
Roles of interpersonal and media socialization agents in adolescent self-reported health literacy: a health socialization perspective

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Abstract

This study proposes a health socialization model and applies it to examine direct, relative and mediating roles of interpersonal and media health socialization agents in predicting adolescent self-reported health literacy. We conducted a paper-and-pencil survey among 452 seventh graders in rural and urban school districts. Our regression analysis results show that both interpersonal and media socialization agents are significantly and positively related to adolescent health literacy. Media socialization agents seem to play a strong role in health literacy orientation, not much weaker than those of interpersonal socialization agents. The proposed health socialization model could contribute to the literature on how adolescents acquire health-related information and channels through which they are most receptive.

Institute of Medicine emphasize the critical importance of reducing health disparities and improving health literacy for a high-quality health system and improved health care [2].

While many efforts have been made on understanding and improving health literacy targeting patients or adults [3–5] in health care settings [6], less attention has been paid to understand adolescent health literacy [7–9]. Given the array of risky health behaviors with which young adolescents often experiment [10], the growing numbers of children with multiple caregivers, which can lead to confused medical information [11], and the increased attention paid to health literacy as a determinant of various health outcomes [8], it is critical to understand the processes and sources by which adolescent health literacy is formed and enhanced and how those processes may lead to health outcomes.

The overall purpose of this study is to propose a health socialization model drawn from both consumer and political socialization models to understand adolescent health literacy. We particularly focus on the extent to which interpersonal and media socialization agents—e.g. parents, peers, school and both traditional and non-traditional media—play direct, relative and mediating roles in adolescent health literacy based on existing socialization models [12–14] and Primary Socialization Theory (PST) [15]. The proposed health socialization model could contribute to the literature on how

Introduction

Central to goals of the Healthy People 2010 initiative is development of a population that is health literate. Such literacy is increasingly vital to help people navigate a complex health system (access and utilization), to comprehend provider messages and to manage self-care [1]. Recent reports from the

adolescents acquire health-related information and channels through which they are most receptive.

Health socialization model and health literacy

Our health socialization model borrows from both political and consumer socialization models that rely on psychological theories of reinforcement and modeling [16, 17]. At their core, socialization processes are those through which a culture transmits its values, habits and norms from one generation to the next. For example, political socialization has been defined as the ‘study of the developmental processes by which children and adolescents acquire political cognition, attitudes, and behaviors’ (p. 20) [18]. For many years, parents (and family) were the agents of greatest influence [19]. Since its origins, though, much research has documented the mediating roles of mass media, especially news, on parents’ influence [20, 21], of friends and peers [22], of schools and citizenship campaigns [23] and other secondary influences like religion and political parties [24]. Additionally, it is known that events can trigger attitude development in the socialization process [25].

Consumer socialization, clearly based on similar principles, has been defined as ‘the processes by which young people acquire skills, knowledge, and attitudes relevant to their functioning as consumers in the marketplace’ [26]. Typically this literature emphasizes the influence of socialization agents (people or organizations) in conveying consumer norms, attitudes and behaviors to the individual [14, 27]. Consumer socialization research has investigated the influence of family, mass media, schools and peers on the childhood consumer socialization process [12–14].

The health socialization model we propose shares basic tenets with both consumer and political socialization in several ways. First, similar to political and consumer socialization, we define health socialization as the processes through which young people acquire health-related orientations, skills, knowledge and attitudes, which, in turn, form their

healthy lifestyles and behaviors. Second, in the socialization process, we note the important roles of interpersonal (e.g. parents, friends and schools) and media (e.g. traditional and non-traditional media) socialization agents in delivering health information and training health-related skills. Third, in addition to the socialization agents, various demographic (e.g. age, gender, race), sociostructural (e.g. socio-economic status, access to resources) and other individual factors (e.g. psychological orientation, health status) are considered as exogenous variables.

The consideration of multiple factors also resonates with the recent development of the Social Ecological Model (SEM) in health education and behavior literature. The SEM proposes that an individual’s health behavior is a function of the complex interplay between the individual, relationship, community and societal and structural factors [28–31]. The multiple factors range from individuals’ psychological factors (e.g. health orientation) to resources, environmental risk factors (e.g. friends’ and family members’ unhealthy behaviors) and other policy and contextual factors (e.g. social and economic structures or SES). The SEM has recently drawn more attention as researchers realize psychosocial models alone may not be sufficient to understand and predict individuals’ health outcomes [30, 32]. Incorporating these multiple factors within our health socialization model may help understand better how adolescents build their health literacy, which leads to their health behaviors. Wharf-Higgins *et al.* [32] indeed employed SEM for their school-based health literacy interventions for better understanding of adolescent interrelation relationships among schools, parents, peers and media. Proposing the health socialization model, we examine health literacy as one important kind of health-related skills and orientations that can be acquired through health socialization processes.

Health literacy is defined as ‘the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions’ [33] (p. 7). Embracing a broader definition of health literacy, Nutbeam argues that health literacy is more than simply being able to read pamphlets and make

medical appointments. It is basic literacy combined with more advanced cognitive and social skills, which empower people to be confident in their ability to find, critique and process health information [34]. Similarly, extending the definition's focus on information, Zarcadoolas *et al.* [35] argue that 'a health-literate person is able to use health concepts and information generatively, applying information to novel situations' (p. 55). Multiple definitions of health literacy have generated confusion [36] and, even if several measurements for health literacy have been developed, no consensus seems to exist on which one most accurately measures health literacy. For example, Manganello argues that the Test of Functional Health Literacy in Adults (TOFHLA) and Rapid Estimate of Adult Literacy in Medicine (REALM; also REALM-Teen), which have been widely used to measure literacy in health care settings, mainly assess literacy as it relates to written comprehension and does not test other aspects of health literacy such as critical thinking skills [8]. As directions for future research, she requested the development of scales and questionnaires that can be used for self-administered large-scale surveys.

