

Nourishing Smiles: Challenges and Lessons Learned from Implementing an Interprofessional School-based Oral Health and Nutrition Literacy Program for Adolescents

**Allison N. Marshall, PhD, MPH, MSSW
Kiana Jenkins, MPH
Carlos G. Fuentes, BS
Dylan Tran
Karen Mejia, MPH
Maja Djukic, PhD, RN, FAAN
Rahma Mungia, BDS, MSc, DDPHRCS
Alexander Testa, PhD
Flor Alvarado, MD, MHS, MPH
Daphne C. Hernandez, PhD, MEd, FAAHB**

ABSTRACT

Increasing autonomy and potential engagement in risky health behaviors during adolescence creates a critical time for oral health and nutrition health promotion. A Social Cognitive Theory-based oral health promotion program was developed and piloted in an under-resourced urban high school. The program was designed to improve health literacy regarding oral health, nutrition, and risky health behaviors that influence oral health through didactic lessons and interactive in-class group activities. In this pilot study, twenty-four students participated and completed both pre-/post-program surveys (mean age=15.6 years [SD=0.97], 63% female; 75% Black; 46% food insecure). Over one-third (38%) of students had not visited a dentist in the past year (67% male; 56% Black, 44% food insecure). While health literacy slightly increased from pre- to post-program, the increase was not significant. The limited positive findings may be related to small sample size in this pilot, as well as implementation challenges that occurred: lack of partnership buy-in, turnover and vacancies, scheduling conflicts, low attendance, and available but inaccessible dental care. Lessons learned from the challenges can inform future program planning and implementation.

Keywords: adolescent; school-based; social cognitive theory; community; oral health; nutrition

*Corresponding author may be reached at daphne.hernandez@uth.tmc.edu

Introduction

Over 26% of low-income Black and Hispanic adolescents ages 12-19 in the United States have untreated dental caries (National Institute of Dental and Craniofacial Research, 2018). Untreated dental caries can negatively impact adolescents' quality of diet, sleep, academic performance, and

school attendance (Ruff et al., 2019; Souza et al., 2018). The behavioral risk factors (consumption of added sugars and simple carbohydrates in items like sugar-sweetened beverages and dessert items) and socioeconomic risk factors (socioeconomic status, racial/ethnic group, parental educational attainment) associated with dental caries (National Institutes of Dental

and Craniofacial Research, 2021) also render Black and Hispanic children at higher risk of obesity and diabetes (Baxevasanos et al., 2021; Northridge et al., 2020). Tobacco and alcohol consumption often begin in adolescence, co-occur, and increase into young adulthood (Jackson et al., 2002; Myers & Kelly, 2006). Both these behaviors are risk factors for poor dental habits and dental caries in adolescence (Akinkugbe, 2019; Freddo et al., 2018; National Institutes of Dental and Craniofacial Research, 2021) and adulthood, as well as oral cancer (Pelucchi et al., 2006). Thus, the oral cavity is the entry point for nutrition and major oral health problems and is linked to overall health and wellbeing (DiMaria-Ghalili et al., 2014; Guarnizo-Herreño et al., 2019).

Education on the direct link between oral care and nutrition has primarily focused on preschool children and early pre-adolescents (Blake et al., 2015; Cooper et al., 2013; S. V. Sharma et al., 2022). There is a lack of evidence-based health promotion programming targeting oral health or oral health related knowledge and behaviors among adolescents (Calderon & Mallory, 2014; National Institutes of Dental and Craniofacial Research, 2021; Tsai et al., 2020; Xiang, Wong, Perfecto, & McGrath, 2020). Adolescence is a key time to address behavioral risk factors for dental caries and other oral health problems (National Institutes of Dental and Craniofacial Research, 2021; Tsai et al., 2020). Adolescents experience increased independence and autonomy in dietary behaviors which may explain increased consumption of foods and drinks that negatively affect oral health as well as increased risk of obesity, such as sugar-sweetened beverages, sweets, and other simple carbohydrates in adolescence, and these lifestyle behaviors and habits tend to track from adolescence into adulthood (National Institutes of Dental and

Craniofacial Research, 2021). Oral health problems and health problems associated with poor nutrition also track from adolescence into adulthood and influence health outcomes or health problems later in life. Thus, interventions to improve adolescent oral health may have far-reaching benefits for oral health later in life (Tsai et al., 2020). They can also be an opportunity to change oral health risk factors such as poor dietary behaviors or tobacco use, which have serious implications for health in adolescence and later in life (National Institutes of Dental and Craniofacial Research, 2021).

