of the DHAT's skills and decides when he or she is ready for certification. The supervising dentist then establishes standing orders for the DHAT based on their observation of the DHAT's skills and clinical competence. The DHAT can then perform only those services that are listed in their standing orders without being at the same site as the supervising dentist.²⁷²

²⁷⁰ Dr. Williard, Interview.

²⁷¹ "Curriculum & Application | Alaska Native Tribal Health Consortium," accessed April 4, 2019, <https://anthc.org/alaska-dental-therapy-education-programs/students/>.

²⁷² Ibid.

After training, DHATs return to their communities in remote Alaska to provide dental care to the population. They work under general supervision; that is, their supervising dentists do not have to be in the same physical site as the DHATs. However, the supervising dentists are always available for consultation. A variety of methods of communication are used to facilitate supervision, including daily phone calls and emails, and a systematically organized system known as the *AFHCAN telehealth solutions program*, which uses technology to store, transfer, and communicate clinical information across electronic databases to make patient care more accessible and efficient for Alaska Natives and rural Alaskans. This is done so by allowing ADTEPs and supervising dentists to use various Web-based technologies to share images, radiographs, and dental and medical records and collaborate via videoconferencing,²⁷³ and in doing so, reduces wait times, travel times, and expenses of specialty care and follow-up visits.

The Evidence

Reducing Barriers to Access & Alleviating Burden of Oral Diseases

Since the implementation of the DHAT program, dental health aide therapists in Alaska have been providing high-quality dental care to thousands of people, which has simultaneously increased access to care and significantly alleviated these populations of oral health issues. Research shows that DHATs have expanded much-needed access to dental care and prevention services for more than 40,000 Alaska Native people living in 81 rural Alaska communities.²⁷⁴ A 2010 evaluation of the DHAT Workforce Model in Alaska by the Research Triangle Institute

²⁷³ “Telehealth | Alaska Native Tribal Health Consortium,” accessed April 2, 2019, <https://anthc.org/what-we-do/telehealth/>.

²⁷⁴ “The Oral Health Crisis Among Native Americans,” accessed April 2, 2019, <http://bit.ly/1HqI74a>.

demonstrated that DHATs are successfully treating cavities in a safe and competent manner, and relieving pain for people who often had to wait months or travel hours to seek treatment.²⁷⁵ In an even more recent 2017 study, the clinical researchers concluded with two main findings, the first being “increased DT [dental therapist] treatment days were significantly associated with increased rates of preventive care and decreased rates of extractions for children and adults,” and second, “children and adults in Alaska Native communities served by dental therapists had significantly better oral health outcomes than people in communities not served by them.”²⁷⁶ These positive health outcomes are further established in a longitudinal evaluation published by Dr. Lenaker in 2017 who reports that “by 2015, we started seeing significant improvements in our ability to keep healthy patients cavity free.. for example, in Emmonak, a small town on the Bering Sea, we had a report of a Head Start class with no new cavities. In rural Alaska, that is a small miracle.”

Indeed, there are sweeping improvements being made DHATs among the indigenous populations in Alaska to increase access to care and alleviate the burden of oral health diseases. The following section delineates how these outcomes are not simply due to the provision of dental services, but also due to the added benefit of improving oral health behaviors from an early age.

²⁷⁵ Wetterhall S, Bader JD, Burrus BB, et al. Evaluation of the dental health aide therapist workforce model in Alaska. 2010. At: www.rti.org/pubs/alaskadhatprogramevaluationfinal102510.pdf. Accessed 2 April. 2019.

²⁷⁶ Chi DL, Lenaker D, Mancel L, et al. Dental utilization for communities served by dental therapists in Alaska’s Yukon Kuskokwim Delta: findings from an observational quantitative study. Seattle: University of Washington, 2017.