In this paper, we use a definition of health literacy that focuses on each individual's capacity to acquire and use new information [36], which is also the definition used by Healthy People 2010, IOM, and several aforementioned scholars. In addition, instead of focusing on reading skills or measurement in health settings, we use self-reported health literacy items that were applied in an adolescent survey setting (e.g. KidsHealth KidsPoll study) [38]. In the KidsHealth KidsPoll study, for example, students' health literacy levels were matched to their interests in health topics, their understanding of health subjects and their motivation to act on what they had learned about staying healthy [38].

Figure 1 presents our proposed conceptual model of health socialization, modified from consumer socialization [14, 39] and political socialization [20]. As a first step in proposing the model and applying it to understanding adolescent health literacy, health literacy serves as an outcome variable in this study.

In the health socialization process, we particularly focus on the roles that both interpersonal and media socialization agents play in adolescent health literacy because these are the major socialization agents for adolescents (i.e. PST) [15].

Interpersonal socialization agents

Past socialization literature has noted roles of family and peers in the socialization process [39, 40]. For example, Moschis [40] argued that communication with family members directly or indirectly affects consumer learning and mediates the effects of other non-family sources of consumer information. The strongest predictor of a young person's political party affiliation and political attitudes, for many years, was his/her parents [19]. Yet, in more recent years, there has been debate among socialization scholars about the strength of parental influence [41]; some argue that it is declining, while the influence of peers is increasing. According to Group Socialization (GS) Theory, for example, young adolescents' experiences with groups of their peers are the single largest environmental factor influencing personality and socialization into the culture [42]. In refuting GS, Vandell [41] argued that available evidence is more consistent with a multiple-influence socialization model that acknowledges the fluid nature of changing levels of influence. This perspective is supported in much health literature. Strong negative influence of friends on adolescent risky health behavior is often documented [43]. But peers can be, along with parents and schoolteachers, critical socialization agents that can disseminate and communicate health information to adolescents to inform and protect adolescents from readily accessible risky health environments [44]. This assumption leads to our first hypothesis on interpersonal socialization agents:

H1: The more frequently adolescents hear about health information from interpersonal socialization agents, the higher their level of health literacy.

Media as health socialization agents

While parents, friends and schools are primary and intimate socialization agents for adolescents, media have also long been considered important socialization agents. Consumer socialization literature documents that media affect acquisition of consumer skills [12, 14, 27]. For example, Moschis and Churchill [14] found a strong relationship between television viewing and an individual's motivation to socialize with others and within cultures to which they belong. Another empirical study found that health information heard from mass media was also positively related to consumer perception of direct-to-consumer pharmaceutical advertising [39]. Thus, this logic can be applied to health literacy where frequent consumption of health information from media can enhance individuals' overall ability to understand health information.

Health information is made available to consumers through many different media channels (e.g. TV, magazine, and Internet) and media types (e.g. news, entertainment, and advertising) [45, 46]. In particular, the exponential growth of the Internet provides opportunities for improving public health. Indeed, a recent national survey reported that 28% of 12- to 17-year-olds in the United States have searched for health information on the Internet [47], a finding consistent with another recent study [48]. Empirical studies also indicate that an increasing number of young people have been going online to find health information [49, 50]. Many of them treat the Internet as the primary source of such information [51]. Thus, the Internet has been considered an optimal way to disseminate health information to adolescents [52]. Adolescents of different socioeconomic and ethnic groups access and use the Internet and search health information [49] and their perception that the Internet is useful, trustworthy and relevant to them did not differ across gender, ethnicity or parents' SES [50]. In addition, some of the health issues that greatly concern young people, such as sexually transmitted dis-

eases, may be too sensitive or embarrassing for them to comfortably discuss with parents and medical professionals [53].

It is not to say that media have only positive impact on adolescent health. In fact, substantial literature documents harmful effects of media on violent behaviors [54], sexual activities [55], child obesity [56, 57] and alcohol, tobacco and other drug uses [58, 59]. However, this study focuses on the roles of traditional and non-traditional media as health socialization agents that disseminate health information to wider numbers and types of adolescents. As a result, these media can help them gain access to, understand and use the information to maintain their health [60]. Thus, the second hypothesis is formulated:

H2: The more frequently adolescents hear about health information from media, the higher their level of health literacy.

Relative strength of roles between interpersonal and media socialization agents

Existing literature seems to suggest that empirical evidence on independent effects of primary socialization sources is as strong as or even stronger than those of media messages on adolescent health [61, 62]. For example, a survey study among adolescents that tested multiple risk factors predicting smoking found that family smoking, peer smoking and prior beliefs about the risk of smoking were more important predictors of participants' smoking level than antismoking information delivered via media [62]. These findings intuitively make sense because proximal health environments such as family and friends' smoking are more likely to be an immediate influence on adolescents' health-related attitudes and behaviors than distal environments such as media [63]. If the same logic is applied to a health literacy context, health information heard from parents, friends and schools should be more strongly related to adolescent health literacy than health information from various media. PST also

supports this argument in ways that parents, peers and schools are the most important forces in adolescent health socialization, with media considered of secondary importance because such primary socialization is based on intimate social interactions [13, 15, 64]. Although few studies have tested the relative strength of the roles played by interpersonal socialization agents over media socialization agents in adolescent health literacy, existing literature seems to support a stronger role of primary socialization agents than secondary (i.e. media) ones in adolescent health [61], particularly among young adolescents [65]. Thus, we formulate the third hypothesis:

H3: Interpersonal socialization agents will be more positively related to adolescent health literacy than media will.

