Integrating Oral, Physical, and Mental Health Via Public Health Literacy

Dean Schillinger, MD; Sepideh Banava, DDS, MSc, MPH; and Stuart A. Gansky, DrPH

Limited health literacy (HL) can impede a person's ability to seek and use health information and preventive services, manage chronic conditions, and to adopt healthy behaviors. Limited HL is associated with poorer health, greater acute care utilization and health care expenses, and higher mortality (Macek et al., 2016; Tan et al., 2019). Disease prevalence at the population level largely results from variation in unhealthy social and environmental conditions that individuals, families, and communities are exposed to over the life course (Schillinger, 2020). Limited HL is more common among populations disproportionately affected by social, economic, political, structural, geographic, and/or historical forces. Among vulnerable populations, the greater risk of unhealthy exposures and higher rates of limited HL they experience combine to undermine overall health status and generate health disparities. Although limited HL is associated with many adverse medical outcomes (Doyle et al., 2017; Frohlich & Potvin, 2008; Macek et al., 2016; Sørensen et al., 2012), it is less widely acknowledged that it is also associated with worse dental, oral, and craniofacial (DOC) health (National Institute of Dental and Craniofacial Research, National Institutes of Health, U.S. Public Health Service, Department of Health and Human Services, 2005). As with general health, public policy influences differential risk exposure and resource distribution and interacts with individual HL to generate worse oral health. Engaging the public in creating and/or supporting equitable policies that promote oral health and reduce oral health-related disparities while also advancing general health requires developing a unique form of community level HL.

The goals of this perspective are to describe the importance of a community level HL—known as "public health literacy"—for oral health, and to employ this construct as a means to better integrate oral health into other public health efforts. We use type 2 diabetes as an exemplar to (1) demonstrate the causal interrelationships between the physical, mental, and DOC health manifestations and complications of the disease; (2) elucidate their common socioenvironmental determinants; and (3) describe implications for public health disparities.

Dean Schillinger, MD, is a Professor in Residence, School of Medicine. Sepideh Banava, DDS, MSc, MPH, is a Postdoctoral Fellow, School of Dentistry. Stuart A. Gansky, DrPH, is a Professor and the Associate Dean for Research, School of Dentistry. All contributors are affiliated with the University of California San Francisco.

Address correspondence to Dean Schillinger, MD, University of California San Francisco, 533 Parnassus Avenue, San Francisco, CA, 94143; email: dean.schillinger@ucsf.edu.

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PUBLIC HEALTH LITERACY

Improving individual level HL is insufficient to make healthy decisions the default decisions (Freedman et al., 2009). Attention is needed to advance public HL to positively influence community norms, institutional practices, and public policy that change the conditions that shape health behaviors. To fulfill this goal, various stakeholders—health care professionals, health organizations, advocates, educators, policymakers, and the public—need to collaborate. Public HL has been defined as "the degree to which individuals and groups can obtain, process, understand, evaluate, and act upon information needed to make public health decisions that benefit the community" (Freedman et al., 2009). The construct includes disease prevention and health promotion strategies (Freedman et al., 2009; Macek et al., 2016; Schillinger et al., 2018; Sørensen et al., 2012). To facilitate such change in an efficient and comprehensive manner, public HL efforts need to integrate oral health concerns with matters related to physical and mental health. Public HL can increase the likelihood that people are exposed to health-promoting environments relevant to the three health domains of physical, mental, and oral health by "making the healthy choice the easy choice" (Volpp & Asch, 2017). Engaging more stakeholders in public health and prevention efforts in an integrated manner could efficiently address upstream health determinants, reducing the morbidity and mortality.