Multiple systematic reviews highlight the lack of research and evidence-based oral health programming for adolescents, with mixed findings from the existing literature regarding improvements in oral health behaviors, oral health knowledge, gingival health, plaque scores, and caries (Calderon & Mallory, 2014; Stein et al., 2018; Tsai et al., 2020; Xiang, Wong, Perfecto, & McGrath, 2020). A 2017 systematic review of oral health education on oral hygiene and dental caries among schoolchildren ages 5-18 years by Stein et al. (2018) found evidence that oral health education programming impacted plaque reduction, but not gingivitis. The authors also noted a lack of long-term evidence of efficacy in school-based oral health education programming to prevent plaque, gingivitis, or dental caries (Stein et al., 2018). Notably, this review did not identify any studies solely focused on high school participants aged 15-18 (Stein et al., 2018). In a systematic review of the effectiveness of behavioral interventions to improve oral health among adolescents, Xiang, Wong, Perfecto and McGrath (2020) found moderate improvements in oral health knowledge and related behavior from behavioral interventions, and authors noted the importance of length of intervention. Most health outcome improvements (plaque, gingival, and bleeding indices) were

identified after six months, while caries improvements occurred after at least one year of intervention (Xiang, Wong, Perfecto, & McGrath, 2020). A systematic review of oral health behavior research in American adolescents conducted in 2014 by Calderon & Mallory found only eight peer-reviewed articles focused on oral health behaviors of U.S. adolescent populations ages 12-19: two intervention studies and six descriptive. Positive findings in the intervention studies suggest adolescent oral health behaviors may be modifiable through intervention, with improvements in oral health knowledge (Biesbrock et al., 2004) and increased flossing after a theory-based intervention (Sherman et al., 2008).

The oral health risk factors during adolescence, the importance of intervening during this time to optimize oral health and overall health, and the lack of peer-reviewed, evidence-based oral health education and health promotion programs targeting adolescents are well-established (Calderon & Mallory, 2014; Tsai et al., 2020; Xiang, Wong, Perfecto, & McGrath, 2020). Most previous school-based oral health programs have not been based on behavioral theory (Calderon & Mallory, 2014; Cooper et al., 2013). Social Cognitive Theory proposes that learning occurs in a social context where reciprocal interactions help reinforce and maintain the new learned behavior (Bandura, 2004). Thus, a school-based program focused on oral health and nutrition that includes group activities derived from Social Cognitive Theory (e.g., mastery building exercises such as reading food labels) was developed to improve health literacy regarding oral health, nutrition, and risky health behaviors that influence oral health (Bashirian et al., 2021; Cooper et al., 2013). This school-based program is called Nourishing Smiles.

Nourishing Smiles

The Nourishing Smiles program is a skill-based program designed to increase health literacy around oral health, nutrition, and risky health behaviors that influence oral health for under-resourced high school students. The 7-week school-based program was adapted from the American Dental Association's (ADA) Smile Smarts Dental Health Curriculum, along with presentations and resources available through the ADA's Mouth Healthy website (American Dental Association, n.d.). Drawing upon these resources, an interprofessional team of experts from dentistry, nursing, public health, and developmental psychology developed the Nourishing Smiles curriculum.

The Nourishing Smiles program targets Social Cognitive Theory constructs by reinforcing and maintaining new learned behavior through reciprocal interactions through didactic and interactive lessons, along with access to professional oral healthcare and oral health supplies (toothbrushes, toothpaste, floss). Each didactic and interactive activity included observational learning (e.g., students observe others performing the behaviors) and mastery building experiences in which students practice the behaviors themselves (Bandura, 2004). For example, students were provided with visual demonstrations and opportunities to practice using mouth models for proper oral hygiene (flossing and brushing) (Table 1); they also received an at-home kit that included toothbrushes, full-size toothpastes, and floss for four family members. All lessons included a brief animated video to highlight specific concepts as well as class discussion. Short, animated videos have been associated with learning (Moreno, 2007) and improving healthcare knowledge (Occa & Morgan, 2019). These videos were created with an emphasis on being inclusive and culturally relevant as recommended in the

literature (Calderon & Mallory, 2014). Video concepts and scripts were informed by Black/African American and Hispanic/Latinx young adults from the area. The videos were well-received by participants in post-program feedback. Each lesson also included healthy snacks associated with the class discussion (fresh fruits, fresh vegetables, low fat dairy products, whole grains). All students were also provided with an opportunity to receive a professional dental cleaning.

The outcomes from the implementation of the Nourishing Smiles pilot program are discussed below. Due to community partnership and programmatic challenges that were encountered, less emphasis is placed on the results and a greater part of the discussion is focused on lessons learned from program implementation. The intention is that the lessons learned and recommendations from this pilot can be applied to future research and programming designed to reduce health disparities in under-resourced communities.

Methods

Recruitment, Eligibility, and Participation

High school students were recruited at an economically under-resourced high school with a high proportion of Black/African American and Hispanic/Latinx students in the Houston, Texas area. Recruitment was conducted through a combination of referrals by an on-campus community-based student support organization, and in-person recruitment sessions by the research team during lunch periods in the school cafeteria over three weekdays. To be eligible to participate in the program, students needed to be able to read and write English and attend the participating high school. Interested students were invited to join a welcome and introductory session which was held after

lunch in a classroom setting, at which time both parental consent and student assent forms were distributed. Further participation in the Nourishing Smiles program, surveys, dental cleanings, and feedback sessions was limited to students who had turned in completed consent forms and assent forms.