Improving Oral Health Behaviors

DHATs are improving oral health behaviors by providing early-intervention and preventive care, especially among children. Dr. Williard, who currently trains DHATs in the program and oversees dental practices in the tribal health system states:

We are starting to build a whole dental workforce that actually mirrors the communities they are serving. They themselves are Alaska natives like the community they are serving, a lot of the time they have grown up there, people know them, trust them, they can speak the language, so getting into a community and building that trust comes much quicker than if an outsider tries to do that. And you can't do much prevention work that is meaningful if you don't have a community that trusts you. To change a behavior you have to trust that somebody is helping you do the right things.²⁷⁷

Moreover, Stephanie Woods, a practicing dental health aide therapist, builds upon this theme of improving oral health behaviors from a young age by drawing attention to the importance of motivational interviewing and oral hygiene instruction by describing her experience of working in a community-based clinic:

The communities where we live in Alaska are small enough to where it could still feel like a school-based oral health program even though we are not connected to the school in any way. We work closely with the school and it's also very easy for me to call a parent and go 'hey I want to check in with your child this morning can I call her from the school and can you come sign the consent form,' and ten out of ten times, they say 'yeah no problem go ahead.' And if there is a conflict that comes up like if the children are sick, or are busy testing, or something else comes up, we work with them to get kids when they are free, and the entire process is very flexible. I talk to the kids every day. We make sure they have brushed their teeth after lunch. It's so easy to transition them from the school to the clinic. The clinic actually seems to be a pit stop for a lot of kids on the way home from school. So we have little ones who visit us every day in need of a new toothbrush or chapstick or floss, or a toy. They are so comfortable seeing me and

²⁷⁷ Dr. Williard, Interview.

approaching me with their problems, and I spend a lot of time answering all of their questions. ²⁷⁸

Based on the aforementioned qualitative and quantitative data by trained dental professionals, it is evident that the DHAT program is proving to be a positive, innovative, site-specific solution to a site-specific problem. Indeed, DHATs are not only increasing access to care, but are providing high-quality, economically viable,²⁷⁹ culturally competent, preventive routine care among its tribal health populations at large to break the cycle of multigenerational poor oral health outcomes.²⁸⁰

The Case Study: Dental Therapy in Minnesota

Minnesota's Dental Therapy Program Overview

In 2009, Minnesota Governor Tim Pawlenty signed into law, a bill authorizing the licensure of the dental therapist, making it the first state to expand the dental workforce to make way for the entry of these mid-level providers. This legislation detailed the licensing, education, training, and supervision requirements of two levels of dental therapy, including a bachelor prepared licensed dental therapist (DT) and a Master's level certified advanced dental therapist (ADT).²⁸¹ As long as dental therapists meet the legislative requirement of serving a patient base that is at least 50% from low-income, uninsured, underserved populations (including HSPAs),²⁸² they can work in a variety of settings throughout the state including, safety net clinics, community health centers, private practices, and sometimes in nursing homes and schools.

²⁷⁸ Stephanie Woods, Interview.

²⁷⁹ Frances M Kim, "Economic Viability of Dental Therapists," 2013, 14.

²⁸⁰ Dane Lenaker, "The Dental Health Aide Therapist Program in Alaska: An Example for the 21st Century," *American Journal of Public Health* 107, no. Suppl 1 (June 2017): S24–25, <https://doi.org/10.2105/AJPH.2017.303831>.

²⁸¹ Karl Self and Colleen Brickle, "Dental Therapy Education in Minnesota," *American Journal of Public Health* 107, no. 1 (June 2017): 78-79, <https://doi.org/10.2105/AJPH.2017.303751>.

²⁸² Ibid.

Indeed, since the implementation of this program, dental therapists have been providing diagnostic, preventive, and restorative care for children and adults using both their dental hygiene and dental therapy scopes of practice to extend care across populations.

Legislative Background

Without the valiant efforts made by a coalition of multidisciplinary groups and individuals over time, Minnesota would not have become the first state to establish the licensure of dental therapist. Indeed, this grassroots organizing process began in 2007 when conversations around Minnesota's alarming oral health issues among dentists, dental hygienists, researchers, health care professionals, consumer groups, and educational institutions came together to develop a set of legislative proposals to improve dental access.^{283,284,285} This included a proposal to establish a mid-level dental practitioner who could offer treatment where dentists were not available and also reduce the cost of treatment for low-income and uninsured patients, known as the advanced dental hygiene practitioner (ADHP).²⁸⁶ This proposal was largely drafted by Dr. Colleen Brickle, an oral health educator and dean of Normandale Community College, who then took steps forward to move this proposal upstream in the implementation process. Once the ADHP program was approved with a detailed outline of its professional competencies by educational institutions, changes began to occur in the political environment and the public agenda.²⁸⁷

²⁸³ Anne E. Gwozdek et al., "The Origins of Minnesota's Mid-Level Dental Practitioner: Alignment of Problem, Political and Policy Streams," *Journal of Dental Hygiene: JDH* 88, no. 5 (October 2014): 296.

