

Investigating knowledge structure and research trends in child and adolescent health literacy research through network text analysis

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ABSTRACT

Purpose: This study aims to investigate the knowledge structure and research trends in child and adolescent health literacy research over the past 30 years by using network text analysis.

Method: The study was conducted in four steps: 1) collecting abstracts, 2) keyword extraction and preprocessing, 3) creation of co-occurrence matrix, and 4) text network analysis.

Results: As a result of the centrality analysis, the upper-ranked core keywords were “health care,” “health behavior,” “prevention,” “treatment,” and “health promotion.” In contrast to earlier times, “barrier,” “caregiver,” “school setting,” and “QOL” have recently emerged as core keywords.

Conclusions: Over the past 30 years, child and adolescent health literacy has been importantly addressed in both clinical and public health approaches. The results of the current study provide references for future research in child and adolescent health literacy.

Implication for practice and research: This study suggests the need for additional research on school-based practices that can improve health literacy and for identifying validated and reliable multidimensional health literacy assessment instruments.

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Introduction

Worldwide, health literacy has gained considerable attention. In the past 15 years, numerous studies on health literacy have been published, demonstrating an exponential growth trend (Qi et al., 2021). Specifically, the development of health literacy is becoming extremely important to prepare individuals and societies to deal with the COVID-19 pandemic, an unprecedented health crisis on a global scale (Paakkari & Okan, 2020). Although health literacy can be defined in several ways (Sørensen et al., 2012), almost all commonly used definitions include elements that describe the skills that enable individuals to obtain, understand, and use available information in order to make decisions and take actions that can affect their health status (Sørensen et al., 2012).

As children and adolescents are considered to have fewer health problems and less interactions with the health system than adults,

child and adolescent health literacy has received little attention at the initial stage of the study of health literacy in a medical setting (Manganello, 2008). However, as the concept of health literacy extends beyond the clinical setting and into a public health perspective, health literacy in children and adolescents has begun to attract attention as a promising approach to healthcare, disease prevention, and health promotion in adulthood (Bröder et al., 2017).

Recent global efforts reflect the importance of health literacy in children and adolescents. In the Shanghai Declaration on promoting health in the 2030 agenda for sustainable development, the World Health Organization (WHO) urged the early promotion of health literacy through school health education (World Health Organization, 2017). The *Health Behavior in School-Aged Children study* reported comparative findings on the health literacy levels of 15-year-old adolescents in Europe as well as the associations between health literacy and self-rated health (Paakkari et al., 2020). A recent study has suggested utilizing action opportunities to implement and evaluate health literacy in schools (World Health Organization, 2021).

Despite the worldwide growth and interest in health literacy among children and adolescents, there is currently a lack of comprehensive research to understand the knowledge structure in this field. Most studies have evaluated child and adolescent health literacy research through

Abbreviations: ERIC, Education Resources Information Center; NTA, Network text analysis; NVS, Newest Vital Sign; QOL, Quality of life; REALM, Rapid Estimate of Adult Literacy in Medicine; WRAT, Wide Range Achievement Test.

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qualitative research methods, such as systematic literature reviews. However, because these studies focused on specific topics, they do not provide a complete overview of the current state of research. A comprehensive quantitative review of the literature can provide valuable information on knowledge structures, research trends, and future research orientation (Chen, 2017). Based on this understanding, network text analysis (NTA) has been adopted in various academic disciplines.

NTA originated with the observation that after encoding semantic connections between concepts, a network of semantically connected concepts could be constructed (Popping, 2000). It is an effective method for conducting quantitative analysis and categorizing text data using a wide range of tools, such as network and graph analysis, as well as for identifying the most influential concepts that produce meaning (Diesner & Carley, 2005; Paranyushkin, 2011). Furthermore, researchers can identify core keywords through centrality indicators derived from network analysis. Additionally, the mapping and visualization of relationships between the keywords help to intuitively understand the knowledge structure in the current research.