Implementation

Nourishing Smiles was implemented under the umbrella of a partner organization that provides student support programming. The Nourishing Smiles program was implemented during the Spring semester of 2022 (cohort 1: January – May 2022) and during the Fall 2022 semester (cohort 2: August – December 2022). The program was delivered once a week for 45 minutes during a designated class period by one postdoctoral scholar with training in public health and social work and two undergraduate students majoring in public health. Faculty from the research team also participated in lessons that were closely aligned with their expertise. Pre- and post-program surveys were accessed on students' laptops or cell phones and administered through Research Electronic Data Capture Survey Software (REDCap) (Harris et al., 2019; Harris et al., 2009) and written surveys when student laptops were not accessible, or technology challenges occurred. At both timepoints, the surveys were administered over two days to reduce participant burden. On each day of measurement, it took students roughly 25-30 minutes to complete the survey. Students were compensated \$25 through an electronic gift card to a nationwide discounted department and grocery store at baseline and at the end of programming. The study was conducted in accordance with the Declaration of Helsinki and approved by UTHealth's Institutional Review Board.

Table 1. Nourishing Smiles Lesson Number, Topic, Lesson Objectives, and In-Class Group Activity

Lesson # and Topic	Lesson Objectives	Example of In-Class Group Activity Derived from Social Cognitive Theory
0. Program Overview	N/A	N/A
1. Overview of Oral Health; Oral and General Health	<ul style="list-style-type: none"> ○ Describe key strategies to maintain good oral health ○ Select healthy foods that are related to good oral health ○ Identify the connection between oral and overall health 	 <p>Students use a mouth model to identify benefits of oral hygiene and possible oral health risks.</p>
2. Overview of Dental Screening + A Balanced Plate	<ul style="list-style-type: none"> ○ Recognize the importance of preventive dental screening ○ Describe what to expect in a dental screening visit, benefits of varnish application ○ Recall components of a balanced eating pattern 	 <p>Students use a food and plate cling set to build healthy meals and snacks. This helps students visualize health meal components and proportions.</p>
3. Cariogenic and Plaque-forming Bacteria + All About Carbohydrates	<ul style="list-style-type: none"> ○ Define cariogenic and plaque-forming bacteria ○ List sources of carbohydrates in the diet ○ Correctly interpret food labels 	 <p>Using a mouth model and blacklight to see how “invisible” plaque stays on teeth helps students understand the importance of professional dental cleanings and brushing teeth.</p>

<p>4. Brushing and Flossing; Cleaning Foods – Detergent and Retentive Foods</p>	<ul style="list-style-type: none"> ○ Demonstrate proper brushing and flossing techniques ○ Identify detergent vs retentive foods ○ Describe the importance of consuming detergent foods 	 <p>Using a mouth model to crush Oreos and brush the teeth afterwards helps students learn about retentive foods.</p>
<p>5. Hydration for Oral Health; What We Drink</p>	<ul style="list-style-type: none"> ○ Interpret the importance of hydration and oral health ○ Understand how beverages impact oral and overall health ○ Demonstrate the amount of sugar in beverages 	 <p>Measuring the amount of sugar in common drinks helps students to visualize the sugar in beverages.</p>
<p>6. Disordered Eating and Oral Health; Fueling the Body</p>	<ul style="list-style-type: none"> ○ Identify eating disorders and disordered eating ○ Describe the medical complications of eating disorders/disordered eating 	 <p>Eggs soak overnight in cola or fluoride mouthwash, and then are submerged in white vinegar. This demonstrates the protective effect of fluoride/harmful effect of acid on tooth enamel (simulated by the eggshell).</p>
<p>7. Good Oral Health Habits – Braces, Mouth Jewelry, and Tobacco Use</p>	<ul style="list-style-type: none"> ○ List oral health problems associated with tobacco use ○ Describe how to take care of braces, mouth appliances 	 <p>Identifying health consequences of tobacco use on the mouth model helps students visualize health complications associated with tobacco use.</p>

Measures

Health Literacy: Oral Health, Nutrition, and Risky Health Behaviors

The curriculum targeted health literacy regarding oral health, nutrition, and risky health behaviors that influence oral health. Fifteen multiple-choice items were developed based on the learning objectives of each lesson in the curriculum. Oral health topics included: brushing and flossing; fluoride; tartar and plaque; recommended dental visit frequency. Nutrition topics included: a healthy diet; cariogenic foods; reading nutrition labels; detergent foods; and drinking water. Risky health behaviors included: eating disorders; smoking and tobacco; vaping and e-cigarettes; grills (mouth jewelry), braces, and oral health; and oral piercings. A score of one was assigned for each correct response; correct responses were summed, with higher total scores indicating higher oral and nutrition health literacy (baseline $\alpha = 0.70$; post-program $\alpha = 0.73$).

The following measures were gathered to learn more about the sample and potential oral health challenges.

Perceived Oral Health Barriers

Perceived oral health barriers were measured using one item to measure the frequency with which students visited the dentist and a six-item scale developed and validated for use with adolescents (Xiang, Wong, Cao, et al., 2020). The item measuring the frequency of dental visits asked participants whether they had visited the dentist at least once a year, had not been to the dentist in the last one to two years, had not been to the dentist in over two years, or had never been to the dentist. The six-item scale asked participants to indicate their level of agreement to potential oral health barriers

(e.g., I think it is difficult for me to brush twice a day; I think I do not have enough time to do an annual dental visit). Responses used a five-point Likert scale response to indicate level of agreement from strongly disagree to strongly agree. These items were summed so that higher scores indicate greater perceived oral health barriers ($\alpha = 0.69$).