²⁸⁴ Mark Schoenbaum, Interview.

²⁸⁵ Dr. Brickle, Interview.

²⁸⁶ Gwozdek et al., 2014.

²⁸⁷ Ibid.

Three organizations were instrumental in embracing the concept of an ADHP as a viable means of addressing access to oral health care and initiating discussions about mid-level dental practitioner legislation: the Minnesota Safety Net Coalition (MN SNC), the Minnesota State Colleges and Universities (MnSCU), and the Minnesota Dental Hygienists' Association (MnDHA).²⁸⁸ Indeed, this pluralistic group was comprised of various members, all of whom advocated for health policies that increased access to underserved populations; from this group, Michael Scandrett, Staff Director of the MN SNC, spearheaded lobbying efforts for this mid-level practitioner law by identifying over 50 health care providers, hospitals and related organizations to support the legislation. Other important members of this political stream were Senators Ann Lynch and Cy Thao who both proposed the creation of this licensed mid-level dental practitioner in the State Senate and State House of Representatives respectively.²⁸⁹ This bill, however, was met with great opposition from by the ADA, the Minnesota Dental Association (MDA) and the University of Minnesota School of Dentistry. Indeed, the process became more challenging and contentious when they entered the political stream. Their efforts included communicating opposition to their association members and the public through newsletters, town hall meetings and public media campaigns (television, radio, newspaper and telemarketing automated-calls). Dr. Brickle notes her experience during this legislative process, stating:

The dental association was strongly opposed to dental therapy, I mean to the point where they did robocalls, they had full page ads in the newspaper in the second year saying that dental therapists are 'untrained.' So during the first two legislative years, the association was totally opposed, they tried absolutely everything in their capacity to stop it. The American Dental Association in Chicago actually gave the Minnesota Dental Association money and they hired even more lobbyists, but you know despite all of that, it was really the strength of collective impact that allowed

²⁸⁸ Ibid.

²⁸⁹ Ibid., 297.

us to overcome it. We organized 59 organizations that were in support of dental therapy, and not all of them were dental-related, some of them were organizations affiliated with special needs, geriatrics, aging, children, mental health services, public health agencies, and in the end, the dental associations were really the only ones opposing it. I do have to say after the bill passed, another key player was the board of dentistry. They spent a lot of time making committees and garnering support to get dental therapists and advanced dental therapists out and practicing. Another thing is that there were some big proponents in the dental associations all along but they had kept quiet.²⁹⁰

Following this opposition, several waves of lobbying efforts among coalition groups, alongside Senator Lynch's efforts of forging relationships between the Senate and House led to the formation of two proposed legislations, one for an oral health practitioner designed by the coalition workgroup,²⁹¹ and the other for a dental therapist by the MDA.²⁹² From there, a combined oral health practitioner/dental therapy legislation was brought to the Minnesota legislature. Once it reached the Senate floor, there was an amendment offered to eliminate the oral health practitioner, which failed by one vote.²⁹³ Thus, the legislature chose to take a pluralist compromise approach to this situation, taking aspects from both the oral health practitioner and dental therapy bills to create both a dental therapist and an advanced dental therapist. Subsequently, these bills were combined into the Minnesota Dental Therapist Law and authorized by the governor in 2009.

Minnesota's policy making process illustrates a more strenuous challenge of implementing the dental therapy model compared to Alaska's unique provision of its tribal health system. Nonetheless, by bringing numerous partnerships and continuing advocacy efforts, Minnesota brought forth an unprecedented law to enhance its dental workforce.

²⁹⁰ Dr. Colleen Brickle, Interview.

²⁹¹ Gwozdek et al., 2014, 298.

²⁹² Ibid.

²⁹³ Ibid., 299.