Relationships among socialization agents and adolescent health literacy

Hypotheses 1–3 focus on the direct relationship between interpersonal or media socialization agents and health literacy. In the analysis of a cross-sectional survey to test the health socialization model (Fig. 1), one important question is whether there are any mediating (and potentially causal) associations among the three variables. Either mediation—i.e. interpersonal socialization agents → media socialization agents → health literacy or media socialization agents → interpersonal socialization agents → health literacy—is possible for different theoretical rationales. The first mediation can be explained by the priming thesis so that information learned from peers and parents can make the similar information on media more salient to individuals because the same information can evoke semantically related thoughts among the individuals through the process of memory accessibility and activation [66, 67]. An empirical study has also found that adolescents who were provided antismoking-related information from primary socialization agents (e.g. schools, parents) reported they were more exposed to anti-smoking messages on media [65].

Meanwhile, the second mediation, media socialization agents → interpersonal socialization agents → health literacy, can be explained by a two-step flow of information so that individuals mediate the information they gained from media to others through informal and formal communications. Empirical studies have evidenced that mass media such as television advertising stimulate discussions with parents as well as with peers [68, 69].

These equally convincing theoretical reasoning and empirical evidence lead to the competing speculation of whether health information from media mediates the relationship between interpersonal channels and health literacy or, alternatively, whether health information from interpersonal agents mediates the relationship between media channels and health literacy. Thus, the following research question is addressed:

RQ1 What are the mediating relationships among interpersonal and media socialization agents, and health literacy?

Methods

Data

A paper-and-pencil survey was conducted among seventh-grade students in three rural and urban public school districts in Georgia: Clayton (urban), Worth (rural) and Sylvester (rural). All three districts possess large proportions of African American students (Clayton = 73%, Worth = 41%, Screven = 55%) and high proportions of children on federal meals programs (74%, 63% and 80% of students eligible for free/reduced price meals, respectively). Previous studies that found poor adolescents appear ‘most’ at risk for health problems reinforce the need to focus on the relationship between adolescent residence and health risk behaviors so that intervention programs and information can be program specific to their needs [70].

All participants were recruited following approved human subjects procedures for conducting research with children (through the Institutional Review Board (IRB) at both the investigators’

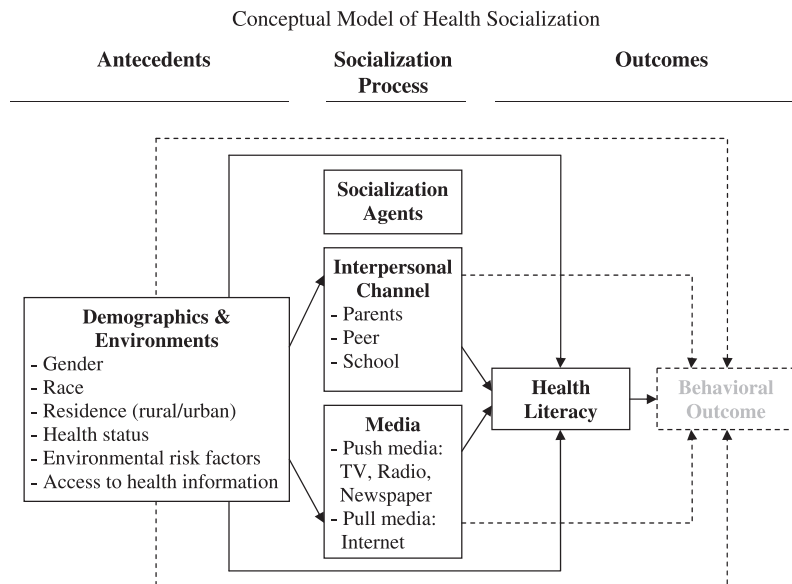


Fig. 1. Conceptual model of health socialization.

Note: This model has been drawn from socialization models in consumer behavior (Moschis and Churchill [14]) and advertising (Lee *et al.* [39]) literatures and modified to fit health context.

university and the school districts); multiple incentives (i.e. drawings for small cash prizes and local store and restaurant gift cards) were offered over a 2-week period when students were encouraged to discuss participation with their parent(s)/guardian(s). Letters were mailed from the districts to the homes that included a full explanation of the study and a parental consent form. The return rate of the consent forms (the number of consent forms sent home divided by the total number of enrolled students) was 23.3%. The return rate seems a bit low, but studies have found no significant difference in the findings between low-return rate and high-return rate studies [71]. In addition, the low return rate itself does not necessarily affect the survey results, unless there is evidence of systematic difference between non-respondents and respondents [72].

Instrument development

The survey instrument was developed based on important primary data [i.e. a focus group study con-

ducted among 4 groups (total $N = 42$)—urban boys (10), rural boys (12), urban girls (8), rural girls (13)—in the same districts one semester prior to the survey] as well as publicly available secondary data about young adolescent health behavior (e.g. Behavioral Risk Factor Surveillance System, Monitoring the Future, National Youth Tobacco Survey). This allowed us to use both standard pre-existing measures on specific health-related questions and to identify from the focus groups the issues, concerns and information sources the young adolescents themselves generated. We also selected some question items guided by our theoretical frameworks. That is, following literature on socialization models, various media and interpersonal channels for information are included in the questions. In addition, based on the SEM [32], we also asked questions related to micro context (e.g. age, gender, access), meso context (school, family, peers) and macro context (e.g. media). The survey instrument was pre-tested by a dozen of the same age cohorts (who

were recruited from a non-participating school) and revised in terms of question wordings and nuances.

Procedures

The survey titled 2008 Youth Health Information Study was administered by the researchers and trained teachers during school hours. Only the students whose parent(s)/guardian(s) sent their consent form to their children's schools were allowed to participate in the survey. Participating students signed personal assent forms on the day of the survey.

