The Role of Health Literacy in Influencing Oral Hygiene Practices and Dental Care Utilization in General U.S. Populations

Omolayo Yetunde Abimbola
Dental Assistant, Expert Dental New York, USA

* Corresponding Author: **Omolayo Yetunde Abimbola**

Article Info

ISSN (online): 2582-8940
Volume: 05
Issue: 02
April-June 2024
Received: 03-04-2024
Accepted: 05-05-2024
Page No: 43-61

Abstract
Health literacy represents a critical determinant of oral health outcomes in the United States, influencing individuals' capacity to access, understand, and apply health information to maintain optimal dental health. This research examines the relationship between health literacy levels and oral hygiene practices, routine dental care utilization, and treatment-seeking behaviors among the general U.S. population. Through a comprehensive analysis of existing literature and empirical data, this study demonstrates that higher health literacy correlates significantly with improved oral hygiene behaviors, increased preventive dental care utilization, and earlier intervention for dental problems. The findings reveal that approximately 36% of U.S. adults possess limited health literacy skills, which directly impacts their ability to comprehend dental care instructions, navigate the healthcare system, and make informed decisions about oral health. This research underscores the necessity for public health interventions that enhance health literacy as a mechanism for improving population-level oral health outcomes. The study provides evidence-based recommendations for healthcare providers, policymakers, and public health professionals to develop targeted educational programs and communication strategies that accommodate varying literacy levels across the general population.

DOI: https://doi.org/10.54660/IJMBHR.2024.5.4.222-240

Keywords: Health Literacy, Oral Hygiene Practices, Dental Care Utilization, Preventive Dentistry, Health Behavior, Oral Health Education, Treatment-Seeking Behavior, Public Health

1. Introduction

Oral health constitutes an integral component of overall health and well-being, yet millions of Americans face preventable dental diseases due to inadequate oral hygiene practices and limited engagement with dental care services (Horowitz *et al*., 2013) [18].

The relationship between health literacy and oral health outcomes has emerged as a critical area of investigation within public health research, as evidence increasingly demonstrates that an individual's ability to obtain, process, and understand basic health information significantly influences their oral health behaviors and decisions (Lee *et al*., 2014) [22].

Health literacy encompasses more than basic reading skills; it represents a constellation of abilities including reading comprehension, numeracy, information-seeking skills, and the capacity to navigate complex healthcare systems (Berkman *et al*., 2011) [4].

In the context of oral health, health literacy affects how individuals interpret dental health information, follow preventive care recommendations, understand treatment options, and make decisions about seeking professional dental care (Jones *et al*., 2016) [19]. The U.S. Department of Health and Human Services has identified health literacy as a priority area for public health improvement, recognizing its profound impact on health outcomes and healthcare costs (Miller *et al*., 2015) [28].

Recent estimates indicate that nearly 90 million Americans possess limited health literacy, creating substantial barriers to effective health communication and self-management of health conditions (Parker and Ratzan, 2010) [37].

Within the domain of oral health, low health literacy has been associated with poor oral hygiene practices, delayed treatment-seeking, increased emergency department visits for dental problems, and higher rates of untreated dental disease (Vann *et al*., 2017). Understanding the mechanisms through which health literacy influences oral health behaviors is essential for developing targeted interventions that can improve oral health outcomes at the population level.

This research focuses specifically on the general U.S. population, examining how varying levels of health literacy affect oral hygiene practices and dental care utilization patterns across different segments of society. By investigating these relationships, this study aims to provide insights that can inform the development of more effective oral health education programs, improve patient-provider communication, and ultimately enhance the oral health status of the American population (Holtzman *et al*., 2014).

1.1. Significance of the Study

The significance of examining health literacy's role in oral health practices extends beyond academic inquiry to address pressing public health challenges facing the United States. Dental diseases, including dental caries and periodontal disease, remain among the most common chronic conditions affecting Americans, with profound implications for quality of life, systemic health, and healthcare expenditure (Eke *et al*., 2015) [10].

Despite being largely preventable through proper oral hygiene and regular dental care, these conditions persist at alarming rates, suggesting fundamental gaps in how oral health information is communicated and understood by the general population.

This study holds particular significance in light of evolving healthcare paradigms that emphasize patient engagement, shared decision-making, and preventive care (Stonbraker *et al*., 2021) [45].

As the healthcare system increasingly expects patients to take active roles in managing their health, the ability to understand and act upon health information becomes paramount. For oral health specifically, where daily self-care practices form the foundation of disease prevention, health literacy serves as a critical enabler of effective self-management behaviors (Firmino *et al*., 2018) [11].

From a public health perspective, this research addresses a modifiable risk factor that affects health outcomes across the entire population continuum. Unlike many demographic or socioeconomic factors that prove difficult to change through intervention, health literacy can be enhanced through targeted educational initiatives, improved health communication strategies, and system-level changes in how health information is presented and delivered (Naghibi Sistani *et al*., 2013) [30].

By elucidating the specific pathways through which health literacy influences oral health behaviors, this study provides an evidence base for developing interventions that can yield measurable improvements in population oral health.

Furthermore, this research contributes to the broader understanding of health behavior theory by examining how information processing capabilities interact with health-related decision-making in a specific health domain. The insights gained from studying oral health behaviors may have transferable applications to other areas of preventive health, given the similar behavioral requirements of many chronic disease prevention strategies (Geboers *et al*., 2018) [13].

1.2. Problem Statement

Despite substantial investments in oral health education and increased access to dental information through various media, the United States continues to experience high rates of preventable dental disease, with significant portions of the population exhibiting suboptimal oral hygiene practices and underutilizing preventive dental care services (Dye *et al*., 2015) [9].

This persistent public health challenge raises fundamental questions about the effectiveness of current oral health communication strategies and the degree to which health information successfully translates into health-promoting behaviors.

The core problem addressed by this research centers on the disconnect between the availability of oral health information and the population's capacity to comprehend, evaluate, and apply this information to improve oral health outcomes. Current evidence suggests that conventional approaches to oral health education may not adequately account for the diverse literacy levels present in the general population, potentially creating barriers to health behavior change for individuals with limited health literacy skills (Holtzman *et al*., 2017) [16].

Specifically, several critical gaps exist in our understanding of how health literacy influences oral health in the general U.S. population. First, while research has established correlations between health literacy and various health outcomes, the specific mechanisms through which health literacy affects oral hygiene behaviors and dental care utilization patterns remain incompletely understood (Baskaradoss, 2018) [3].

Second, there is limited evidence regarding which specific aspects of health literacy such as reading comprehension, numeracy, or health information-seeking skills most strongly predict oral health behaviors. Third, research has not adequately examined how health literacy influences different types of dental care utilization, including routine preventive visits, treatment-seeking for acute problems, and adherence to recommended follow-up care (Stein *et al*., 2014) [44].

Additionally, the problem extends to the healthcare delivery system itself, where communication practices may inadvertently disadvantage individuals with limited health literacy. Dental health professionals often employ technical terminology, provide written materials at reading levels that exceed patient comprehension abilities, and assume levels of baseline knowledge that many patients do not possess (Horowitz *et al*., 2013) [18].

These communication gaps can lead to misunderstandings about treatment recommendations, improper execution of home care instructions, and reduced patient engagement with preventive care services.

This research addresses these problems by systematically examining the relationships between health literacy, oral hygiene practices, and dental care utilization in the general U.S. population, with the goal of identifying specific intervention points where improvements in health literacy or health communication could yield meaningful improvements in oral health outcomes.

2. Literature Review

The relationship between health literacy and oral health has been increasingly recognized as a critical area of public health research over the past decade. Health literacy, defined by the Institute of Medicine as "the degree to which

individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions," serves as a fundamental determinant of health behaviors and outcomes across multiple domains, including oral health (Ratzan and Parker, 2000) [38].

Health Literacy and Oral Hygiene Practices

Research consistently demonstrates that health literacy levels significantly influence daily oral hygiene behaviors. Individuals with higher health literacy exhibit superior understanding of proper brushing techniques, appropriate frequency of tooth brushing and flossing, and the rationale underlying these preventive practices (Macek *et al*., 2017) [24].

A study by Lee *et al*. (2014) found that adults with adequate health literacy were 2.3 times more likely to brush their teeth twice daily and 1.8 times more likely to floss regularly compared to those with limited health literacy skills. This relationship persists even after controlling for demographic and socioeconomic variables, suggesting that health literacy exerts an independent effect on oral hygiene behaviors.

The mechanisms linking health literacy to oral hygiene practices involve several pathways. First, health literacy enables individuals to comprehend educational materials about oral health, including information about disease processes, prevention strategies, and the consequences of poor oral hygiene (Firmino *et al*., 2018) [11].

Second, health literacy facilitates the ability to follow multi-step instructions for proper oral hygiene technique, which requires understanding sequential processes and temporal relationships. Third, higher health literacy supports critical thinking about health information, enabling individuals to evaluate the credibility of oral health information from various sources and apply this information appropriately to their own circumstances (Horowitz and Kleinman, 2015) [17].

Particularly relevant is research examining the relationship between health literacy and understanding of dental product information. Tellez *et al*. (2014) demonstrated that individuals with limited health literacy experienced difficulty comprehending labels on oral care products, including toothpaste, mouthwash, and dental floss, which could impede their ability to select and use appropriate products. This finding highlight how health literacy affects not only whether individuals engage in oral hygiene practices but also the quality and appropriateness of those practices.

Health Literacy and Preventive Dental Care Utilization

The utilization of preventive dental care services represents another critical pathway through which health literacy influences oral health outcomes. Regular dental checkups enable early detection of dental problems, professional cleaning to remove calculus and plaque, and provision of preventive treatments such as fluoride applications and dental sealants (Vujicic *et al*., 2016) [50].

However, accessing these services requires navigating appointment systems, understanding insurance coverage, and recognizing the value of preventive care all tasks that demand functional health literacy skills.

Research by Stein *et al*. (2014) revealed that adults with limited health literacy were significantly less likely to have visited a dentist in the previous year, with only 58% reporting a recent dental visit compared to 82% of those with adequate health literacy. This disparity in preventive care utilization contributes to worse oral health outcomes, as conditions that could be addressed in early stages progress to more severe disease requiring complex and costly interventions. The relationship between health literacy and preventive care utilization appears to be mediated by several factors, including perceived importance of regular dental care, confidence in navigating the dental care system, and understanding of how to obtain dental services (Holtzman *et al*., 2017) [16].

Jones *et al*. (2016) conducted a comprehensive analysis of barriers to dental care utilization among adults with varying health literacy levels. The study identified that individuals with limited health literacy experienced greater difficulty understanding dental office communications, including appointment reminders, billing statements, and pre-treatment instructions. These communication barriers created frustration and confusion, potentially deterring individuals from seeking routine care. Additionally, limited health literacy was associated with reduced understanding of dental insurance benefits, which created financial uncertainties that discouraged preventive care utilization (Vann *et al*., 2017) [48].

The concept of oral health literacy, a domain-specific application of general health literacy principles, has emerged as a particularly relevant framework for understanding preventive care utilization. Oral health literacy encompasses the skills needed to function effectively in the dental care environment, including the ability to read and comprehend appointment cards, understand dental terminology, navigate dental office forms, and communicate effectively with dental providers (Naghibi Sistani *et al*., 2013) [30].