CAUSAL INTERRELATIONSHIPS BETWEEN SOCIOENVIRONMENTAL EXPOSURES AND PHYSICAL, MENTAL, AND ORAL HEALTH

Achieving overall health first requires understanding health as an integrated state in which physical, mental, and DOC health often are interconnected **(Figure 1)** (Schillinger, 2019). Specifically, unfavorable conditions in any of these domains can affect other domains. Ideally, efforts to improve public HL in one dimension should enhance health status in others (Schillinger, 2019). Overall health at the population level is a function of the balance between unhealthy exposures and access to health-promoting resources and protective factors. Differential exposures to risks and resources (including but not limited to access to care) can affect one or more interrelated health dimensions. Social structures and systems, including but not limited to socioeconomics, inferior education, proximity to violence, and limited food access, elevate risk exposures as well as undermine exposures to health-promoting resources, jeopardizing health in all three domains of physical, mental, and oral health.

Finally, disease burden in any domain often leads to downward economic mobility, generating greater social vulnerability and creating a negative feedback loop that leads to greater disease burden within and across domains (Schillinger, 2019). For example, based on the American Dental Association (n.d.) Health Policy Institute report, one-third of adults with incomes <138% federal poverty level (FPL) reported their teeth/mouth appearance affected their job interview, versus 15% of people with incomes >400% FPL; employers shown either a pre-treatment or post-treatment image of the same person perceived the pre-treatment group as less intelligent and less likely to be hired (Pithon et al., 2014). In contrast, people who received welfare benefits completing their dental treatment were twice as likely to gain favorable employment (Hyde et al., 2006). Community water fluoridation has been shown to be associated with an increase in women's earnings 4% on average, an effect amplified for women with low socioeconomic status (Neidell et al., 2010).

INTER-RELATIONSHIPS BETWEEN ORAL, PHYSICAL, AND MENTAL HEALTH: TYPE 2 DIABETES AS EXEMPLAR

Evidence has linked DOC conditions, such as dental caries and periodontal diseases, to chronic diseases, including type 2 diabetes mellitus (T2DM), coronary heart disease, pulmonary diseases, and stroke (Preshaw et al., 2012; Verhulst et al., 2019). Nearly 1 in 8 U.S. adults has T2DM (Menke et al., 2015) causing significant physical, mental, and oral health problems. Complications in one domain can affect both incidence and severity in other domains (Bădescu et al., 2016; Schillinger, 2019). For example, a bidirectional relationship between diabetes and periodontal diseases exists. Oral bacterial load is higher in patients with T2DM, contributing to higher dental caries rates (Coelho et al., 2018). People with diabetes and poor metabolic control also have 3 times higher periodontitis risk (Preshaw et al., 2012). Worse glycemia leads to increased insulin resistance in tissues, generating systemic inflammatory mediators which advance periodontitis. A recent trial of treating periodontitis improved diabetes control (Munjal et al., 2019), suggesting that this relationship may, in part, be causal. Further, T2DM is strongly linked to depression, particularly when vision loss, amputation, end-stage kidney disease, and tooth loss occur (Bădescu et al., 2016). Depression negatively influences self-management behaviors, including those required to maintain physical and oral health (Wiener et al., 2018). Finally, costs and disability related to excess care for dental and diabetes complications can have significant economic consequences, leading to stress, depression, downward economic mobility, and worse disease trajectory **(Figure 1)**.

The cyclical nature of trans-domain disease incidence and control illustrated in **Figure 1** reflects additional reciprocal relationships beyond how medical conditions affect other domains. For example, depression is an independent risk factor for developing T2DM through behavioral pathways (Bădescu et al., 2016). In addition, many medications used to treat mental illness cause metabolic dysregulation and contribute to greater T2DM risk (Schmitz et al., 2016). Oral health itself is associated with both physical health and mental health/social well-being. According to the American Dental Association (n.d.) Health Policy Institute report, among U.S. adults with low-income in 2015, 42% reported difficulty biting and chewing that resulted in poor nutrition and physical health; 23% reduced social activity participation, 35% felt embarrassment, and 37% avoided smiling due to the condition of their mouth and teeth, worsening mental health.