Food Insecurity

Food insecurity was measured using a nine-item food security scale (Connell et al., 2005; Connell et al., 2004). These questions ask about food security at home (e.g. how often do they worry that food at home will run out before the family gets money to buy more; how often did food the family bought run out and they didn't have money to get more; how often were they not able to eat a balanced meal because their family didn't have enough money; how often did they have to skip a meal because their family didn't have enough money for food). Participants who responded affirmatively on two or more of the nine items were classified as food insecure ($\alpha = 0.87$).

Attendance

Students were required to sign in for each session on a sign-in sheet to comply with school policy for attendance tracking. These attendance sheets were verified by the research team at each session and these data were recorded for program dosage received. A total of six sessions were implemented in each cohort. Possible attendance ranged from 0-6.

Demographics

Demographic information collected included: self-reported age (years), gender (Male, Female), grade level (9th, 10th, 11th, or 12th), race/ethnicity (American Indian, Black,

Hispanic, or two or more races), number of people living in household, number of bathrooms in the home (as proxy for socioeconomic status).

Analysis

Descriptive statistics were calculated for demographic data. Frequency counts and percentage of correct responses for each health literacy question on the pre- and post-program surveys were calculated and compared. In addition, t-tests were conducted on the pre- and post-program survey average total health literacy score. All analyses were conducted using Stata 18 (College Station, TX: StataCorp LLC).

Results

A total of 39 students expressed initial interest and attended the welcome and introductory sessions, and 24 of the 39 students returned completed consent forms and completed the pre- and post-program surveys. The 24 students (Table 2) were primarily female (63%), Black (75%), in 9th grade (42%), and on average 15.6 years of age (SD = 0.97). Forty-six percent of the students reported that they were experiencing food insecurity and more than one-third (38%) of the students had not visited a dentist in the past year. Among the students that had not visited a dentist in the past year, students were primarily male (67%); Black (56%), in 10th grade (56%) and 44% of those students

Table 2. Characteristics of Students Participating in the Nourishing Smiles Program (n=24)

	Mean (SD) [Range] or n (%)
Age	15.6(0.97) [14-17]
Gender	
Male	9(37.5%)
Female	15(62.5%)
Grade	n(%)
9	10 (41.7%)
10	9 (37.5%)
11	4 (16.7%)
12	1 (4.2%)
Race/ethnicity	
American Indian	2 (8.3%)
Black	18 (75%)
Hispanic	1 (4.2%)
2 or more races	3 (12.5%)
Food insecurity	11 (45.8%)
Number of people in household	3.8 (1.7) [2-9]
Number of bathrooms in home	1.8 (.89) [1-4]
Frequency of Dental Visits	
Visit the dentist at least once per year	15 (62.5%)
Have not been to the dentist in the last 1-2 years	2 (8.3%)
Have not been to the dentist in over 2 years	4 (16.7%)
Never been to the dentist	3 (12.5%)
Perceived Oral Health Barriers ^a	9.3 (3.5) [6-18]
Program Attendance	4.5 (1.14) [3-6]

a. Higher score indicate greater barriers

Table 3. Students' Pre- and Post-program Correct Responses on Health Literacy Items and Average Total Score (n=24)

Topic of the Learning Objective Questions	Pre-program	Post-program
Oral Health n (%)		
Question 1 – Brushing and Flossing	20 (83.3%)	20 (83.3%)
Question 2 – Fluoride	22 (91.7%)	23 (95.8%)
Question 3 – Tartar and Plaque	17 (70.8%)	22 (91.7%)
Question 4 – Dental Visit Recommended Frequency	21 (87.5%)	22 (91.7%)
Nutrition n (%)		
Question 5 – Diet	15 (62.5%)	18 (75%)
Question 6 – Cariogenic Foods	19 (79.2%)	19 (79.2%)
Question 7 – Nutrition Label	17 (70.8%)	15 (62.5%)
Question 8 – Detergent Foods	11 (45.8%)	9 (37.5%)
Question 9 – Example of Detergent Food	12 (50%)	17 (70.8%)
Question 10 – Drinking Water	19 (79.2%)	20 (83.3%)
Risky Health Behaviors n (%)		
Question 11 – Eating Disorder	18 (78.3%)	18 (78.3%)
Question 12 – Smoking & Tobacco	24 (100%)	24 (100%)
Question 13 – Vaping and e-cigarettes	24 (100%)	24 (100%)
Question 14 – Grills and Oral Health	20 (83.3%)	18 (75%)
Question 15 – Oral Piercings	21 (87.5%)	21 (87.5%)
Average Total Score [M (SD)]	Pre-program	Post-program
Health Literacy Score (out of 15)	11.67 (2.60)	12.08 (.52) ^b

Bold = Number of correct responses improved over time

Italics = Number of correct responses maintained over time

^bPre- and post-program average total score p-value = 0.53

also experienced food insecurity (results not reported in Table 2). Across the full sample, all participating students (100%) wanted to obtain a dental visit (results not reported in Table 2). Students attended a mean of 4.5 sessions out of six (SD = 1.14, range = 3-6). All students were part of a high school drop-out prevention program in 9th-12th grade (not reported in Table 2).