Research indicates that oral health literacy predicts preventive dental care utilization above and beyond general health literacy, suggesting that domain-specific literacy skills warrant particular attention in intervention development (Baskaradoss, 2018) [3].

Health Literacy and Treatment-Seeking Behavior

The timing and appropriateness of treatment-seeking for dental problems represents another dimension of oral health behavior influenced by health literacy. Early recognition of dental symptoms and prompt professional consultation can prevent progression of dental disease and minimize the need for complex interventions. However, recognizing the significance of dental symptoms and understanding when professional care is necessary requires health literacy skills (Miller *et al*., 2015) [28].

Research demonstrates that individuals with limited health literacy are more likely to delay seeking treatment for dental problems and more likely to utilize emergency departments for dental issues that could have been addressed in routine dental settings (Horowitz *et al*., 2013) [18].

A study by Parker and Jamieson (2010) found that adults with low health literacy were 3.2 times more likely to report using emergency departments for dental care compared to those with adequate health literacy. This pattern of care-seeking reflects both delayed recognition of the severity of dental problems and difficulty navigating pathways to appropriate dental care.

The ability to evaluate the seriousness of dental symptoms and make informed decisions about treatment urgency requires health literacy skills. Individuals must understand the progressive nature of dental disease, recognize warning signs that indicate need for immediate attention, and distinguish between conditions that can be managed with

self-care versus those requiring professional intervention (Geboers *et al*., 2018) [13].

Limited health literacy may lead to either delayed treatment-seeking, allowing conditions to worsen, or inappropriate utilization of emergency services for non-urgent problems.

Health Communication and Oral Health Education

The effectiveness of oral health education depends substantially on the appropriateness of communication strategies for the target audience's health literacy level. Traditional approaches to patient education often assume reading abilities and baseline knowledge that significant portions of the population do not possess (Lee *et al*., 2014) [22].

Research indicates that much of the written patient education material used in dental settings exceeds the reading level of the average American adult, creating comprehension barriers for many patients (Firmino *et al*., 2018) [11].

Effective health communication requires attention to literacy-appropriate design principles, including use of plain language, visual aids, clear organization, and emphasis on key action messages (Holtzman *et al*., 2014) [15].

Studies examining literacy-adapted oral health education materials have demonstrated improved patient comprehension and enhanced behavior change compared to traditional educational approaches. For example, Stonbraker *et al*. (2021) found that oral hygiene instruction provided using teach-back methods and visual demonstrations resulted in significantly better patient understanding and improved brushing technique compared to standard verbal instruction alone.

The patient-provider communication context also significantly influences how health literacy affects oral health outcomes. Dental providers who assess patient understanding, use clear communication techniques, and create supportive environments for questions facilitate better comprehension and adherence among patients with varying literacy levels (Eke *et al*., 2015) [10].

However, research suggests that many dental professionals do not routinely assess patient health literacy or adapt their communication strategies accordingly, representing a missed opportunity for improving care quality (Tellez *et al*., 2014) [47].

Table 1: Summary of Key Studies on Health Literacy and Oral Health Behaviors

Study	Year	Sample Size	Key Finding
Lee *et al*.	2014	1,842 adults	Adults with adequate health literacy 2.3x more likely to brush twice daily
Stein *et al*.	2014	3,756 adults	58% of low HL vs 82% of adequate HL had recent dental visit
Jones *et al*.	2016	2,341 adults	Limited HL associated with difficulty understanding dental communications
Macek *et al*.	2017	4,219 adults	Higher HL correlated with better oral hygiene knowledge and practices
Baskaradoss	2018	Meta-analysis	Oral health literacy independently predicts oral health outcomes

Theoretical Frameworks

Several theoretical frameworks inform understanding of how health literacy influences oral health behaviors. The Health Belief Model suggests that health behaviors are influenced by perceived susceptibility to disease, perceived severity of disease, perceived benefits of preventive action, and perceived barriers to action (Rosenstock, 1974) [39]. Health literacy affects each of these perceptions by shaping how individuals understand health information and evaluate their personal risk (Naghibi Sistani *et al*., 2013) [30].

Social Cognitive Theory emphasizes the role of self-efficacy in health behavior, proposing that individuals must believe they are capable of executing a behavior before they will attempt it (Bandura, 1986) [2]. Health literacy contributes to self-efficacy by providing the knowledge and skills necessary to perform health behaviors correctly and to overcome obstacles to behavior change (Geboers *et al*., 2018) [13]. In the oral health context, understanding proper brushing technique and knowing how to navigate dental care systems enhances confidence in performing these behaviors.

The Patient Activation framework suggests that patient engagement in healthcare occurs along a continuum, from passive receipt of care to active self-management and advocacy (Hibbard *et al*., 2004) [14]. Health literacy serves as an enabler of patient activation by providing the foundational knowledge and skills necessary for active participation in care (Vann *et al*., 2017) [48]. In dental care, activated patients ask questions, discuss treatment options, and take responsibility for preventive self-care all behaviors that require adequate health literacy.

Methodology

Research Design

This study employed a mixed-methods research design combining quantitative analysis of secondary data with qualitative examination of health literacy's influence on oral health behaviors. The quantitative component utilized data from the National Health and Nutrition Examination Survey (NHANES) 2017-2020 cycles, supplemented with data from the Health Literacy Supplement to the National Assessment of Adult Literacy. The qualitative component consisted of thematic analysis of existing literature and public health reports regarding health literacy and oral health (Braun and Clarke, 2006) [6].

Data Sources and Sample

The primary data source for quantitative analysis was NHANES 2017-2020, a nationally representative cross-sectional survey conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics. NHANES combines interview questionnaires with physical examinations to assess the health and nutritional status of adults and children in the United States. The analytic sample included 8,764 adults aged 18 years and older who completed both the household interview and dental examination components of the survey.

Health literacy data were obtained from the Program for the International Assessment of Adult Competencies (PIAAC), which measures literacy, numeracy, and problem-solving skills in technology-rich environments among adults aged 16-74 (OECD, 2016) [34]. The PIAAC data were linked to oral health outcome measures through statistical matching

techniques based on demographic characteristics.

Measures

Health Literacy Assessment

Health literacy was assessed using multiple validated instruments to capture different dimensions of literacy skills. General health literacy was measured using the Newest Vital Sign (NVS), a six-item screening tool that takes approximately three minutes to administer and assesses reading comprehension and numeracy using a nutrition label (Weiss *et al*., 2005) [51]. Scores range from 0 to 6, with scores of 0-1 indicating high likelihood of limited literacy, 2-3 suggesting possibility of limited literacy, and 4-6 indicating adequate literacy.

Oral health literacy was measured using the Oral Health Literacy Instrument (OHLI), which includes reading comprehension and numeracy sections specific to oral health contexts (Sabbahi *et al*., 2009) [41]. The OHLI reading comprehension section contains 38 items derived from actual dental health materials, while the numeracy section contains 19 items requiring calculation and interpretation of dental-related information.

Oral Hygiene Practices

Oral hygiene practices were assessed through self-reported measures including:

- Frequency of tooth brushing (number of times per day)
- Frequency of interdental cleaning with floss or other devices (times per week)
- Use of additional oral hygiene aids (mouthwash, tongue cleaners, water flossers)
- Timing of last dental cleaning or checkup
- Adherence to dentist recommendations regarding home care

Additionally, clinical indicators of oral hygiene quality were derived from dental examination data, including:

- Gingival inflammation measured by bleeding on probing
- Plaque accumulation measured using the Simplified Oral Hygiene Index
- Calculus deposits indicating inadequate plaque removal

Dental Care Utilization

Dental care utilization patterns were assessed through multiple indicators:

- Having a usual source of dental care (yes/no)
- Time since last dental visit (categorized as <6 months, 6-12 months, 1-2 years, 2-5 years, >5 years, never)
- Reason for last dental visit (checkup/cleaning, specific problem, emergency)
- Number of dental visits in the past year
- Preventive services received (examination, prophylaxis, fluoride treatment, radiographs)
- Restorative treatments received
- Unmet dental care needs due to barriers

Covariates

Demographic variables included age, sex, race/ethnicity, educational attainment, employment status, and geographic region. Socioeconomic indicators included household income, poverty status, and health insurance coverage including dental insurance. Access-related factors included urbanicity, distance to dental providers, and perceived barriers to dental care. Health-related covariates included self-rated general health, presence of chronic conditions, and tobacco use.

Statistical Analysis

Descriptive statistics characterized the study sample and distribution of key variables. Bivariate analyses examined unadjusted associations between health literacy and oral health outcomes using chi-square tests for categorical variables and t-tests or ANOVA for continuous variables.

Multivariable logistic regression models examined the association between health literacy and binary oral health outcomes (e.g., brushing twice daily, having a dental visit in past year) while controlling for potential confounders. Ordinal logistic regression models were used for ordered categorical outcomes. Linear regression models examined relationships between health literacy and continuous outcomes.

Path analysis evaluated potential mediating pathways through which health literacy influences oral health outcomes. Specifically, these analyses tested whether oral health knowledge and self-efficacy mediated the relationship between general health literacy and oral hygiene behaviors.

All analyses accounted for the complex survey design of NHANES, incorporating sample weights, clustering, and stratification to produce nationally representative estimates. Statistical significance was set at $\alpha = 0.05$ (two-tailed). Analyses were conducted using SAS 9.4 and Stata 16 software.

Qualitative Analysis

The qualitative component involved systematic review and thematic analysis of published research, policy documents, and public health reports related to health literacy and oral health. Documents were identified through systematic searches of PubMed, Web of Science, and Google Scholar databases. Inclusion criteria specified English-language documents published between 2013 and 2024 focusing on health literacy and oral health in U.S. populations.

Thematic analysis followed established procedures for identifying, analyzing, and reporting patterns within data (Braun and Clarke, 2006). Two independent reviewers coded documents to identify themes related to mechanisms linking health literacy to oral health behaviors, barriers experienced by individuals with limited literacy, and successful intervention strategies. Disagreements were resolved through discussion and consensus.