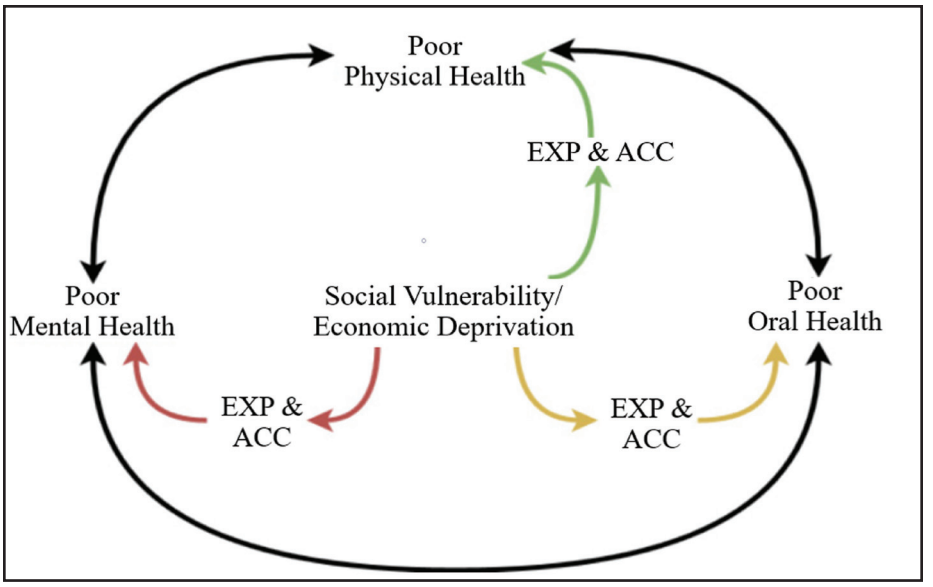

Figure 1. Causal interrelationships among socioenvironmental risks, behavioral risks, and health domains. EXP = unhealthy exposure; ACC = access to resources.

SHARED RISK EXPOSURES, GEOGRAPHY, AND OPPORTUNITIES FOR PUBLIC HEALTH LITERACY

Lower socioeconomic status, sugar sweetened beverage (SSB) consumption, tobacco use, alcohol consumption, food insecurity, and proximity to violence are some exposures that predispose people and communities to various diseases, jeopardizing health across the three domains of physical, mental, and oral health (Schillinger, 2019). These common epidemiologic and behavioral risk factors are more common in communities with people who have been economically and socially marginalized, where the burden of diseases, including T2DM and oral diseases, is highest. Geocoding in San Francisco related to T2DM demonstrates that neighborhoods with the highest rates of households with low income have the greatest concentration of SSB purchases and hospitalizations for uncontrolled diabetes (San Francisco Department of Public Health, 2018) **(Figure 2A-2C)**. This same pattern exists for caries among kindergarteners and for complete tooth loss among adults older than age 65 years; yet dental visits among adults older than age 18 years are the lowest in the same neighborhoods **(Figure 2D-2F)** (CavityFree SF, n.d.; Centers for Disease Control and Prevention, 2020).

Because enhancing efforts to minimize exposures would positively influence physical, mental, and oral health, each exposure represents a target for public HL efforts to foster community, institutional, and public policy changes.

Improving Dietary Quality and Reducing Added Sugars

Consuming added sugars and SSBs is a shared risk factor for dental caries, periodontal disease, T2DM, cardiovascular disease, and obesity (Chow, 2017; Verdu & Danska, 2018); evidence strongly suggests that these relationships are causal. According to Healthy People 2020, families at less than 100% FPL and African Americans have the highest mean percentage intake of total daily calories from added sugars (both at 16.6% vs. the 9.7% target for 2020) (Office of Disease Prevention and Health Promotion, n.d.). Limited HL is a known risk factor for consuming SSBs (Lee et al., 2019); consumers with the lowest HL drink, on average, 240 calories of soda per day more than those with the highest HL (Zoellner et al., 2016).