Pre- and post-program mean scores for learning objective items used to measure health literacy in the areas of oral health, nutrition, and risky behaviors that influence oral health are presented in Table 3. On six of the 15 learning objectives, the percentage of participants answering correctly increased over time. In addition to those six learning

objective items, on six other learning objective items, participants maintained the correct answer. While the mean total health literacy score increased over time, the positive difference between the start and end of the program was not significant.

Discussion

Enhancing health literacy regarding oral health, nutrition, and risky health behaviors that can influence oral health was the primary goal of Nourishing Smiles. After the program, students' oral health and nutrition health literacy did increase over time; however, the increase was not significant. Overall, the program was well-received:

students reported that they enjoyed the snacks, animated videos, group activities, and learning about oral health and nutrition. Recruitment was successful, yielding a sufficient sample size for a pilot study (Beets et al., 2021). However, there were limited positive findings, which may be related to numerous implementation challenges. Two sets of challenges were encountered: 1) community partnership challenges, and 2) program-related challenges. The community partnership-related challenges included lack of partnership buy-in, turnover and vacancies, and scheduling conflicts. Program-related challenges included low attendance and barriers to accessing dental care. The challenges are discussed below as lessons learned with the intention that these lessons and recommendations are applied to future programming and research focused on under-resourced communities.

Community Partnership Challenges: Lack of Partnership Buy-in

The importance of strong buy-in from the school's leadership, faculty, and staff, in addition to any community-based student support organizations, is critical for successful implementation of health promotion programs in schools (Herlitz et al., 2020). To implement Nourishing Smiles in an under-resourced high school, the research team collaborated with a community-based student support organization that was already integrated within the school and would serve as a liaison. The collaboration led to buy-in from the school's leadership; however, the research team did not have full engagement in terms of faculty and staff proactively encouraging students to attend or outwardly embracing the importance of the program. As programming progressed, leadership became less engaged in assisting the research team with weekly program challenges and less responsive to requests. During cohort 2, the

classroom space availability was limited to one class period with no setup time in the classroom prior to arrival of students for the sessions.

Community Partnership Challenges: Turnover and Vacancies

The lack of community partnership buy-in could be related to the turnover and vacancies observed among the school administration and staff, and the community-based student support organization. For instance, the school's administration experienced several changes with the most significant being the principal being placed on administrative leave mid-year. Among the community-based student support organization, the liaison between the school administration and the research team left, leaving a critical staff vacancy during the start of the implementation of the second cohort. This individual assisted school staff with coordinating hall passes and related recruitment efforts and maintained up-to-date communication about school scheduling/events. The vacancies and turnover, and the associated instability that comes with vacancies and turnovers made it difficult to maintain momentum in program recruitment and implementation. Turnover can lead to ineffective communication and contributes to school-based programs not being sustainable (Herlitz et al., 2020).

Community Partnership Challenges: Scheduling Conflicts

The high turnover and vacancies may have contributed to the school facing challenges in maintaining a consistent schedule. A month prior to school starting, the research team provided the community-based student support organization and school administration with the program schedule and asked whether changes to the program

were necessary. Despite receiving approval of the program's schedule, at least one lesson in each cohort had to be rescheduled at the last minute. In these scenarios, the research team arrived at the scheduled time to campus, prepared for the lesson, only to be told at the scheduled time for the lesson that a school-wide event (e.g. assemblies, field trips) was occurring that day.

Program Challenges: Low Attendance

Barriers to student learning included inconsistent attendance during the lessons. Our efforts to increase attendance included in-person distribution of paper hall passes in the cafeteria, providing both a visual cue (the pass), and in-person interaction with the research team. In cohort 1, students received reminders of programming through an online learning and class management tool (Microsoft Teams), although not all students utilized the platform consistently. During cohort 1, the community-based student support organization partner also sent reminders to teachers via Microsoft Teams about which students would be attending the program. During cohort 2, the community-based student support organization partner notified the research team that Microsoft Teams was not being utilized. At that point, reminder communications shifted to cellphone text messaging and email reminders directly to students using a program-specific Googlevoice number and program-specific email account. Some students responded affirmatively to email or text reminders to confirm their attendance, while others did not. According to school policy all students should have school-issued laptops and most have personal cellphones; however, there were still issues of students forgetting and/or losing chargers, laptops, and phones. This negatively affected the utility of our digital-based reminder process.

Program Challenges: Available, but Not Accessible, Dental Care

While Nourishing Smiles was not designed to measure clinical oral health outcomes, students received instruction on oral health behaviors (brushing and flossing) and received oral health supplies to facilitate the behaviors. Access to brushing and flossing supplies is linked with higher performance of those oral health behaviors among minority adolescents (M. Sharma et al., 2022). Consequently, across both cohorts, 100% of the students reported that they wanted to obtain a dental visit. In cohort 1, the research team provided the students with a referral for a free dental cleaning that was underwritten by the student support organization; however, several barriers prevented students from obtaining a dental appointment (e.g., scheduling, transportation, and lack of time needed to attend the appointment). The original referral for a cleaning would have to be done during the workday with a parent or guardian present, and parents may have to pay for transportation or parking at the facility. Ultimately, only one student scheduled an appointment, and no students in cohort 1 (when the referral option was offered) completed a dental visit within the timeframe during which the free dental cleaning would be funded. In response, in cohort 2, mobile dental services were implemented to provide students with a full dental examination and cleaning on school premises during school hours. Mobile dental services have been successful in increasing preventive and restorative dental care among low-income children who have limited access to oral health services (Dawkins et al., 2013; Partido et al., 2021; Spetz et al., 2019; Wiener et al., 2020). When a mobile dental van was implemented on campus, all students from both cohorts were eligible to get a dental cleaning, and 100% of students from both

cohorts (n=24) received the full dental cleaning. This dental cleaning included a full exam with X-rays, dental scaling when needed, and referrals for students with more serious issues that required periodontal expertise.