Therefore, this study aimed to identify core keywords and keyword networking of child and adolescent health literacy research by using NTA and to understand research trends over the past 30 years.

Methods

Data collection

Literatures published from January 1991 to July 2021 were collected from PubMed, Embase, the Cumulative Index to Nursing and Allied Health Literature, and Education Resources Information Center (ERIC). The first year, 1991, was chosen because it was when the Rapid Estimate of Adult Literacy in Medicine (REALM; Davis et al., 1991), the first health literacy assessment instrument that stimulated research on health literacy, was developed. Table 1 presents the search strategy used in each of the databases is listed. Journal articles addressing health literacy in children and adolescents aged 18 or younger in abstracts were included in the review. Further, studies were included if they concerned a wider age range but had considered individuals 18 or younger as the primary sample. We excluded all studies that (a) were not journal articles, (b) had no abstracts, (c) were not written in English, (d) had unclear authors, (e) did not address any component of health literacy, (f) did not target children and adolescents, and (g) focused on mental health literacy that arose from health literacy but one that needs to be independently assessed based on their ongoing evolution and development (Kutcher et al., 2016). In all, 557 articles were selected for text analysis. Fig. 1 shows the article inclusion process.

Analysis

We conducted NTA to identify the knowledge structure in child and adolescent health literacy research by using the semantic network analysis module of NetMiner version 4.3 (Cyram, 2021) as follows: (1) keyword extraction and preprocessing, (2) creation of co-occurrence matrix, and (3) text network analysis. NetMiner is an application software used for social network analysis and visualization; it has an

internal Python-based script engine. NetMiner with “semantic network analysis” can extract words from unstructured text data through a morphological analyzer and create a word network. Additionally, User Dictionary enables researchers to register proper nouns, compound nouns, abbreviations, etc. as well as single words for words that have similar meaning, thus facilitating text preprocessing.

Prior to the analysis, bibliographic information—including publication year and abstract—was organized into one row and saved as an Excel file. Then, we developed dictionaries for a thesaurus, defined words, and exception words. First, the thesaurus was created so that words and abbreviations with the same or similar meaning could be extracted as one representative word. Second, the defined word dictionary included proper nouns and compound nouns, such as “body mass index,” “*The Newest Vital Sign*,” “health promotion,” and “chronic disease.” Third, we created an exclusion word dictionary to remove words with little useful information. For example, words such as “aim,” “conclusion,” “background,” and “result” that frequently appear in abstracts and those that are directly used in literature searches—such as “health literacy,” “child,” and “adolescent” as well as other similar words—were included in an exclusion word dictionary. Furthermore, the words “information,” “skill,” “accessibility,” “decision,” “understanding,” “motivation,” and “ability,” which appear in the definition of health literacy, were excluded.

Then, a term document matrix was created, and frequency analysis was conducted. Words that appeared only once in the entire document were excluded. If a word frequently appears in multiple documents, it can be assumed that the keyword is unrelated to the document as a nonspecific keyword (Kim & Delen, 2018; Ramos, 2003). Therefore, the bottom 10% of words were excluded based on the term frequency–inverse document frequency value, indicating how important words are in a document (Ramos, 2003).

For network analysis, the extracted words were constructed into a co-occurrence matrix. The co-occurrence approach is useful to map and understand the structure of the underlying document set as it identifies semantic relationships among terms present in the documents (He, 1999). Co-occurrence distribution demonstrates the importance of a term, and terms with a high frequency of co-occurrence are more likely to be keywords (Matsuo & Ishizuka, 2004). Therefore, we used keywords in the network analysis, which were in the top 10% of word co-occurrence frequency. The centrality analysis was conducted to quantify the relationship between the keywords. Centrality is an extremely important concept for identifying important nodes within a network and is a core principle of network analysis (Zafarani et al., 2014). In this study, we measured the most common centralities: degree and betweenness (Wasserman & Faust, 1994). Degree centrality is the simplest way to measure node connectivity; it evaluates importance based on the number of links that each node has, that is, how many connections each node has to other nodes in the network (Wasserman & Faust, 1994). Betweenness centrality shows nodes acting as bridges between the nodes in a network; this measure is useful for identifying keywords that influence the flow of connections between keywords in a network (Wasserman & Faust, 1994). Finally, based on degree centrality, a network of the top 30 keywords was visualized by applying the Fruchterman–Reingold and Pathfinder

Table 1
Database search strategies.