The survey administrators informed students that their answers would be completely confidential and that they could decline to answer any questions. The survey took approximately 20 minutes to complete. The total sample size was 452: females = 52%; rural adolescents = 54.9%; Blacks = 56.4% and Whites = 27.4%. The race and gender composition closely resembled the populations of the participating schools.

Measures

This study uses adolescent self-reported health literacy as the outcome variable and the following variables as predictor variables: (i) health socialization agents—frequency of hearing health information from (a) interpersonal channels and (b) (traditional and non-traditional) media channels; (ii) amount of time spent on media—(a) watching TV, (b) reading magazine and (c) using the Internet; (iii) demographic and environmental factors—sex, race, rural/urban residence, adolescents' own health status, ease of access to various health information sources and friends' and parents' risky health behaviors. The reasons for including time spent on use of various media include: (i) to see the association between general media use and health literacy but, more importantly, (ii) to partial out any confounding effects because frequency of obtaining health information from media should be highly associated with amount of time spent with media. In media effects literature, it is not uncommon to control amount of time spent on media for similar reasons [73, 74].

The items that construct each variable were determined first with Exploratory Factor Analysis

(EFA) used with the Principal Component Analysis (PCA) extraction method (Varimax rotation; Eigen value criterion of 1) and second with Cronbach's alpha reliability analysis. Then, Confirmatory Factor Analysis (CFA) was performed to validate the variable construction.

Self-reported health literacy

The following four health literacy items were drawn from literature with a 5-point scale [38]: (i) I try to get as much information about health as possible; (ii) I try to follow what I'm taught about health (1 = never to 5 = all the time); (iii) Most of what I hear about health is (1) very hard to understand to (5) very easy to understand and (iv) How much do you think a kid can do to grow up to be a healthy adult? (1 = almost nothing to 5 = a lot) {The descriptive statistics of the four items indicate that the participants' level of health literacy seems quite comparable to that of the participants by Brown *et al.* That is, about 69% of our participants (89% of them are 12–13 years old) report that most of what they hear about health is easy and very easy to understand health information, compared with 69–73% of the 12- to 13-year-old participants who answered similarly in the study of Brown *et al.* For the question 'I try to follow what I'm taught about health', about 78% of the participants answered positively, compared with 73.5–87% of the participants in the study of Brown *et al.* For the question, 'how much do you think a kid can do to grow up to be a healthy adult?', about 68% of the participants answered positively, compared with 74–88% of the participants in the study of Brown *et al.* Finally, for the question on 'how interested are you in learning about health?', about 74% of our participants were somewhat or very interested, while 57–65% of the participants in the study of Brown *et al.* were interested. Although the participant characteristics may be different (i.e. the participants of the study of Brown *et al.* study were recruited among those who attended programs at 11 health education centers in the United States), this comparison suggests that our data are not substantially deviant from those collected among the same age cohorts [38]}. Based on EFA (49.4% of

total variance explained) and Cronbach's alpha reliability analysis ($\alpha = 0.65$), the four items were averaged to construct the index of health literacy (mean = 3.81, SD = 0.78).

Health socialization agents were measured with the following nine question items (5-point Likert scale from 1 = not at all often to 5 = very often): How often do you hear about the various health topics from each of the following sources? (i) Parents or other guardians at home, (ii) friends or siblings, (iii) school (teachers, counselors or coaches), (iv) broadcast news programs (like newscasts, 60 Minutes, Dateline, 20/20), (v) broadcast entertainment (like Grey's Anatomy, ER, CSI, Oprah), (vi) broadcast advertising (e.g. TV and radio), (vii) print news (newspaper or magazine articles), (viii) print advertising and (ix) the Internet (e.g. Google or specific websites like WebMD). EFA showed clearly two factors: the three interpersonal items construct one latent factor (labeled as interpersonal socialization agents; 39.8% of total variance explained) and the six media channels construct the second latent factor (labeled as media socialization agents; 13% of total variance explained). Cronbach's alpha reliability analysis also indicates reasonably good internal consistency for each of the two factors ($\alpha = 0.66$ and 0.79). Thus, the two variables were constructed as averaging indices of the respective question items (for interpersonal socialization agent, mean = 3.10, SD = 1.11; for media socialization agents, mean = 2.95, SD = 1.00).

In addition, general media use variables were included in our model to partial out the effects of general media use on health literacy that otherwise may have confounded the effects of health socialization agents. Participants were asked to answer how frequently they used TV (weekend and weekday), the Internet (weekend and weekday) and reading a magazine or newspaper with a 5-point ordinal scale (see Appendix 1). The TV-use and Internet-use variables were measured by averaging the respective two weekday and weekend items (inter-item $r = 0.51$ and 0.67 , respectively). Print (magazine or newspaper)-use variable was a single item. EFA among the TV-use, Internet-use, and maga-

zine use question items indicated that various media use items did not construct clear latent factors (also, $\alpha = 0.11$ among all the items). Thus, the three media use items were included separately in our model.

The ease of access to various health information sources was measured as a proxy of access measures because quite a few studies on adolescent health use 'ease' of access measures rather than directly measure access to the health care [76–78]. Participants were asked how easy they feel they are able to access each of the various health information sources (e.g. doctor, parents, school teachers and the Internet). EFA indicates that the four, 5-point Likert scale question items do not seem to form a latent factor; thus, the four items were included separately in the model.

Additionally, two environmental risk behaviors were measured. First, friends' risky health behavior was measured as an averaging index of four 5-point ordinal-scale items (smoking, drinking, illegal drug use and sexual behavior) (EFA = 63.8% of total variance explained; $\alpha = 0.81$; mean = 2.2, SD = 1.18). Family's risky health behavior was measured by counting 'yes' responses of the three binary items (chronic disease, smoking and drinking) (mean = 1.0, SD = 0.93).