Recommendations to Reduce Challenges

Future researchers may consider setting up a community advisory board (CAB) to help identify and leverage key stakeholders in the community to facilitate buy-in. The CAB could include school alumni that are seen as leaders in the community, representatives from community-based organizations that address oral health or youth-focused programming, along with other prominent figures (e.g., religious leaders, elected officials, and highly visible first responders). Additionally, a school advisory board (SAB) could be created to include representatives from leadership, faculty and staff. Leadership, faculty, and staff would be financially compensated for their time on the SAB. The SAB would assist with advising the research team on the school climate, make the research team aware of schedule conflicts, and champion the program to leadership, faculty, staff, and students. A SAB would be especially important in reducing low attendance among the students. The SAB would engage in encouraging students to attend program sessions and reduce challenges associated with missing lessons. The research team could also draft an email and request leadership send out the email to the whole school and all parents to advertise the program and provide program updates twice during the programming. This could be framed as a newsletter and could include some photos of program activities, and could celebrate the accomplishments of students, such as attendance to keep the program visible and positive.

Implications for Health Behavior Research

This paper presents challenges and lessons learned from the implementation of a school-based oral health promotion program targeting adolescents in an under-resourced high school. These challenges and lessons learned should be considered in developing health promotion policies and programs in the school-based setting. These challenges to health promotion programming and research should not be used as rationale not to implement these types of programs, but rather, as an impetus to share information on challenges experienced and possible strategies to address these challenges. Students that attend under-resourced schools deserve to receive health promotion programming despite challenging circumstances.

There is a gap in peer-reviewed journals regarding inconclusive or nonsignificant findings of studies. The lessons learned from non-significant studies are important to disseminate to enable other researchers and practitioners to continue to learn from and build on each other's work. In particular, the challenges presented here are relevant to under-resourced and underserved communities, which are also often experiencing health disparities. Understanding and responding to the challenges specific to these settings is an important step towards health equity. In addition to building on the challenges, lessons learned, and recommendations discussed here, researchers are encouraged to disseminate (via publications) more challenges and lessons learned regarding program development and implementation, especially among studies with non-significant findings (Kirk et al., 2022).

Discussion Questions

Our findings indicate a need to build and preserve school and community partner buy-in within challenging and under-resourced circumstances. How can health promotion program planners build and retain buy-in among teachers and school staff who experience challenging workloads, burnout, and high turnover?

Students in under-resourced schools are often experiencing complex situations in their homes and at schools. How can school-based health promotion program planners build rapport and cultivate program adherence amid competing priorities and sometimes larger external influences that students may be experiencing?

Acknowledgements

We thank the leadership, faculty, and staff at the high school where Nourishing Smiles was implemented and staff at community-based student support organization for their collaborative efforts on this program. The oral health supplies distributed to the students enrolled in Nourishing Smiles were provided by Procter and Gamble. The design, implementation, and evaluation of Nourishing Smiles was supported by The University of Texas Health Science Center at Houston's School of Dentistry and Cizik School of Nursing Seed Grant to the PI (last author). Funding for the undergraduate research assistants came from the Research and Extension Experiential Learning for Undergraduates Program of the National Institute of Food and Agriculture, USDA, Grant #2022-68018-36607 also to the last author. As a part of the *Health Behavior Research* mentorship issue, we describe the mentoring collaboration that occurred. The mentorship of the undergraduate and graduate students (second – fifth authors)

was under the supervision of the postdoctoral scholar (first author) and last author. The last author mentored the postdoctoral scholar.

References

- Akinkugbe, A. A. (2019). Cigarettes, e-cigarettes, and adolescents' oral health: Findings from the Population Assessment of Tobacco and Health (PATH) study. *JDR Clinical & Translational Research*, 4(3), 276-283. <https://doi.org/10.1177/2380084418806870>
- American Dental Association. (n.d.). *Lesson Plans*. Retrieved August 11, 2021 from <https://www.mouthhealthy.org/en/resources/lesson-plans>
- Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior*, 31(2), 143-164. <https://doi.org/10.1177/1090198104263660>
- Bashirian, S., Seyedzadeh-Sabounchi, S., Shirahmadi, S., Karimi-Shahanjarini, A., Soltanian, A. R., & Vahdatinia, F. (2021). Predictors of oral health promotion behaviors among elementary school children: Examination of an extended social cognitive theory. *International Journal of Paediatric Dentistry*, 31(2), 191-203. <https://doi.org/10.1111/ipd.12659>
- Baxevanos, K., Menexes, G., Lazaridou, A., Coolidge, T., Topitsoglou, V., & Kalfas, S. (2021). Dental caries and psychosocial factors: Testing a conceptual model in adolescents. *Community Dentistry and Oral Epidemiology*, 49(4), 314-321. <https://doi.org/10.1111/cdoe.12653>
- Beets, M. W., von Klingraeff, L., Weaver, R. G., Armstrong, B., & Burkart, S. (2021). Small studies, big decisions: the role of pilot/feasibility studies in incremental science and premature scale-up of behavioral interventions. *Pilot and Feasibility Studies*, 7, 1-9.