Database	Search engine	Entry term	Result
MEDLINE	PubMed	“health literacy”[Title/Abstract] AND (allchild[Filter] OR child[Filter] OR adolescent[Filter])	1939
EMBASE	EMBASE	‘health literacy’:ab,ti AND ([adolescent]/lim OR [child]/lim OR [school]/lim)	2080
CHINAHL	EBSCO	TI “Health Literacy” OR AB “health literacy” Limiters–Age Group: Child: 6–12 years, Adolescent: 13–18 years, All Child	1288
ERIC	EBSCO	(TI “health literacy” OR AB “health literacy”) AND (TI adolescen* OR TI child* OR TI youth OR TI student* OR AB adolescen* OR AB child* OR AB youth OR AB student*)	223

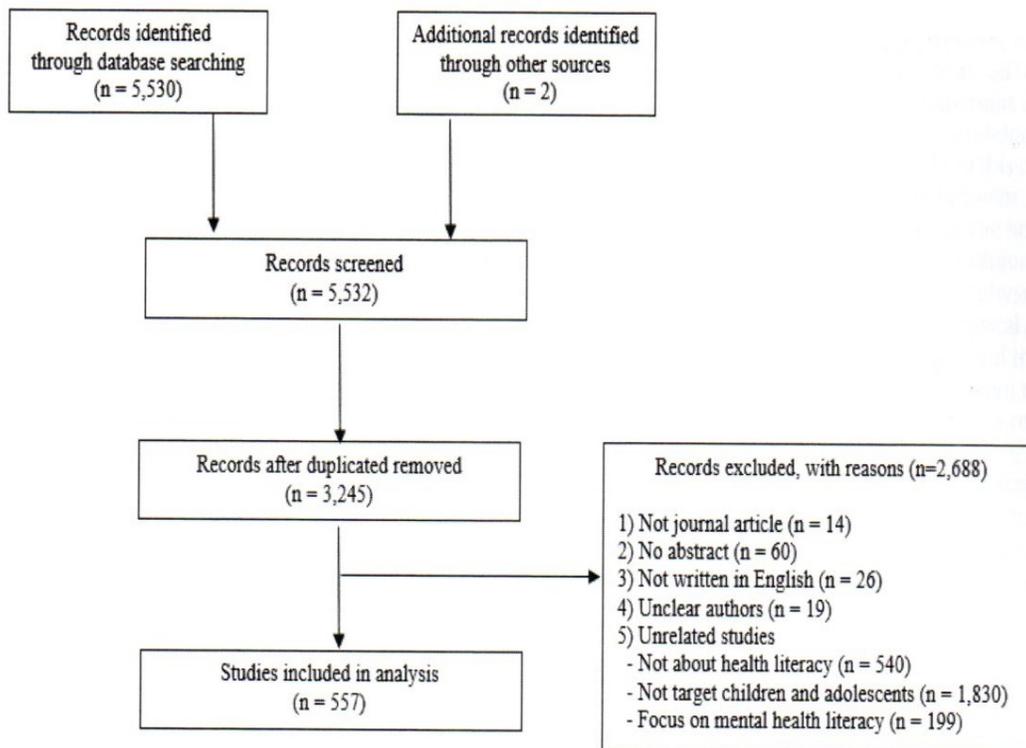


Fig. 1. Flow diagram of data collection.

algorithms to understand the semantic structure. Specifically, a pathfinder network enables effective link reduction without losing important information by including all potentially significant links (Quirin et al., 2008).

