A Scoping Review of Health Literacy Measurement Tools in the Context of Cardiovascular Health

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Abstract

Background. Despite the strong link between health literacy and cardiovascular health outcomes, health literacy measurements remain flawed and fragmented. There exists a gap in the knowledge when formulating a valid measurement to capture the broad concept of health literacy. The existence of various tools for health literacy measurement also hampers the availability of health literacy data. Additionally, little research is available on a valid measurement tool for cardiovascular health literacy. *Objective.* This study aims to provide an overview of the health literacy measurement tools used in the context of cardiovascular health. *Methods.* A scoping review was conducted. Two electronic databases, Medline and Embase, were searched to identify studies that described a tool for the measurement of health literacy in the context of cardiovascular health. *Results.* After reviewing the available studies, 53 studies met the inclusion criteria. A total of 26 health literacy measurement tools were identified in the studies. Among the 26 tools, 16 used an objective measurement approach, 9 adopted a subjective approach, and 1 employed a mixed approach. Additionally, 28 studies used tools to measure print literacy, 15 studies measured print literacy and numeracy, and 5 studies measured print literacy, oral literacy, and numeracy. *Conclusions.* STOFHLA, TOFHLA, and REALM were the mostly commonly-used tools in the selected studies. The majority of tools were based heavily on reading skills and word recognition. Researchers should focus on the development of more comprehensive and reliable health literacy measurement tool/s specific to cardiovascular health to assist health care providers to more efficiently and accurately identify people with cardiovascular problems who have inadequate health literacy.

Health Literacy

Health literacy (HL) refers to an individual's ability to read, understand, and use the information necessary to enjoy good health and to obtain adequate health care in order to maintain their health (Sorensen et al., 2012; U.S. Department of Health and Human Service, 2009). HL involves a constellation of skills including the ability to interpret documents, read and write prose (print literacy), use quantitative information (numeracy or quantitative literacy), and communicate effectively (oral literacy; Drainoni et al., 2008; Garcia-Retamero & Galesic, 2010; Nutbeam, 2000).

HL is essential for successful access to and use of health care services, self-care of noncommunicable conditions, and maintenance of health and wellness. Studies have reported that people with higher levels of HL are more likely to make health-promoting decisions, adopt healthier behaviors, and be able to access and use relevant resources, including information and services (Kutner et al., 2006; Cho, Lee, Arozullah, & Crittenden, 2008; Dewalt, Berkman, Sheridan, Lohr, & Pignone, 2004; Hasman & Chiarella, 2009; Hope, Wu, Tu, Young, & Murray, 2004). In contrast, low HL is associated with poorer comprehension of health care services and health outcomes, riskier choices, less participation in health-promoting activities, higher probability of hospitalization, lower utilization of screening and preventive services, increased medical costs, poor adherence to medication, higher prevalence and severity for some chronic diseases, increased morbidity, and premature death (Baker et al., 1999; Hasselkus, 2009; Koh et al., 2012; Nutbeam, 2008; Pleasant & McKinney, 2011; Shaw, Huebner, Armin, Orzech, & Vivian, 2009; World Health Organization, 2010; 2011).

Health Literacy Measurements

Objective and subjective measurement approaches have been used for the measurement of HL (Berkman, Davis, & McCormack, 2010). In an objective measurement approach, respondents'

abilities are assessed by having them solve tasks dealing with print literacy, oral literacy, and/or numeracy, whereas a subjective approach is characterized by the self-report of respondents' own perceived abilities in multiple domains. The Rapid Estimate of Adult Literacy in Medicine (REALM), the Medical Term Recognition Test (METER), the Newest Vital Sign (NVS), and the Test of Functional Health Literacy in Adults (TOFHLA) are commonly used tools for the measurement of HL in the literature.