Analytic strategy

Before fitting the regression model for hypothesis testing, we tested our measurement model among the major variables (i.e. health literacy and health information from interpersonal and media channels) by performing CFA using the LISREL 8.72 program. The purpose of fitting the measurement model is to demonstrate construct validity in addition to face validity demonstrated in EFA. The CFA model with all 3 latent factors and 13 observed variables included was well fitted, with $\chi^2(62) = 145.50$, $P = 0.00$, Root Mean Square Error of Approximation (RMSEA) = 0.06, Non-Normed Fit Index (NNFI) = 0.95, Comparative Fit Index (CFI) = 0.96, Global Fit Index (GFI) = 0.95 and Standardized Root Mean Square Residual (SRMR) = 0.05 [78, 79]. In addition, we also

investigated the possibility that traditional media (often called ‘push’ media) and the Internet (‘pull’ media) are separate latent constructs as some studies have treated them separately [80]. The CFA model with the four latent factors was also well fitted, with $\chi^2(62) = 139.09$, $P = 0.00$, RMSEA = 0.06, NNFI = 0.95, CFI = 0.97, GFI = 0.95 and SRMR = 0.05. But the chi-square difference test between the three-factor and the four-factor models reveals no statistical significance ($\chi^2D(2) = 4.90$, $P = 0.08$), which indicates the superiority of the three-factor model over the four-factor model in terms of model parsimony.

Following the verification of the measurement model fit, discriminant validity and convergent validity of the latent variables were each examined. Our examination indicated that all items significantly ($P < 0.001$) loaded to the intended factors, indicating good convergent validity [81]. Next, our investigation of correlations showed that all measures had higher correlations with the items of the corresponding latent variable than with items of the other latent variables, demonstrating discriminant validity [78]. Table I presents factor loadings for the three-factor CFA model.

To test Hypotheses 1 and 2, a hierarchical regression model was performed. Before the regression

models were analyzed, the associations between all predictors and the dependent variable were examined closely with Pearson correlation (for correlations between each of the predictors and individual health literacy item, see Appendix 2). Then, predictors were entered in the hierarchical regression model in the following order: demographics and adolescents’ own health status were entered in the first block; environmental factors in the second block; general media use variables were entered in the third block and in the fourth block, health informations from interpersonal and media channels were entered. Our diagnostic statistics did not detect any multicollinearity problem ($0.55 < \text{tolerance for all the predictors} > 1.0$; all Variance Inflation Factors (VIFs) < 2). Table II shows results of Pearson correlation analysis and hierarchical regression analysis.

To test Hypothesis 3, we used the Fisher’s z -transformation procedure [82]. This procedure allows one to test whether the difference in two correlation coefficients is statistically significant. Thus, following the formula, the correlation coefficients between health information from interpersonal socialization agents and health literacy and between health information from media and health literacy were transformed to a z -score for comparison.

Table I. CFA among information sources and health literacy

	Interpersonal	Media	Health literacy	R^2
Parents	0.89			0.40
Peer	0.97			0.46
School	0.84			0.33
Broadcast news		0.83		0.33
Broadcast entertainment		0.69		0.24
Broadcast advertising		0.99		0.52
Print articles		0.95		0.48
Print advertising		0.93		0.50
Internet		0.76		0.29
Health literacy item 1			0.45	0.18
Health literacy item 2			0.78	0.55
Health literacy item 3			0.55	0.24
Health literacy item 4			0.79	0.41
Goodness of fit statistics	$\chi^2(62) = 145.50$, $P = 0.00$, RMSEA = 0.06, NNFI = 0.95, CFI = 0.96, GFI = 0.95, SRMR = 0.05			

Standardized coefficients

Table II. Hierarchical regression analysis for adolescent health literacy ($n = 446$)

Predictors	r	Beta in ^a	Beta final ^b
Demographics (control)			
Sex (male)	-0.13*		-0.12*
Race (white)	-0.05		-0.05
Residence (urban)	-0.01		-0.02
Health status	0.13*		0.10*
ΔR^2			0.04***
Environments (control)			
Friends' risky health behavior	-0.21***		-0.18***
Family's risky health behavior	-0.04		0.00
Access to doctors for health information	0.14***		0.07
Access to parents for health information	0.19***		0.11*
Access to school teachers for health information	0.20***		0.08
Access to the Internet for health information	0.03		-0.02
ΔR^2			0.09**
Media use (control)			
Watching TV	-0.05	-0.05	-0.02
Reading magazine	0.17***	0.17***	0.12*
Using the Internet	-0.07	-0.07	-0.09*
ΔR^2			0.04***
Socialization agents			
Interpersonal	0.29***	0.25***	0.20***
Media	0.24***	0.19***	0.10*
ΔR^2			0.06***
Total R^2 (%)			0.23***

All Beta coefficients are standardized

^aBetas are taken from the equation with the variables in the first and second block and without the variables in the same block controlled.

^bBetas are taken from the final equation with all the variables in.

* $P < 0.05$; ** $P < 0.01$, *** $P < 0.001$.

For research question 1 regarding mediation tests, we took a standard mediation specification procedure [83]. That is, we first investigated the four conditions that Baron and Kenny required for mediating relationships: (i) the independent variable is significantly related to the mediator, (ii) the independent variable is significantly related to the dependent variable in the absence of the mediator, (iii) the mediator has a significant unique effect on the dependent variable and (iv) the effect of the independent variable on the dependent variable reduces when the mediator is added to the model. While the first two conditions are examined by running a regression analysis with the independent variable predicting the mediator and the mediator

predicting the dependent variable, the Sobel test replaces the last three conditions and reports statistical significance of the indirect effects. In particular, we used the Aroian version of the Sobel test suggested by Baron and Kenny and others [83–86]. This method offers ‘the most power and the most accurate Type I error rates in all cases compared to the other methods’ [84] (p. 99).

