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United Stated Adolescent Health Literacy Development, Disparities, and Preventive Service Use Throughout the Lifecourse

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UNITED STATES ADOLESCENT HEALTH LITERACY DEVELOPMENT, DISPARITIES, AND PREVENTIVE SERVICE USE THROUGHOUT THE LIFECOURSE

by
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DEDICATION

I dedicate this work to my family, especially my mother, Daphne Askew, and my late aunt, Katherine Askew Dorsey, whose love, support, and encouragement empowered me as I worked to reach this milestone. This has been a long journey, and without you all I could not reach this milestone. Words can't express my gratitude for the love and support that I received throughout this journey. Thank You !

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ABSTRACT

Health literacy, an individual's ability to access and process health information to make health decisions, is an understudied topic among adolescents and young adults. Low health literacy potentially increases negative health outcomes such as chronic diseases, substance use, and overuse of health care services later in young adulthood. Understanding health literacy throughout the life course presents opportunity to decreases low health literacy, the associated negative health outcomes, and the onus its puts on society and the healthcare system.

This dissertation aims to assess health literacy development during adolescent years with theoretical constructs geared towards health literacy development along with social and environmental factors. Adolescent health literacy geographic disparities are also explored. In addition, adolescent health literacy is assessed across specific time points during adolescence and young adulthood. The changes in health literacy from adolescence to young adulthood is evaluated along with changes in preventive service use during young adulthood. Data from the National Longitudinal Survey of Youth 1997 cohort (NLSY97) and the County and City Databook are used to evaluate the development of adolescent health literacy, geographic disparities in adolescent health literacy, and the associations of adolescent health literacy with preventive service use, health behaviors, and health outcomes. This research provides an assessment of adolescent health literacy at the national level and address important research gaps for understanding adolescent health literacy development, geographic proportion of adolescent health literacy and, preventive service use over time. It also provides supporting evidence for health literacy changes throughout the life course. The results have implications for policies that address health literacy development and disparities among adolescents.

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CHAPTER I: INTRODUCTION

Background and Gaps in the Literature on Health Literacy and Adolescents

Health literacy is defined as the ability of an individual to access, process, and understand health information to make informed health decisions and lead healthy lifestyles (Nutbeam, 2000). Low health literacy signifies difficulty in understanding health information or making health decisions without additional help (U.S. Department of Health and Human Services, 2008; Centers for Disease Control and Prevention, 2019). It is a prominent public health issue linked to many negative health outcomes, including preventable hospital emergency visits, decreased use of preventive health services, increased odds of chronic diseases, and higher health care costs (Baker et al., 1998; Broder et al., 2017; Williams et al., 1988; Howard, Gazmararian, & Parker, 2005). A 2003 National Assessment of Adult Literacy surveyed over 19,000 U.S. (a representative sample of the U.S population) adults to determine the proportion of those with below basic (i.e., low) health literacy (U.S. Department of Health and Human Services, 2008). The assessment found that over 44 million Americans representative of the study scored below basic on health literacy (Schillinger et al., 2002; Yin et al., 2007; U.S. Department of Health and Human Services, 2008).

Adequate health literacy is a crucial determinant of health (Schillinger et al., 2002; Zarcadoolas, Pleasant, & Greer, 2005; Centers for Disease Control and Prevention, 2019). Proficient health literacy means that an individual can independently understand health information and make positive health decisions without difficulty (Centers for Disease Control and Prevention, 2019). In the United States, for example, a minimum eighth grade reading level is necessary to process most health information (Safeer and Keenan, 2005). Consequently, policies and legislation such as the Patient Protection and Affordable Care Act (ACA) of 2010,

promote health literacy as a strategy for improving health. Improving health literacy thus can address several issues within the healthcare system, such as decreasing economic burdens on the health system (U.S. National Library of Medicine, n.d.).

Most health literacy literature focuses on adult populations, specifically regarding adherence to medical instructions, label reading, and managing chronic conditions (Parker et al., 1995; Berkman, 2004; Yin et al., 2009; Stellefeson et al., 2019). However, adolescence is a crucial period when intellectual, psychological, and social development occurs. As such, it also is a crucial period for health literacy and health behavior development (Pediatrics, 2012). With health literacy proving to be predictive of health behaviors (Fernandez, Larson, & Zikmund-Fisher, 2016), medical compliance (Miller, 2016), and proper use of health services (Bailey et al., 2015), and with the Institute of Medicine recommendations for research on health literacy and adolescents, health literacy research has extended to include adolescents and young adult populations (Broder et al., 2017).

Health literacy is a broad concept that poses many challenges when measuring adolescent outcomes. Thus, research around adolescent health literacy has centered on validating tools and assessments (Okran et al., 2018). For example, the Rapid Estimate of Adult Literacy in Medicine (REALM-teen), validated in 2006, measures health word recognition and pronunciation in mostly health care settings although it can be used in a variety of settings (Davis et al., 2006). The health words in the REALM-teen test range from the fourth grade to tenth grade levels and arranges words in ascending order of difficulty to asses health literacy in a brief manner. Another validated measure is the Test of Functional Health Literacy in Adults for adolescents 2007), which measures numeracy and reading comprehension (Chisolm and Buchanan, 2007). Beyond attempts to validate measures for adolescent health literacy, some studies have analyzed the

impacts of health literacy on health behaviors among adolescents (Manganello, 2008). For example, research has reviewed health literacy among adolescents with regard to behaviors such as sexual activity, substance use, and mental health service utilization, with lower health literacy linked to increases in these behaviors (Taylor, 2015; Ogorchukwu et al., 2016; Lee et al., 2017). Additionally, Chisolm et al. (2014) found that teens with high health literacy were less likely to use alcohol compared to their peers with lower health literacy.

Although adolescent health literacy has been explored at the state level, health literacy research at the national level has mostly been limited to adults (U.S. Department of Health and Human Services, 2008; Yin et al., 2009). Considering the implications of adolescent health literacy on their future health outcomes, more research is needed to identify influences, contributing factors, and disparities related to adolescent health literacy. To improve the quality of health, reduce costs associated with low health literacy, and diminish health disparities, many public health experts agree that health literacy should be prioritized during adolescence. The school system has been identified as an essential intervention point (Institute of Medicine et al., 2004).

Purpose, Aims, and Objectives

This dissertation explores health literacy among adolescents in the United States and how it affects their future health behaviors in young adulthood. The overall purpose is to contribute to the literature by addressing gaps in the understanding of adolescent health literacy across the life course and to promote public policy for improving adolescent health literacy. First, this dissertation analyzes patterns of adolescent health literacy development to understand the predictors of health literacy development. Understanding these patterns could provide insight to better measurement tools for adolescent health literacy (Fleary et al., 2018) and identify areas to

address for preventing low health literacy. Next, disparities in adolescent health literacy are explored, along with geographic factors, such as physician availability, hospital availability, and urban versus rural status. Socioeconomic and environmental factors have been associated with health literacy, and low socioeconomic status is known to decrease access to health sources that are important for health literacy attainment (Institute of Medicine et al., 2004; Kevin and Fiscella, 2009). Understanding geographical disparities in relation to health literacy can help diminish the disparity gap by creating opportunities to promote equal access to health information. Finally, adolescent health literacy is explored in relation to positive health service utilization, specifically preventive service use. The use of preventive service throughout adolescence and young adulthood is analyzed in relation to adolescent health literacy. By addressing the following three research aims, this dissertation provides an in-depth understanding of adolescent health literacy and its associated impacts:

Aim 1: Assess adolescent health literacy development using developmental theories.

Aim 2: Evaluate adolescent health literacy at the national level and assess county-level geographic disparities.

Aim 3: Assess associations of adolescent health literacy on preventive service use in young adulthood.

In conclusion, this dissertation addresses important research gaps associated with adolescent health literacy. It also provides insight on areas to target for prevention of low health literacy. Additionally, this dissertation identifies areas for future research.

CHAPTER II: HEALTH LITERACY DEVELOPMENT AMONG ADOLESCENTS IN THE UNITED STATES: A LATENT VARIABLE, MIXTURE MODEL APPROACH

Abstract

Purpose: The objective of this study is to understand adolescent health literacy development throughout the life course by using developmental theories to assess patterns of health literacy, identify contributing factors of health literacy development, and identify subgroups of health literacy development classes.

Methods: We analyzed data from 1,454 U.S. adolescents aged 13 to 15 who were surveyed in the National Longitudinal Survey of Youth 1997 at baseline. We also used constructs from the Social Ecological Model and the Health Belief Model as developmental theories for life course predictors of health literacy. Latent variable mixture modeling with latent class analysis was used to assess patterns and characteristics of health literacy and its contributing factors.

Results: We identified four classes of healthy literacy development from the latent class analysis. Significant pattern distinctions among classes included interpersonal and community factors as well as health behaviors. Adolescents with positive peer relations, authoritative parenting styles, and healthy perceptions and health behaviors were more likely to develop proficient or high health literacy.

Conclusions: The distinct profiles of health literacy development classes showed substantial separations between peers, and these relationships had significant influence on the way that adolescents adopted knowledge about health. Peers who use substances (e.g., drugs, alcohol) may be more likely to develop lower health literacy than those with limited or no substance use. The promotion of healthy behaviors could increase the chances of higher health literacy development. Additionally, parenting styles during adolescent years may significantly impact where and how adolescents develop health literacy.

Implications and contributions: This study presents an analysis of health literacy development patterns using a national sample. The results may provide direction for factors to target within schools and surrounding communities for primary prevention of low health literacy development among adolescents.

Keywords: adolescents; health literacy; latent variable mixture modeling; National Longitudinal Survey of Youth 1997

Introduction

Low health literacy among the U.S. population is a growing concern. The 2003 National Assessment of Adult Literacy classifies adult health literacy into four categories: proficient (individual can perform complex tasks, such as identifying and defining a medical term in a written document); intermediate (individual can perform moderately challenging tasks, such as determining an appropriate weight range); basic (individual can perform simple tasks, such as determining when to be tested for a disease after reading a pamphlet), and below basic (individual can perform only the simplest tasks, such as scheduling a doctor's appointment). This assessment revealed that over 14% of the U.S population had below basic health literacy (U.S. Department of Health and Human Services, 2008). Below basic health literacy is an indicator of diminished ability to understand or process health information and make sound health decisions, which increases the risk for negative health outcomes. Low health literacy in the United States also has been consistently linked to negative health outcomes among adults (Manganello, 2007), including increased risk of chronic disease, decreased use of preventive health services, and higher health care expenditures (Baker et al., 1998; Broder et al., 2017; Williams et al., 1988; Howard et al., 2005). Adolescence is the period before adulthood and following the onset of puberty when intellectual, psychological, and social development occurs. Adolescents with low health literacy are more likely to develop and suffer from negative health behaviors than their peers. Thus, understanding the associations between health literacy and health outcomes among adolescents can help identify ways to ameliorate the negative impacts of low health literacy.

Many factors impact health literacy among adolescents. For example, psychological research has identified four parenting styles (uninvolved, permissive, authoritative, and authoritarian) that can influence development (Chen et al., 1997; Dornbusch et al., 1987).

Uninvolved and permissive parenting styles allow more input but offer less direction than other types. Authoritative parents typically provide guidance and nurturing with directive leadership. In contrast, authoritarian parents are very directive, less nurturing, and autocratic.

The persistent associations between low health literacy and negative health behaviors have prompted researchers to explore predictors and patterns of behaviors among adolescents. For example, Brandt and colleagues (2019) examined health literacy as a predictor for smoking and alcohol use among adolescents and found that teens with higher health literacy were less likely than their peers to use drugs and alcohol. Adolescents with low health literacy are more likely to engage in risky sexual behaviors and substance abuse (Taylor, 2015; Ogorchukwu et al., 2016; Lee et al., 2017). Regionally, adolescents in rural areas with low health literacy tend to be overweight and more likely to engage in unhealthy dietary and sexual behaviors, compared with their urban counterparts (Park et al., 2017). For these reasons, in 2004, the Institute of Medicine recommended health literacy assessments and primary interventions in schools to improve health literacy among adolescents (Institute of Medicine et al., 2004).

High health literacy can moderate negative health behaviors among adolescents, specifically regarding substance use (Chisolm et al., 2014). Despite this and other known impacts of adolescent health literacy on long-term health, minimal research has investigated health literacy development among adolescents. We aim to fill this gap by responding to calls to identify health literacy developmental patterns in adolescents (Fleary et al., 2018). Using conceptual models that emphasize social and cultural attributes of health literacy development (Higgins et al., 2009; Okan et al., 2019), we identify classes of health literacy development among adolescents based on behavior patterns and influential factors.

The social ecological model and health belief model serve as foundational models for the conceptual framework of adolescent health literacy development. These models align influential factors along the developmental continuum. The social ecological model helps explain psychological development and social factors of influence (Sallis and Owen, 2015). This multifactor model accounts for relationships and interactions that influence development to explain how an individual develops and interacts within a system. It comprises five core levels of influence: individual or intrapersonal, interpersonal, institutional, community, and environment or public policy (Mcleroy et al., 1988). Higgins et al. (2009) used this model to conceptualize adolescent health literacy in classroom health education in Canada. They found that the social ecological model offers theoretical and methodological opportunities to assess health literacy among adolescents, specifically when including influencing interpersonal factors. They also found that the adolescents in their study developed health literacy from observing peer and parental modeling behaviors. Thus, the social ecological model offers a sociocultural context, but it neglects personal behaviors and health promotion, which are key domains in health literacy among adolescents (Okan et al., 2019).