Further analysis was conducted to identify the research keyword trends by period. The collected articles were classified into three periods based on the year in which Healthy People 2020 (Ratzan, 2011) and the Shanghai Declaration on promoting health in the 2030 Agenda for Sustainable Development (World Health Organization, 2017), which could be the driving forces for health literacy research, were declared. Subsequently, a co-occurrence matrix was created for each period, and a centrality analysis was conducted. Keyword trends were identified by selecting and comparing the top 30 keywords based on each period's degree centrality.

Results

Core keywords and knowledge structure of child and adolescent health literacy research

In all, 557 articles related to child and adolescent health literacy were published up to 2021. The words that appeared in these articles have been refined, and a total of 1861 words were constructed into a co-occurrence matrix. For the significant analysis, frequency and centrality analyses were conducted using 551 keywords that were included in the top 10% based on co-occurrence frequency. Table 2 lists the top 30 keywords by frequency, degree centrality, and betweenness centrality. The keywords commonly included in the upper ranks based on centrality were “health care,” “health behavior,” “prevention,” “treatment,” and “health promotion.” These five keywords appeared to play central roles and act as bridges in the network (Fig. 2).

Trends in child and adolescent health literacy research

To identify trends of keywords over time, articles were divided into three periods, and the numbers of articles for each period were 51 in 1991–2010, 154 in 2011–2016, and 352 in 2017–2021. The numbers of top 10% keywords based on co-occurrence frequency used in the

network analysis were 55 in 1991–2010 (Period I), 389 in 2011–2016 (Period II), and 346 in 2017–2021 (Period III). Table 3 presents the top 30 keywords by centrality according to time period. The core keywords that appeared in common in the three periods were “health care,” “concept,” “chronic disease,” “instrument,” “health behavior,” “health

Table 2

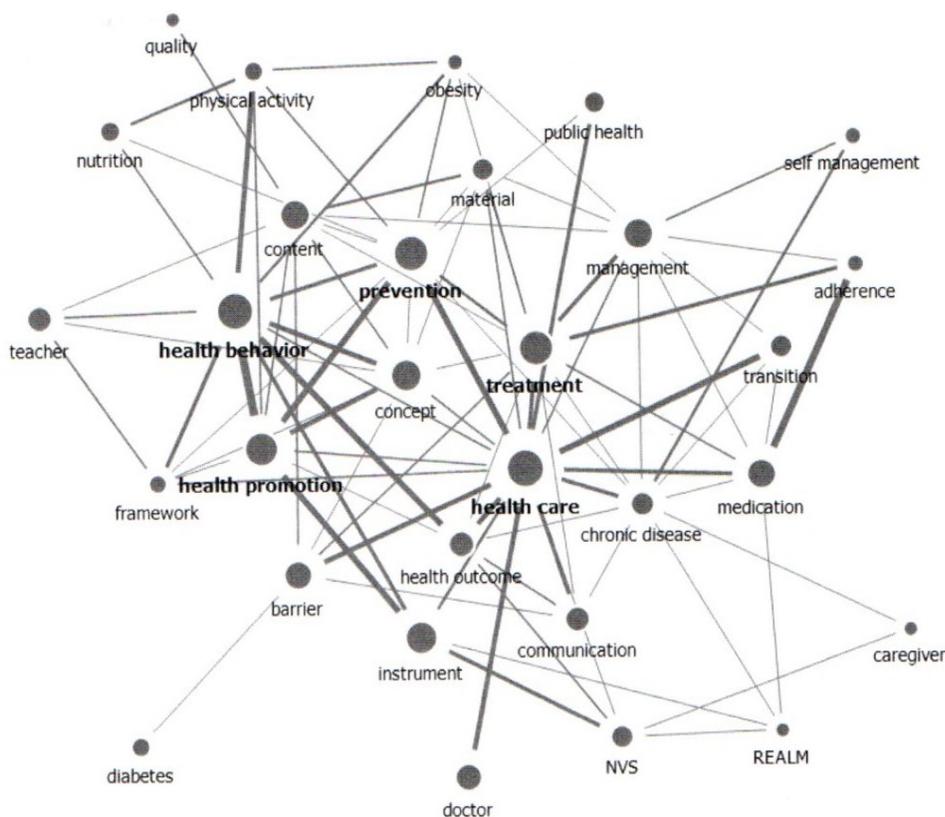
The top 30 keywords by frequency and centrality.