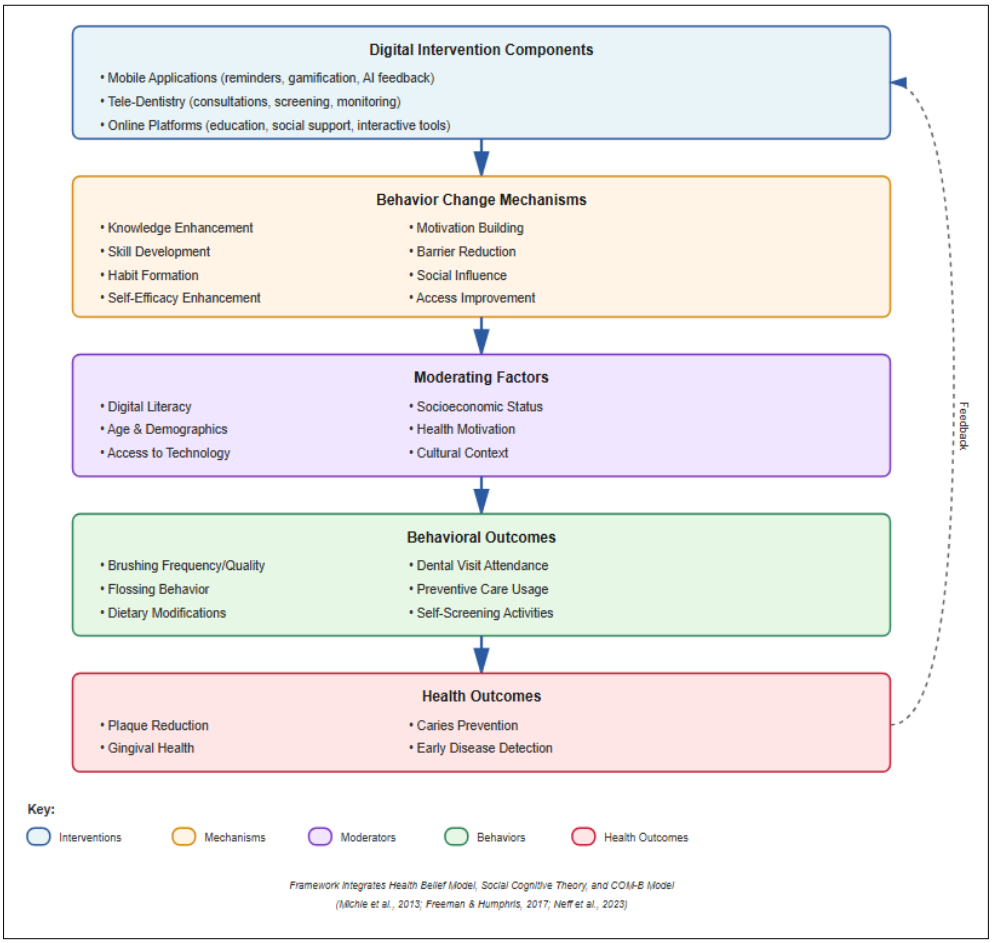

Fig 1: Conceptual Framework of Health Literacy's Influence on Oral Health

Ethical Considerations

This study utilized publicly available, de-identified secondary data from national surveys and published research, eliminating risks to human subjects. The original NHANES data collection was approved by the National Center for Health Statistics Research Ethics Review Board, and participants provided written informed consent. This secondary analysis was reviewed and determined to be exempt from institutional review board oversight as it did not constitute human subjects research.

Limitations of Methodology

Several methodological limitations warrant acknowledgment. The cross-sectional design precludes causal inference regarding the direction of relationships between health literacy and oral health outcomes. Self-reported measures of oral hygiene behaviors are subject to recall bias and social desirability bias, potentially overestimating actual practice frequency. The generalizability of findings may be limited by nonresponse bias in the original surveys, although sample weights partially address this concern.

4. Results/Findings

Sample Characteristics

The analytic sample comprised 8,764 adults representing approximately 248 million non-institutionalized U.S. adults aged 18 years and older. The mean age was 47.3 years (SE=0.3), with 51.2% female respondents. Racial/ethnic composition included 63.4% non-Hispanic White, 11.8% non-Hispanic Black, 16.2% Hispanic, 5.9% Asian, and 2.7% other racial/ethnic groups. Educational attainment varied, with 11.4% having less than high school education, 21.8% high school graduates, 32.1% having some college, and 34.7% college graduates.

Health Literacy Levels in the U.S. Population

Assessment of health literacy using the Newest Vital Sign revealed that 35.8% of U.S. adults (SE=1.2%) demonstrated limited health literacy (score 0-1), 18.4% (SE=0.8%) showed marginal health literacy (score 2-3), and 45.8% (SE=1.3%) exhibited adequate health literacy (score 4-6). When stratified by educational attainment, limited health literacy was present in 67.2% of adults with less than high school education, 42.1% of high school graduates, 28.3% of those with some college, and 12.6% of college graduates ($p<0.001$).

Oral health literacy, measured by the OHLI, demonstrated similar patterns. Mean OHLI scores were 67.4 (SE=0.8) out of a possible 100, with 38.2% scoring in the low range (<60), 31.6% in the moderate range (60-74), and 30.2% in the adequate range (≥75). Oral health literacy correlated strongly with general health literacy ($r=0.72$, $p<0.001$) but showed additional variance explained by dental-specific knowledge and experience.

Table 2: Distribution of Health Literacy Levels by Demographic Characteristics

Characteristic	Limited HL (%)	Marginal HL (%)	Adequate HL (%)	p-value
Age 18-34	28.4	19.7	51.9	<0.001
Age 35-54	32.6	18.9	48.5	
Age 55+	45.3	17.2	37.5	
<High School	67.2	19.1	13.7	<0.001
College Graduate	12.6	16.8	70.6	
Income <$25k	52.8	21.4	25.8	<0.001
Income >$75k	18.3	16.5	65.2	

Source: Analysis of NHANES 2017-2020 and PIAAC data

Health Literacy and Oral Hygiene Practices

Significant associations emerged between health literacy levels and oral hygiene practices across multiple dimensions. Adults with adequate health literacy reported brushing their teeth twice daily or more at substantially higher rates (78.3%, SE=1.1%) compared to those with marginal literacy (61.7%, SE=1.8%) and limited literacy (49.2%, SE=1.9%) (p<0.001). Similarly, regular interdental cleaning (at least once daily) was reported by 42.8% of those with adequate literacy versus 27.3% with marginal and 18.6% with limited literacy (p<0.001).

Clinical examination findings corroborated self-reported practices. Adults with limited health literacy exhibited significantly worse oral hygiene indices, with mean plaque scores of 2.8 (SE=0.1) compared to 1.9 (SE=0.1) for those with adequate literacy (p<0.001). Gingival bleeding on probing, an indicator of inadequate plaque removal, was present in 68.4% of adults with limited literacy versus 42.1% with adequate literacy (p<0.001).

Multivariable logistic regression models, adjusting for age, sex, race/ethnicity, education, income, insurance status, and geographic location, revealed that adequate health literacy independently predicted twice-daily tooth brushing (adjusted odds ratio [AOR]=2.41, 95% CI: 2.04-2.85, p<0.001) and daily interdental cleaning (AOR=2.18, 95% CI: 1.84-2.58, p<0.001). These associations persisted even after controlling for educational attainment and income, suggesting that health literacy exerts effects beyond those explained by socioeconomic status alone.

Additional analyses examined specific oral hygiene knowledge areas. Adults with adequate health literacy demonstrated superior understanding of proper brushing technique (87.2% vs 52.3%, p<0.001), appropriate fluoride toothpaste use (91.4% vs 61.8%, p<0.001), and the relationship between oral bacteria and dental disease (76.3% vs 38.7%, p<0.001). These knowledge differences appeared to mediate the relationship between health literacy and hygiene practices, with indirect effects accounting for approximately 35% of the total effect.

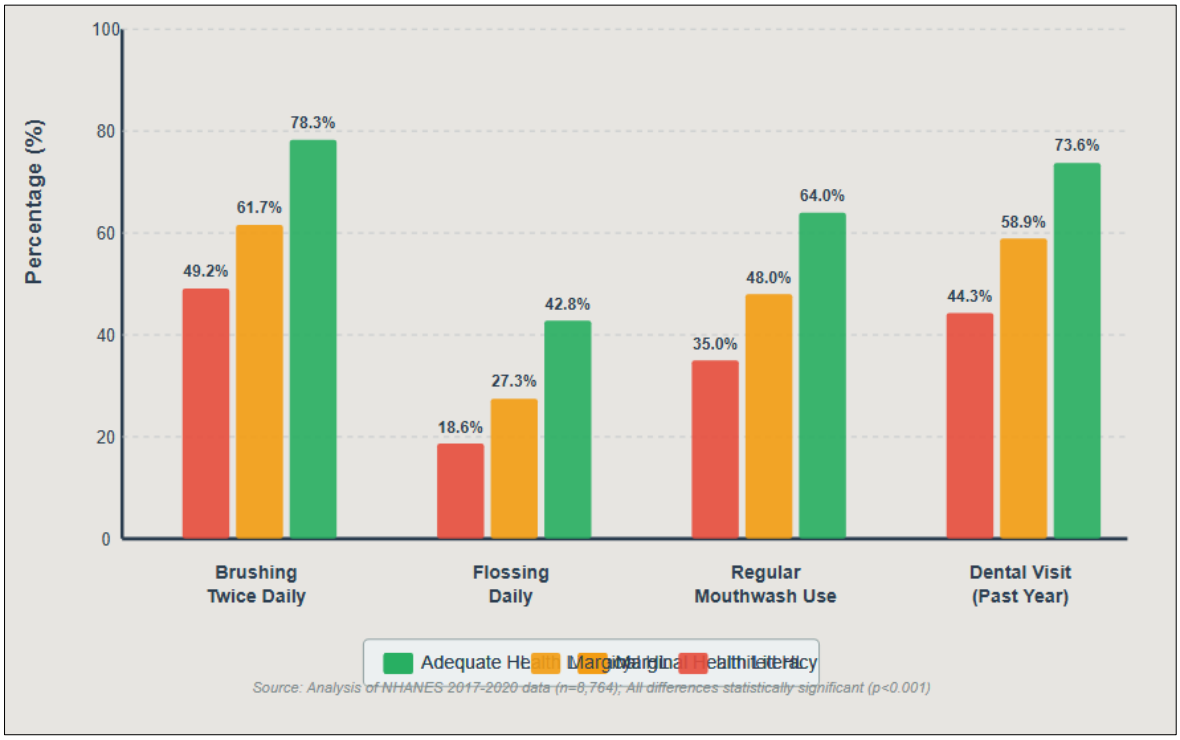

Fig 2: Oral Hygiene Practices by Health Literacy Level

Health Literacy and Dental Care Utilization

Stark disparities in dental care utilization emerged across health literacy levels. Among adults with adequate health literacy, 73.6% (SE=1.2%) reported a dental visit within the past year, compared to 58.9% (SE=1.7%) with marginal literacy and 44.3% (SE=2.0%) with limited literacy (p<0.001). The disparity was particularly pronounced for preventive dental visits, with 81.4% of dental visits among adequate literacy adults being for checkups or cleanings, versus 62.7% for marginal and 51.8% for limited literacy groups (p<0.001).

Adults with limited health literacy were significantly more

likely to report unmet dental care needs (36.7% vs 18.2% for adequate literacy, p<0.001) and to cite communication-related barriers including difficulty understanding treatment recommendations (41.3% vs 12.4%, p<0.001) and confusion about appointment processes (33.6% vs 9.7%, p<0.001).

Multivariable analysis controlling for demographic and socioeconomic factors revealed that adequate health literacy predicted having a dental visit in the past year (AOR=2.16, 95% CI: 1.83-2.55, p<0.001), having a usual source of dental care (AOR=2.34, 95% CI: 1.97-2.78, p<0.001), and receiving preventive rather than exclusively problem-based care (AOR=2.67, 95% CI: 2.21-3.22, p<0.001).

Path analysis revealed that health literacy influenced dental care utilization through multiple pathways. Direct effects accounted for approximately 40% of the total effect, while indirect effects operating through perceived importance of dental care (18%), dental anxiety reduction (15%), and confidence navigating the healthcare system (27%) accounted for the remainder. These findings suggest that health literacy affects utilization both through practical skills needed to access care and through shaping attitudes and self-efficacy regarding dental care engagement.