The health belief model addresses these key domains. This psychology model explains health behaviors along six primary constructs centered on personal perceptions: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. This model has been used to understand how perceptions influence behaviors (Janz & Becker, 1984). We used the combined constructs from these models to help address our study aims as shown in **Figure 1**.

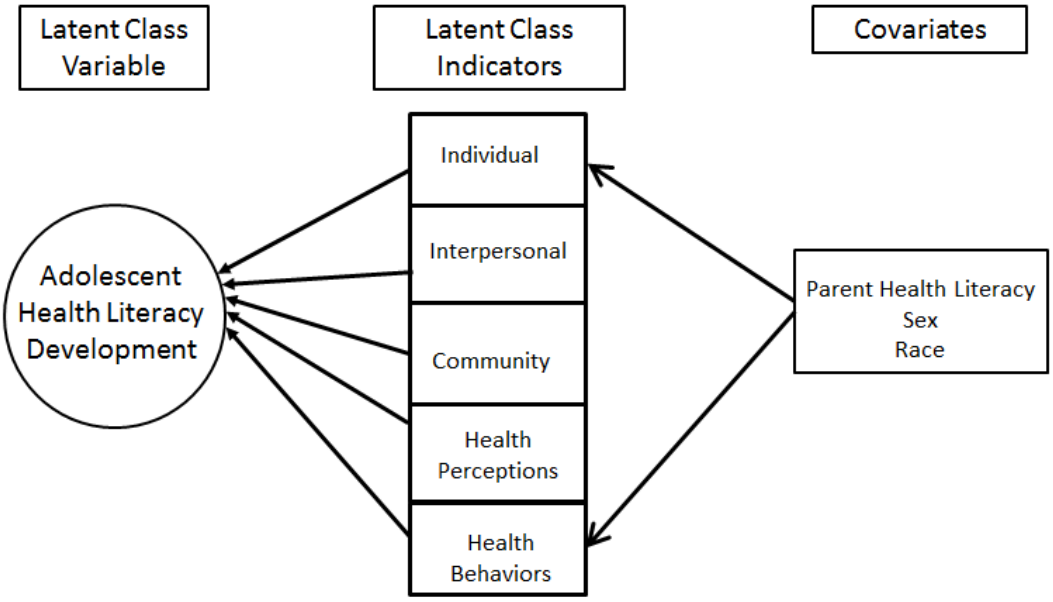


Figure 1. SEM and HBM Conceptual Framework for Adolescent Health Literacy Development.

This study had three aims: 1) understand the prominent factors during adolescence that influence health literacy development, 2) identify combinations of factors (i.e., classes) related to health literacy development among adolescents using the social ecological model and the health belief model, and 3) investigate significant predictors of health literacy development among adolescents. Previous research has provided insights on the impact of low health literacy on adolescent health behaviors. However, scant research has assessed patterns of health literacy development among adolescents using developmental theories or conceptual frameworks. Adolescence is an important time for health literacy and health behavior development (Pediatrics, 2012). Thus, it is imperative to understand the patterns of health literacy development across the life course to address low health literacy among adolescents.

Methods

Data

This study used data from the National Longitudinal Survey of Youth 1997, which includes a nationally representative sample (n=8,984) of adolescents aged 12–18 years (including an oversampling of Black and Hispanic or Latino respondents to meet sufficient numbers for statistical analysis) living in the United States (U.S. Department of Labor, 2006). The survey followed adolescents from 1997 to 2017, for a total of 17 rounds of sampling. It collected self-reported information on employment, education, family and family processes, health, and crime. A computer-assisted personal interview instrument and electronic questionnaire were used at each sampling round (National Longitudinal Surveys, 2019). For more information about the screening process and sample design, see the National Longitudinal Surveys website (https://www.nlsinfo.org).

Study Sample from the National Longitudinal Survey of Youth 1997

Adolescents who answered disease knowledge questions were selected for the study sample (n=1454). The questions were as follows: 1) "Does smoking one or more packs of cigarettes per day increase the risk (chance) of getting heart disease?" 2) "Does having 5 or more drinks of alcohol once or twice each week increase the risk (chance) of damaging the liver?" 3) "Does having 5 or more drinks once or twice each week increase the risk (chance) of getting heart disease?" 4) "Does having 5 or more drinks once or twice each week increase the risk (chance) of getting arthritis?" and 5) "Does having 5 or more drinks once or twice each week increase the risk (chance) of becoming addicted to alcohol?" These variables were selected to proxy for health literacy based on previous research on adolescent health knowledge using data from the National Longitudinal Survey of Youth 1997 cohort (Altindag et al., 2011). We

conducted an additional confirmatory factor analysis of the selected questions to verify the reliability of the health literacy measure. A composite reliability of 0.69 further verified the health literacy measure (Zhang & Yuan, 2016).

Indicator Variables

We selected indicator variables from the social ecological model and health belief model. Individual and predisposing variables included race (five standardized categories), as well as sex and health insurance status (binary items). Interpersonal variables included peer smoking influence, peer drinking influence, peer illegal substance use, and parenting styles (Okan et al., 2019). Community variables included urban/rural status, U.S. census region, exposure to home break-ins, and exposure to community gun violence. Health perception and perceived need variables included the youth's general health self-perception, weight self-perception, and chronic disease status. Health behavior variables included youth's drinking status, smoking status, and number of days of exercise for at least 30 minutes based on Surgeon General guidelines (Centers for Disease Control and Prevention, 1996). All indicator variables, with the exception of chronic disease status, were self-reported by the adolescents. Chronic disease status was reported by the parent or guardian. All indicator variables are categorical in nature. Predictor variables for class distribution were age, sex, and parental health literacy. The parental health literacy variable was created and coded from the same variables used to create the youth health literacy variable. A composite reliability coefficient from a confirmatory factor analysis verified reliability of the variable.

Statistical Analysis

First, we screened the data for normality, missingness, and outliers, using descriptive statistics within Mplus. Final descriptive statistics on the study sample were conducted in SAS

9.4, and cross-sectional sample weights were utilized. We found the data to be non-normal, with 25 missing patterns, thus we used robust maximum likelihood estimation for the parameter estimation, missingness, and non-normality. We used a latent variable mixture modeling (LVMM) to predict classes of health literacy development. LVMM is an analytical technique that identifies patterns in data that can explain unobserved variables (Berlin et al., 2014; Geiser, 2013). Specifically, LVMM focuses on similarities and differences among the respondents rather than the relationships among the variables (Berlin et al., 2014). LVMM can help identify homogenous subgroups of individuals within a specific dataset, based on their unique characteristics. Latent classes emerge from the subgroup members of the indicator variables and are represented by a categorical latent variable (Berlin et al., 2014). We used a categorical latent variable in a cross-sectional manner. Thus, the LVMM was a latent class analysis, and model fit was determined by appropriate fit indices.

The appropriate statistical fit indices, Bayesian information Criteria (BIC), Lo-Mendell-Rubin test (LMRT), and bootstrap likelihood ratio test (BLRT), determined the optimal number of classes for this data. We also evaluated entropy for latent class classification. BIC is a comparison measure for nested models with different numbers of latent classes, wherein smaller values indicate better fit (Schwartz, 1978). The LMRT and BLRT indices compare improvement between models of different classes (Nylund et al., 2007; McLachlan & Peel, 2000). These indices use p-values to determine significant improvement from one class model to the next. Entropy measures how accurately an indicator defines a latent class. Values range from 0 to 1, with values closer to 1 signifying certainty. We also evaluated class distribution size; classes with at least 5% of the study sample were acceptable (Nasserinejad et al., 2017). An covariate analysis (R3step) was conducted to predict class membership sex, parent health literacy, and

race. Latent class analysis was conducted in Mplus version 8.0 to assess classes of health literacy development among adolescents within the United States. We allowed subtypes of each observed indicator variable to have fractional membership in each class.

Results

Table 1 provides the descriptive results for the study sample. Among the respondents, most were aged 13 or 14 (99.0%), white (59.3%), male (52.3%), covered by health insurance (76.6%), and perceived themselves to have excellent or very good health (74.3%). Most reported that their peers never used illegal substances (51.6%) or alcohol (63.2%). Over half reported their peers using cigarettes (63.7%). Additionally, most of the study sample reported no use of cigarettes (69.0), alcohol (69.5), or marijuana (30.5), and most had high health literacy (84.5%).

Table 1.

Demographic Characteristics of Study Sample at Baseline, 1997

Factors	**N (Weighted %)**
Individual Factors	
Age	
13	67.4 (1.3)
14	31.6 (1.3)
15	0.96 (0.27)
Race	
White	854 (59.0)
Black	380 (26.3)
American Indian	12 (0.8)
Asian or Pacific Islander	24 (1.7)
Other	177 (12.2)
Sex	
Male	765 (52.3)
Female	689(47.4)
Health Insurance	
Not covered	340 (23.4)
Covered	1114 (76.6)
Interpersonal Factors	
Peer Illegal Substance Use	

Almost none	739(51.6)
About 25%	336 (23.5)
About 50%	183 (12.8)
About 75%	119 (8.3)
Almost all >90%	54 (3.8)
Peer Cigarette Use	
Almost None	524 (36.3)
About 25%	387 (26.8)
About 50%	287 (19.9)
About 75%	174(12.0)
Almost all >90%	72(5.0)
Peer Alcohol Use	
Almost None	906 (63.2)
About 25%	270 (18.8)
About 50%	151 (10.5)
About 75%	73 (5.1)
Almost all >90%	34 (2.4)
Parental Health Literacy	
Low	179 (12.2)
High	1275 (87.8)
Mother's Parenting style	
Uninvolved	156 (11.2)
Permissive	435 (31.2)
Authoritarian	199 (14.3)
Authoritative	605 (43.4)
Father Parenting style	
Uninvolved	134 (12.4)
Permissive	267 (24.7)
Authoritarian	243 (22.5)
Authoritative	436 (40.4)
Community Factors	
US Census Region	
Northeast	254 (17.5)
Northcentral	335 (23.0)
South	549 (37.8)
West	316 (21.7)
Urban/Rural Status	
Rural	314 (21.6)
Urban	1086 (74.7)
Unknown	54 (3.7)
Chronic Condition	
No	1136 (78.1)
Yes	155 (10.7)

Unknown	163 (11.2)
Health Perceptions	
General Health	
Excellent	570 (39.2)
Very good	510 (35.1)
Good	313 (21.5)
Fair or poor	61 (4.2)
Weight Perception	
Very underweight	61 (4.2)
Slightly underweight	182 (12.5)
About right weight	789 (54.3)
Slightly overweight	357 (24.6)
Very overweight	63 (4.3)
Cigarette Use	
No	1002 (69.0)
Yes	450 (31.0)
Alcohol Use	
No	1008 (69.5)
Yes	443 (30.5)
Marijuana Use	
No	1285 (88.6)
Yes	166 (11.4)
Exercise 30 Minutes	
0 days	112 (7.7)
1 day	52 (3.6)
2 days	140 (9.6)
3 days	182 (12.5)
4 days or more	967 (66.6)
Health Literacy	
Low	226 (15.4)
High	1228 (84.5

Table 2 shows the latent class models that were analyzed for adolescent health literacy development. We assessed five latent class models to select the optimal number of classes. Due to the inability to obtain relevant information from the LMRT and for the BLRT of each class, the BIC, entropy, class number, and data from previous literature were used to select the best model with the optimal number of classes (Nylund et al., 2007). The results from the models indicated that the four-class model was best, based on entropy (0.847), BIC (47276.99), BLRT

(p<0.001), and smallest class number (n=189; 13% of study population). The competing models with classes 2 and 3 had significant BLRTs; however, the BIC of these classes were larger than the four-class model.

Table 2.

Latent Variable Mixture Model Fit Indices to Determine the Number of Classes

Classes	Entropy	BIC	LMRTp	BLRTp	Smallest Class, (%)
1	N/A	48964.66	N/A	N/A	n = 1454 (100.0)
2	0.808	47554.41	<.001	<.001	n= 531 (37.0)
3	0.857	47370.41	<.001	<.001	n= 204 (14.0)
4	**0.845**	**47276.89**	**<.001**	**<.001**	**n= 189 (13.0)**
5	0.796	47448.54	0.783	<.001	n= 181(12.4)

Note. BIC = Bayesian information criterion; BLRTp = bootstrap likelihood ratio test p-value; LMRTp = Lo-Mendell-Rubin test p-value

We did not select the five-class model due to its higher BIC (47,448.54), insignificant LMRT (0.783), and lower entropy (0.796). After selecting the four-class model, we ran the R3Step on this model to assess predictors of class distribution by race, sex, and parent health literacy, as shown in **Table 3**. Parent health literacy, sex, and race were found to be significant predictors of health literacy development classes.