Lastly, post-hoc power analyses were conducted using the software package, GPower3, in order to determine the degree of reliability in the study results and to assess whether the statistical tests in this study can guard against Type II error [87]. We assessed power in multiple regression using alpha level (0.05), number of predictors (16), sample sizes

(both pooled and subgroup) and predetermined effect sizes. In accordance with Cohen's criteria, the weak, medium and large effect sizes (f^2) are predetermined as 0.02, 0.15 and 0.35, respectively [88]. Our results show the following: $f^2 = 0.02$, power = 0.85; $f^2 = 0.15$, power = 1.0; $f^2 = 0.35$, power = 1.0. Following Cohen's cutoff criteria of statistical power, 0.80, our study seems to have more than adequate statistical power to detect small, moderate and large effects (see Holbert and Hansen [89], for their application and interpretation of analysis using a similar GPower program).

Table II shows coefficients of each predictor in a step-by-step manner: in the first column, the bivariate correlation coefficient of each of all the predictors; in the second column, each 'beta in' coefficient of the major predictors, where demographics and environmental factors are controlled; in the third column, 'beta final' coefficients from the final equation in which all the predictors are controlled.

Results

H1 Interpersonal health socialization agents and health literacy

Hypothesis 1 predicted a positive relationship between health information from interpersonal socialization agents and adolescent health literacy. This hypothesis was strongly supported. As shown in Table II, the relationship remained statistically significant even after controlling for all the demographic, environmental and structural variables as well as general media use variables (beta final = 0.20, $P < 0.001$). In other words, the more frequently the participants report that they hear about health information from their parents, friends and school teachers, the higher their self-reported level of health literacy.

H2 Media health socialization agents and health literacy

Hypothesis 2 predicted a positive relationship between health information from media socialization agents and adolescent health literacy. This hypothesis was also strongly supported. The significant,

positive relationship between the two variables at a bivariate level ($r = 0.24$, $P < 0.001$) became slightly weaker as the other demographic variables and environmental variables (blocks 1 and 2) were controlled (beta in = 0.19, $P < 0.001$). But even after general media use variables were controlled, the positive association between health information from media channel and health literacy remained significant (beta final = 0.10, $P < 0.05$).

H3 Stronger role of interpersonal socialization agents than media in health literacy

Guided by PST, hypothesis 3 predicted that the association between health information from interpersonal socialization agents and health literacy would be stronger than that between media and health literacy.

z -tests show that the association between health information, interpersonal and media socialization agents, and health literacy is not statistically different ($Z = 0.86$, $P = ns$). Thus, Hypothesis 3 was not supported.

RQ1 Mediating relationships among socialization agents and health literacy

Research question 1 asked whether there are any potential mediating relationships among interpersonal and media socialization agents and health literacy with a particular interest in mediating roles of the socialization agents—i.e. interpersonal socialization agents ~ media ~ health literacy, media ~ interpersonal socialization agents ~ health literacy. The mediation test results are provided in Table III. The results indicate that health information from media significantly mediates interpersonal socialization agents and health literacy ($Z = 2.40$, $P < 0.01$). Meanwhile, health information from interpersonal socialization agents significantly mediates media and health literacy ($Z = 2.40$, $P < 0.01$).

Other significant factors

Although not hypothesized in this study, several findings are noteworthy. First, as shown in Table II (beta final column), females and healthier

Table III. *Mediation tests*

Predictors	Mediating relationship I		Mediating relationship II	
	Media (M)	Health literacy (DV)	Interpersonal (M)	Health literacy (DV)
Step1: Direct effects of the independent variable on the mediator (M)				
Interpersonal socialization agents (IV)	0.415 (0.036)***			
Media socialization agents (IV)			0.556 (0.048)***	
Step2: Direct effects of the independent variable on the dependent variable (DV)				
Interpersonal socialization agents (IV)		0.207 (0.032)***		
Media socialization agents (IV)				0.193 (0.037)***
Step3: Effects of both the independent variables and the mediator on the dependent variable				
Interpersonal socialization agents		0.165 (0.036)***		0.165 (0.036)***
Media socialization agents		0.103 (0.042)*		0.103 (0.042)*
Sobel test (z-score)		2.39*		4.25***

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

The steps are based on the mediation specification procedure of Baron and Kenny. The numeric values are unstandardized beta coefficients in regression models. In parentheses are standard errors. For statistical significance testing of the indirect effects (that replace Steps 3 and 4), the Aroian version of the Sobel test suggested by Baron and Kenny [83] and others (MacKinnon *et al.* [84]; also see Gelfand *et al.* [85]; Luthans *et al.* [86]). The formula is the following:

$$\sqrt{b^2s_a^2 + a^2s_b^2 + s_a^2s_b^2}$$

where s_a indicates standard error for a , which is the unstandardized beta coefficient of the independent variable on the mediator and s_b means standard error for b , which is the beta coefficient of the mediator on the dependent variable (when the independent variable is also a predictor of the dependent variable). These numbers were drawn from the regression models. Then, z -test was performed to see statistical significance of the indirect effect coefficient.

$$z\text{-value} = ab / \left(\sqrt{b^2s_a^2 + a^2s_b^2 + s_a^2s_b^2} \right)$$

adolescents appear to have higher levels of health literacy than males and less healthier ones (beta final = -0.12 and 0.10 , $P < 0.05$). Second, unlike a non-significant finding of role of family risky health behaviors in predicting health literacy, friends' risky health behaviors seem strongly and negatively related to health literacy (beta final = -0.18 , $P < 0.001$). Those who have more smoking, drinking and sexually active friends tend to have lower levels of health literacy. Third, with regard to ease of access to various health information sources, easy access to parents for health information seems significantly and positively related to health literacy (beta final = 0.11 , $P < 0.05$). Fourth, in terms of general media use, reading magazines is positively (beta final = 0.12 , $P < 0.05$), while Internet

use is negatively (beta final = -0.09 , $P < 0.05$), related to health literacy.