Rank	Frequency ^a	Degree centrality	Betweenness centrality
1	health care	health care	health care
2	health behavior	health behavior	health behavior
3	instrument	prevention	prevention
4	health promotion	treatment	treatment
5	concept	health promotion	concept
6	prevention	instrument	instrument
7	health outcome	concept	health promotion
8	treatment	content	content
9	content	management	doctor
10	teacher	medication	teacher
11	communication	barrier	barrier
12	management	doctor	management
13	barrier	health outcome	medication
14	material	communication	NVS
15	chronic disease	teacher	nutrition
16	medication	chronic disease	communication
17	framework	NVS	health outcome
18	NVS	material	diabetes
19	doctor	transition	injury
20	quality	public health	physical activity
21	measurement	nutrition	mother
22	adherence	diabetes	CAIHLQ
23	physical activity	physical activity	material
24	nutrition	framework	quality
25	public health	adherence	transition
26	transition	self-management	chronic disease
27	self-efficacy	obesity	pregnancy
28	obesity	caregiver	public health
29	self-management	quality	adherence
30	caregiver	REALM	theory

Note: NVS = The Newest Vital Sign; REALM = The Rapid Estimate of (Adult/Adolescent) Literacy in Medicine; CAIHLQ = Chinese Adolescent Interactive Health Literacy Questionnaire.

^a Document Frequency.

a.



b.