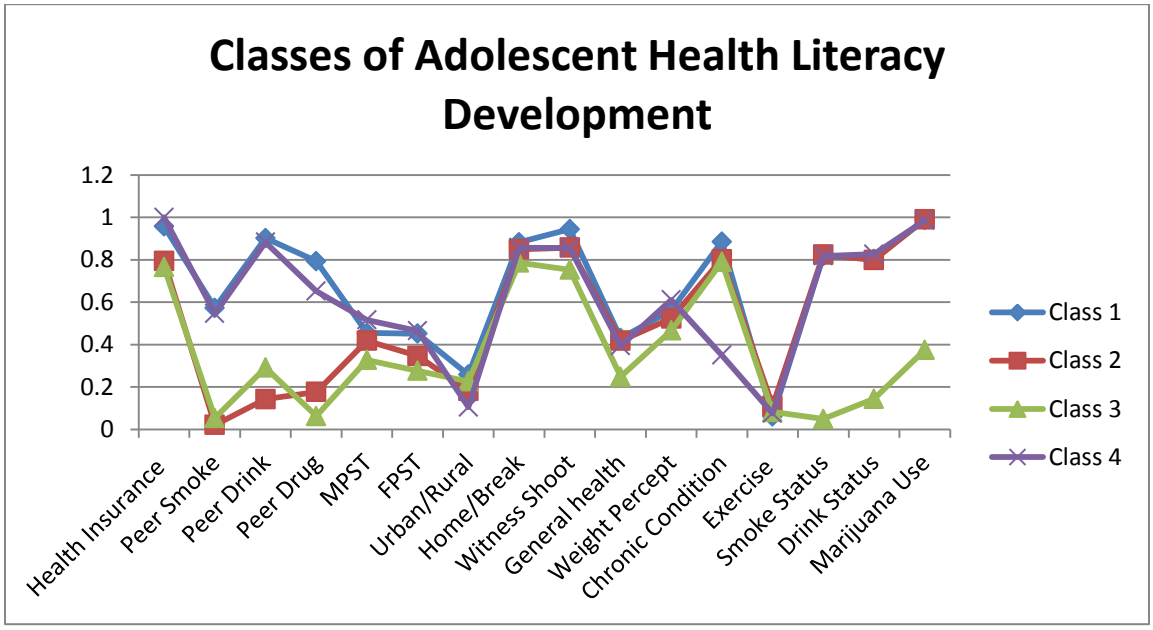
Table 3.

Individual Predictors of Health Literacy Development Latent Class Membership (Intermediate Reference Class)

Class Prediction	Estimate (Logged Odds)	Standard Error	Estimate/ Standard Error	P Value
Class 1 ON				
Sex	0.635	0.164	3.886	0.000
Parent Health Literacy	-0.039	0.124	-0.314	0.754
Race	0.101	0.061	1.645	0.100
Class 2 ON				
Sex	0.149	0.218	0.684	0.494
Parent Health Literacy	-2.362	0.294	-8.022	0.000
Race	0.297	0.080	3.711	0.000
Class 3 ON				
Sex	0.163	0.170	0.962	0.336
Parent Health Literacy	-0.426	0.133	-3.190	0.001
Race	-0.152	0.068	2.253	0.024

The four-class model suggests four identities for health literacy development. The classes have significant separation around the interpersonal factors peer substance, alcohol use, and parenting styles, as well as the community factors home robbery and witnessing shootings, as shown in **Figure 1** and **Table 4**. The first class is categorized by strong interpersonal and community factors, along with positive health perceptions and low need factors. The second class is categorized by weaker interpersonal factors, positive individual and community factors, and low need factors. The third class has low interpersonal factors, high community factors, negative health perceptions, and high need factors. The fourth class is categorized by strong interpersonal factors, positive community factors, positive health behaviors, and inconsistent need factors. In the covariate analysis for prediction of class membership, we found that sex and parent health literacy were likely to be significant predictors of class membership.

Latent Classes of Health Literacy Development: Four Latent Classes



Note. Values represent proportions in the highest reference category.

Figure 2

Table 4.

Latent Class Proportions of Indicator Variables

Indicator Variable	**Latent Classes**			
	Class 1	**Class 2**	**Class 3**	**Class 4**
Health Insurance Status				
Covered	0.958	0.795	0.766	1
Not Covered	0.042	0.205	0.234	0
Peers Cigarette Use				
Almost None	0.573	0.021	0.053	0.546
About 25%	0.314	0.184	0.236	0.278
About 50%	0.092	0.354	0.346	0.149
About 75%	0.019	0.328	0.226	0.019
Almost all >90%	0.002	0.113	0.139	0.007
Peer Alcohol Use				
Almost None	0.902	0.142	0.291	0.883
About 25%	0.092	0.391	0.273	0.098
About 50%	0.005	0.279	0.242	0.014
About 75%	0.001	0.123	0.141	0

Indicator Variable	Latent Classes			
	Class 1	Class 2	Class 3	Class 4
Almost all >90%	0	0.065	0.053	0.005
Peer Illegal Drug Use				
Almost None	0.793	0.176	0.062	0.652
About 25%	0.179	0.291	0.283	0.285
About 50%	0.021	0.29	0.281	0.053
About 75%	0.005	0.183	0.234	0.009
Almost all >90%	0.002	0.06	0.141	0
Mother Parenting Style				
Uninvolved	0.086	0.102	0.222	0.086
Permissive	0.341	0.318	0.274	0.235
Authoritarian	0.117	0.163	0.177	0.163
Authoritative	0.455	0.418	0.327	0.516
Father Parenting Style				
Uninvolved	0.091	0.123	0.172	0.197
Permissive	0.283	0.275	0.186	0.135
Authoritarian	0.174	0.257	0.367	0.203
Authoritative	0.451	0.346	0.276	0.465
Urban/ Rural Status				
Rural	0.258	0.181	0.226	0.105
Urban	0.696	0.788	0.748	0.867
Unknown	0.046	0.031	0.025	0.028
Experience Home Robbery				
No	0.882	0.85	0.786	0.857
Yes	0.118	0.15	0.214	0.43
Witnessed Shooting				
No	0.944	0.857	0.753	0.855
Yes	0.056	0.143	0.247	0.145
General Health Perception				
Excellent	0.43	0.418	0.248	0.394
Very good	0.377	0.323	0.353	0.297
Good	0.178	0.18	0.328	0.268
Fair	0.015	0.08	0.071	0.041
Weight Perception				
Very underweight	0.035	0.032	0.069	0.05
Slightly underweight	0.142	0.107	0.098	0.128
About right weight	0.561	0.523	0.466	0.611
Slightly overweight	0.229	0.284	0.29	0.188
Very overweight	0.033	0.053	0.077	0.023
Chronic Condition Status				
No	0.885	0.802	0.79	0.35
Yes	0.115	0.131	0.116	0.022

Indicator Variable	Latent Classes			
	Class 1	Class 2	Class 3	Class 4
Unknown	0	0.067	0.095	0.629
30-Minute Exercise Frequency				
0 days	0.061	0.111	0.082	0.075
1 day	0.024	0.042	0.045	0.059
2 days	0.098	0.084	0.076	0.137
3 days	0.139	0.137	0.108	0.077
4 days or more	0.679	0.626	0.688	0.653
Tobacco Use				
No	0.817	0.824	0.951	0.818
Yes	0.183	0.176	0.049	0.182
Alcohol Use				
No	0.803	0.799	0.856	0.826
Yes	0.197	0.201	0.144	0.174
Marijuana Use				
No	0.988	0.991	0.626	0.986
Yes	0.012	0.009	0.374	0.014

Discussion

Understanding peer relations during the developmental years is particularly important for promoting appropriate health behaviors and attitudes. Engagement in negative health behaviors (e.g., substance use) during adolescence is associated with low health literacy (Brandt et al., 2019). Using a nationally representative sample of adolescents living in the United States, we found that interpersonal factors among teens demonstrating substance use behaviors differed significantly from other teens. Notably, teens with higher (proficient or intermediate) versus lower (basic or below basic) health literacy were less likely to engage in substance use. Adolescence is a stressful time, and some teens use substances as coping mechanisms (Goodman et al., 2016). This type of stress management behavior can influence their attitudes towards health and health behaviors.

Similar to adolescent peer relations, interpersonal relationships between parents and adolescents are important for adolescent health literacy development (Okan et al., 2019).

Adolescents have been seen to adopt specific beliefs and attitudes from their parents, which influence their behaviors (Newman et al., 2008), including those associated with health literacy development. Psychology research has identified four parenting styles (authoritative, authoritarian, permissive, and uninvolved) in which patterns of control and warmth, rather than neglect and permissiveness, have been associated with more positive behaviors during adolescence. The type of parenting style to which adolescents are exposed also can affect their academic performance (Dornbusch et al., 1987).

This study identified a significant difference in the distribution of parenting styles across health literacy development classes. For example, adolescents with authoritarian fathers were most likely to have below basic health literacy. Authoritarian parents are usually strict and coercive with only one-way communication wherein the parent must be obeyed. Research among Chinese populations has shown that children with authoritarian parents have higher aggression, more negative peer acceptance, and more learning difficulties compared to children with authoritative or permissive parenting styles. (Chen et al., 1997).

In contrast with authoritarian parenting, authoritative parenting involves more open communication between the parent and the child (Dornbusch et al., 1987; Kopko, 2007). Having authoritative parents appears to be a highly influential factor in health literacy development among adolescents, as these adolescents have lower proportions of substance use and exposure to negative health behaviors than their peers. Some studies have shown that authoritative parenting is associated with fewer high-risk behaviors and positive dietary and physical activity behaviors among teens (Newman et al., 2008).

Finally, this study should be interpreted with some limitations in mind. First, the survey data used in this study were self-reported responses and thus may bias the responses on some

indicator variables. Second, the cross-sectional design, in which factor variables were assessed at a single point, did not account for changes in development. For instance, parents may have adopted an authoritative parenting style to help direct and guide their young children and then transitioned to a permissive parenting style later in adolescence. These changes in parenting styles could threaten the internal validity of the family dynamics results, though our analysis method helped control for this threat by compensating for measurement and random errors on each indicator and the independent variable (Berlin et al., 2014).

In sum, many factors can influence adolescent health literacy development. As adolescents develop, interpersonal relationships may hold more significant prominence in the way that they develop health literacy. Considering that peer relations during this developmental period are highly influential, interventions geared towards building healthy interpersonal relationships among peers may be areas to target to promote health literacy within schools. The Institute of Medicine has deemed the school setting an ideal place for behavior intervention, health education, and health literacy improvement among adolescents (Hernandez, 2009). We suggest a standardized policy geared towards adolescent health that focuses on substance use prevention. As the results from this study and from previous literature have shown, substance use among adolescents is associated with diminished learning, which can hinder development of proficient health literacy. Additionally, school policies and initiatives t could implement positive parenting coaching. Positive parenting coaching is a resource for parents to learn how to implement integrity, respect, and effective communication with their children to foster healthy parent-child relationships (Positive Discipline Association, 2017). This type of coaching has been done within schools and have shown positive results with improving relationships between parents and their children (Positive Parenting Association, 2017). Parenting styles also can

significantly impact adolescent behavior and learning, and parental health literacy is an important predictor of health literacy development in children. Thus, parents also should be targeted for primary prevention of low health literacy among adolescents.

CHAPTER III: ASSOCIATIONS OF GEOGRAPHIC DISPARITIES AND ADOLESCENT HEALTH LITERACY

Abstract

Background: High adolescent health literacy is imperative for positive health outcomes. Geographic disparities hinder high health literacy achievement and diminish access to resources of health information that is vital for high adolescent health literacy.

Purpose. This study aimed to assess adolescent health literacy at the national level and address the contributing factors of geographic disparities related to adolescent health literacy in the United States.

Methods. Geocoded data from the National Longitudinal Survey of Youth 1997 with matched variables from the County and City Databook were utilized to assess geographic disparities of health literacy predictors. The study sample consisted of adolescents (N = 1575) who answered disease knowledge questions. Health literacy was measured from the disease knowledge of adolescents. Descriptive analysis was utilized to assess adolescent health literacy across the U.S. Multilevel logistic regression analysis was conducted to evaluate disparities in health literacy and associations of geographical factors with low adolescent health literacy.

Results. Having low adolescent health literacy was associated with lack of health insurance (aOR=1.85; p=0.04), low parental health literacy (aOR= 1.78, p=0.002), authoritarian maternal parenting styles (aOR= 1.636,p= 0.03, and the inadequate number of physicians (aOR 1.576; p=0.04). Living in suburban areas decreased the odds of having low adolescent health literacy (aOR=0.34, p = 0.04).

Conclusions. Geographic disparities in adolescent health literacy should be addressed. Centralized education could provide neutral access to health information that is pertinent to

health literacy. National policy regarding health information attainment, such as school curriculum, should be targeted.

Keywords: Adolescents, , health literacy, geographic disparities, National Longitudinal Survey of Youth 1997 (NLSY97)

Introduction

Low health literacy negatively impacts health outcomes among adolescents and young adults (Lee et al., 2017). Although disparities in health literacy among adults have been widely studied, (Institute of Medicine et al.,2004; Cheng, Dreyer, & Jenkins, 2009; Hill, 2019, there are relatively few studies about disparities in health literacy among adolescents. Adults and adolescents living in areas with lower socioeconomic status (SES) tend to have adverse health outcomes (e.g., obesity, substance use, and chronic diseases), compared to those in areas with higher SES status (Fiscella & Williams, 2009; Institute of Medicine et al., 2004).