Discussion

This study examined direct, relative and potentially mediating roles of interpersonal and media health socialization agents in adolescent self-reported health literacy. In understanding adolescent health literacy, we proposed a health socialization model guided by past consumer and political socialization models. The multiple factors included in our model were also guided by the SEM that the public health field has recently begun to embrace. Because this

study is an initial application of our proposed model using a cross-sectional survey, we mainly examined whether antecedents (demographic, sociostructural and environmental variables) and health socialization agents contribute to health literacy at least as defined in this study.

First, for the relationships between health socialization agents and health literacy, our findings indicate that higher frequency of getting health information from either interpersonal or media socialization agents was associated with higher health literacy. Just as socialization agents have been found to play important roles in children's learning about political knowledge and consumption behaviors in other socialization literature [40,90,91], socialization agents can play important roles in adolescents' ability to understand and use health information. Similarly, traditional and non-traditional media can also serve as important health socialization agents. In addition, we found that there was no significant difference between the role of interpersonal socialization agents and that of media socialization agents in predicting adolescent self-reported health literacy. This finding seems contradictory to some past health education and socialization literature. For example, studies guided by PST have found that parents and peers, as primary socialization agents, may be more influential in adolescent health and cognitive development than media as secondary socialization agents [13, 15]. Because past studies have examined the role of primary versus secondary socialization agents in adolescent health behaviors [61,92], our finding may not be accurately comparable. As far as health literacy concerns, the finding may be due to the fact that various kinds of health information have been made available to audiences through many different media channels (news, advertising and entertainment) [45, 46]. In addition, exponential growth of the Internet and its increased utility as a health information channel seems to contribute to more availability of health information on media [93]. But, considering existing research that highlights the increased importance of the Internet as a health information source among adolescents [49–51], it is not surprising to observe the surge of the Internet as

an optimal way to disseminate health information to adolescents [52].

Another explanation for the similarly important roles of interpersonal and media socialization agents in health literacy may be that adolescents gaining health information blur the line between interpersonal and media channels. The recent development of online social media and social networks can build new types of relationships and may serve as a proxy for interpersonal health information sources, thereby crossing the gap between interpersonal and mass mediated health information sources. On another note, our mediation tests suggest that interpersonal agents mediate media agents and health literacy more strongly than the other way around, which is consistent with the two-step flow of information thesis. But either direction of mediation is possible due to the nature of our cross-sectional data—that is, the adolescents who hear about health information through interpersonal channels can also be receptive to information from media and vice versa.

It should be noted that a few past studies have differentiated push (e.g. TV) and pull (e.g. Internet) media due to their different nature and to people's differing orientations to use and search for health information [80]. However, our EFA as well as CFA results demonstrate that the two kinds of media may not be differentiated at least among adolescents such as those in our study.

Lastly, our data show that other demographic and environmental factors contribute to adolescent health literacy. As suggested by the SEM, for example, easy access to parents for health information may help adolescents enhance health literacy. At the same time, environmental risk factors such as friends' risky health behaviors should be noteworthy because they may significantly deter adolescent capability or motivation of learning and understanding health information. The relationship between the participants' amount of time spent on the Internet and their health literacy also appears noteworthy because the non-significant bivariate relationship between the two variables becomes statistically significant when the other factors are taken into consideration. Such a relationship may

be evidence of suppression because it seems to be the case that a predictor has near-zero correlation with the dependent variable but becomes a significant predictor in the multiple regression model [94]. It implies that the relationship between Internet use and health literacy may be better understood in consideration of demographic and environmental factors, such as friends' and family's risky behavior and access to resources in the case of our model.

As with any empirical research, several limitations should be acknowledged. First, due to the nature of our cross-sectional survey data, we were not able to test fully the causal relationships in our proposed health socialization model. Related, because our main interest was to examine the significant roles of interpersonal and media socialization agents in adolescent health literacy, we considered health literacy as our outcome variable. But as shown in Fig. 1, health literacy should be treated as a mediator rather than an outcome variable, which eventually leads to health outcomes. Future research should analyze longitudinal survey data to establish more firmly the causal relationship of the health socialization model with various health outcomes mediated by health literacy. Also, it should be noted that health outcomes could be positive as well as negative depending on the level of health literacy; thus, more efforts should be made on improving the level of health literacy.

Second, when testing the health socialization model, other mediating factors can also be tested. This is because health literacy may be only one of many potential mediators (e.g. health beliefs, attitude toward specific health behaviors) that link health socialization agents to health outcomes. In addition, other environmental factors such as access to the health system could be included to situate the model in a broader social context.

Third, our measure of adolescent health literacy is limited. Our conception of health literacy was based on individuals' capacity that allows the person to acquire and use new information [36], the definition shared by Healthy People 2010 and Institute of Medicine [2, 95]. Accordingly, we use self-reported health literacy items that were used

in an adolescent survey setting (e.g. KidsHealth KidsPoll study) [38]. However, the health literacy items drawn from Brown *et al.* have not been validated in other studies, which can be a crucial drawback. Even though we demonstrated various types of validity of the items through rigorous statistical analyses, future research should replicate our findings by using more skill-based measures such as the (S)TOFHLA, REALM or Wide Range Achievement Test (WRAT) or by using validated health literacy measures [96,97]. While established health literacy scales tend to focus more on health care settings among patients or adults, more efforts should be made to develop more relevant and feasible health literacy scales for adolescents in both health care (REALM-Teen as one exception) [3] and non-health care settings. A few recent studies have discussed in greater detail on problems and directions for adolescent health literacy measurement and research [9,98].