However, public HL efforts have largely missed the opportunity to bring oral health concerns to the fore. For example, media stories—an important public HL influence—discuss health policies related to curbing SSB consumption by linking SSBs to obesity and diabetes, but not to oral health problems (Somji et al., 2016). Although caries is the most prevalent chronic disease caused by SSBs, diabetes was discussed by the media 17 times and obesity 19 times more frequently than oral health consequences (Somji et al., 2016). Furthermore, transnational corporations influence public discourse around added sugars policy impedes public HL (Kearns &

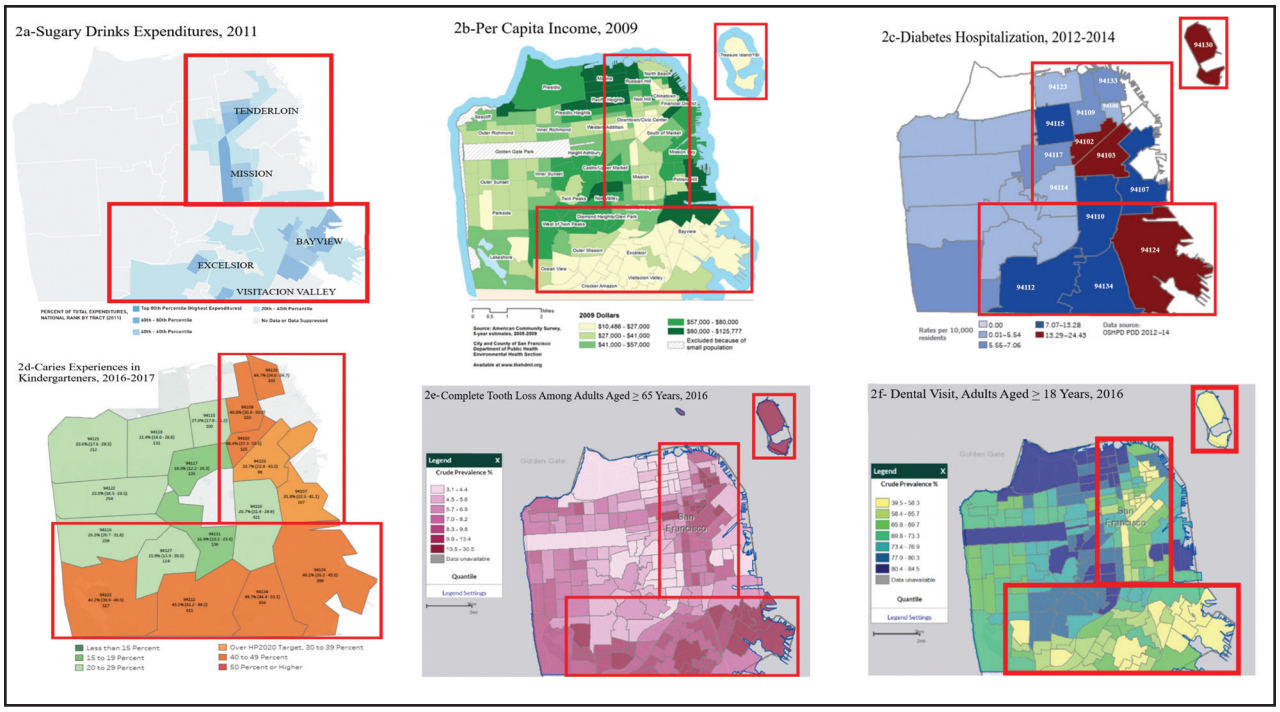

Figure 2. San Francisco, CA, maps displaying geography of populations that were most affected: (A) sugary drinks expenditures; (B) per capita income (poverty); (C) diabetes hospitalizations; (D) kindergarteners' with caries; (E) adults older than age 65 years with complete tooth loss; (F) dental visits in adults older than age 18 years. Adapted from CavityFree SF, n.d.; Centers for Disease Control and Prevention, 2020; and San Francisco Department of Public Health, 2018.