A prior study outlined the impact of geographic disparities in health literacy and the negative impacts across the life cycle (Kevin & Fiscella, 2009). Kevin and Fiscella (2009) concluded that health outcomes and health literacy in adulthood are significantly impacted by populations who experienced limited access to health care and social marginalization earlier in life. These populations are most likely to be residentially segregated by SES factors (Fiscella & Williams, 2009). Disparities in health literacy have also been identified among people with high disease prevalence such as men, Blacks, Hispanics, and elderly individuals (Kutner et al.,2003; U.S. Department of Health and Human Services; Centers for Disease Control and Prevention, 2018). Aside from

Studies have also shown that SES signal changes in access to resources that directly impact inequalities in health literacy, such as having health insurance and primary care physicians (Rikard, Thompson, McKinney, & Beauchamp, 2016). Other research has shown that health outcomes among adolescents are disproportionately worse when adolescents grow in "multi-burden" communities (Patton et al., 2016). This study also indicates that poor health

outcomes among adolescents and young adults may stem from the lack of social policy addressing disparities for the vulnerable population (Patton et al., 2016).

Literature has suggested that disparities in health literacy should be studied in the social context (Rikard et al., 2016). Although spatial analyses of health literacy among the U.S. population were conducted for adults, there is a lack of research that analyzes these disparities for adolescents at the national level (Fiscella & Williams, 2009; Cheng, Dreyer, & Jenkins, 2009). The Institute of Medicine has emphasized the need to address health disparities and increase health literacy among young populations (Institute of Medicine et al.; 2004; Cheng, Dreyer, & Jenkins, 2009; Rikard et al.,2016). This study provides a descriptive analysis of adolescent health literacy at the national level. Primarily, we aim to address geographical disparities of health literacy among adolescents.

Methods

Conceptual Framework and Study Design

This study utilized theoretical constructs from the social-ecological model (SEM) to assess health disparities among adolescents. SEM emphasizes the environmental influences of health and geographic variations (Reifsnider, Gallagher, & Forgione, 2005). Specifically, constructs of the individual (micro-level), interpersonal (meso-level), and community (macro-level) factors were used to explore geographical disparities of health disparity among adolescents as shown in **Figure 3**. Individual factors such as race, sex, and insurance status are the factors that influence behavior knowledge, beliefs and personality, and impact health literacy (Janz & Becker, 1984; Martin et al.,2009). Research has utilized individual factors among adults as determinants of health literacy, concluding significant differences in health literacy attainment based upon these factors (Sun et al., 2013). Studies have assessed interpersonal factors such as

household dynamics and parent health literacy with adolescent health literacy (Chisolm et al.,2015). Community and environmental factors have been used to evaluate disparities in various populations, including adolescents for sexually transmitted diseases, and health-protecting factors (Reifsnider et al., 2005).

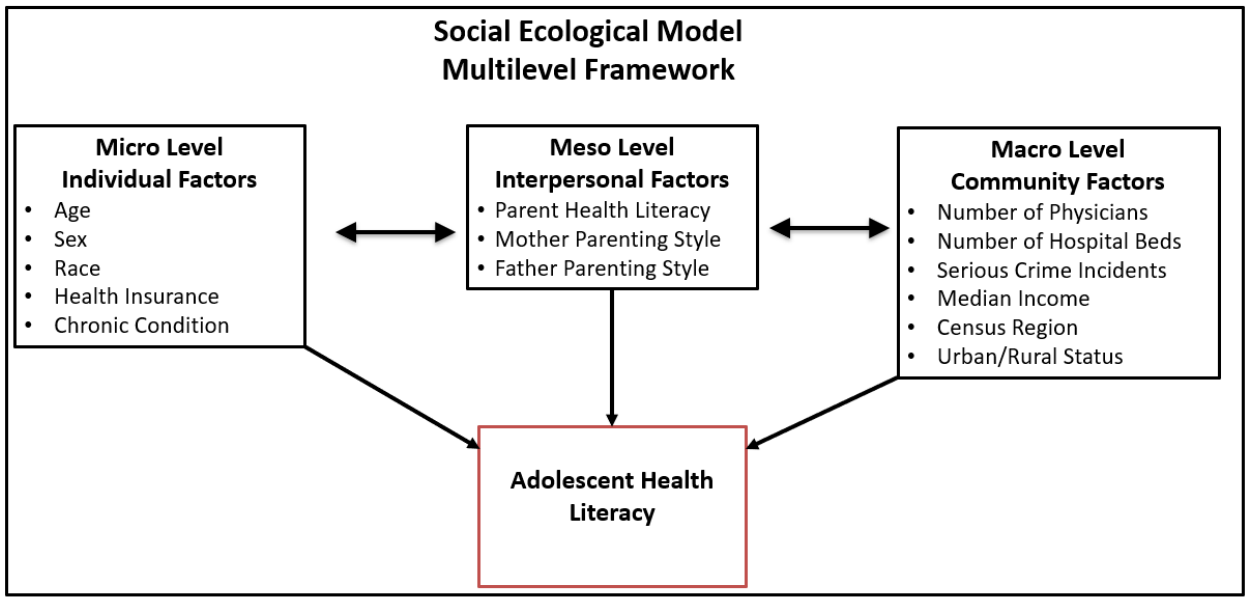


Figure 3 Multilevel Conceptual Framework for Adolescent Health Literacy

Data and Study Sample

This study used data from the National Longitudinal Survey of Youth 1997 (NLSY97), which includes a nationally representative sample (n=8,984) of adolescents aged 12–18 years (including an oversampling of Black and Hispanic or Latino respondents to meet sufficient numbers for statistical analysis) living in the United States (U.S. Department of Labor, 2006). The survey followed adolescents from 1997 to 2017, for a total of 17 rounds of sampling. It collected self-reported information on employment, education, family and family processes, health, and crime. Additionally, the NLSY97 geocode data of youth's state, city, and county were collected from the Bureau of Labor and Statistics and merged with the NLSY97 original

dataset (United States Department of Labor, 2006). The NLSY97 geocode is a subset of the NLSY97 dataset (United States Department of Labor, 2006). It included geographic information for each respondent, such as city, state, county, zip code, and recognizable Federal Information Processing Standards (FIPS) codes. The NLSY97 geocode data is matched to the County and City Databook (CCDB) (Bureau, November 2001). The CCDB is a segment of data from the U.S. Census Bureau that includes county-level geographical data by population such as poverty-level status, health care resources (number of physicians, hospital beds, and hospitals, etc.), and crime severity. Data from the CCDB is categorized by 100,000 population for each year.

A computer-assisted personal interview instrument and electronic questionnaire were used at each sampling round (National Longitudinal Surveys, 2019). For more information about the screening process and sample design, see the National Longitudinal Surveys website (https://www.nlsinfo.org). Adolescents who answered disease knowledge questions at baseline (1997) were selected for the study sample (n=1,585), as this study utilizes disease knowledge as a proxy for health literacy. Research has supported health knowledge and disease knowledge as functions of critical health literacy (Institute of Medicine et al.,2004; Hernandez et al.,2009).

Dependent Variable

Health literacy, as defined by disease knowledge questions (Massey et al., 2013; Okan et al., 2018), was the primary outcome for this study. This variable was coded as high if a composite score was four or higher and low if the composite score was less than four, as high health literacy was the reference category. This coding follows a research study that analyzed health knowledge with disease knowledge variables (Altnidag et al., 2011). The disease knowledge questions included: 1) “Does smoking one or more packs of cigarettes per day increase the risk (chance) of getting heart disease?” 2) “Does having 5 or more drinks of alcohol

once or twice each week increase the risk (chance) of damaging the liver?" 3) "Does having 5 or more drinks once or twice each week increase the risk (chance) of getting heart disease?" 4) "Does having 5 or more drinks once or twice each week increase the risk (chance) of getting arthritis?" and 5) "Does having 5 or more drinks once or twice each week increase the risk (chance) of becoming addicted to alcohol?" The response items for each of these questions are yes or no. These variables were selected as a proxy measure for health literacy based on previous research on adolescent health knowledge using data from the NLSY97 cohort (Altindag et al., 2011). We conducted an additional confirmatory factor analysis of the selected questions to verify the reliability of the health literacy measure. There was an acceptable level of composite reliability (0.69), which further verified the health literacy measure (Zhang & Yuan, 2016).

Independent Variables

Micro-Level

Micro-level variables were all categorical variables with original coding from the NLSY97 dataset. Variables included were age (13-15), sex (male vs. female), race/ethnicity (non-Black Hispanic, Black, Hispanic, mixed-race Non-Hispanic), and chronic condition status (yes vs. no). Health insurance status (covered vs. not covered) was also included at the micro-level as reported by the adolescents and verified by the parents.

Meso-Level

Meso-level variables (or interpersonal factors) included parental health literacy, a variable generated by the parent's response to the same health knowledge questions asked of adolescents in the study (composite reliability: 0.72). This variable was coded as high if a composite score was four or higher and low if the composite score was less than four. Mother

and father parenting styles (uninvolved, permissive, authoritarian, and authoritative) were also included as meso-level variables.

Macro-Level

Macro-level variables, obtained from the NLSY97 geocode data, including the number of physicians, the number of hospitals available, population median income levels, and the number of serious crime incidents. These variables were matched from the CCDB and were representative per 100,000 population. The number of physicians and hospital beds was categorized as less than 200, 200 - 299, 300 - 399, 400 - 499, 500 - 599, and greater than or equal to 600. The categories were coded based upon the averages for each variable during that year. The average number of both physicians and hospitals per 100,000 people was between 280 and 300 in 1997 (Salsberg, 2002). Median income levels were categorized into quintiles from less than $20K to greater than $60K. The average median income was around $37K, and the federal poverty level during this time frame was less than $30K (United States Census Bureau,1998). The number of serious crimes was categorized as less than 3,000, 3,000 – 5,999, 6,000 – 8,999, and greater than or equal to 9,000. Statistics showed that the national average number of serious crimes was around 4,300 during the year of 1997 (United States Crime Rates 1960-2018, 2019). Other macro-level variables included U.S. census regions (Northeast, Northcentral, South, and West) and urban/rural status (urban, rural, and suburban).

Analytical Approach

Descriptive statistics were conducted on the study sample to outline adolescent health literacy. A bivariate analysis with chi square was conducted with each level of variables, as outlines from the SEM. Chi Square was utilized to assess significant associations with health literacy and geographic variables. Multilevel logistic regression analysis was conducted for each

level of variables (micro, meso, macro) to assess the relationship with these variables and associations with low health literacy. The micro level logistic regression model was performed first, as the parent model. The meso and macro logistic regression models builds upon the previous model. All analysis was conducted in SAS 9.4 (SAS Institute Inc., 2011)

Results

Table 5 shows the demographic characteristics of the study population. In 1997, the majority of the adolescents were between ages 13 and 14 (99.0%), Non-Black Non-Hispanic (70.0%), male (51.0%), had health insurance (79.4%) and had parents with high health literacy (56.7%). Most of the sample had mothers with either permissive or authoritative parenting styles (71.6%). At the county level, the study population had less than 200 available physicians (54.8%), median income between $30K and $40K (52.1%) and had less than 6000 incidents of serious crime per 100,000 people (77.7%). The study population resides mostly in southern or western census regions (54.6%) and urban areas (70.8%).

Table 5.

Demographic Statistics of Study Sample Characteristics 1997 (N= 1,575).

Variables	n (Weighted %)
Micro Level	
Age	
13	1077 (67.9)
14	482 (31.1)
15	16 (1.0)
Sex	
Female	753 (49.1)
Male	822 (51.0)
Race/ Ethnicity	
Non-Black Non-Hispanic	836 (70.0)
Black	404 (16.1)
Hispanic	322 (12.8)
Mixed Race Non-Hispanic	18 (1.1)
Health Insurance Status	

Variables	n (Weighted %)
Covered	1208 (79.4)
Not Covered	367 (20.6)
Chronic Condition	
Yes	164 (10.4)
No	1236 (78.9)
Missing	175 (10.6)
Meso Level	
Parent Health Literacy	
High	894 (56.7)
Low	350 (23.6)
Missing	331 (19.7)
Mother Parenting Style	
Uninvolved	164 (10.3)
Permissive	461(31.4)
Authoritarian	229 (14.14)
Authoritative	658 (40.2)
Missing	63 (3.4)
Father Parenting Style	
Uninvolved	140 (8.9)
Permissive	292 (20.3)
Authoritarian	261 (17.0)
Authoritative	477 (31.4)
Missing	405 (22.3)
Macro Level	
Physicians*	
Less than 200	801 (54.8)
200-299	517 (29.5)
300-399	137 (9.0)
400-499	62(3.2)
500-599	20 (1.2)
≥600	38 (3.3)
Hospital Beds*	
Less than 200	258(18.6)
200-299	407 (27.7)
300-399	278 (16.3)
400-499	307 (17.8)
500-599	124 (7.6)
≥600	192 (11.7)
Missing	9 (0.75)
Serious Crime *	
Less than 3000	294 (41.2)
3,000-5,999	516 (35.6)

Variables	n (Weighted %)
6,000-8,999	544 (31.2)
≥9,000	221 (11.3)
Median Income*	
Less than 20,000	58 (2.6)
$20,000-29,999	330 (20.4)
$30,000-39,999	816 (52.12)
$40,000-49,999	232 (15.3)
$50,000-59,999	114 (7.7)
≥$60,000	25 (1.8)
Census Region	
Northeast	275 (18.1)
Northcentral	374 (27.4)
South	586 (34.1)
West	340 (20.5)
Urban /Rural	
Urban	1170 (70.8)
Rural	348 (25.6)
Suburban/other	57 (3.6)

[1] Study characteristics in 1997 at the county level.
*Population variable representing per 100,000 populations at the county level, based on the City and County Databook 1994.