Education & Scope of Practice

Currently, there are two dental therapy education programs in Minnesota offered at the University of Minnesota School of Dentistry, and the Metropolitan State University program administered in partnership with Normandale Community College. At the University of Minnesota School of Dentistry's Master in Dental Therapy program, dental therapists must have a BS or a BA degree with specific prerequisite courses, complete a 32-month, dual degree program, learning alongside dental and dental hygiene students up to their scope of practice, to earn both a Bachelor of Science in Dental Hygiene and a Master in Dental Therapy and respective licensures. At the Metropolitan State University and Normandale Community College's Master of Science in Advanced Dental Therapy program, advanced dental therapists are Minnesota licensed dental hygienists who have earned a BS or a BA degree, completed a restorative functions course, and successfully completed a 16-month program taught by dentists who educate them up to their scope of practice. Moreover, both DTs and ADTs must pass comprehensive, competency-based clinical examinations approved by the Board of Dentistry or another board-approved accreditation body, and provide completed documentation of 2000 hours of clinical practice as a dental therapist under indirect or general supervision of a dentist. ADTs in particular must also go through the three-part certification process offered by the Minnesota Board of Dentistry to earn their certification to practice.²⁹⁴

In terms of scope of practice, all DTs and ADTs must work under the supervision of a Minnesota-licensed dentist after entering into a written contract called a Collaborative Management Agreement (CMA) that establishes the practice relationship. The level to which DTs and ADTs are permitted to do certain procedures within their scope of practice either within

²⁹⁴ Ibid.

the general or indirect supervision of a general dentist depends on this established agreement, as well as what Minnesota law and administrative rules define as different levels of dentist supervision applying to the service provided.

As discussed up until this point, Minnesota law specifically defines educational, examination and practice requirements for licensed dental therapists and advanced dental therapists, with a distinct provision being that both levels of dental therapists must practice in settings serving primarily low-income, uninsured and underserved patients, or in areas designated as Health Professional Shortage Areas (HPSAs) for dental care.²⁹⁵

The Evidence

Increasing Access to Dental Care & Alleviating Burden of Oral Diseases

An early assessment report conducted by the Minnesota Board of Dentistry, Minnesota Department of Health (MDH), and the Department of Human Services (DHS) to evaluate dental therapists' impact on the delivery of and access to dental services found that dental therapists are seeing thousands of new patients, 84% of whom were enrolled in public programs, and from this patient base “nearly one-third of all patients surveyed experienced a reduction in wait times for an appointment since the dental therapist was employed, with the impact more pronounced in rural areas.”²⁹⁶ Indeed, this extensive report provides key evidence of dental therapists making significant impacts on increasing access to care and patient satisfaction, as well as savings on personnel costs that spurred clinics to expand capacity to serve more underserved and public

²⁹⁵ Ibid.

²⁹⁶ Minnesota Department of Health. Early impacts of dental therapists in Minnesota: report to the Minnesota Legislature 2014. 2014. Available at: <http://www.health.state.mn.us/divs/orhpc/workforce/dt/dtlegisrpt.pdf>. Accessed April 2, 2019.

program patients.²⁹⁷ Moreover, a more recent case study conducted by Apple Tree Dental, a Minnesota-based nonprofit, found that most of the oral health needs of residents in the Minnesota Veterans Home are being met by a dental therapist providing on-site care, further establishing that dental therapists are in indeed increasing access to care among vulnerable populations.²⁹⁸

Generating Positive Financial Outcomes

According to a review of two recent case studies conducted by the Pew Charitable Trust, reports that the addition of dental therapists at two private, for-profit clinics in rural Minnesota helped increase access to oral health services for low-income and underserved residents while providing quality care and significantly increased cost-efficiency.”²⁹⁹ These results show that clinics were not only able to serve more patients with public insurance after hiring dental therapists, but also generated positive financial returns.³⁰⁰ Additionally, dental therapists contributed to the overall increase in productivity of practice settings by liberating dentists to carry out more complex, high-fee procedures while dental therapists focus on routine restorative procedures.³⁰¹ Thus, by increasing efficiency in the workforce model, which essentially allows everyone on the team to practice to the highest level of their scope of practice, dental therapists are generating positive financial outcomes for dental professionals, practices, and the patients.

In summation, there is ample qualitative and quantitative evidence to support that dental therapists in both Alaska and Minnesota are indeed increasing access to care and alleviating the

²⁹⁷ Ibid.