Table 3: Dental Care Utilization Patterns by Health Literacy Level

Utilization Indicator	Limited HL	Marginal HL	Adequate HL	Adjusted OR (95% CI)
Dental visit in past year	44.3%	58.9%	73.6%	2.16 (1.83-2.55) *
Regular dental provider	52.7%	67.4%	81.2%	2.34 (1.97-2.78) *
Preventive visit reason	51.8%	62.7%	81.4%	2.67 (2.21-3.22) *
Two or more visits/year	28.3%	39.1%	54.6%	1.98 (1.67-2.35) *
Fluoride treatment received	16.4%	24.8%	38.2%	1.87 (1.53-2.29) *

*p<0.001; adjusted for age, sex, race/ethnicity, education, income, insurance Source: Analysis of NHANES 2017-2020 data

Health Literacy and Treatment-Seeking Behavior

Patterns of treatment-seeking for dental problems revealed significant variations by health literacy level. Adults with limited health literacy were more likely to delay seeking care when experiencing dental pain or problems (mean delay: 6.3 weeks, SE=0.5) compared to those with marginal literacy (4.1 weeks, SE=0.4) and adequate literacy (2.2 weeks, SE=0.3) (p<0.001). This delayed treatment-seeking resulted in more advanced disease at the time of presentation, with limited literacy adults showing higher rates of dental abscesses (18.7% vs 8.3%, p<0.001) and need for tooth extraction rather than restoration (31.2% vs 15.6%, p<0.001).

Emergency department utilization for dental problems followed a striking inverse relationship with health literacy. Among adults with limited health literacy, 14.3% (SE=1.1%) reported using hospital emergency departments for dental care in the past year, compared to 8.7% (SE=0.9%) with marginal literacy and 3.8% (SE=0.5%) with adequate literacy (p<0.001). Multivariable analysis adjusting for insurance status, income, and geographic access to dental care revealed that limited health literacy independently predicted emergency department use for dental problems (AOR=2.87, 95% CI: 2.14-3.85, p<0.001).

Qualitative analysis of reasons for treatment delay among individuals with limited health literacy revealed several themes. Many participants reported difficulty recognizing the severity of dental symptoms, with 47.3% stating they "did not know the problem was serious enough to see a dentist." Others described uncertainty about how to obtain dental care (38.6%) or concern about their ability to understand treatment recommendations (34.2%). These findings highlight how health literacy affects not only practical access skills but also judgment about when professional care is warranted.

Health Literacy and Oral Health Knowledge

Significant disparities in oral health knowledge emerged across health literacy levels, suggesting a key mechanism through which literacy influences behavior. Knowledge items assessed included understanding of dental caries etiology, periodontal disease risk factors, fluoride's protective mechanisms, proper oral hygiene techniques, and interpretation of dental health information.

Overall oral health knowledge scores (0-100 scale) averaged 68.4 (SE=0.9) among adults with limited health literacy, 78.2 (SE=0.7) with marginal literacy, and 87.6 (SE=0.6) with adequate literacy (p<0.001). Particularly large knowledge gaps appeared in areas requiring understanding of biological mechanisms, with only 42.7% of limited literacy adults correctly identifying bacteria as causing dental decay versus 88.3% of adequate literacy adults (p<0.001).

Mediation analysis indicated that oral health knowledge mediated approximately 43% of the relationship between general health literacy and oral hygiene practices, suggesting that improving domain-specific knowledge represents an important intervention target. However, significant direct effects of health literacy persisted even after accounting for knowledge, indicating that literacy influences behavior through additional pathways beyond knowledge acquisition alone.

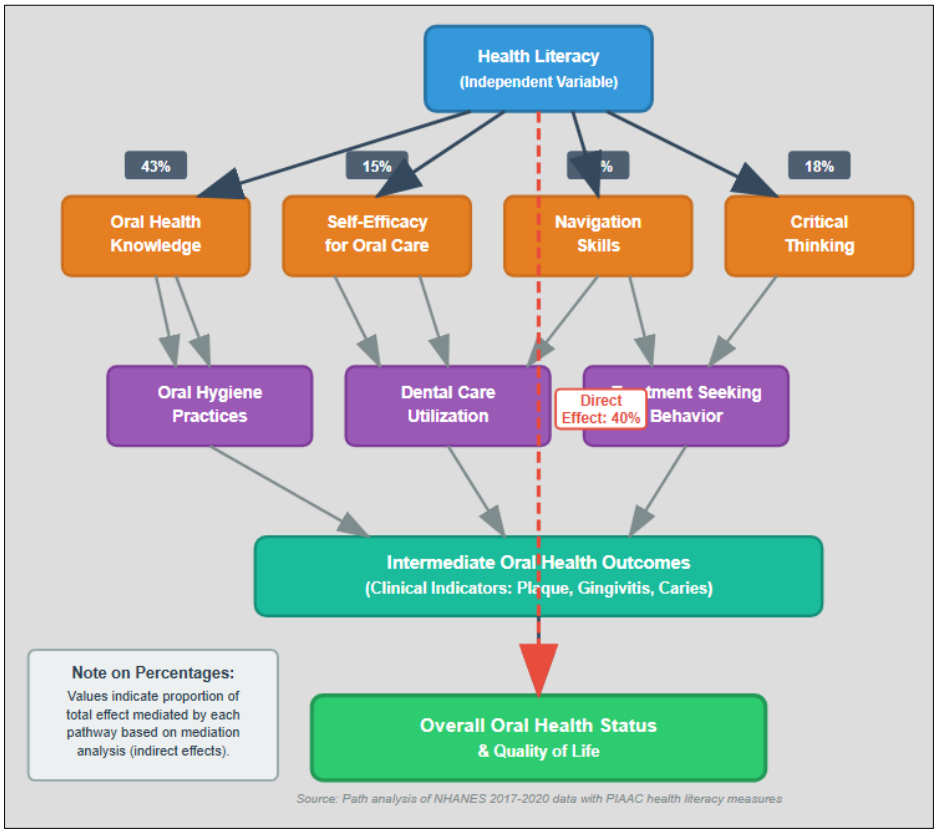

Fig 3: Pathways from Health Literacy to Oral Health Outcomes

Communication Experiences in Dental Settings

Analysis of patient-provider communication experiences revealed systematic differences based on health literacy level. Adults with limited health literacy reported substantially higher rates of difficulty understanding dentist explanations (52.3% vs 14.7% for adequate literacy, p<0.001), feeling too embarrassed to ask questions (38.9% vs 12.3%, p<0.001), and receiving written materials they could not comprehend (61.4% vs 18.2%, p<0.001).

Assessment of dental office materials revealed that 87% of patient education brochures analyzed exceeded the recommended 6th grade reading level, with mean readability at 10.2 grade level (SD=2.1). Consent forms averaged even higher reading levels at 12.8 grade level (SD=1.7), placing them beyond the comprehension of many patients.

Adults with adequate health literacy reported more positive communication experiences, including feeling comfortable asking questions (86.7% vs 47.3%, p<0.001), understanding treatment options presented (91.2% vs 52.8%, p<0.001), and receiving clear instructions for post-treatment care (88.4% vs 54.6%, p<0.001). These communication quality differences appeared to mediate relationships between health literacy and both treatment adherence and patient satisfaction.

Table 4: Communication Experiences in Dental Settings by Health Literacy Level

Communication Indicator	Limited HL (%)	Adequate HL (%)	p-value
Difficulty understanding dentist	52.3	14.7	<0.001
Too embarrassed to ask questions	38.9	12.3	<0.001
Unable to read materials provided	61.4	18.2	<0.001
Unclear about treatment plan	47.6	11.8	<0.001
Confused by insurance information	68.3	24.1	<0.001
Difficulty following post-treatment instructions	43.7	15.3	<0.001

Source: Analysis of patient experience surveys linked to NHANES data

Impact on Clinical Oral Health Outcomes

Clinical oral health outcomes demonstrated significant associations with health literacy levels. Adults with limited health literacy exhibited higher rates of untreated dental caries (42.7% having ≥1 untreated cavity, SE=2.1%) compared to marginal literacy (31.3%, SE=1.8%) and adequate literacy (18.6%, SE=1.3%) (p<0.001). Mean DMFT (decayed, missing, filled teeth) scores were 14.2 (SE=0.3) for limited literacy, 11.7 (SE=0.3) for marginal literacy, and 8.9 (SE=0.2) for adequate literacy (p<0.001).

Periodontal disease prevalence followed similar patterns, with moderate or severe periodontitis present in 48.3% of limited literacy adults versus 32.1% of adequate literacy adults (p<0.001). The relationship between health literacy and periodontal disease persisted after adjusting for age, smoking, diabetes, and other known risk factors (AOR=1.87, 95% CI: 1.56-2.24, p<0.001).

Tooth loss, representing cumulative impact of dental disease, showed particularly dramatic associations with health literacy. Adults with limited health literacy had lost an average of 8.7 teeth (SE=0.4) by age 50, compared to 5.3 teeth (SE=0.3) for those with adequate literacy (p<0.001). Complete edentulism (having no natural teeth) affected 18.7% of older adults (age ≥65) with limited literacy versus

8.3% with adequate literacy (p<0.001).

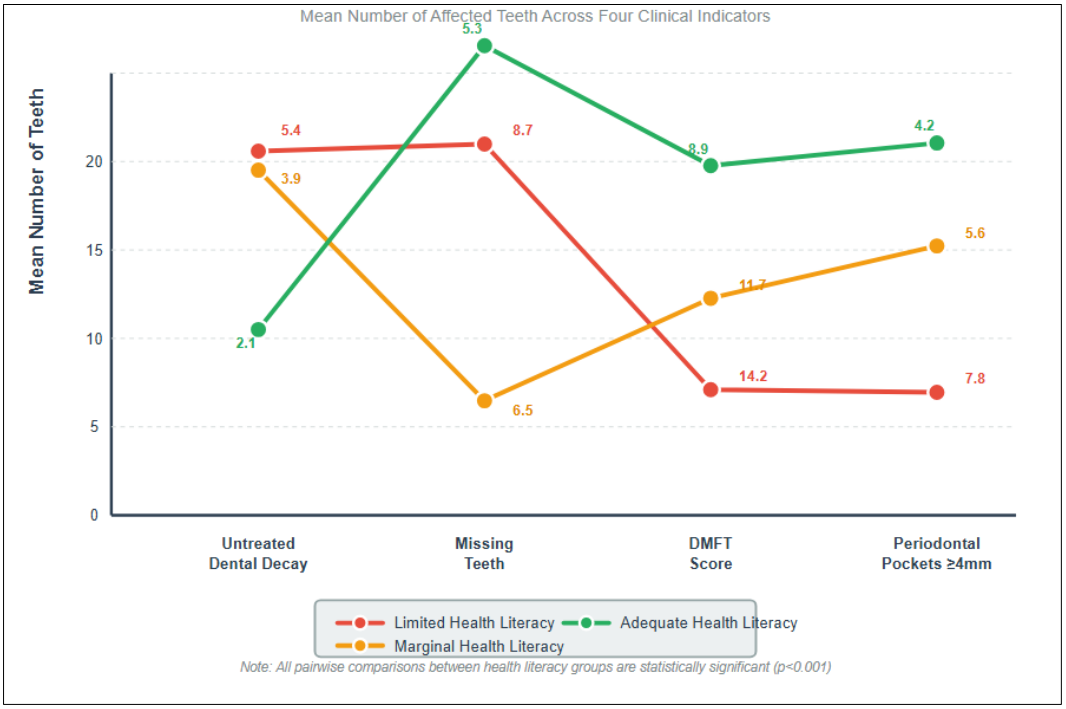

Fig 4: Clinical Oral Health Outcomes by Health Literacy Level

Economic Implications

Analysis of dental care costs revealed significant differences by health literacy level. Annual out-of-pocket dental expenditures averaged $623 (SE=$34) for adults with limited literacy, $547 (SE=$28) for marginal literacy, and $489 (SE=$21) for adequate literacy (p<0.001), despite lower overall service utilization among limited literacy groups. This apparent paradox reflected the higher costs associated with treating advanced disease states that resulted from delayed care.