- <https://doi.org/https://doi.org/10.1186/s40814-021-00909-w>
- Biesbrock, A., Walters, P. A., & Bartizek, R. D. (2004). Short-term impact of a national dental education program on children's oral health and knowledge. *Journal of Clinical Dentistry*, *15*(4), 93-97.
- Blake, H., Dawett, B., Leighton, P., Rose-Brady, L., & Deery, C. (2015). School-based educational intervention to improve children's oral health-related knowledge. *Health Promotion Practice*, *16*(4), 571-582.
<https://doi.org/10.1177/1524839914560568>
- Calderon, S. J., & Mallory, C. (2014). A systematic review of oral health behavior research in American adolescents. *The Journal of School Nursing*, *30*(6), 396-403.
<https://doi.org/10.1177/1059840514544034>
- Connell, C. L., Lofton, K. L., Yadrick, K., & Rehner, T. A. (2005). Children's experiences of food insecurity can assist in understanding its effect on their well-being. *Journal of Nutrition*, *137*(7), 1683-1690.
<https://doi.org/10.1093/jn/135.7.1683>
- Connell, C. L., Nord, M., Lofton, K. L., & Yadrick, K. (2004). Food security of older children can be assessed using a standardized survey instrument. *Journal of Nutrition*, *134*(10), 2566-2572.
<https://doi.org/10.1093/jn/134.10.2566>
- Cooper, A. M., O'Malley, L. A., Elison, S. N., Armstrong, R., Burnside, G., Adair, P., Dugdill, L., & Pine, C. (2013). Primary school-based behavioural interventions for preventing caries. *Cochrane Database of Systematic Reviews*(5), CD009378.
<https://doi.org/10.1002/14651858.CD009378.pub2>
- Dawkins, E., Michimi, A., Ellis-Griffith, G., Peterson, T., Carter, D., & English, G. (2013). Dental caries among children visiting a mobile dental clinic in South Central Kentucky: a pooled cross-sectional study. *BMC Oral Health*, *13*, 19.
<https://doi.org/10.1186/1472-6831-13-19>
- DiMaria-Ghalili, R. A., Mirtallo, J. M., Tobin, B. W., Hark, L., Van Horn, L., & Palmer, C. A. (2014). Challenges and opportunities for nutrition education and training in the health care professions: intraprofessional and interprofessional call to action. *American Journal of Clinical Nutrition*, *99*(5 Suppl), 1184s-1193s.
<https://doi.org/10.3945/ajcn.113.073536>
- Freddo, S. L., Cunha, I. P., Bulgareli, J. V., Cavalcanti, Y. W., & Pererira, A. C. (2018). Relations of drug use and socioeconomic factors with adherence to dental treatment among adolescents. *BMC Oral Health*, *18*(1), 221.
<https://doi.org/10.1186/s12903-018-0674-4>
- Guarnizo-Herreño, C. C., Lyu, W., & Wehby, G. L. (2019). Children's Oral Health and Academic Performance: Evidence of a Persisting Relationship Over the Last Decade in the United States. *The Journal of Pediatrics*, *209*, 183-189.e182.
<https://doi.org/10.1016/j.jpeds.2019.01.045>
- Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L., Delacqua, G., Delacqua, F., & Kirby, J. (2019). The REDCap consortium: building an international community of software platform partners. *Journal of Biomedical Informatics*, *95*, 103208.
<https://doi.org/http://dx.doi.org/10.1016/j.jbi.2019.103208>
- Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research