²⁹⁸ “Dental Therapists Could Provide Cost-Efficient Care in Veterans’ Nursing Homes | The Pew Charitable Trusts,” accessed April 22, 2019, <https://www.pewtrusts.org/en/research-and-analysis/articles/2017/09/20/dental-therapists-could-provide-cost-efficient-care-in-veterans-nursing-homes>.

²⁹⁹ “Dental Therapy Helps Increase Revenue, Access to Oral Health Care,” Pew Charitable Trust, accessed December 12, 2018, <http://pew.org/2uZEKZJ>.

³⁰⁰ Ibid.

³⁰¹ Ibid.

burden of oral health diseases across populations. The uniqueness of Alaska's model is that the workforce model specifically caters to the needs of small communities where DHATs set up practices in clinics or schools to deliver care where it is needed most. In a similar regard, Minnesota extends care to locations outside of the private practice to meet the needs of vulnerable populations. Essentially in both cases, dental therapists are making a significant impact in healthcare by extending dental services through an early-intervention approach to provide care for those who need it the most.

CHAPTER SIX: CONCLUSIONS & POLICY RECOMMENDATIONS

Despite increasing scientific knowledge around the importance of oral health, the silent epidemic of oral health diseases continues to plague our nation due to the damaging infrastructure of the U.S. healthcare system. This fragmented system compounds the effects of the medical-dental divide, large-scale inaccessibility to dental providers, and social determinants of oral health. As a result of these systemic barriers to good oral health, oral health outcomes have evolved along a social gradient, affecting the most disadvantaged and underserved populations. Thus, not only have we been effectively socialized to view the mouth and body as separate entities, but we have also ignored the effects of oral health inequity over time.

While the healthcare system is one obvious point of reform to address oral health disparities, it is not does seem likely that an equitable system of access to dental care will be prioritized or achieved by the current federal administration in the near future. Thus, adopting other well-evidenced public health interventions to address these disparities, such as dental therapy, is a valuable point of departure in maximizing access to dental care and oral health literacy to break down barriers of inaccessibility and address social determinants of oral health.

Indeed, in this moral era of healthcare, there is an ethical imperative to challenge regulatory, statutory, and political arenas throughout the country in order to achieve oral health equity that is effectively modeled after the systematic redistribution of power and resources. In doing so, this can shift the paradigm towards centering marginalized populations, and essentially gives voice to the silent epidemic.

Policy Recommendations

In order to effectively adapt the dental therapy model to California, I recommend following two overarching policy processes:

1. Launch dental therapy in the California Healthcare Workforce Pilot Project (HWPP) Program sponsored by the California's Office of Statewide Health Planning and Development (OSHPD). This HWPP program allows organizations to test, demonstrate, and evaluate new or expanded roles for healthcare professionals, or new healthcare delivery alternatives before changes in licensing laws are made by the state legislature.³⁰²

2. Evaluate the results of the HWPP program, and draft legislation that makes what is learned permanent. By drawing on the strengths and weaknesses from this pseudo-launch, the necessary changes can be made to fit the needs of the infrastructure, leading to a more refined implementation strategy.

The following short recommendations should be the focus of future research and consideration by dental therapy advocates in California to spur the aforementioned policy processes.

1). Build a multidisciplinary, oral health workforce innovation coalition.

Paralleling the efforts of Minnesota to introduce dental therapy, a coalition network is crucial to spur upstream political processes. This network should be comprised of policymakers, state leaders, oral health advocacy groups (of public and private organizations), stakeholders, dentists and dental auxiliaries, and other experts across multiple disciplines (i.e. medicine, education, social services, special needs, geriatrics, etc.). By having individuals and groups with

³⁰² “Health Workforce Pilot Projects Program - OSHPD,” accessed April 22, 2019, <https://oshpd.ca.gov/workforce-capacity/health-workforce-pilot-projects/>.

various expertise, experience, and perspectives, this coalition can build and strengthen cross-disciplinary, culturally competent, community-based, and community-wide efforts.