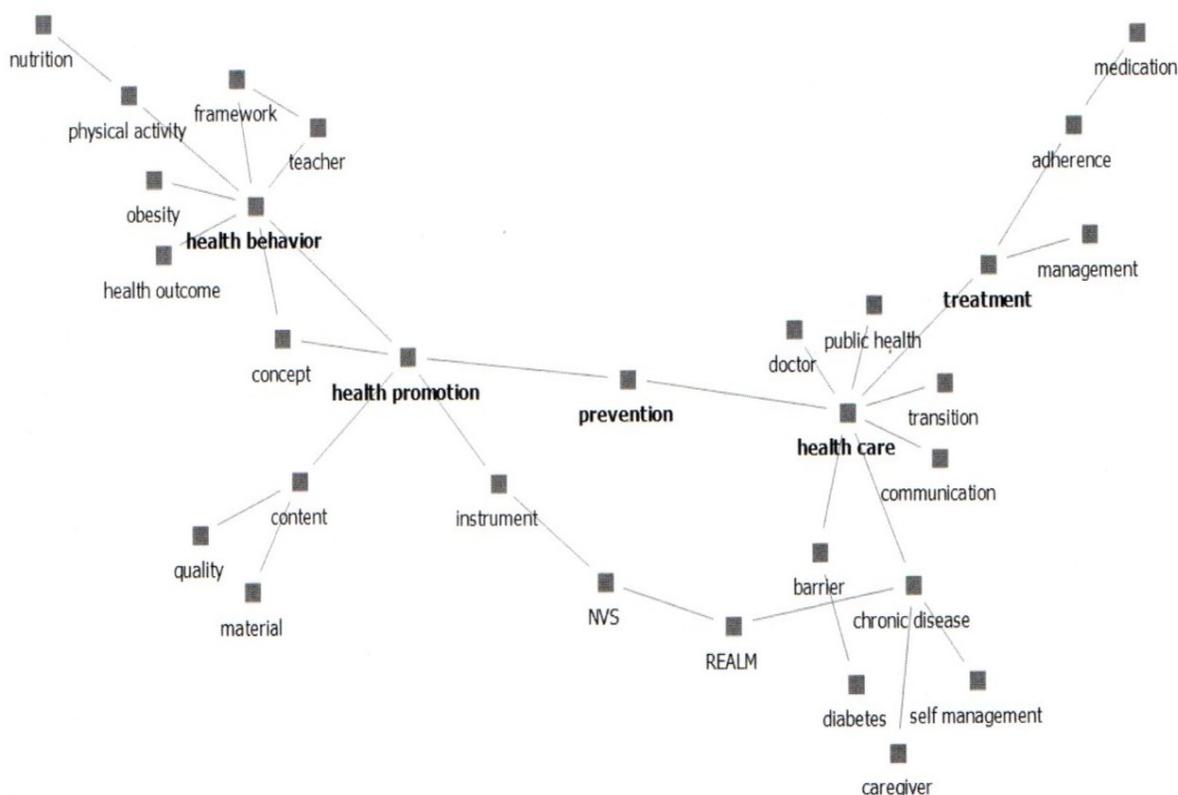


Fig. 2. Maps of the keywords in child and adolescent health literacy research.

Note: (a) The top 30% of link weights have been visualized to improve readability. (b) The most salient semantic relationships among the keywords were visualized by a pathfinder algorithm. The size of nodes indicates the keyword centrality, and the thickness of the links indicates the co-occurrence frequency of keyword pairs. Bold letters are the top five keywords by degree centrality. NVS = The Newest Vital Sign; REALM = The Rapid Estimate of (Adult/Adolescent) Literacy in Medicine.

promotion,” “prevention,” “material,” “treatment,” and “adherence.” The core keywords in 1991–2010 were as follows: “framework,” “evaluation,” “standard,” “WRAT,” “educator,” “smoking,” “BMI,” and “measurement.” From 2011 to 2016, “public health,” “management,” “diabetes,” “asthma,” “mother,” “burden,” “pregnancy,” “SCD,” and

“healthcare utilization” emerged as new core keywords compared with 1991–2010. From 2017 to 2021, “barrier,” “caregiver,” “quality,” “school setting,” and “QOL” were core keywords compared with other periods. Additionally, it was found that “health behavior,” “instrument,” “content,” and “NVS” were ranked higher than in the previous period.

Table 3
The top 30 keywords by degree centrality according to time period.

Rank	Period I (1991–2010) (n = 54) ^a	Period II (2011–2016) (n = 154) ^a	Period III (2017–2021) (n = 352) ^a
1	health care	health care	health behavior
2	concept	prevention	health care
3	medicine	treatment	content
4	health outcome	health promotion	instrument
5	physical activity	health behavior	treatment
6	standard	concept	barrier
7	chronic disease	public health	prevention
8	instrument	management	health promotion
9	health behavior	diabetes	health outcome
10	health promotion	chronic disease	management
11	prevention	material	concept
12	REALM	medication	NVS
13	material	adherence	teacher
14	teacher	asthma	communication
15	WRAT	transition	medication
16	communication	instrument	doctor
17	nutrition	mother	transition
18	self-efficacy	framework	caregiver
19	educator	nutrition	material
20	obesity	pregnancy	quality
21	smoking	burden	chronic disease
22	BMI	doctor	framework
23	NVS	health status	obesity
24	adherence	medicine	school setting
25	framework	obesity	public health
26	health status	physical activity	self-efficacy
27	measurement	self-management	QOL
28	self-management	SCD	adherence
29	treatment	content	self-management
30		healthcare utilization	REALM

Note: The degree centrality value was the same from rank 30 and below in Period I. REALM = The Rapid Estimate of (Adult/Adolescent) Literacy in Medicine; WRAT = Wide Range Achievement Test; NVS = The Newest Vital Sign; BMI = Body Mass Index; SCD = Sickle Cell Disease; QOL = Quality of Life.