Fourth, our main purpose was to propose a health socialization model and explore the roles that various socialization agents play in adolescent health literacy as defined in this study. Thus, we focused on how much adolescents get health information from the various sources, not the quality or reliability of that source. Existing knowledge indicates that Internet may be the most convenient source for health information but not the best source for learning [38]. Another line of research has also documented that specific health topics may lead adolescents to different health information sources [53]. Future research should delve into much deeper understanding of various kinds of health information sources and their roles as a convenient, reliable and/or trustworthy source. Refining the measures of media variables could also advance such endeavor because adolescent media use is complex along with the changing media environments.

Finally, the response rate of our participants is relatively low, which may weaken the generalizability of our findings. Literature shows no significant difference of the findings between low-return rate and high-return rate studies [71]. But future research should find better ways to recruit participants and

replicate our findings to study other populations (e.g. different regions and SES) and age groups.

Despite several limitations, our proposed model and findings provide a much richer understanding of how adolescent health literacy can be formed and reinforced. It also provides a promise to understand better how their health outcomes should be understood as complex interplay among health literacy, interpersonal and media socialization agents and multiple factors. Understanding a wider spectrum and process of adolescent health literacy will help find better ways to promote adolescent healthy behaviors and to prevent their risky behaviors.

Conflict of interest statement

None declared.

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Appendix I

Question wordings for control variables

Items with scales	Descriptives (frequency)		
	Mean	SD	
Ease of access to various health information sources How easy is it for you to ... (5-point scale: 1 = not at all easy to 5 = very easy)			
(1) See a doctor when you need one?	4.17	1.09	
(2) Talk with your parents about health issues?	3.99	1.27	
(3) Talk with your schoolteachers, counselors or coaches about health issues?	3.05	1.37	
(4) Find a computer with internet access?	4.54	0.97	
Self-reported health status			
How healthy do you think you are? Being healthy means not having any disease or ongoing illness and being physically, emotionally, and mentally fit. (5pt scale: 1- not at all healthy to 5-very healthy)	4.29	0.93	
Frequency of media use			
1. TV use^a	3.33	1.02	
(5-point scale: 1 = don't watch at all; 2 = <2 hours; 3 = 2–4 hours; 4 = >4 and <6 hours; 5 = >6 hours)			
(1) On a typical WEEKDAY (school day), how many hours a day do you watch TV?	3.16	1.10	
(2) On a typical WEEKEND day, how many hours a day do you watch TV?	3.51	1.26	
2. Web use^b	2.55	1.03	
(5-point scale: 1 = don't go online; 2 = <2 hours; 3 = 2–4 hours; 4 = >4 and <6 hours; 5 = >6 hours)			
(1) On a typical WEEKDAY, how many hours do you spend online (for example, email, Google, visiting certain websites, viewing image clips on YouTube, IM, MySpace) that is NOT related to school?	2.46	1.09	
(2) On a typical WEEKEND day, how many hours do you spend online that is NOT related to school?	2.63	1.17	
3. Magazine or newspaper use	2.37	1.13	
How often do you read a magazine or a newspaper?(5-point scale: 1 = never; 2 = less than once a week; 3 = 1–2 days a week; 4 = >2 and <5 days a week; 5 = almost everyday)			
Friends' risky health behaviors			
(5-point scale: 1 = none, 2 = one, 3 = two, 4 = three, 5 = four or more) How many of your close friends ...			
(1) Smoke?	2.15	1.52	
(2) Drink beer or liquor?	2.05	1.48	
(3) Have used some sort of illegal drugs [YOUR BEST GUESS]?	1.89	1.40	
(4) Do you think have engaged in sexual relationships [YOUR BEST GUESS]?	2.51	1.55	
Family risky health behaviors Do any of your family members living with you ...	Yes	No	Don't know
(1) Have health problems or illness such as cancer or diabetes?	39.8	49.3	10.9
(2) Smoke regularly?	46.8	48.4	4.9
(3) You have a drinking problem?	18.2	75.7	6.1

^aThe following two items were averaged to for the 'TV use' index.

^bThe following two items were averaged to for the 'Web use' index.

Appendix II

Correlations between each of the predictors and individual health literacy item

Predictors	Item 1	Item 2	Item 3	Item 4
Demographics (control)				
Sex (male)	0.01	-0.07	-0.07	-0.17***
Race (white)	-0.01	-0.01	0.13*	-0.18***
Residence (urban)	0.04	0.02	-0.01	-0.05
Health status	0.11*	0.15***	0.06	0.07
Environments (control)				
Friends' risky health behavior	-0.09	-0.16***	-0.20***	-0.19***
Family's risky health behavior	-0.03	-0.05	-0.06	-0.06
Access to doctors for health information	0.13***	0.11*	0.14***	0.04
Access to parents for health information	0.14***	0.14***	0.15***	0.08
Access to school teachers for health information	0.19***	0.12*	0.11*	0.10*
Access to the Internet for health information	0.09	0.05	0.00	-0.01
Media use (control)				
Watching TV	0.05	-0.09	-0.05	0.00
Reading magazine	0.07	0.08	0.04	0.19** ^{image_type=[taginfo "hercyq082f01_ht", rg_type]*}
Using the Internet	0.06	-0.08	-0.09	-0.06
Socialization agents				
Interpersonal	0.18***	0.22***	0.12*	0.20***
Media	0.14***	0.19***	0.11*	0.21***

Item 1: I try to get as much information about health as possible (1 = never to 5 = all the time); Item 2: I try to follow what I'm taught about health (1 = never to 5 = all the time); Item 3: Most of what I hear about health is (1) very hard to understand to (5) very easy to understand; Item 4: How much do you think a kid can do to grow up to be a healthy adult? (1 = almost nothing to 5 = a lot).
 * $P < 0.05$; ** $P < 0.01$, *** $P < 0.001$.