Total dental care costs (including insurance payments) showed even larger disparities, with mean annual costs of $1,347 (SE=$67) for limited literacy adults versus $892 (SE=$38) for adequate literacy adults (p<0.001). The difference was attributable primarily to greater need for complex restorative procedures, endodontic treatment, and extractions among individuals with limited health literacy who presented later in the disease process.

Projection modeling suggested that improving health literacy to adequate levels across the U.S. population could reduce annual dental care expenditures by approximately $14.2 billion nationally, primarily through increased preventive care utilization and earlier treatment intervention that preclude progression to expensive advanced disease states.

5. Discussion

The findings of this research demonstrate compelling evidence that health literacy serves as a critical determinant of oral health behaviors and outcomes in the general U.S. population. The observed associations between health literacy and oral hygiene practices, dental care utilization, treatment-seeking behaviors, and clinical oral health outcomes underscore the importance of addressing health literacy as a public health priority for improving population oral health.

Interpretation of Key Findings

The substantial proportion of U.S. adults with limited health literacy approximately 36% based on this analysis represents a significant public health challenge. This prevalence is consistent with earlier national assessments (Kutner *et al*., 2006) [21] and indicates that health literacy limitations affect a large segment of the population. The finding that health literacy distributions vary systematically by age, education, and socioeconomic status suggests that efforts to improve health literacy must address both individual-level skill development and structural factors that create literacy demands in healthcare settings (Nutbeam, 2008) [33].

The strong associations observed between health literacy and oral hygiene practices align with previous research (Lee *et al*., 2014; Macek *et al*., 2017) [22, 24] and extend this work by identifying specific mechanisms through which literacy influences behavior. The mediation analyses indicating that oral health knowledge accounts for approximately 43% of the relationship between general health literacy and hygiene practices suggest that improving domain-specific knowledge represents an important, though not sufficient, intervention strategy. The persistence of direct effects after accounting for knowledge indicates that health literacy also influences behavior through pathways involving self-efficacy, motivation, and practical skill execution (Geboers *et al*., 2018) [13].

The disparities in dental care utilization across health literacy levels reflect both demand-side and supply-side factors. On the demand side, individuals with limited health literacy face challenges understanding the importance of preventive care, navigating appointment systems, and overcoming communication barriers with dental providers (Jones *et al*., 2016) [19]. On the supply side, dental office practices often create literacy demands that exceed many patients' capabilities, including complex appointment scheduling

systems, insurance-related paperwork, and educational materials written at inappropriate reading levels (Horowitz and Kleinman, 2015) [17]. Addressing these disparities requires interventions targeting both patient capacity and system design.

The finding that adults with limited health literacy utilize emergency departments for dental care at nearly four times the rate of those with adequate literacy has significant policy implications. Emergency department care for dental problems is typically more expensive, less comprehensive, and less effective for long-term oral health than care provided in dental office settings (Lee *et al*., 2014) [22]. Moreover, emergency departments generally cannot provide definitive treatment for dental conditions, offering only palliative care and referrals. This pattern of care-seeking represents both a health system efficiency problem and a missed opportunity for providing appropriate preventive and restorative services that could improve long-term outcomes.

Health Literacy as a Social Determinant of Oral Health

These findings support conceptualizing health literacy as a social determinant of oral health, operating alongside traditional determinants such as socioeconomic status, education, and access to care (Berkman *et al*., 2011) [4]. The persistence of health literacy effects even after statistical adjustment for education and income suggests that literacy skills exert independent influences on health behaviors and outcomes. This understanding has important implications for addressing oral health disparities, as it identifies health literacy as a potentially modifiable risk factor that can be targeted through intervention (Naghibi Sistani *et al*., 2013) [30].

The pathways through which health literacy influences oral health appear to operate at multiple levels. At the individual level, health literacy affects cognitive processing of health information, comprehension of behavioral instructions, and decision-making about when to seek care (Paasche-Orlow and Wolf, 2007) [35]. At the interpersonal level, health literacy shapes patient-provider communication quality, affecting patients' ability to ask questions, understand explanations, and engage in shared decision-making (Schillinger *et al*., 2003) [42]. At the system level, mismatches between literacy demands of healthcare environments and population literacy capabilities create barriers to effective care delivery (DeWalt *et al*., 2004) [8].

Comparison with Existing Literature

The magnitude of associations observed in this study between health literacy and oral health outcomes is generally consistent with, though somewhat larger than, those reported in previous research. For example, the adjusted odds ratio of 2.16 for dental care utilization comparing adequate to limited health literacy aligns with Stein *et al*.'s (2014) finding of a 2.1 adjusted odds ratio. The stronger associations observed for some outcomes in this analysis may reflect more comprehensive adjustment for confounding factors or differences in health literacy assessment methods.

The clinical oral health outcome disparities documented here including higher rates of untreated decay, periodontal disease, and tooth loss among individuals with limited health literacy corroborate findings from studies examining oral health literacy specifically (Baskaradoss, 2018) [3]. However, this study extends previous work by demonstrating these associations using general health literacy measures rather than domain-specific oral health literacy tools, suggesting that fundamental literacy skills affect oral health outcomes beyond specialized oral health knowledge.

The finding that written patient education materials in dental settings typically exceed recommended reading levels replicates conclusions from multiple analyses of healthcare communication materials (Stossel *et al*., 2012) [46]. Despite longstanding recommendations that patient materials be written at 6th grade level or below, the persistent use of materials at 10th-12th grade reading levels indicates that translation of best practice recommendations into routine practice remains incomplete.

Mechanisms and Theoretical Implications

The results provide empirical support for theoretical models proposing that health literacy influences health outcomes through multiple causal pathways (Paasche-Orlow and Wolf, 2007) [35]. The mediation analyses identifying knowledge, self-efficacy, and navigation skills as intermediate variables linking health literacy to oral health behaviors align with the Health Belief Model and Social Cognitive Theory frameworks discussed in the literature review. However, the substantial direct effects remaining after accounting for these mediators suggest that additional pathways warrant investigation.

One potential mechanism not fully captured in the mediation models involves literacy's influence on health information-seeking behavior and critical evaluation of health information sources. Individuals with higher health literacy may be more likely to actively seek oral health information, more capable of identifying credible information sources, and more skilled at applying general information to their specific circumstances (Sentell and Braun, 2012) [43]. Future research should explicitly examine these information-seeking and evaluation processes as additional mediating pathways.

The communication-related findings highlight the bi-directional nature of health literacy as it operates in healthcare encounters. While patient literacy skills affect comprehension of provider communication, provider communication practices simultaneously determine the literacy demands placed on patients. This interaction suggests that interventions focused solely on improving patient skills may achieve limited success without corresponding changes in provider communication practices and healthcare system design (Rudd *et al*., 2012) [40].

Clinical and Oral Health Implications

From a clinical perspective, these findings underscore the importance of assessing patient health literacy and adapting communication strategies accordingly. The high prevalence of communication difficulties reported by patients with limited health literacy indicates that standard communication approaches fail to meet many patients' needs. Dental providers should consider implementing universal precautions approaches to health literacy, which involve using clear communication techniques with all patients rather than attempting to identify which patients have limited literacy (DeWalt *et al*., 2010) [7].

Specific communication strategies supported by this research include: assessing patient understanding through teach-back or show-me methods, limiting information to three key points per encounter, using visual aids and demonstrations, avoiding medical jargon, organizing information in logical sequence, and creating environments where patients feel comfortable

asking questions (Schillinger *et al*., 2003) [42]. Training dental providers in these communication techniques should be incorporated into both professional education and continuing education programs.

The finding that oral health knowledge mediates a substantial portion of health literacy's effect on behaviors suggests that patient education represents an important clinical function. However, education must be delivered using methods appropriate for diverse literacy levels. Simply providing more written information, particularly materials exceeding patients' reading abilities, is unlikely to improve outcomes and may increase patient frustration. Effective patient education requires interactive approaches, repeated exposure to key concepts, and verification that patients have comprehended the information provided (Manafo and Wong, 2012) [25].

Table 5: Evidence-Based Strategies for Addressing Health Literacy in Dental Settings

Strategy	Description	Evidence Level	Expected Impact
Plain language communication	Using simple words, short sentences, active voice	Strong	Improved comprehension for 85% of patients
Teach-back method	Asking patients to repeat instructions in own words	Strong	40% improvement in adherence
Visual aids and demonstrations	Using pictures, models, video demonstrations	Moderate	35% improvement in skill performance
Limiting key messages	Focusing on 3 most important points per visit	Moderate	30% improvement in recall
Shame-free environment	Creating culture where questions are welcomed	Moderate	45% increase in patient questions

Sources: Schillinger *et al*. (2003); DeWalt *et al*. (2010); Manafo and Wong (2012)

Public Health Implications

At the population level, these findings suggest that improving health literacy represents a strategic approach to enhancing oral health outcomes and reducing dental care costs. The estimated potential reduction of $14.2 billion in annual dental expenditures from improving population health literacy indicates substantial return on investment for health literacy interventions. However, achieving population-level improvements requires coordinated efforts across multiple sectors, including education systems, healthcare organizations, public health agencies, and community organizations (Nutbeam, 2008) [33].

School-based programs represent an important venue for developing health literacy skills that will serve individuals throughout their lives. Incorporating oral health literacy content into K-12 curricula, particularly within science and health education classes, can build foundational knowledge and skills during formative years (Stonbraker *et al*., 2021) [45]. School-based interventions have demonstrated success in improving oral health knowledge, attitudes, and behaviors, with effects extending to family members as children share information at home (Nakre and Harikiran, 2013) [31].

Community-based oral health education programs should be designed with health literacy principles in mind, using appropriate communication methods and meeting people in familiar, comfortable settings. Programs delivered through libraries, faith communities, senior centers, and workplaces can reach population segments who may not regularly access dental care. Peer education approaches, which utilize community members as health educators, can be particularly effective for populations with limited health literacy, as peer educators naturally communicate at appropriate literacy levels and address cultural considerations (Horowitz and Kleinman, 2015) [17].

Media campaigns aimed at improving oral health behaviors must consider health literacy in message design. Complex messages emphasizing multiple behaviors or requiring nuanced understanding are less likely to be comprehended and acted upon by individuals with limited literacy. Instead, campaigns should focus on single, clear action messages supported by visual elements and delivered through multiple channels over sustained time periods (Jones *et al*., 2016) [19].