Table 6 shows the bivariate analysis of associations between multilevel factors and adolescent health literacy at baseline (1997). At the micro-level, none of the factors showed initial significance; however, insurance status was approaching significance (P=.09). At the meso-level parental health, literacy was associated with adolescent health literacy. The majority of adolescents with high health literacy had parents with high health literacy (58.4%, p<.001). At the macro level, the number of physicians available per 100,000 people was borderline significant (p= 0.06).

Table 6.

Bivariate Analysis of Health Literacy and Geographic Characteristics (N=885)

	High Health Literacy	Low Health Literacy	P-Value
Micro Level			
Age			0.63
13	911 (68.0)	166 (67.4)	
14	410 (31.1)	72 (30.9)	

	High Health Literacy	Low Health Literacy	P-Value
15	12 (0.89)	4 (1.7)	
Sex			0.52
Female	644 (49.5)	109 (47.0)	
Male	689 (50.5)	133 (53.0	
Race/ Ethnicity			0.15
Non-Black Non-Hispanic	727 (71.1)	109 (63.3)	
Black	335 (15.6)	69 (19.1)	
Hispanic	260 (12.2)	62 (16.3)	
Mixed Race Non-Hispanic	11 (1.1)	2 (1.2)	
Health Insurance Status			0.09
Covered	1036 (80.2)	172 (74.8)	
Not Covered	297 (19.8)	70 (25.2)	
Chronic Condition			0.91
Yes	141 (10.5)	23 (10.3)	
No	1043 (79.0)	190 (78.2)	
Missing	146 (10.5)	29 (11.6)	
Meso Level			
Parent Health Literacy			<.001
High	775 (58.4)	119 (46.4)	
Low	284 (22.5)	66 (30.7)	
Missing	274 (19.2)	57 (22.9)	
Mother Parenting Style			0.12
Uninvolved	135 (10.1)	29 (11.0)	
Permissive	402 (32.3)	59 (26.2)	
Authoritarian	180 (13.2)	49 (20.0)	
Authoritative	564 (40.5)	94 (38.6)	
Missing	52 (3.9)	11 (4.4)	
Father Parenting Style			0.79
Uninvolved	113 (8.7)	27 (10.2)	
Permissive	248 (20.4)	44 (20.0)	
Authoritarian	225 (17.3)	36 (15.3)	
Authoritative	411 (31.7)	66 (29.9)	
Missing	336 (22.0)	69 (24.8)	
Macro Level			
Physicians*			0.06
Less than 200	688 (55.5)	113 (51.0)	
200-299	423 (28.2)	94 (36.9)	
300-399	120 (9.3)	17 (6.7)	
400-499	52 (3.4)	10 (2.4)	
500-599			
≤600	50 (3.6)	8 (3.0)	
Hospital Beds*			0.93
Less than 200	55 (4.5)	11 (4.4)	
200-299	162 (13.8)	30 (13.4)	

	High Health Literacy	Low Health Literacy	P-Value
300-399	352 (28.2)	55 (25.2)	
400-499	229 (15.9)	49 (18.6)	
500-599	260 (17.7)	47 (18.3)	
≤600	275 (19.9)	50 (20.3)	
Serious Crime*			0.52
< 3000	487 (41.0)	98 (45.3)	
3,000 -5,999	515 (38.4)	90 (34.9)	
6,000-8,999	269 (16.5)	44 (15.4)	
≥9,000	62 (4.1)	10(4.3)	
Median Income*			0.33
<20,000	50 (2.7)	8 (2.3)	
$20,000 -29,999	280 (20.5)	50 (20.1)	
$30,000 -39,999	686 (51.4)	130 (56.7)	
$40,000 -49,999	38 (14.9)	194 (15.4)	
$50,000 -59,999	100 (8.1)	14 (5.2)	
≥ $60,000	23 (2.0)	2 (0.8)	
Census Region*			0.87
Northeast	229 (18.0)	46 (18.63)	
Northcentral	318 (27.0)	56 (29.3)	
South	500 (34.5)	86 (31.8)	
West	286 (20.5)	54 (20.3)	
Urban/ Rural*			0.12
Urban	981 (70.1)	189 (74.9)	
Rural	300 (26.0)	48 (23.3)	
Suburban/other	52 (3.9)	5 (1.8)	

*Population variable representing per 100,000 population at the county level, based on the City and County Databook 1994.

Table 7 shows the factors related to low health literacy among adolescents at micro, meso, and macro levels. In Model 1 (micro-level only including individual and interpersonal level factors), adolescents without health insurance were more likely to have low health literacy compared to adolescents with health insurance (aOR=1.85; p=0.038). In Model 2 (meso-level including both individual and interpersonal level factors), associations with low adolescent health literacy were seen with parental health literacy, and an adolescent's mother's parenting style when adjusted for sex, race and ethnicity, health insurance status, chronic condition, and parenting styles. Adolescents who had parents with low health literacy were more likely to have

low health literacy (aOR = 1.78, p = 0.002). Additionally, adolescents with mothers or maternal guardians who exercised authoritarian parenting styles were more likely to have low health literacy (aOR = 1.64, p = 0.03). In Model 3 (macro-level including individual, interpersonal, and community factors), parental health literacy, the number of available physicians, and urban/ rural status were associated with low adolescent health literacy. Adolescents that resided in areas with less than 300 physicians were more likely to have low health literacy (aOR 1.58, p = 0.04). Adolescents who lived in suburban areas were less likely to have low health literacy compared to those that lived in urban areas (aOR 0.34, p = 0.04).

Table 7.

Multilevel Logistic Regression with Adjusted Odds of Adolescent Spatial Disparities and Low Health Literacy (Vs. High Health Literacy; N=585)[1]

	Model 1		Model 2		Model 3	
	N = 1400	P - Value	N = 885	P - Value	N = 885	P - Value
Micro Level						
Sex (Ref = Female)						
Male	1.162 (0.766, 1.764)	0.48	1.113 (0.818, 1.514)	0.49	1.132 (0.827, 1.550)	0.44
Race/ Ethnicity (Ref = Non-Hispanic White)						
Non-Hispanic Black	1.190 (0.701, 2.021)	0.52	1.302 (0.904, 1.875)	0.16	1.417 (0.946, 2.123)	0.09
Hispanic	1.109 (0.669, 1.840)	0.69	1.412 (0.961, 2.076)	0.08	1.385 (0.917, 2.094)	0.12
Non-Black Non-Hispanic	0.972 (0.104, 9.114)	0.98	1.338 (0.261, 6.858)	0.73	1.552 (0.273, 8.832)	0.62
Health Insurance (Ref= Covered)						
Not Covered	1.850 (1.039, 3.296)	0.04	1.466 (0.934, 2.301)	0.09	1.556 (0.977, 2.477)	0.06
Chronic Condition (Ref=No)						
Yes	0.909 (0.450, 1.834)	0.79	0.971 (0.580, 1.624)	0.91	1.006 (0.594, 1.705)	0.98
Meso Level						
Parent Health Literacy (Ref = High)						
Low			1.781 (1.240, 2.557)	0.002	1.822 (1.261, 2.633)	0.001
Mother Parenting Style (Ref = Authoritative)						
Uninvolved			1.096 (0.642, 1.872)	0.74	1.166 (0.676, 2.008)	0.58
Permissive			0.813 (0.532, 1.243)	0.34	0.820 (0.531, 1.267)	0.37
Authoritarian			1.636 (1.054, 2.540)	0.03	1.626 (1.036, 2.552)	0.03
Father Parenting Style (Ref = Authoritative)						
Uninvolved			1.125 (0.636, 1.991)	0.69	1.117 (0.621, 2.008)	0.71
Permissive			1.163 (0.712, 1.900)	0.55	1.187 (0.718, 1.960)	0.50
Authoritarian			0.782 (0.473, 1.293)	0.34	0.739 (0.437, 1.251)	0.26
Macro Level						
Physicians (Ref $\leq$ 200)*						
200 - 299					1.576 (1.020, 2.436)	0.04
300 - 399					0.849 (0.417, 1.728)	0.65
400 - 499					0.829 (0.336, 2.044)	0.68

500 - 599			0.818 (0.120, 5.579)	0.84
≥600			1.028 (0.333, 3.179)	0.96
Hospital Beds (Ref ≤ 200)*				
200 - 299			0.845 0.496, 1.439)	0.54
300 - 399			0.894 (0.490, 1.628)	0.71
400 - 499			0.812 (0.440, 1.500)	0.51
500 - 599			1.022 (0.464, 2.254)	0.96
≥600			0.939 (0.485, 1.816)	0.85
Serious Crime (Less than 3000)*				
3,000 - 5,999			0.849 (0.531, 1.357)	0.49
6,000 - 8,999			0.566 (0.316, 1.012)	0.06
≥ 9,000			0.646 (0.325, 1.286)	0.21
Median Income (Ref= < 20,000)*				
$20,000 - 29,999			0.956 (0.351, 2.606)	0.93
$30,000 - 39,999			1.058 (0.393, 2.852)	0.91
$40,000 - 49,999			0.868 (0.285, 2.642)	0.80
$50,000 - 59,999			0.507 (0.138, 1.861)	0.31
≥ $60,000			0.350 (0.047, 2.590)	0.30
Census Region				
Northcentral			1.031 (0.604, 1.760)	0.91
South			0.846 (0.478, 1.496)	0.56
West			0.941 (0.508, 1.744)	0.85
Urban/ Rural				
Rural			0.816 (0.530, 1.258)	0.36
Suburban/Other			0.338 (0.119, 0.960)	0.04
Model R^2	0.006	0.021	0.040	

[1]Each model accounts for the full sample size at that level.

*County-level variables are representing per 100,000 populations based on the City and County Databook 1994

Discussion

To the best of our knowledge, this is the first study to show the national depiction of U.S. adolescent health literacy while assessing its associated geographic disparities (Institute of Medicine et al., 2004; Rikard et al., 2016). There has been a significant research gap in understanding the national level of adolescent health literacy for a comparable assessment with adult health literacy (Rikard et al.,2016).

Health Insurance

Health insurance coverage is vital for access to health information and health literacy among adolescents (Institute of Medicine et al., 2004; Patient Protection and Affordable Care Act, 2010). Research has supported the importance of health insurance, which provides access to care and found that those without health insurance had lower health literacy compared to those with health insurance coverage (Kutner et al., 2006; Levy & Janke, 2016). Research has shown that individuals without health insurance have lower health literacy compared to those with health insurance (Vernon et al., 2007). Chari and colleagues found that among adolescents with at least minimal health insurance coverage (e.g., Medicaid), compared to adolescents without coverage or limited coverage, decreased chances of having low adolescent health literacy (Chari, 2013). As seen in our study, disparities with adolescent health insurance coverage were associated with low health literacy, and the lack of coverage increased the odds of having low health literacy. This finding emphasizes the importance of health insurance for better health literacy. It also supports initiatives from the Affordable Care Act (ACA) to increase health literacy by pushing initiatives from Medicaid health insurance enrollment and the Children's Health Insurance Program (CHIP) among youth populations (Sorensen et al., 2012; Parragh et al., 2015).

Parents' Health Literacy and Parenting Styles

In addition to health insurance, parental health literacy is an essential factor in adolescent health literacy (Bröder et al., 2017; Reynolds, Rolnick, & Temple, 2014). As shown at each level in this study, parental health literacy had a significant association with adolescent health literacy. Lower health literacy among parents increased the odds of adolescents having low health literacy. This finding is consistent with other research studies that have found negative associations with low parental health literacy and youth health literacy and their health outcomes (Brega, 2016; Okran et al.,2018; DeWalt et al.,2007). This association is commonly seen because parents are viewed as role models, in which their children often adopt their behaviors and beliefs around health (Okran et al.,2018; Fok & Wong, 2017; Zarcadoolas, Pleasant & Greer; 2003; Manganello,2008). Studies have found that geographic disparities in parent's education and their understanding of health were associated with adolescents being obese, specifically in central and southern states(Singh et al., 2008; Ricketts, 2002) . Ricketts concluded that variations in geographic policies attributed to the disparity in parent education and adolescent health (Ricketts, 2002). As we assessed in our study, adolescents with low health literacy were highly concentrated within the northcentral and southern regions where geographically adolescents' health outcomes have been disproportional to other regions.

Aside from parental health literacy, the correlation between parenting styles and adolescent health literacy, specifically, the mother's parenting style is associated with low health literacy. Authoritarian mothering style significantly increased the odds of low health literacy. This association aligns with research that has shown authoritarian parenting styles to be restrictive of youth performance in school, essentially negatively impacting adolescent literacy levels (Chen et al., 1997; Dornbusch et al., 1987). Authoritarian parenting styles are often

restrictive with communication between the youth and parent, with the parent asserting more dominance, which often leads to emotional and health behavioral problems among adolescents (Jabeen, Anis-ulHaque, & Riaz, 2013). This type of relationship signals negative emotional associations with the parent (Bronte-Tinkew et al.,2006), and leads to social and academic problems (Fabes, Eisenberg, & Miller, 1990; Jabeen, Anis-ulHaque, & Riaz, 2013).