Coalition-building can strengthen the implementation process by garnering various levels of support, and more so, can lead to more refined methods of incorporating dental therapy that accurately mirrors the needs of impacted communities. Thus, if there is strong opposition from organized dentistry during the legislation process, each sector can demonstrate their respective needs and benefits of the proposed model so dental associations will have virtually nothing to oppose in terms of access, safety, quality, etc. other than their financial gains; and hopefully policymakers will align with what is ultimately best for the state of California. Therefore, it is especially important to get a buy in from policymakers, dentists in organized dentistry who are proponents, and others who can be especially helpful during the legislative process later on. Once this coalition forms, further actions can be taken to form a task force that focuses on drafting coalition-meetings, and ultimately develops a strong proposal for the HWPP. Some identified members in the oral health advocacy community include, The Children's Partnership, The L.A. Trust for Children's Health, and SCOPE (Strategic Concepts in Organizing and Policy Education), and Community Catalysts California.

2). Develop a dental therapy model proposal that works for California by considering the following factors:

1. Target dental health professional shortage areas.

In order to combat the prevalent issue of an inadequate dental workforce capacity, it is important to target sites that are affected by the maldistribution of dental providers.

Dental health professional shortage areas are a great measure to target populations where this maldistribution is evident, so that dental therapists can be funneled into these regions and provide care for the underserved.

2. Take advantage of the infrastructure in place.

There are plenty of dental schools (6) and safety net dental clinics throughout California.

Therefore, when establishing didactic and education standards to train dental therapists that effectively mirror the needs of underserved communities, it is best to incorporate these programs within the established infrastructure. This way, resources can be maximized, and adapted accordingly for the training and education of dental therapists. Moreover, within these established infrastructures, dental therapists can learn alongside other members of the dental team (i.e. dental students, dental hygiene students, dental assistants) and be normalized in the dental workforce early on.

3. Model legislation around the Commission on Dental Accreditation Standards for dental therapy.

The dental therapy educational standards were adopted by the American Dental Association's Commission on Dental Accreditation (CODA) in 2015.³⁰³ Thus, when forming core competencies for dental therapy (i.e. coursework, educational and training requirements, admission processes, program quality) in California, it is important to model it after the provided criteria so state legislators can feel comfortable authorizing dental therapists, given that CODA itself, the national accrediting body that accredits all dental education institutions, has legitimized dental therapy as a profession worthy of accredited standards.

4. Incorporate ways to bridge the medical-dental divide.

A key approach to bridging this divide early on is to involve medical professionals in the coalition network. In doing so, more clinical and social competencies around health needs can be incorporated into public health intervention strategies because there is largely no

³⁰³ "Experts Develop Model Dental Therapy Legislation," accessed April 22, 2019, <https://pew.org/2OxA6SY>.

integration between diagnostic code language that integrates medical and dental records.

Moreover, this established partnership between medical and dental professionals can dismantle socialized perceptions of the medical-dental divide to some extent.

5. Establish a permanent financing model.

While the HWPP will be supported outside of the permanent state financing system for dental care, more research will need to be done to incorporate dental therapy into California's health delivery system in an effective and sustainable manner.

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APPENDIX A.

Interview Guide

1. Dr. Mary E Williard, DDS (Alaska, Dentist and Director of Department of Oral Health Promotion at Alaska Native Tribal Health Consortium)
2. Dr. Shoffstall-Cone, DDS, MPH (Alaska, Dentist, Commissioned officer in U.S. Public Health Service, and Clinical Site Director for the DENTEX program at Anchorage and Bethel training sites)
3. Dr. Linda Maytan, DDS, MPH (Minnesota, Dental Policy Director, Minnesota Department of Human Services)
4. Dr. Colleen Brickle, Dental hygienist with a doctorate in healthcare education (Minnesota, Dean of Health Science at Normandale Community College)
5. Mark Schoenbaum (Minnesota, Senior Advisor, New Americans Alliance for Development; Retired Director of Office of Rural Health & Primary Care, Minnesota Dept of Health)
6. Stephanie Woods, Certified Dental Health Aide Therapist (Alaska)
7. Kari Douglass, Dental Health Aide Therapist Student (Alaska)
8. Jenny Hendrickson, Dental therapist with hygiene background (Minnesota)
9. Gemma Pillai, Dental therapist with hygiene background (Minnesota)
10. Mary Otto, Author of *Teeth*
11. Jenny Kattlove, Oral Health Consultant (Children's Partnership)