^a The number of articles.

Discussion

This study aimed to identify knowledge structures and research trends in child and adolescent health literacy research. It demonstrated that most of the keywords with high degree centrality also exhibited high betweenness centrality, and “health care,” “health behavior,” “prevention,” “treatment,” and “health promotion” were identified as influential words. This finding indicates that health literacy among children and adolescents was importantly addressed in clinical and public health approaches. The maps showing the semantic relationships between the top-ranked keywords based on centrality provide a contextual structure centered on the aforementioned five core keywords. “Healthcare” represented the most salient relationships with “treatment,” “transition,” “prevention,” “doctor,” “barrier,” “communication,” and “chronic disease”; of these, “transition” was the most frequently co-occurring keyword with “health care.” Many studies have mentioned that the transition from pediatric to adult healthcare services is an important issue for children and adolescents that have various health conditions, and health literacy is a factor that influences transition readiness and optimizes transition (Beal et al., 2016; Zhong et al., 2020). Further, “health care” has strong links with “treatment,” “chronic disease,” “communication,” and “barrier,” meaning that a great deal of research has been conducted on the topic of treatment and management of children and adolescents with healthcare needs. Indeed, associations between health literacy, treatment, and medication adherence (Ahmad & Sorensen, 2016; Dharmapuri et al., 2015; Murphy et al., 2009) as well as self-management of chronic diseases (Valerio et al., 2016; Zhong et al., 2020) have been validated by many researchers.

“Health behavior” had the second-highest degree and betweenness centrality, and it showed the strongest link with “health promotion.” From the perspective of health promotion, health literacy can be

considered an “asset” that supports control over various determinants of health (Gugglberger, 2019; Nutbeam et al., 2018). Health behaviors during childhood and adolescence are important health determinants that contribute to the development of a lifelong healthy lifestyle (Friedman et al., 2008; Wiium et al., 2015). In this context, the relationship between health literacy and health behavior may have become a major topic of research aimed at promoting the health of general children and adolescents (Fleary et al., 2018). Additionally, “health behavior” has a prominent link with “nutrition,” “physical activity,” “BMI,” and “obesity.” Considering that nutrition, physical activity, and obesity are being used as national health indicators and that health literacy is an important health policy agenda, it can be seen that three keywords were used as major variables to investigate the relationship between health literacy and health behavior.

For research trend analysis, NTA was conducted by dividing published articles into three periods. The keywords that appeared in common in all the periods were “health care,” “concept,” “chronic disease,” “instrument,” “health behavior,” “health promotion,” “prevention,” “material,” “treatment,” and “adherence,” and these can be seen as topics that have been continuously explored in child and adolescent health literacy research for the past 30 years. Furthermore, the degree centrality rankings of “health behavior,” “instrument,” “content,” and “NVS” continued to increase over time, indicating that they are keywords with a growing influence.

The changes in keywords emerging in each period reflect the changes in research topics over time. In Period I (1991–2010), “standard” and “educator” appeared as core keywords compared with other periods. The term health literacy was first used in 1974 in a publication on health education as a policy issue (Simonds, 1974). In the early 1990s, health literacy was defined by the American Association for Health Education and considered a desirable outcome to be achieved through health education as an enabling factor in promoting healthy behaviors (Schima & Ames, 1996). Thus, it is possible that the initial research on the health literacy of children and adolescents focused on health education because of this trend. “WRAT” is also a keyword that only appears in Period I. Wide Range Achievement Test (WRAT) is a word recognition test validated as an instrument that has reading ability (Wilkinson, 1993). It seems to have emerged as a core keyword in this period as it was used as part of functional health literacy measurement instruments, such as REALM (Davis et al., 1991) and Newest Vital Sign (NVS; Weiss et al., 2005).