- informatics support. *Journal of Biomedical Informatics*, 42(2), 377-381. <https://doi.org/http://dx.doi.org/10.1016/j.jbi.2008.08.010>
- Herlitz, L., MacIntyre, H., Osborn, T., & Bonell, C. (2020). The sustainability of public health interventions in schools: a systematic review. *Implementation Science*, 15, 1-28. <https://doi.org/http://dx.doi.org/10.1186/s13012-019-0961-8>
- Jackson, K. M., Sher, K. J., Cooper, M. L., & Wood, P. K. (2002). Adolescent alcohol and tobacco use: onset, persistence and trajectories of use across two samples. *Addiction*, 97(5), 517-531. <https://doi.org/10.1046/j.1360-0443.2002.00082.x>
- Kirk, K., Schuler, B. R., & Hernandez, D. C. (2022). Lessons learned from conducting health behavior research in an under-resourced, urban community. *Health Behavior Review*, 5 (3), <https://doi.org/10.4148/2572-1836.1153>
- Moreno, R. (2007). Optimising learning from animations by minimising cognitive load: cognitive and affective consequences of signalling and segmentation methods. *Applied Cognitive Psychology*, 21(6), 765-781. <https://doi.org/10.1002/acp.1348>
- Myers, M. G., & Kelly, J. F. (2006). Cigarette smoking among adolescents with alcohol and other drug use problems. *Alcohol Research & Health*, 29(3), 221-227.
- National Institute of Dental and Craniofacial Research. (2018, July 2018). *Dental Caries (Tooth Decay) in Adolescents (Age 12 to 19)*. Retrieved August 27 from <https://www.nidcr.nih.gov/research/data-statistics/dental-caries/adolescents#table2>
- National Institutes of Dental and Craniofacial Research. (2021). *Section 2B Oral Health Across the Lifespan: Adolescents*. (J. Albino & B. Dye, Eds.). National Institutes of Health. <https://www.ncbi.nlm.nih.gov/books/NBK578289/>
- Northridge, M. E., Kumar, A., & Kaur, R. (2020). Disparities in access to oral health care. *Annual Review of Public Health*, 41, 513-535. <https://doi.org/10.1146/annurev-publhealth-040119-094318>
- Occa, A., & Morgan, S. E. (2019). Animations about clinical trial participation for cancer patients and survivors. *Journal of Health Communication*, 24(10), 749-760. <https://doi.org/10.1080/10810730.2019.1668089>
- Partido, B. B., Bean, C., Chartier, E. A., & Sprinkle, E. (2021). Outcome evaluation of the dental Health Outreach Mobile Experience (HOME) coach program. *Journal of Dental Education*, 85(1), 37-43. <https://doi.org/10.1002/jdd.12403>
- Pelucchi, C., Gallus, S., Garavello, W., Bosetti, C., & La Vecchia, C. (2006). Cancer risk associated with alcohol and tobacco use: Focus on upper aerodigestive tract and liver. *Alcohol Research & Health*, 29(3), 193-198.
- Ruff, R. R., Senthil, S., Susser, S. R., & Tsutsui, A. (2019). Oral health, academic performance, and school absenteeism in children and adolescents: A systematic review and meta-analysis. *Journal of the American Dental Association* 150(2), 111-121.e114. <https://doi.org/10.1016/j.ada.2018.09.023>
- Sharma, M., Batra, K., Chen, C., Dai, C., Batra, R., & Cappelli, D. P. (2022). Predicting flossing through the application of the Multi-Theory Model (MTM) of health behavior change among minority adolescents in the United States. *International Journal of Environmental Research and Public Health*, 19(22), 15106. <https://doi.org/10.3390/ijerph192215106>

- Sharma, S. V., Kelder, S., Yamal, J. M., Chuang, R. J., Byrd-Williams, C., Bona, G., Bajaj, N., Brito, F., & Neumann, A. S. (2022). Development and feasibility testing of CATCH Healthy Smiles, an oral health promotion intervention for prevention of dental caries among elementary school children. *The Journal of School Health*, 92(1), 20-30. <https://doi.org/10.1111/josh.13100>
- Sherman, D. K., Updegraff, J. A., & Mann, T. (2008). Improving oral health behavior: A social psychological approach. *Journal of the American Dental Association*, 139(10), 1382-1387. <https://doi.org/10.14219/jada.archive.2008.0050>
- Souza, J. G. S., Souza, S. E., Noronha, M. d. S., Ferreira, E. F. e., & Martins, A. M. E. d. B. L. (2018). Impact of untreated dental caries on the daily activities of children. *Journal of Public Health Dentistry*, 78(3), 197-202. <https://doi.org/http://dx.doi.org/10.1111/jphd.12259>
- Spetz, J., Pourat, N., Chen, X., Lee, C., Martinez, A., Xin, K., & Hughes, D. (2019). Expansion of dental care for low-income children through a mobile services program. *Journal of School Health*, 89(8), 619-628. <https://doi.org/10.1111/josh.12789>
- Stein, C., Santos, N. M. L., Hilgert, J. B., & Hugo, F. N. (2018). Effectiveness of oral health education on oral hygiene and dental caries in schoolchildren: Systematic review and meta-analysis. *Community Dentistry and Oral Epidemiology*, 46(1), 30-37. <https://doi.org/10.1111/cdoe.12325>
- Tsai, C., Raphael, S., Agnew, C., McDonald, G., & Irving, M. (2020). Health promotion interventions to improve oral health of adolescents: A systematic review and meta-analysis. *Community Dentistry and Oral Epidemiology*, 48(6), 549-560. <https://doi.org/10.1111/cdoe.12567>
- Wiener, R. C., Summerlin, T., Smith, L. B., Carrier, D. T., & Wiener, M. A. (2020). Dental care needs of male versus female children visiting a school-based mobile dental facility in West Virginia. *Journal of Dental Hygiene*, 94(3), 48-55.
- Xiang, B., Wong, H. M., Cao, W., Perfecto, A. P., & McGrath, C. P. (2020). Development and validation of the Oral health behavior questionnaire for adolescents based on the health belief model (OHBQAIBM). *BMC Public Health*, 20, 1-11. <https://doi.org/http://dx.doi.org/10.1186/s12889-020-08851-x>
- Xiang, B., Wong, H. M., Perfecto, A. P., & McGrath, C. P. (2020). The effectiveness of behavioral interventions to improve oral health in adolescents at different periods of follow-up: A systematic review and meta-analysis. *Patient Education and Counseling*, 103(4), 725-733. <https://doi.org/10.1016/j.pec.2019.11.030>