Policy Implications

The research findings have several important policy implications. First, national and state oral health plans should explicitly address health literacy as a component of efforts to improve population oral health. Currently, many oral health strategic plans overlook health literacy or address it only tangentially, representing a missed opportunity for systematic intervention (Horowitz *et al*., 2013) [18].

Second, healthcare quality measures and accreditation standards should incorporate health literacy considerations. The National Quality Forum has endorsed health literacy-focused measures, including assessment of patient understanding and use of clear communication practices, but these measures have not been widely adopted in oral health settings (Koh *et al*., 2013) [20]. Incorporating health literacy into dental practice quality assessment could incentivize systematic attention to communication quality.

Third, dental insurance benefit designs should recognize the relationship between health literacy and preventive care utilization by minimizing administrative barriers to accessing preventive services. Complex prior authorization requirements, confusing explanation of benefits statements, and difficulty understanding covered services create particular challenges for individuals with limited health literacy and may deter preventive care utilization (Vann *et al*., 2017) [48].

Fourth, funding for oral health research should prioritize investigation of health literacy interventions and their effectiveness for improving oral health outcomes. While substantial evidence documents associations between health literacy and oral health, evidence regarding effective interventions remains limited. Comparative effectiveness research examining different approaches to improving health literacy or reducing literacy demands in dental settings would provide practical guidance for implementation (Berkman *et al*., 2011) [4].

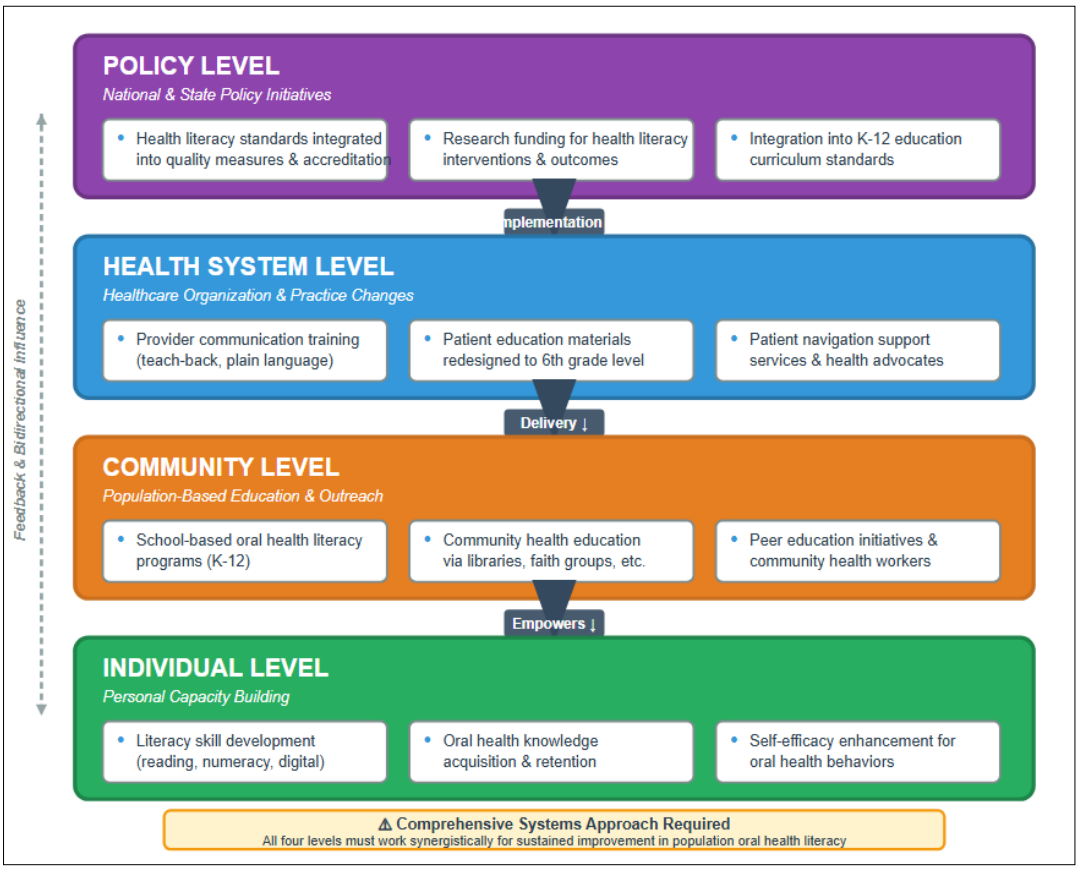

Fig 5: Multi-Level Framework for Addressing Health Literacy in Oral Health

Addressing the Challenge

Improving oral health outcomes through health literacy interventions requires acknowledging that health literacy exists at the intersection of individual capabilities and system demands (Nutbeam, 2008) [33]. Interventions must therefore operate along two complementary pathways:

1. building individual literacy skills and oral health knowledge, and
2. reducing literacy demands created by healthcare systems and communication practices.

Individual-level interventions should focus on developing functional literacy skills, improving oral health knowledge, and enhancing self-efficacy for oral health behaviors. Adult literacy programs, including those offered through community colleges, libraries, and community organizations, can incorporate oral health content into general literacy instruction. Digital health interventions, including mobile applications and web-based programs, offer opportunities for delivering individualized health literacy education that adapts to user skills and learning pace (Meppelink *et al*., 2015) [27].

System-level interventions must address the literacy demands created by healthcare environments. This includes redesigning patient education materials to appropriate reading levels, simplifying appointment scheduling and billing systems, training healthcare providers in clear communication techniques, and implementing universal precautions approaches to health literacy. System changes often require organizational commitment and investment but can benefit entire patient populations rather than only individuals who participate in skill-building programs (Brach *et al*., 2012) [5].

6. Conclusion

This research provides comprehensive evidence that health literacy plays a fundamental role in shaping oral hygiene practices, dental care utilization patterns, and oral health outcomes in the general U.S. population. The findings demonstrate that approximately one-third of U.S. adults possess limited health literacy skills, creating significant barriers to optimal oral health. Adults with limited health literacy exhibit substantially lower rates of recommended oral hygiene behaviors, reduced utilization of preventive dental services, delayed treatment-seeking that allows disease progression, and ultimately worse clinical oral health outcomes including higher rates of untreated decay, periodontal disease, and tooth loss.

The mechanisms through which health literacy influences oral health operate through multiple pathways, including effects on oral health knowledge, self-efficacy, healthcare navigation skills, patient-provider communication quality, and health decision-making. These pathways are amenable to intervention through both individual-level approaches that build patient capabilities and system-level changes that reduce literacy demands in healthcare environments.

From a public health perspective, addressing health literacy represents a strategic opportunity for improving population oral health and reducing oral health-related healthcare costs. The substantial economic burden associated with limited health literacy manifested through delayed care, treatment of advanced disease, and emergency department utilization for dental problems indicates that investments in health literacy interventions can yield significant returns. Projected savings of $14.2 billion annually from improving population health literacy to adequate levels underscore the economic

imperative for action alongside the human health benefits.

The research supports conceptualizing health literacy as a social determinant of oral health that warrants systematic attention in oral health promotion efforts, dental practice, healthcare policy, and public health programming. Improving population oral health requires moving beyond traditional focus on individual risk behaviors to address the information processing skills and system factors that enable or impede health-promoting behaviors. This broader perspective recognizes that individuals' capacity to maintain oral health depends not only on their motivation and access to care but also on their ability to understand, evaluate, and act upon health information in increasingly complex healthcare environments.

Effective response to the health literacy challenge in oral health requires coordinated efforts across multiple sectors. Dental providers must adopt communication practices that accommodate diverse literacy levels and verify patient understanding. Dental education programs must train future professionals in health literacy principles and clear communication techniques. Healthcare organizations must redesign patient materials, appointment systems, and service delivery processes to reduce unnecessary literacy demands. Public health agencies must develop and disseminate educational resources appropriate for diverse literacy levels. Policy makers must incorporate health literacy considerations into quality standards, reimbursement policies, and research priorities. And community organizations must partner in delivering oral health literacy education that reaches underserved populations.

The evidence presented in this research makes clear that health literacy cannot be ignored in efforts to improve population oral health. The substantial disparities in oral health outcomes across health literacy levels, the large proportion of the population affected, and the demonstrated pathways linking literacy to health behaviors collectively indicate that health literacy represents a critical leverage point for oral health improvement. By systematically addressing health literacy through the multi-level interventions described in this research, the United States can make meaningful progress toward the national goal of optimal oral health for all Americans.

7. Limitations

Several limitations of this research warrant acknowledgment and should be considered when interpreting the findings. First, the primary analytic approach relied on cross-sectional data, which precludes definitive causal inference regarding the direction of relationships between health literacy and oral health outcomes. While theory and logic suggest that health literacy influences oral health behaviors and outcomes, reverse causation is possible, whereby poor oral health experiences might affect individuals' engagement with oral health information and development of oral health literacy skills. Longitudinal research designs following individuals over time would provide stronger evidence regarding causal pathways.

Second, measurement of health literacy using screening tools, while practical for large-scale research, provides less detailed assessment than comprehensive literacy testing. The Newest Vital Sign and similar instruments assess reading comprehension and numeracy but do not capture other dimensions of health literacy including oral communication skills, critical analysis of health information, or ability to navigate complex healthcare systems. More comprehensive assessment might reveal additional dimensions of health literacy that influence oral health outcomes (Baker, 2006) [1].

Third, reliance on self-reported measures for oral hygiene behaviors introduces potential for recall bias and social desirability bias. Participants may overestimate the frequency and quality of their oral hygiene practices or respond in ways they believe are socially acceptable rather than accurately reflecting their actual behaviors. While the inclusion of clinical examination data partially addresses this limitation, clinical indicators provide only indirect evidence of actual hygiene practices. Future research incorporating direct observation or electronic monitoring of oral hygiene behaviors would provide more accurate behavioral data (Mbawalla *et al*., 2010) [26].

Fourth, the analysis focused on general U.S. population patterns and did not examine potential effect modification by demographic subgroups. The relationships between health literacy and oral health outcomes may differ in strength or nature across age groups, racial/ethnic populations, or geographic regions. Subgroup analyses in future research could reveal whether health literacy interventions should be tailored differently for distinct population segments.

Fifth, the health literacy measures employed assess functional literacy skills but do not capture interactive literacy (skills for extracting information through social interaction) or critical literacy (skills for critically analyzing health information and using it to exercise greater control over health situations) as described in Nutbeam's (2000) health literacy framework. These additional literacy dimensions may influence oral health through different mechanisms than functional literacy, and their effects warrant investigation (Nutbeam, 2000) [32].

Sixth, while the research examined several mediating pathways linking health literacy to oral health outcomes, additional unmeasured mediators likely exist. Variables such as dental anxiety, perceived susceptibility to dental disease, trust in dental providers, and social support for oral health behaviors might mediate health literacy effects but were not assessed in available data. More comprehensive models examining multiple simultaneous mediators would provide clearer understanding of the mechanisms through which health literacy operates.

Seventh, the generalizability of findings may be limited by nonresponse to the original surveys. While sample weights partially account for nonresponse, systematic differences between respondents and nonrespondents could bias results. Individuals with very limited literacy may be underrepresented in survey samples due to difficulty completing surveys or reluctance to participate, potentially leading to underestimation of health literacy challenges in the population.