In Period II, new core keywords, such as “management,” “diabetes,” “asthma,” “SCD,” “public health,” and “healthcare utilization,” emerged compared with Period 1, suggesting that health literacy among children and adolescents with special health needs is beginning to be actively explored. The early 2010s was a time when national efforts to improve health literacy accelerated based on the accumulation of evidence on adult health literacy levels and healthcare service use and health outcomes (Benjamin, 2010; Sorensen et al., 2015). During this period, health literacy was proposed as a public health goal in numerous countries (Australian Commission on Safety and Quality in Health Care, 2014; Scottish Government, 2014; U.S. Department of Health and Human Services, 2010). It can be assumed that public health efforts on health literacy led to calls for the improvement of health literacy among children and adolescents and contributed to the expansion of related research. During this period, “pregnancy” and “mother” were also specific core keywords. In the same period, there was a worldwide emphasis on protecting young individuals from early childbearing to reduce maternal and child mortality (World Health Assembly, 64, 2011; UNFPA, 2013). This global concern may have prompted investigations into the role of health literacy for the prevention of pregnancy in adolescents and the health of adolescent mothers and their children.

In Period III, new core keywords, such as “school setting” and “QOL,” emerged. WHO stated health literacy to be an important determinant of health and a critical component of efforts to reduce health inequality (World Health Organization, 2017). Furthermore, health literacy was

emphasized, above all, as an integral part of the skills and competencies developed through school curriculum (World Health Organization, 2017). The 5th European Conference on Health-Promoting Schools suggested that health literacy could be enhanced as a whole-school approach to health (Dadaczynski et al., 2020). As the role of schools for improving the health literacy of children and adolescents is emphasized amid such international interest, the keyword “school setting” seems to have emerged as a new core keyword. Quality of life (QOL) is a multidimensional concept that measures an individual's wellbeing (The WHOQOL Group, 1995), and it is an important indicator in chronic disease management (Van der Vinne, 2009). Lower health literacy has been reported to be associated with poor QOL among adult patients with chronic diseases (Zheng et al., 2018). Therefore, the emergence of “QOL” as a core keyword in Period III indicates that the research on the relationship between health literacy and QOL of children and adolescents with chronic diseases has begun to increase, as interest in child and adolescent health literacy in health care increases.

Topics that need further investigated have been identified through research trends as follows: First, “school setting” has recently emerged as a core keyword in of child and adolescent health literacy research, suggesting that the interest in improving school-based health literacy has increased. However, there is still little evidence of implementation and evaluation for health literacy in school settings. Further research on school-based practices could contribute to the provision of evidence of effective implementation for improving child and adolescent health literacy. Second, although instruments for measuring health literacy in general children and adolescents have been actively developed (Okan et al., 2018), NVS, which measures functional health literacy, has been the most used instrument so far, and there is no gold standard for multidimensional health literacy assessment instruments. Therefore, more research is required to identify validated and reliable, multifaceted health literacy measurement instruments that can be applied from the health promotion and education perspective.

Practice implications

Health literacy is an important asset for health care and health promotion of children and adolescents. This study provides a variety of information on health literacy by presenting the knowledge structure and research trends on health literacy in children and adolescents. In addition, this study suggests the need for additional research on school-based practices that can improve health literacy and for identifying validated and reliable multidimensional health literacy assessment instruments.

Limitations

This study has limitations in that it did not consider influential articles or authors by focusing on keyword network analysis. Future analyses of research trends should develop more extended knowledge maps of child and adolescent health literacy research by building co-authorship and co-citation networks.

Conclusions

This study provides information on the knowledge structure and research trends in health literacy research of children and adolescents. Over the past 30 years, child and adolescent health literacy has been importantly addressed in both clinical and public health approaches. The results of the current study provide references for future research in child and adolescent health literacy.

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Credit authorship contribution statement

Eun Jung Bae: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Formal analysis, Visualization. **Ah. Ram Jang:** Conceptualization, Methodology, Writing – review & editing. **Hyena Park:** Conceptualization, Methodology, Writing – review & editing. **Ju Young Yoon:** Conceptualization, Methodology, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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