On the other hand, authoritative parenting styles allow more open lines of communication and enable adolescents to have a sense of autonomy. Research has suggested that autonomy is needed for positive adolescent development and regulation (Jabeen, Anis-ulHaque,& Riaz, 2013). Authoritative parenting styles are more conducive to positive learning (Bingham et al., 2017). Bingham and colleagues found that authoritative parenting practices more literacy skills with children at home compared to other parenting styles. Research has shown that adolescents with authoritarian parenting styles maintained better adherence to diabetes care compared to those with authoritarian parenting styles (Radcliff et al., 2017).

Physician Access

Another finding from this study is the association of physician availability with low health literacy. Physician availability is crucial for health information attainment, and limited access or effective use of the health care system is associated with low health literacy (Safeer and Keenan, 2005; U.S. National Network of Libraries of Medicine). Furthermore, research has discussed parents as gatekeepers in part with adolescent health literacy, as they are seen as the primary person responsible for health information practices, such as making sure adolescents attend regular health appointments (Massey, Prelip, Calimlim, Quiter, & Glik, 2012). The number of physicians available within a population could impact parents' ability to schedule adolescents for regular check-ups of routine preventive appointments (Zerehi, 2008). The

geographic disproportion of available physicians must be addressed as potential barrier for diminishing low adolescent health literacy, as physicians provide access to health information (IOM, 2004).

Suburban Regions

Regional placement is a factor of quality of life and adolescent health literacy (Ran et al., 2018). Chinese adolescents living in rural areas were found to have a lower quality of life and lower health literacy compared to adolescents living in urban regions (Ran et al., 2018). As seen in our study, living in suburban areas decreased odds of having low health literacy. Research has shown that individuals living in suburban areas have higher access to physicians, which is a factor for high health literacy, compared to those in rural areas (Adams, 2011). Research has found that individuals living in suburban areas, compared to those living in urban or rural areas, report having fewer issues with access to good doctors, hospitals, and community care (PEW, 2018). Regional placement impacts access to these resources, and potentially the quality of these resources (Ricketts, 2002). Expanding resources to those in rural areas could decrease health access disparities and increase the chances of high health literacy (Ricketts, 2002). Moreover, initiatives providing incentives for useful resources, such as quality doctors and health care services, to be positioned in rural areas could potentially diminish this disparity among adolescents.

Limitations

This study has limitations. We were unable to account for spatial disparities at the zip code level. The geocoded data that was provided by the Census Bureau of Statistics only consisted of protected respondents' information up to the county level. Despite being unable to assess for spatial disparities, this study still provides insight into geographical disparities

associated with low health literacy. We also were not able to evaluate the full scope of disparities in access to health information, which could be substantiated by transportation availability in the region, as an example. However, access to health information was still assessed with health insurance and the number of physicians. These variables were utilized for evaluating access in other studies (National Collaborating Centre for Aboriginal Health, (NCCAH, 2011; Parragh et al., 2015). This study is also limited in its ability to utilize updated health literacy measures that have been validated. Data collection from this study was conducted before the release of validated health measures for teenagers. Despite this limitation, we utilized a reliable health literacy measure, based upon health knowledge variables that were provided and psychometric validation of the measure. Additionally, research supports disease and health knowledge as a measure of health literacy (Broder et al., 2017; Okan et al., 2018; Institute of Medicine et al., 2004; Taggart et al., 2012; Hernandez et al., 2009).

Policy Implications

Health literacy is one of the determinants of health, and disparities in health literacy and health literacy promoting factors dis-proportionally pose challenges for adolescents navigating the health system and achieving positive health outcomes. This understanding should push policymakers to diminish the health literacy gap among adolescents. Although there are national health education standards, currently there is a lack of national requirements for health literacy education despite the standardized guidelines, which are not mandated (Institute of Medicine et al.,2004; American Alliance for Health; Standards, Joint Committee on National Health, 1995; American Cancer Society, 2007; Taggart et al.,2012; Winkleman et al., 2016; CDC, 2019). Policy mandating a federal curriculum requirement for health literacy education across all states and regions within the U.S. could be an integral step towards decreasing the health literacy gap.

Research has supported unified health educational curriculum in secondary schools to increase health literacy (Winkleman et al., 2016). This approach has been utilized in Australia and individual U.S. high schools in states of Delaware, Wisconsin, Illinois, and Texas, where health literacy was significantly improved among adolescents (Australian Curriculum; Wilson, 2018). Despite other geographic factors that are associated with health literacy, a national health education standard within the educational curriculum would, at minimum, expose all adolescents to adequate health information for higher chances of achieving high or adequate health literacy.

Conclusions

Geographic disparities of socioeconomic factors are considered essential for improving health literacy. Cultural and geographic disparities should be addressed, as these disparities pose barriers to educational attainment that is necessary for adequate health literacy (National Collaborating Centre for Aboriginal Health, 2011; Eberhardt,2001). Geographic issues should continue to be addressed to support efforts in making the U.S. a health literate nation, as adolescents age into health-literate adults. As seen in other countries (e.g., Canada and Australia), low health literacy was shown among adolescents with low familial resource environments, parents with low health literacy, and individuals with weak family relationships (Mantwill, Monestel-Umana, & Schultz, 2015;). Just as efforts have been made to increase health literacy among adults, close attention to environmental factors should be fortified to decrease the chances of low health literacy for adolescents and improve their health outcomes (Broder et al., 2017). Future research could continue monitoring national adolescent health literacy and reducing geographic disparities while utilizing one of the validated health literacy tools such as rapid estimate for literacy in medicine (REALM-teen) (Davis et al., 2006).

CHAPTER IV: ASSOCIATIONS OF ADOLESCENT HEALTH LITERACY AND PREVENTIVE SERVICE USE BEHAVIORS IN YOUNG ADULTHOOD

Abstract

Purpose: To understand the significance of health literacy on preventive service use over time and assess changes in health literacy at two time points: adolescence and early young adulthood. To understand how changes in health literacy are associated with changes in preventive service use during young adulthood.

Methods: Data from the National Longitudinal Survey of Youth 1997 cohort was analyzed. This cohort comprised survey data from 962 adolescents who answered health knowledge questions in 1997 and 2002. Changes in health literacy and preventive service use were assessed using multinomial logistic regression analysis. Age, sex, race, health insurance status, body mass index, and cigarette and alcohol use were controlled in the analysis.

Results: Adolescents who increased health literacy during young adulthood were more likely to increase preventive service use (OR=3.14, p=0.038), compared with adolescents who maintained high health literacy and high preventive service use. Adolescents who decreased health literacy during young adulthood were more likely to maintain low preventive service use (OR=2.08, p = 0.051), compared to adolescents who maintained high health literacy and high preventive service use, although the results were less significant.

Conclusions: Adolescent health literacy is important for maintaining positive health behaviors, such as preventive service use. Increasing health literacy during adolescence may promote use of preventive services in young adulthood. Providing health insurance to adolescents and young adults remains an important factor in their preventive service use.

Keywords: adolescents, health literacy, preventive service use, NLSY97

Introduction

Unnecessary health care utilization is a problem in the United States (Broder et al., 2017). Overutilization of health care services for preventable and chronic health issues, such as obesity, cigarette smoking, and tooth decay, could cost over $332 billion annually in health care expenditures (CDC, 2019). Research has shown that low health literacy can lead to chronic disease onset, lack of preventive service use, overutilization of medical services, high medical expenditures, and early mortality (Baker, Parker, Williams, & Clark, 1998; Broder, et al., 2017; Williams, Baker, Parjer, & Nurss, 1988; Howard, Gazmararian, & Parker, 2005). Considering the possible impact of low health literacy and lack of preventive service use, researchers and government have moved toward more initiatives to increase health literacy and preventive service use among the U.S. population (Institue of Medicine; Nielsen-Bohlman Panzer, Kindig, 2004; Marrie, Salter, Tyry, Fox, & Cutter, 2014).

Preventive health services are an important part of the U.S. health care system (Agency for Healthcare Research and Quality; U.S. Department of Health and Human Services, 2019). These services, which include health screenings, routine check-ups, counseling services, and reproductive health services, have been shown to decrease overall health care expenditures (Howard, Gazmararian, & Parker, 2005). The U.S. Affordable Care Act of 2010 highlights the importance of preventive service, mandating that all preventive health services are covered free of charge under insurance plans (Patient Protection and Affordable Care Act, 2010). Since this mandate, studies analyzing preventive service use among youth show improved health behaviors and outcomes (Lebrun-Harris, Canto, & Vodicka, 2019). For example, the U.S. Prevention Service Task Force found that the use of preventive counseling services led to decreased smoking behaviors among adolescents (Moyer, 2013).

Studies have shown that effective use of preventive health services among adolescents improves health behaviors in the short term (Harris, et al., 2017). Baseline health literacy analyses show positive associations between high health literacy and preventive service use and increased positive health behaviors (Kaplan, Calonge, Gunusery, & Hanrahan, 1988; Braun & Provost, 2010). Harris et al. (2017) assessed preventive service use among adolescents at the national level and identified gaps in preventive service use over the long term. Other research has identified gaps in health literacy over time (Patton, et al., 2016; Lau, Adams, Irwin, & Ozer, 2012). Still, the long-term outcomes of these associations remain unclear. Therefore, we aim to address this gap by assessing health literacy and preventive service use behaviors at two time points: adolescence and young adulthood. In doing so, we provide data on changes in health literacy and preventive service use behaviors.

Methods

Conceptual Framework and Study Design

This study was guided by theoretical constructs from Anderson's (1995) Model of Health Care Utilization and the Health Belief Model, which explains health care utilization using personal and environmental predictive factors (predisposing factors, enabling factors, and need factors). The Health Belief Model explains the likelihood that an individual to participate in health behaviors or to take specific health initiatives, promoted by perfectionism beliefs around health and severity of health (Janz & Becker, 1984). In this study, the constructs of perceived severity, and perceived susceptibility form the conceptual framework that guides variable selection for this analysis, as shown in **Figure 4**.

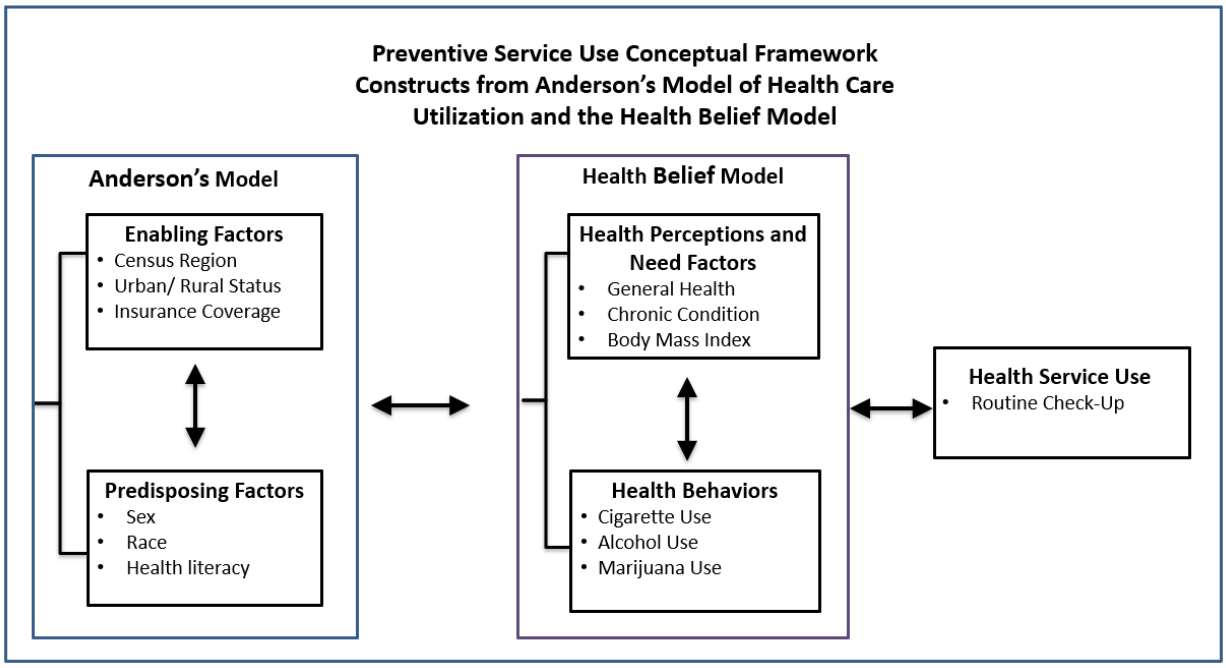


Figure 4 Adolescent Health Service Use Conceptual Framework

Data and Study Sample from the National Longitudinal Survey of Youth 1997

This study used data from the National Longitudinal Survey of Youth 1997 (NLSY97), which includes a nationally representative sample (n=8,984) of adolescents aged 12–18 years (including an oversampling of Black and Hispanic or Latino respondents to meet sufficient numbers for statistical analysis) living in the United States (U.S. Department of Labor, 2006). The survey followed adolescents from 1997 to 2017, for a total of 17 rounds of sampling. It includes self-reported information on employment, education, family and family processes, health, and crime. A computer-assisted personal interview instrument and electronic questionnaire were used at each sampling round (National Longitudinal Surveys, 2019). For more information about the screening process and sample design, see the National Longitudinal Surveys website (https://www.nlsinfo.org). Adolescents who answered preventive service use questions in 2002, 2007, and 2011 and disease knowledge questions in 1997 (baseline) and 2002 were selected for the study sample (n=962).