Watt, 2019). Conflicts of interest between the sugar industry and dental organizations reveal how industry has attempted to co-opt the dental profession, harnessing the profession as an information gatekeeper to hinder public HL in this domain (Kearns & Bero, 2019).

Changing Patterns of Unfluoridated Bottled Drinking Water Use

Non-fluoridated water can lead to tooth decay and tooth loss, resulting in poor dietary quality, malnutrition, anxiety and depression, and diet-related chronic illnesses (Rozier et al., 2017). Community water fluoridation (CWF), a top 10 greatest 20th century public health achievement, is a cost-effective community-based solution to decrease dental caries (Slade et al., 2018). According to the Community Preventive Services Task Force (n.d.), CWF reduces dental caries among children by nearly 30%. Despite controversy (Bashash et al., 2018; Green et al., 2019), consensus favors CWF as a powerful, cost-effective community-based strategy to reduce caries and oral health disparities (Neidell et al., 2010; Slade et.al., 2018). According to Healthy People 2020, nearly 75% of the U.S. population has fluoridated tap water (Office of Disease Prevention and Health Promotion, n.d.).

However, bottled water, which costs hundreds of times more than tap water, is the fastest-growing U.S. drink of choice, with average annual expenditures more than $100 per person (Rosinger et al., 2018). Based on the International Bottled Water Association (n.d.), only 15 of 640 bottled water products in 2020 contained fluoride. Excluding geographic areas with unpleasant tasting or high mineral content water, one-third of U.S. adults drink bottled water (Horowitz et al., 2015). Tap and bottled water consumption patterns differ by race and ethnicity, nativity, and education. Non-Hispanic Black people, Hispanic people, and adults who are not U.S. born have 2.20, 2.37, and 1.46 greater odds, respectively, of consuming bottled water than non-Hispanic White people and U.S.-born adults (Rosinger et al., 2018). Non-Hispanic Black people and Hispanic people also have lower odds of consuming tap (fluoridated) water (0.44 and 0.55, respectively) compared to non-Hispanic White people. Moreover, parents/caregivers with low-income who have young children rarely drink tap water or give it to their children; instead, they tend to drink bottled water and have a limited understanding of using fluoride to prevent caries (Horowitz et al., 2015). The combination of higher consumption of SSBs and consumption of non-flouridated bottled water creates synergistic risk exposures.

In the U.S., regulatory fluoride content labeling standards—another vehicle to promote public HL—appear inadequate. The U.S. Food and Drug Administration does not

require labels stating that a bottled water product lacks fluoride. Rather, bottled water manufacturers may include the following health claim: "Drinking fluoridated water may reduce the risk of (dental caries or tooth decay)." The Environmental Protection Agency (2005) only states that consumers should ask bottlers if their water contains fluoride. Relatedly, while water filtration is associated with higher odds of drinking tap water, filtration can affect fluoride content; reverse osmosis (the most common sink filter system), distillation, and active alumina filtration systems all remove fluoride (Shen & Schäfer, 2014), whereas carbon filters do not. Lack of clear information about water filters' effects on fluoride reduces public HL.

Reducing Tobacco Use

Tobacco use can lead to chronic obstructive pulmonary disease, depression, oral cancer, and periodontitis (Hobbins et al., 2017; Jin et al., 2016; Zhang et al., 2019). Additionally, people with anxiety, depression, and schizophrenia are more likely to consume tobacco products (Fluharty et al., 2017). According to Healthy People 2020, in 2018, 24% of the families with less than 100% FPL consumed tobacco (the target is 12%) (Office of Disease Prevention and Health Promotion, n.d.). People with less than a high school education had the highest tobacco use (25%). Multilevel tobacco regulation has increased public HL regarding tobacco's ill effects on population health.