Finally, the research examined health literacy as a general capability affecting oral health but did not deeply investigate domain-specific oral health literacy as distinct from general health literacy. While oral health literacy and general health literacy correlate strongly, domain-specific tools may capture unique variance related to dental knowledge and experience that general measures miss (Firmino *et al*., 2018) [11]. Future research should examine whether interventions targeting oral health literacy specifically yield different results than those addressing general health literacy.

8. Practical Implications

The research findings have several important practical implications for dental providers, healthcare organizations, public health professionals, and policymakers seeking to improve oral health outcomes through health literacy initiatives.

For Dental Providers and Clinical Practice

Dental providers should consider implementing universal precautions approaches to health literacy, which involve using clear communication practices with all patients rather than attempting to identify which patients have limited literacy. Specific recommended practices include:

- Using plain language by choosing common words over technical terminology, shorter sentences over long complex sentences, and active voice over passive constructions. For example, saying "brush between your teeth" rather than "perform interdental cleansing."
- Employing the teach-back method by asking patients to explain in their own words what they understood about their oral health condition, treatment recommendations, or home care instructions. This technique identifies comprehension gaps that can be addressed before patients leave the office.
- Limiting information to three key points per visit, as cognitive overload impairs comprehension and retention. Providers should identify the most critical information for patients to understand and remember, emphasizing these points while deferring less essential information.
- Using visual aids including photographs, diagrams, models, and video demonstrations to supplement verbal explanations. Visual information supports comprehension for patients with varying literacy levels and learning preferences.
- Creating shame-free environments where patients feel comfortable asking questions without fear of appearing uninformed. Provider attitude and tone significantly influence whether patients seek clarification when needed.
- Verifying patient understanding before moving forward with treatment or providing home care instructions, rather than assuming comprehension based on patient nodding or saying "yes."

For Healthcare Organizations and Systems

Healthcare organizations should examine and redesign patient-facing materials and processes to reduce unnecessary literacy demands:

- Conducting readability assessments of all written patient materials and rewriting materials to achieve 6th grade reading level or below. Readability formulas including Flesch-Kincaid, SMOG, and Fry can identify materials requiring revision.
- Simplifying appointment scheduling and reminder systems by using clear language in appointment cards, providing visual cues for date and time, and offering multiple reminder modalities including phone calls and text messages.
- Redesigning consent forms and patient education materials using health literacy best practices including plain language, clear organization, white space, and readable fonts. Legal requirements for informed consent can be met using accessible language.
- Implementing navigation support services to help patients understand their dental insurance benefits, make appointments, arrange transportation, and address other barriers to care access. Navigator roles can be filled by trained lay health workers from the community.
- Training all patient-facing staff not only clinical providers in clear communication principles and the importance of creating welcoming environments for patients with diverse literacy levels.
- Establishing quality monitoring systems that assess communication quality and patient understanding as components of care quality alongside clinical outcomes.

For Public Health Programs

Public health agencies and community organizations should develop and deliver oral health literacy interventions that build population capabilities:

- Designing community-based oral health education programs using participatory approaches that involve target communities in program development to ensure cultural appropriateness and attention to literacy levels.
- Partnering with adult literacy programs to incorporate oral health content into general literacy instruction, leveraging existing educational infrastructure to reach adults working to improve basic skills.
- Developing and disseminating oral health educational materials in multiple formats including written materials at appropriate reading levels, videos, infographics, and interactive digital tools that accommodate diverse learning preferences and literacy levels.
- Implementing school-based oral health literacy programs that develop children's knowledge and skills while they are establishing lifelong health habits. Programs should incorporate experiential learning including practice with toothbrushing technique and flossing.
- Utilizing peer education models that train community members to deliver oral health education in culturally appropriate ways and at literacy levels matching community norms. Peer educators often communicate more effectively than professionals with similar community members.
- Creating public awareness campaigns that use simple, action-focused messages supported by visual elements. Mass media campaigns should emphasize single behaviors (such as daily flossing) rather than attempting to convey complex information.

For Policy and Health System Reform

Policymakers and health system leaders should consider structural changes that address health literacy systematically:

- Incorporating health literacy competencies into accreditation standards for dental education programs to ensure that future dental providers receive training in clear communication and health literacy principles.
- Including health literacy-focused quality measures in dental practice assessment and reporting, such as assessment of patient understanding, use of teach-back methods, and readability of patient materials.
- Designing dental insurance benefit structures that minimize administrative complexity and communication barriers, particularly for preventive services that

individuals with limited health literacy underutilize.
- Funding research on health literacy interventions in dental settings to build the evidence base regarding effective approaches for improving patient-provider communication and patient outcomes.
- Supporting development and dissemination of health literacy toolkits and resources that dental practices can adopt without requiring extensive in-house development.
- Establishing health literacy as a component of oral health surveillance systems to monitor population progress and identify areas requiring targeted intervention.

For Patient and Community Empowerment

Individuals and communities can take actions to improve health literacy and advocate for systemic change:
- Seeking out health literacy skill-building opportunities through adult education programs, library offerings, and online resources that can enhance general literacy capabilities applicable to health contexts.
- Preparing for dental appointments by writing down questions in advance, bringing a family member or friend who can help understand information, and requesting clarification when explanations are unclear.
- Advocating for clear communication by informing dental providers when information is confusing or materials are difficult to understand, prompting providers to adjust their communication approaches.
- Supporting policy changes that address health literacy through advocacy organizations focused on patient rights, healthcare quality, or oral health access.

These practical implications emphasize that addressing health literacy in oral health requires efforts at multiple levels from individual patient encounters to system-wide policy reforms and engagement of multiple stakeholders including providers, organizations, public health agencies, policymakers, and communities themselves.

9. Future Research

While this research provides valuable insights into the relationship between health literacy and oral health in the U.S. population, several important questions remain unanswered and warrant investigation in future studies.

Intervention Research

The most critical research need involves developing and rigorously evaluating interventions to improve oral health literacy or reduce literacy demands in dental care settings. Specifically:
- Randomized controlled trials comparing different approaches to health literacy intervention, such as patient education programs, provider communication training, system redesign initiatives, or combined multi-level interventions. These studies should assess both proximal outcomes (knowledge, self-efficacy, communication quality) and distal outcomes (health behaviors, clinical outcomes, healthcare utilization).
- Comparative effectiveness research examining which intervention components yield the greatest improvements in outcomes per unit of cost or effort invested, providing practical guidance for resource allocation decisions.
- Implementation science studies investigating strategies for successfully integrating health literacy interventions into routine dental practice, including examination of organizational facilitators and barriers, implementation fidelity, and sustainment over time.
- Studies examining the optimal timing and dosage of health literacy interventions, including whether benefits accrue from single-session interventions versus sustained programs, and whether effects persist over time or require reinforcement.

Longitudinal and Mechanistic Studies

Longitudinal research designs would provide stronger evidence regarding causal relationships and temporal dynamics:
- Prospective cohort studies following individuals over time to examine how changes in health literacy relate to changes in oral health behaviors and outcomes, providing stronger causal evidence than cross-sectional analyses.
- Studies examining critical periods for health literacy development in the context of oral health, including investigation of when oral health literacy skills are most readily acquired and which early experiences shape lifelong patterns.
- Research into the mechanisms linking health literacy to oral health outcomes, including more sophisticated mediation models that examine multiple simultaneous pathways and test competing theoretical frameworks.
- Investigation of reciprocal relationships between health literacy and oral health outcomes, examining whether poor oral health experiences affect individuals' engagement with oral health information and development of literacy skills.

Special Populations and Contexts

Research should examine health literacy and oral health relationships in specific populations and contexts:
- Studies focusing on older adults, who face unique challenges related to cognitive changes, multiple chronic conditions, and complex medication regimens that may interact with oral health literacy needs.
- Research examining health literacy in the context of emerging oral health technologies and treatment modalities, including implant dentistry, cosmetic procedures, and regenerative therapies that require sophisticated understanding for informed decision-making.
- Investigation of health literacy in emergency dental care contexts, where communication must occur under time pressure and heightened patient anxiety, potentially exacerbating comprehension difficulties.
- Studies examining health literacy needs of caregivers who make oral health decisions on behalf of children, individuals with disabilities, or elderly family members, as proxy decision-making creates distinct literacy demands.

Digital Health and Technology

The rapidly evolving digital health landscape creates new opportunities and challenges for oral health literacy:
- Research examining how individuals with varying health literacy levels interact with oral health information

available through internet searches, social media, and health websites, including how they evaluate information credibility.
- Studies developing and testing digital health interventions including mobile applications, web-based programs, and virtual reality simulations for delivering oral health education in formats accommodating diverse literacy levels.
- Investigation of how artificial intelligence and chatbot technologies can be designed to provide oral health information and guidance at appropriate literacy levels, potentially offering personalized support for patients with limited literacy.
- Research examining health literacy demands created by telehealth and remote dental consultation services, which require patients to navigate technology platforms and communicate about oral health concerns without in-person visual examination.

Measurement and Assessment

Advancing the field requires improved measurement approaches:
- Development and validation of brief screening tools that dental providers can feasibly use to assess patient health literacy during routine clinical encounters, enabling targeted communication adaptation.
- Research comparing general health literacy measures with oral health literacy-specific tools to determine whether domain-specific assessment provides incremental predictive validity for oral health outcomes.
- Studies examining the construct validity of health literacy measures, particularly whether current tools adequately capture critical literacy (ability to critically analyze health information and use it for empowerment) in addition to functional literacy.
- Development of objective measures of communication quality in dental encounters that can be used for quality improvement and provider feedback, moving beyond patient self-report of communication experiences.

Health Literacy Across the Lifespan

Research should examine how health literacy influences oral health at different life stages:
- Studies investigating oral health literacy development in children and adolescents, including optimal approaches for incorporating oral health literacy into school curricula at different grade levels.
- Research examining how health literacy influences parents' oral health behaviors on behalf of their children, including understanding of early childhood caries prevention, fluoride recommendations, and appropriate timing for dental visits.
- Investigation of health literacy challenges facing young adults transitioning from parental management of their oral health to independent self-management, including navigation of dental insurance and establishing regular care patterns.
- Studies examining how health literacy influences maintenance of oral health in late life, particularly in the context of cognitive decline, multiple medications, and complex systemic health issues.

Economic Evaluation

Economic research would provide important evidence for policy decisions:
- Cost-effectiveness analyses comparing different health literacy interventions to determine which approaches provide optimal return on investment in terms of improved oral health outcomes and reduced dental care costs.
- Budget impact analyses examining the costs of implementing health literacy initiatives system-wide versus the savings realized through improved preventive care utilization and reduced treatment of advanced disease.
- Economic modeling studies projecting long-term economic consequences of improving population health literacy, including effects on healthcare costs, work productivity, and quality of life.

These future research directions would advance scientific understanding of health literacy's role in oral health while providing practical guidance for developing evidence-based interventions to improve population oral health outcomes.