Measures

Dependent Variable

Preventive service use was measured using adolescents' responses to having a routine checkup. This categorical variable had a binary response (high or low) and was measured in 2002, 2007, and 2011. Respondents who had a routine check-up within the past year were coded as “high preventive service” and “low preventive service” otherwise.

Independent Variables

The main independent variable was health literacy (high or low), as defined by disease knowledge questions. A composite score of four or higher was coded as “high,” and a composite score or four or lower was coded as “low.” The disease knowledge questions were as follows: 1) “Does smoking one or more packs of cigarettes per day increase the risk (chance) of getting heart disease?” 2) “Does having 5 or more drinks of alcohol once or twice each week increase the risk (chance) of damaging the liver?” 3) “Does having 5 or more drinks once or twice each week increase the risk (chance) of getting heart disease?” 4) “Does having 5 or more drinks once or twice each week increase the risk (chance) of getting arthritis?” and 5) “Does having 5 or more drinks once or twice each week increase the risk (chance) of becoming addicted to alcohol?” These questions were selected to proxy for health literacy based on previous research on adolescent health knowledge using data from the NLSY97 cohort (Altindag et al., 2011). We also conducted an additional confirmatory factor analysis of the selected questions to verify the reliability of the health literacy measure, and a composite reliability of 0.69 further verified the health literacy measure (Zhang & Yuan, 2016).

Predisposing and Enabling Factors

The predisposing factors included sex (male or female) and race (White, Black, American Indian, Asian, or Pacific Islander and other). The enabling factors included insurance status (yes or no), census region (Northeast, Northcentral, South, or West), and urban-rural status (urban, rural, or suburban/other).

Need Factors, Health Perceptions, and Health Behaviors

The need factors included presence of chronic disease (yes or no) and baseline BMI (underweight, normal, overweight, or obese). BMI was created from height (cm) and weight (lbs.) variables and categorized according to Centers for Disease Control and Prevention (2017) thresholds. Health perception and perceived need variables included general health self-perception (excellent, very good, good, fair, or poor) and presence of chronic disease (yes or no). Health behavior variables included alcohol use (yes or no), smoking use (yes or no), and number of days of exercise for at least 30 minutes based on Surgeon General guidelines (Centers for Disease Control and Prevention, 1996). All indicator variables, except for chronic disease status, were self-reported. Chronic disease status was reported by the parent or guardian.

Analysis

Descriptive statistics of the study sample were conducted in SAS 9.4 (SAS Institute Inc., 2011). Baseline characteristics, along with survey data from years 2002, 2007, and 2011, were included in the analysis. Bivariate analysis was used to assess associations between preventive service use and covariates. The preliminary bivariate analysis used a chi square test to analyze baseline health literacy and preventive service use in 2002, 2007, and 2011 and assessed associations between health literacy and preventive service use. The chi square analysis showed associations between baseline health literacy and preventive service use in 2007. To further

understand this association, changes in health literacy from 1997 to 2002 were assessed, along with changes in preventive service use and covariates of health insurance status, alcohol and cigarette use, and BMI from 2002 to 2007 or from 2002 to 2011. The last-observation-carried-forward method was utilized to retain the sample size. A multinomial logistic regression analysis was conducted to assess associations between changes in adolescent health literacy and changes in preventive service use. The change in preventive service use was regressed with the changes in adolescent health literacy. The analysis controlled for sex and race and for changes in health insurance status, cigarette use, alcohol use, and BMI.

Results

Table 8 shows the demographic characteristics of the study population in 1997, 2002, 2007, and 2011. At baseline in 1997 (n=962), most were 13–14 years old (99.8%), White (73.9%), male (51.4%), and insured (89.9%). Most reported high health literacy (78.4%) and no use of cigarettes (65.3%), marijuana (87.6%), or alcohol (66.0%). At the first follow-up in 2002, the study sample (n=878) had mostly high health literacy (84.0%) and many reported using alcohol (69.1%) and having a routine check-up in the previous year (61.0%). In 2007, the most prevalent use of substances was alcohol (79.9%), and nearly half (45.0%) had used cigarettes; more than half (51.8%) reported using preventive services. In 2011, most respondents (81.7%) reported using alcohol, and most (61.2%) did not use cigarettes.

Table 8.

Demographic Characteristics from Adolescence to Young Adulthood (1997–2011)[1]

	1997 n =962	2002 n=878	2007 n= 726	2007 n=670
		N (Weighted %)		
Age				
13	663 (68.9)	611 (68.5)	502 (68.3)	466 (68.7)
14	297 (30.9)	267 (40.5)	224 (31.7)	204 (31.3)

	1997 n =962	2002 n=878	2007 n= 726	2007 n=670
		N (Weighted %)		
15	2 (0.2)	0 (0.0)	0 (0.0)	0 (0)
Race				
White	591 (73.9)	545 (74.0)	451 (73.6)	407 (73.3)
Black	240 (14.3)	217 (14.9)	182 (15.1)	175 (15.3)
American Indian	9 (1.2)	9 (1.31)	8 (1.4)	7 (1.4)
Asian or Pacific Islander	13 (1.8)	12 (1.8)	11 (1.9)	10 (1.9)
Other	109 (3.2)	95 (7.9)	74 (7.9)	71 (8.1)
Sex				
Male	506 (51.4)	457 (51.7)	361 (51.6)	327 (51.5)
Female	456 (48.6)	421 (48.2)	365 (48.4)	343 (48.7)
Health Insurance				
No	119 (10.1)	231 (24.7)	227 (29.6)	202 (28.7)
Yes	843 (89.9)	643 (74.9)	497 (70.4)	468 (71.3)
Missing	0 (0.)	4 (0.45)	2 (0.23)	
US Census Region				
Northeast	174 (18.6)	159 (18.6)	121 (17.0)	109 (16.5)
Northcentral	241 (28.4)	211 (27.4)	170 (26.9)	156 (27.3)
South	338 (32.7)	317 (33.8)	271 (35.1)	256 (36.1)
West	209 (20.4)	186 (19.5)	158 (20.4)	139 (20.1)
Missing		5 (0.73)	6 (0.74)	10 (1.4)
Urban/ Rural Status				
Rural	227 (27.2)	207 (27.3)	150 (22.0)	132 (21.5)
Urban	703 (69.5)	637 (68.7)	538 (72.9)	523 (76.4)
Suburban/Other	32 (3.3)	28 (3.2)	31 (4.9)	15 (0.61)
Missing	0 (0)	6 (0.85)	7 (0.91	11 (1.5)
Chronic Condition[2]				
No	853 (88.5)	776 (88.4)	576 (79.7)	--
Yes	109 (11.5)	106 (11.6)	66 (8.5)	--
Missing	0 (0)	0 (0)	84 (11.4)	--
General Health				
Excellent	370 (39.1)	289 (32.5)	204 (29.2)	148 (23.9)
Very Good	346 (36.4)	303 (36.3)	246 (34.9)	235 (35.6)
Good	207 (20.7)	229 (25.4)	203 (27.0)	194 (27.6)
Fair or Poor	39 (3.8)	57 (5.8)	73 (8.8)	93 (12.8)
Youth BMI[4]				
Underweight	478 (49.3)	100 (11.2)	37 (4.9)	42 (5.7)
Normal	65 (7.0)	465 (54.9)	285 (41.5)	227 (36.4)
Overweight	50 (5.2)	199 (21.9)	220 (30.7)	204 (30.5)
Obese	379 (38.5)	114 (11.9)	184 (22.9)	197 (27.4)
Cigarette Use				

	1997 n =962	2002 n=878	2007 n= 726	2007 n=670
		N (Weighted %)		
No	651 (65.3)	506 (54.3)	420 (54.8)	431 (61.2)
Yes	311 (34.7)	372 (45.7)	304 (45.1)	232 (38.1)
Missing		0 (0.0)	2 (0.17)	7 (0.7)
Marijuana Use				
No	846 (87.6)	0 (0)	573 (78.4)	546 (78.7
Yes	116 (12.4)	0 (0)	139 (21.6)	124 (20.1)
Missing	0 (0)		12 (0.02)	10 (1.15)
Alcohol Use				
No	645 (66.0)	307 (30.8)	165 (19.0)	138 (17.1)
Yes	317 (34.0)	570 (69.1)	561 (79.9)	519 (81.7)
Missing		1 (0.13)	12 (1.46)	13 (1.04)
Health Literacy[3]				
High	742 (78.4)	739 (84.0)	--	--
Low	220 (21.6)	139 (16.0)	--	--
Routine Check-Up				
Yes	--	547 (61.0)	364 (51.8)	355 (49.9)
No	--	328 (39.0)	361 (48.1)	315 (50.0)
Missing	--	3 (0.34)	1 (0.18)	0 (0.0)

[1]Each year sample size is indicative of respondents remaining from baseline.
[2]Chronic condition was only assessed every five years in the study and then every 2 years.
[3]Health literacy was assessed only om 1997 and 2002.
[4]Body Mass Index

Table 9 shows the bivariate analysis of association changes in adolescents' health literacy and preventive service use from 2002–2011. Four groups of health literacy and preventive service use were assessed. The four groups consisted of those that maintained low, increased, decreased, and maintained high health literacy. The bivariate analysis revealed significant associations with changes in health insurance status and preventive service use (P<.001). Of those who maintained high preventive service use (n=172), most (72.4%) had health insurance coverage. Changes in adolescent cigarette use through young adulthood also showed a significant association with changes in young adult preventive service use. Of those who maintained preventive service use(N=172), most (52.5%) continued non-usage of cigarettes. Unadjusted changes in health literacy were not associated with changes in preventive service use.

Table 9.
Bivariate Analysis of Changes in Adolescent Health Literacy and Young Adult Covariates with Changes in Young Adult Preventive Service Use (2002–2011)

	Maintained High n=172	Increased* n=110	Decreased** n=174	Maintained Low n= 98	P - Value
Health Insurance					<.001
Maintained High Coverage	121 (72.4)	63 (61.1)	80 (49.0)	34 (38.8)	
Increased Coverage	23 (12.1)	32 (26.4)	16 (8.3)	17 (17.0)	
Decreased Coverage	21 (11.6)	10 (8.0)	57 (31.4)	26 (27.8)	
Maintained Low	7 (3.9)	5 (4.5)	21 (11.4)	21 (16.4)	
Cigarette Use					0.03
Maintained Non-Usage	98 (52.5)	55 (50.2)	93 (49.4)	31 (30.7)	
Increased Usage*	13 (5.8)	7 (3.3)	16 (9.2)	7 (7.1)	
Decreased Usage**	22 (12.9)	17 (13.5)	20 (11.8)	22 (21.7)	
Maintained Usage	39 (28.8)	31 (33.0)	45 (30.0)	38 (40.6)	
Alcohol Use					0.44
Maintained Non-Usage	27 (10.9)	10 (7.3)	22 (10.4)	10 (7.3)	
Increased Usage*	51 (28.3)	23 (19.9)	39 (20.0)	20 (22.0)	
Decreased Usage**	10 (4.2)	9 (6.8)	13 (8.6)	13 (10.4)	
Maintained Usage	84 (56.6)	38 (66.0)	100 (60.9)	55 (60.4)	
BMI Category					0.64
Under Recommendations	6 (4.0)	6 (5.4)	12 (5.2)	6 (5.3)	
Over Recommendation	100 (52.3)	68 (61.2)	99 (56.8)	62 (62.6)	
Meet Recommendations	66 (43.8)	36 (33.4)	63 (38.0)	30 (32.1)	
Health Literacy					0.18
Maintained High	67 (45.4)	38 (36.7)	67 (40.6)	28 (30.5)	
Increased	10 (4.1)	10 (9.8)	6 (3.4)	5 (3.9)	
Decreased	81 (44.5)	55 (50.0)	84 (47.6)	57 (58.7)	
Maintained Low	14 (6.0)	7 (5.6)	17 (8.0)	8 (6.8)	

[1]Changes in covariates and preventive service use are indicative of last reported preventive service use in either 2007 or 2011
[2]BMI categories are measured by the WHO guidelines for underweight, normal, or overweight and obese.
[3]Health Literacy is measured form 1997-2002 during adolescent years.
* Increased usage indicates that the respondent change from reporting non-usage to usage
** Decreased usage indicates that the respondent changed from reporting usage to non-usage.

Table 10 shows the adjusted odds association of changes in adolescent health literacy and changes in preventive service use. Sex, race, health insurance status, chronic condition status, and changes in cigarette and alcohol use were controlled in this analysis (not shown). A significant association was found between those who increased their health literacy and increased preventive service utilization (p=0.038). Young adults who increased their health literacy, compared with those who maintained high health literacy, were 3.14 times more likely to increase preventive service use, compared to those that maintained high use (OR=3.14, p=0.038). Young adults who decreased their health literacy, compared with those who maintained high health literacy, were 2.08 times more likely to maintain low use of preventive service (OR=2.081, p=0.051).