Curbing Excess Alcohol Use

Strengthening alcohol regulation and changing social norms through increased public HL regarding alcohol's ill effects on its consumers or those exposed to its consumers, could positively influence all three health domains. Excess alcohol use is associated with periodontal diseases and oral cancer, liver disease, cardiovascular disease, depression, domestic violence, gun violence and death, including suicide (Priyanka et al., 2017; Ryder et al., 2018). Alcohol's economic and health burden is high; about 95,000 people die from alcohol-related causes annually (Esser et al., 2020); in 2010, U.S. alcohol misuse costs $249 billion (Kranzler & Soyka, 2018). About 10% of youth and 56% of young adults reported drinking in the past month (Quigley, 2019). In 2016, 26.2% of adults reported prior month binge drinking and 6% reported ongoing heavy alcohol consumption (Quigley, 2019). In 2019, 10,142 alcohol-impaired driving fatalities occurred (28% of driving fatalities) (U.S. Department of Transportation. National Highway Traffic Safety Administration, 2020).

Reducing Domestic Violence

Increasing public HL related to intimate partner violence (IPV) and its effects across all three health domains could lead to more robust support for community level changes and policy initiatives to reduce violence exposure. According to the Centers for Disease Control and Prevention (Black et al., 2011), more than 10 million Americans experienced physical violence. IPV and trauma can lead to tooth loss and jaw injuries, causing poor dietary quality, posttraumatic stress disorder, and depression (Kundu et al., 2014), all of which predispose to T2DM. Reducing violence due to homicide, firearm, physical assault, and motor vehicle-related injuries was a Healthy People 2020 goal; mid-course results showed injuries and proximity to violence were somewhat higher in groups that have been marginalized.

PUBLIC HEALTH LITERACY IMPROVEMENT STRATEGIES

Audiences for communications designed to build public HL include the public, advocacy groups, health care organizations, insurance entities, industry, and policymakers. Various strategies could be proposed to improve oral, physical, and mental health. Achieving more widespread regulations such as taxing SSBs, placing warning notices on (Schillinger & Jacobson, 2016) or restricting advertisements for SSBs (as has been done with tobacco), requiring fluoride content labeling on bottled water or encouraging fluoride content in bottled water, or using public dollars to enable families with low income to consume more fresh fruits and vegetables, would improve health in all three domains. Achieving these goals will require innovative efforts to enhance public HL and would benefit from featuring more integrated messages across physical, mental, and oral health domains.

Finding the "second-hand smoke equivalent" that moved the public to think differently about the tobacco-related epidemic will be important for preventing different, interrelated physical, mental, and oral health problems resulting from other shared risk exposures. An example of one such efforts is *The Bigger Picture* (www.thebiggerpicture.org), a youth led T2DM prevention campaign that develops and disseminates content related to social determinants of health and disease drivers, associated risk exposures, and the physical, mental, and oral health domains jeopardized by the disease (Schillinger & Huey, 2018). Another example involves a U.S. Department of Agriculture-funded training program for physicians and dentists to develop their public HL communication skills through *The Champion Provider*

Fellowship, whose goal is to prevent obesity through local policy, systems, and environmental change.

CONCLUSION

Communication that is frequently conveyed to the public regarding oral and systemic health—and the associated risk factors that lead to oral and systemic diseases—are largely misaligned with public HL principles, focusing on personal choices and individual behaviors rather than on ways to change the unhealthy environments and exposures that influence health. In addition, the synergy that could be achieved across health domains by implementing interventions to promote public health are rarely featured. Many public HL communications ignore oral health benefits that could accrue from policy and practice change, thereby limiting the number of potential stakeholders and undermining the potential effectiveness. This has impeded public policy efforts to prevent oral health problems and their related physical and mental health correlates.

The reciprocal relationships between diabetes, dental health, and depression provide one clear example in which common exposures can interact to generate physical, mental, and oral health consequences. To further demonstrate the importance of public HL, research is needed to delineate how oral health problems affect complication rates of, and costs related to, medical illnesses, and vice versa. Making the economic case to invest in public HL, including for oral diseases, will also require quantifying the hidden costs of maintaining the status quo. In addition, health communications research and practice should evaluate the added value of involving framing and containing content that explicitly integrates oral health into public HL campaigns.

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