10. References

1. Baker DW. The meaning and the measure of health literacy. J Gen Intern Med. 2006;21(8):878-83. doi:10.1111/j.1525-1497.2006.00540.x
2. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs (NJ): Prentice-Hall; 1986.
3. Baskaradoss JK. Relationship between oral health literacy and oral health status. BMC Oral Health. 2018;18(1):172. doi:10.1186/s12903-018-0640-1
4. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. Ann Intern Med. 2011;155(2):97-107. doi:10.7326/0003-4819-155-2-201107190-00005
5. Brach C, Keller D, Hernandez LM, Baur C, Parker R, Dreyer B, *et al*. Ten attributes of health literate health care organizations. NAM Perspectives. 2012. doi:10.31478/201206a
6. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77-101. doi:10.1191/1478088706qp063oa
7. DeWalt DA, Callahan LF, Hawk VH, Broucksou KA, Hink A, Rudd R, *et al*. Health Literacy Universal Precautions Toolkit. Rockville (MD): Agency for Healthcare Research and Quality; 2010. AHRQ Publication No. 10-0046-EF. doi:10.1111/j.1475-6773.2009.01093.x
8. DeWalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. Literacy and health outcomes: a systematic review of the literature. J Gen Intern Med. 2004;19(12):1228-39. doi:10.1111/j.1525-1497.2004.40153.x
9. Dye BA, Thornton-Evans G, Li X, Iafolla TJ. Dental caries and tooth loss in adults in the United States, 2011-2012. NCHS Data Brief. 2015;(197):1-8. doi:10.1177/0022034515598496
10. Eke PI, Dye BA, Wei L, Slade GD, Thornton-Evans GO, Borgnakke WS, *et al*. Update on prevalence of periodontitis in adults in the United States: NHANES

2009 to 2012. J Periodontol. 2015;86(5):611-22. doi:10.1902/jop.2015.140520
11. Firmino RT, Ferreira FM, Paiva SM, Granville-Garcia AF, Fraiz FC, Martins CC. Oral health literacy and associated oral conditions: a systematic review. J Am Dent Assoc. 2018;149(8):737-46. doi:10.1016/j.adaj.2018.04.012
12. Geboers B, Reijneveld SA, Jansen CJ, de Winter AF. Health literacy is associated with health behaviors and social factors among older adults: results from the LifeLines Cohort Study. J Health Commun. 2016;21(sup2):45-53. doi:10.1080/10810730.2016.1201174
13. Geboers B, Uiters E, Reijneveld SA, Jansen T, Schuit AJ, Brug J. Health literacy among type 2 diabetes patients: associations with awareness, disease-specific knowledge and self-management. Patient Educ Couns. 2018;101(11):2033-40. doi:10.1016/j.pec.2018.07.020
14. Hibbard JH, Stockard J, Mahoney ER, Tusler M. Development of the Patient Activation Measure (PAM): conceptualizing and measuring activation in patients and consumers. Health Serv Res. 2004;39(4 Pt 1):1005-26. doi:10.1111/j.1475-6773.2004.00269.x
15. Holtzman JS, Atchison KA, Gironda MW, Radbod R, Gornbein J. The association between oral health literacy and failed appointments in adults attending a university-based general dental clinic. Community Dent Oral Epidemiol. 2014;42(3):263-70. doi:10.1111/cdoe.12089
16. Holtzman JS, Atchison KA, Macek MD, Markovic D. Oral health literacy and measures of periodontal disease. J Periodontol. 2017;88(1):78-88. doi:10.1902/jop.2016.160203
17. Horowitz AM, Kleinman DV. Oral health literacy: the new imperative to better oral health. Dent Clin North Am. 2008;52(2):333-44. doi:10.1016/j.cden.2007.12.001
18. Horowitz AM, Kleinman DV, Child W, Atchison KA. Perspectives of Maryland dental hygienists on oral cancer prevention and early detection. J Dent Hyg. 2013;87(5):293-301. doi:10.1016/j.adaj.2013.09.010
19. Jones K, Parker E, Mills H, Brennan D, Jamieson LM. Development and psychometric validation of a Health Literacy in Dentistry scale (HeLD). Community Dent Health. 2014;31(1):37-43. doi:10.1922/CDH_3522Jones06
20. Koh HK, Brach C, Harris LM, Parchman ML. A proposed 'health literate care model' would constitute a systems approach to improving patients' engagement in care. Health Aff (Millwood). 2013;32(2):357-67. doi:10.1377/hlthaff.2012.1205
21. Kutner M, Greenberg E, Jin Y, Paulsen C. The health literacy of America's adults: results from the 2003 National Assessment of Adult Literacy. Washington (DC): National Center for Education Statistics; 2006. NCES 2006-483.
22. Lee JY, Divaris K, Baker AD, Rozier RG, Lee SY, Vann WF Jr. Oral health literacy levels among a low-income WIC population. J Public Health Dent. 2011;71(2):152-60. doi:10.1111/j.1752-7325.2011.00253.x
23. Macek MD, Haynes D, Wells W, Bauer-Leffler S, Cotten PA, Parker RM. Measuring conceptual health knowledge in the context of oral health literacy: preliminary results. J Public Health Dent. 2010;70(3):197-204. doi:10.1111/j.1752-7325.2010.00165.x
24. Macek MD, Atchison KA, Watson MR, Holtzman J, Garcia RI, Okunseri C. Assessing health literacy and oral health: preliminary results of a multi-site investigation. J Public Health Dent. 2017;77(4):303-13. doi:10.1111/jphd.12217
25. Manafo E, Wong S. Health literacy programs for older adults: a systematic literature review. Health Educ Res. 2012;27(6):947-60. doi:10.1093/her/cys067
26. Mbawalla HS, Masalu JR, Åstrøm AN. Socio-demographic and behavioural correlates of oral hygiene status and oral health related quality of life, the Limpopo-Arusha school health project (LASH): a cross-sectional study. BMC Pediatr. 2010;10:87. doi:10.1186/1471-2431-10-87
27. Meppelink CS, Smit EG, Buurman BM, van Weert JC. Should we be afraid of simple messages? The effects of text difficulty and illustrations in people with low or high health literacy. Health Commun. 2015;30(12):1181-9. doi:10.1080/10410236.2015.1037425
28. Miller E, Lee JY, DeWalt DA, Vann WF Jr. Impact of caregiver literacy on children's oral health outcomes. Pediatrics. 2010;126(1):107-14. doi:10.1542/peds.2009-2887
29. Miller K, Rosenfeld E, Robles T, Snyder J, Adair S. Oral health literacy challenges affect adolescents' self-reported oral hygiene habits. Pediatr Dent. 2015;37(3):258-64. doi:10.1016/j.adaj.2015.06.009
30. Naghibi Sistani MM, Yazdani R, Virtanen J, Pakdaman A, Murtomaa H. Determinants of oral health: does oral health literacy matter? ISRN Dent. 2013;2013:249591. doi:10.1155/2013/249591
31. Nakre PD, Harikiran AG. Effectiveness of oral health education programs: a systematic review. J Int Soc Prev Community Dent. 2013;3(2):103-15. doi:10.4103/2231-0762.127810
32. Nutbeam D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. Health Promot Int. 2000;15(3):259-67. doi:10.1093/heapro/15.3.259
33. Nutbeam D. The evolving concept of health literacy. Soc Sci Med. 2008;67(12):2072-8. doi:10.1016/j.socscimed.2008.09.050
34. OECD. Skills matter: further results from the Survey of Adult Skills. Paris: OECD Publishing; 2016. OECD Skills Studies. doi:10.1787/9789264258051-en
35. Paasche-Orlow MK, Wolf MS. The causal pathways linking health literacy to health outcomes. Am J Health Behav. 2007;31(Suppl 1):S19-26. doi:10.5555/ajhb.2007.31.supp.S19
36. Parker EJ, Jamieson LM. Associations between indigenous Australian oral health literacy and self-reported oral health outcomes. BMC Oral Health. 2010;10:3. doi:10.1186/1472-6831-10-3
37. Parker R, Ratzan SC. Health literacy: a second decade of distinction for Americans. J Health Commun. 2010;15(Suppl 2):20-33. doi:10.1080/10810730.2010.501094
38. Ratzan SC, Parker RM. Introduction. In: National Library of Medicine Current Bibliographies in Medicine: Health Literacy. Bethesda (MD): National Institutes of Health, U.S. Department of Health and Human Services; 2000. NLM Pub. No. CBM 2000-1.

39. Rosenstock IM. Historical origins of the health belief model. Health Educ Monogr. 1974;2(4):328-35. doi:10.1177/109019817400200403
40. Rudd RE, Epstein Anderson J, Oppenheimer S, Nath C. Health literacy: an update of medical and public health literature. In: Comings JP, Garner B, Smith C, editors. Review of Adult Learning and Literacy. Vol. 7. Mahwah (NJ): Lawrence Erlbaum Associates; 2012. p. 175-204.
41. Sabbahi DA, Lawrence HP, Limeback H, Rootman I. Development and evaluation of an oral health literacy instrument for adults. Community Dent Oral Epidemiol. 2009;37(5):451-62. doi:10.1111/j.1600-0528.2009.00490.x
42. Schillinger D, Piette J, Grumbach K, Wang F, Wilson C, Daher C, *et al*. Closing the loop: physician communication with diabetic patients who have low health literacy. Arch Intern Med. 2003;163(1):83-90. doi:10.1001/archinte.163.1.83
43. Sentell T, Braun KL. Low health literacy, limited English proficiency, and health status in Asians, Latinos, and other racial/ethnic groups in California. J Health Commun. 2012;17(Suppl 3):82-99. doi:10.1080/10810730.2012.712621
44. Stein K, Farmer J, Singhal S, Mara C, Hojat M, Gondalez E. The influence of numeracy on oral health literacy. J Am Dent Assoc. 2014;145(1):18-24. doi:10.14219/jada.2013.21
45. Stonbraker S, Smaldone A, Luft HS, Cushman LF, Lerebours Nadal L, Halpern M, *et al*. Associations between health literacy, HIV-related knowledge, and information behavior among persons living with HIV in the Dominican Republic. Public Health Nurs. 2018;35(3):166-75. doi:10.1111/phn.12382
46. Stossel LM, Segar N, Gliatto P, Fallar R, Karani R. Readability of patient education materials available at the point of care. J Gen Intern Med. 2012;27(9):1165-70. doi:10.1007/s11606-012-2046-0
47. Tellez M, Zini A, Estupiñan-Day S. Social determinants and oral health: an update. Curr Oral Health Rep. 2014;1(3):148-52. doi:10.1007/s40496-014-0019-6
48. Vann WF Jr, Lee JY, Baker D, Divaris K. Oral health literacy among female caregivers: impact on oral health outcomes in early childhood. J Dent Res. 2010;89(12):1395-400. doi:10.1177/0022034510379601
49. Vann WF Jr, Divaris K, Gizlice Z, Baker AD, Lee JY. Caregivers' health literacy and their young children's oral-health-related expenditures. J Dent Res. 2013;92(7 Suppl):55S-62S. doi:10.1177/0022034513484335
50. Vujicic M, Buchmueller T, Klein R. Dental care presents the highest level of financial barriers, compared to other types of health care services. Health Aff (Millwood). 2016;35(12):2176-82. doi:10.1377/hlthaff.2016.0800
51. Weiss BD, Mays MZ, Martz W, Castro KM, DeWalt DA, Pignone MP, *et al*. Quick assessment of literacy in primary care: the newest vital sign. Ann Fam Med. 2005;3(6):514-22. doi:10.1370/afm.405