Table 10.
Multinomial Logistic Regressions with Adjusted Odds of the Association of Changes in Adolescent Health Literacy and Preventive Service Use Changes in Young Adulthood from 1997–2011 (n=585)[1]

	Preventive Service Use Changes[2]					
	Increased to High vs. Maintained High	P-Value	Decreased to Low vs. Maintained High	P-Value	Maintained Low vs. Maintained High	P-Value
Health Literacy (Ref = Maintained High)[3]						
Increased*	3.14 (0.981, 10.024)	0.038	1.13 (0.288, 4.450)	0.857	1.39 (0.208, 9.246)	0.737
Decreased**	1.57 (0.840, 2.933)	0.157	1.33 (0.753, 2.348)	0.316	2.08 (1.041, 4.157)	0.051
Maintained Low	1.18 (0.353, 3.968)	0.786	1.65 (0.620, 4.403)	0.305	1.38 (0.396, 4.744)	0.618

[1] The analysis controlled for changes in cigarette use, alcohol use, health insurance, chronic condition status, BMI, sex, and race.
[2] Reference category is maintained high usage.
[3] Change is health literacy is measured from 1997-2002, and changes in preventive service use is measured from 2002-2011
*Increased from low to high health literacy
** Decreased from high to low health literacy

Discussion

This study is unique in that it uses a nationally representative sample to show an association between adolescent health literacy and their subsequent preventive service use as young adults. In doing so, it answers calls from researchers and policy makers to address a gap in the research about long-term outcomes of adolescent health literacy (Patton, et al., 2016; Lau, Adams, Irwin, & Ozer, 2012). It also addresses research gaps related to long-term associations between health literacy and health behaviors (Harris, et al., 2017).

Study participants were followed from 1997 to 2011, during which they aged from adolescents into young adults. Over this time, preventive service use decreased across the study population, despite health insurance status remaining relatively consistent. This finding could be due to legislation around health insurance coverage during those years. This study recorded preventive service use in 2007 and 2011, before implementation of the 2010 Affordable Care Act, which required insurance companies to fully cover preventive services. Thus, it is likely that participants saved costs by omitting these services (Preventive Services Covered by Private Health Plans under the Affordable Care Act, 2015). Furthermore, research has reported significantly less preventive service use among individuals without health insurance coverage (Sudano & Baker, 2003; Tipirneni et al., 2018).

This study also showed changes in health literacy from middle (13–15 years old) to late (18–19 years old) adolescence, where four groups of health literacy were observed (maintained low, increased to high decreased to low, and maintained high). One group decreased in health literacy from 1997 to 2002, and their alcohol and cigarette use increased. The potential increase in substance use as adolescents age into young adults could decrease health literacy and potentially self-care behaviors, such as preventive service use. Studies of adolescent cognition

found that adolescents between 13 and 15 years old who consume alcohol either at all or by binge drinking can develop positive expectations of the substance (Patton et al., 2018). Considering health literacy is a measure of disease knowledge, including alcohol use, the association between alcohol use and its potential impacts could affect health literacy. Research has shown that alcohol use among adolescents is associated with low health literacy and that the positive expectations of alcohol use are associated with increased sociability (Chisolm, Manganello, Kelleher, & Marshal, 2014). Our finding thus supports research showing the need for interventions to decrease alcohol use among adolescents (Komro & Toomey, 2002).

Increasing opportunities for high health literacy during adolescent years can promote preventive service use. The Institute of Medicine deemed the school system a pertinent place to improve health literacy and thus decrease disease rates and future economic burdens on the health care system (Institute of Medicine et al., 2004). We observed that low health literacy was associated with continued low preventive service use, and increased health literacy was associated with increased preventive service use. Other research confirms that compared with adolescents who have high health literacy, those with lower health literacy often do not use preventive services (Berens, Vogt, Messer, Hurrelmann, & Schaeffer, 2016; Berkman et al., 2011). Improving health literacy during the adolescent years therefore could increase preventive service use during young adulthood.

Consistent insurance coverage throughout adolescence and young adulthood also is important for preventive service use. As shown in this study, having health insurance is highly associated with preventive service use. This finding is particularly meaningful for policies regarding the expansion of Medicaid and the retention of adolescents and young adults' on their parent's insurance (Racher, Kendal, & Anthony, 2019). States that opted not to expand Medicaid

coverage for adults aged 18–55 and between 100% and 138% of the federal poverty level have been shown to have higher medical expenditures, slower rates of smoking cessation, worse behavioral health, and more emergency visits, compared with states that expanded coverage (Antonisse et al., 2019). Given that preventive service use is associated with health cost savings (Antonisse et al., 2019), providing health insurance coverage for adolescents and young adults should remain a priority.

Limitations

This study must be interpreted in light of some limitations. First, self-reported data was used for assessments, which could introduce biases towards social desirability or selective recall (Althubaiti, 2016). Questions involved socially unacceptable behaviors for adolescents, such as alcohol, cigarette, and marijuana use, which could lead to false responses (Althubaiti, 2016). Despite the use of self-reported data, biased responses may be reduced by using computer-assisted personal interviewing as the sampling method. Research with the National Longitudinal Surveys has shown that this method is more efficient at retrieving truthful responses to sensitive questions than paper-assisted personal interview methods (Tourangeau and Plewes, 2013). Second, the dichotomization of health literacy potentially causes loss of precision in calculations, as those between high and low health literacy are not assessed separately. However, the assessment for changes in health literacy provides insight into the changes between health literacy levels (CDC, 2019). Third, we were unable to adjust for intermittent coverage or non-coverage of health insurance during the study. The assessment of health insurance coverage was recorded at one point in the year, at which point coverage may have increased or decreased. Despite this limitation, research on intermittent health insurance coverage has confirmed that,

even across long periods, lack of health insurance yields higher rates of non-use of preventive services (Sudano & Baker, 2003).

Conclusion and Recommendations

Adolescents age into young adults who navigate the health care system. Their health literacy can impact how they use health services. This research helps explain how changes in health literacy are associated with health behaviors, such as preventive service use, over time. The importance of health literacy in this research can support interventions aimed at increasing adolescent health literacy, such as the standardized health literacy curriculum for U.S. school systems. It also can provide support for expanding health insurance coverage to promote preventive service use. Future research could assess preventive service use among adolescent populations that are in between low and high health literacy.

CHAPTER V: SUMMARY AND CONCLUSIONS

Summary

This dissertation assessed key aspects associated with health literacy throughout the life course of adolescence to young adulthood. This exploratory study across U.S. adolescents attempted to provide a better understanding of how health literacy can be impacted by social and environmental interactions, and how those interactions can impact the way health literacy is used throughout adulthood. It is anticipated that the results of this study would inspire future research on adolescent health literacy, and potentially support policy initiation for adolescent health literacy.

Considering the growing need of the U.S. to become a health literate nation (Institute of Medicine, 2004; Patent Pending Affordable Care Act, 2010), addressing issues associated with low health literacy at a primary stage of health literacy development, adolescence is pertinent for reaching this goal (Institute of Medicine, 2004; Okran et al., 2019; Winkleman et al.,2016). Low health literacy has been consistently associated with poor health quality (Department of Health and Human Services, Office of Disease Prevention and Health Promotion, 2010; Zheng et al., 2018), increased risk of chronic diseases (Sudore et al., 2006; Department of Health and Human Services, Office of Disease Prevention and Health Promotion, 2010; Patton et. al., 2016) and unnecessary overuse of health services (Sudore et al., 2006; Valerie and Mayer, 2007). Although studies have assessed predictors of adolescent health literacy (Chisolm et al., 2015), assessing the development of health literacy among adolescents has not been widely studied (Fleary et al., 2018).

Furthermore, assessment with adolescent health literacy has been limited to specific populations within the U.S. and lacks analysis of adolescent health literacy at the national level.

With that, I believe this study could provide an opportunity to understand the issues hindering high health literacy attainment while diminishing the gap between those with high health literacy and low health literacy across the nation (Institute of Medicine, 2004; Patton et al., 2016; Rikard et al., 2016).

The current study suggests that patterns of interpersonal relationships during adolescent years are important for high health literacy development. Specifically, associations with peers who utilize substances increased the likelihood for adolescents to develop low health literacy. Research has suggested that the pathway for low health literacy development from negative peer influences is due to increased beliefs about health by peers (Paxton et al., 1999; Shoemaker and Furman, 2009). Psychological research has concluded that learned behaviors and peer associations impact perceptions and beliefs about health (Gottlieb and Baker, 1986; Brown and Larson, 2006; Tome et al.,2012). Moreover, health behavior patterns were seen as important factors for adolescent health literacy development. Two areas in which health literacy appears to be developed by adolescents are health behaviors and the interpersonal relationships around those behaviors (Cites). Adolescent's engagement in substance use potentially diminishes the associated perception of negative consequences of the substance (Tome et al., 2012). This mentality potentially impacts health literacy, as it distorts the understanding of disease knowledge, which has been understood as a factor of health literacy. Research has shown that substance use among adolescents impacted literacy by increasing difficulty with concentration and decreasing cognition (Bentley and Conley,1992). Addressing areas of peer influences and adolescent substance use through policy or educational initiatives could buffer negative impacts from these relationships. Reduction in substance use among peers could positively alter

perceptions about health consequences related to substance use and promote positive peer influences.

Aside from traditional predictors of adolescent health literacy such as race, sex, and parent health literacy, interactions with parents and peers could assert an important role in health literacy development. This study found that adolescents with the likelihood of developing low health literacy have more interactions with peers who have negative health behaviors, and parents with parenting styles, specifically authoritarian parenting styles that might diminish autonomy among adolescents. The understanding of this correlation brings attention to aspects outside of literacy measures that should be addressed to improve adolescent health literacy.

Geographical dispositions could impact health literacy through different channels. Access to health information resources such as physicians is very important (Fiscella and Williams, 2009). As shown in this study, combined socioeconomic factors such as physician availability, and urban/rural status tended to increase the odds of low health literacy among adolescents. In addition to environmental factors, geographic disposition is also related to interpersonal factors. Research has shown that geographic location is associated with parenting styles (Kovess-Masfety et al., 2016). Kovess-Masfety and colleagues (2016) found that low affluent geographic regions correlated to negative parenting styles. As seen with geographic assessment in our study, the majority of the adolescents resided in the south region, and those with mothers who adopted authoritarian parenting styles were more likely to have low health literacy. Geographic differences in parenting style should be monitored by assessing adolescent and parental communications through decision making processes at home, as done in previous research (Huebner &Howell, 2003). Accounting for factors associated with low adolescent health literacy is important for health navigation in young adulthood.

As interpersonal factors and disparities in access to health information sources (physicians, insurance, high parent health literacy) are associated with low adolescent health literacy, low health literacy is associated with low preventive service use among adolescents and young adults. Research has generally shown that individuals with low health literacy tended to useless preventive health services, and overuse of health services for avoidable conditions (Kaiser Family Foundation, 2015). This showed that adolescent health literacy as associated with preventive service use in young adulthood and those with low health literacy would likely continue to have low or decreased preventive service use. At the same time increasing health literacy over time showed an increase in preventive service use. These findings support the claim that health literacy could positively impact preventive service use (Patient Protection and Affordable Care Act, 2010).

Limitations

Although this dissertation has assessed gaps in adolescent health literacy, this research has limitations that could be addressed for future studies. This study is limited in its ability to assess the full scope of health literacy. Health literacy has approximately thirty nine definitions, and studies have inconclusively used different measures for health literacy (Okan et al., 2019). However, health knowledge and disease knowledge have been common measures of adolescent and parent health literacy, although they do not address the full scope of health literacy (Broder et al., 2017; Okan et al., 2019). Another limitation of this study is the use of a study sample with adolescents from 1997, which could be an outdated sample. Technology has advanced dramatically since 1997, in which adolescents have more access to information and more advanced peer relations (Schaefer, 2019). This could bias the percentage of adolescents with low and high health literacy, as access to health information from medical internet resources such as

Medline Plus and Health can potentially influence the health literacy of adolescents (Cite). Additionally, this dissertation did not account for the scope of spatial disparities that may impact health literacy levels among adolescents. Some disparities such as access resources (physicians and transportation) are available at the zip code level and could impact access to health information. Future studies could address some of these limitations.

Future Studies

Future studies could address adolescent health literacy at the national level with one of the validated health literacy measures for adolescent health literacy, such as the TOFHLA-teen (Chisolm and Buchanan, 2007). Although that measure is not exhaustive of health literacy, it is a validated measure that assesses a fuller scope of adolescent health literacy. Additionally, future studies could assess adolescent health literacy with a more recent population. This could provide a better scope of the status of adolescent health literacy within the United States.

Other studies could assess adolescent health literacy disparities at the zip code level. This study provided details on disparities associated with low adolescent health literacy at the county level. Assessment at the zip code level could provide a better understanding of community-wide disparities that negatively impact adolescent health literacy. This could provide direction at the community level to improve adolescent health literacy. Finally, future studies assessing adolescent health literacy preventive service use could explore different types of preventive services that are impacted by adolescent health literacy. This could provide direction for interventions geared towards promoting adolescent health literacy and preventive service use.

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