Regarding the domains that the different tools measure, early HL measurements focused exclusively on reading capacity, seeking to establish links between reading skills and health outcomes (Dickson-Swift, Kenny, Farmer, Gussy, & Larkins, 2014). Contemporary measurements extend beyond simply the capacity to read. Many researchers suggest that HL tools should focus on writing, numeracy, speaking, listening capacity, and understanding of the health care system (Nutbeam, 2000; Parker & Kreps, 2005; Sorensen et al., 2012). It is believed that these concepts are central for promoting self-management and individual responsibility for health care (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Rothman, Montori, Cherrington, & Pignone, 2008).

Health Literacy and Cardiovascular Health

Cardiovascular disease (CVD) is a term used to describe all diseases of the heart and blood vessels, and an estimated 17.5 million people died of CVDs in 2012, representing 31% of all global deaths (World Health Organization, 2012). Cardiovascular health (CVH) emphasizes a more integrative definition of health to include protective biological factors and behaviors, but it has not been investigated in relation to individuals' perspectives of their own health (Manczuk et al., 2017). Cardiovascular HL can therefore refer to the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions to manage their CVH.

In particular, a growing number of scientific reports have shown that HL plays a significant role in the management of CVD (Safeer, Cooke, & Keenan, 2006). Limited HL is a major barrier that blocks many people from achieving good CVH or benefitting from effective treatment for myocardial infarction, heart failure, stroke, and other CVDs (Manczuk et al., 2017). Most CVDs can be prevented by addressing behavioral risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity, and harmful use of alcohol through population-wide strategies. At the same time, evidence has accumulated that HL is correlated with healthy behavior and better health outcomes.

Improvement of cardiovascular HL is significant to the management of CVH. The identification of HL levels among cardiovascular patients and the general populations would also enable the provision of tailored-made support in prevention and disease management. Thus, it is important to understand which HL measurement tools have been used among people with CVDs in different settings. This study identifies current cardiovascular HL measurement tools in the literature and provides some information on the advantages and limitations of the identified tools. To the best of our knowledge, there has not yet been a scoping review that specifically addresses this question in the context of cardiovascular health.

Method

Objective of the Study

A scoping review of the literature was conducted using the framework approach (Arksey & O'Malley, 2005) to identify the tools that currently exist for the measurement of cardiovascular HL. Scoping reviews allow researchers to examine the extent, range, and nature of research activities on a specific topic, to summarize and disseminate research findings, and to identify research gaps in the existing literature (Arksey & O'Malley, 2005; Berkman et al., 2010).

Search Strategy

A comprehensive literature search of the Medline and Embase databases was conducted for all available years to March 31, 2017 in English and Chinese. Only original research articles focusing on cardiovascular health literacy measurements published in peer reviewed journals were included. Two researchers and two health sciences librarians at the University of Oslo Medical Library were included in the study.

Search Terms

In order to capture all studies to contribute to a thorough review, the final search terms included were [(health AND literacy) OR (cardiovascular AND literacy)] AND (cardiovascular OR heart OR vascular OR arrhythmias OR cardiac OR myocardial OR aneurysm OR aortic OR cerebrovascular OR stroke) AND (instrument* OR tool* OR questionnaire* OR survey* OR interview*).

Study Selection and Charting the Data

After removal of duplicates, articles were screened in order by titles, abstracts, and then full text. The screening process was performed independently by two authors, and any disagreement was resolved through discussion until consensus was achieved. Data were extracted by the first author and cross-checked by the second author.

Our systematic search of the electronic databases yielded 740 potential articles. After deletion of duplicates, 555 articles remained for the analysis. Irrelevant studies that were not original research, did not use a tool to measure HL, or had no cardiovascular focus were screened out (see Figure 1). At the full text screening stage, 31 articles were excluded because they were disease-specific systematic review studies, studies of HL level among caregivers without a specific HL tool, measurements of health professionals' knowledge of health literacy

without any HL tool, educational intervention programs for families without any HL tool, or e-health and health literacy studies without HL tools.

As a result of the full text review, 53 articles were included in this study. Using Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA) spreadsheet, the studies were charted and summaries developed that included author, journal, publication year, research question or aim, setting, sample, and instrument used (see Table 1).

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Results

Of the 53 studies identified in the literature, a total of 26 HL measurement tools were used for the measurement of cardiovascular HL levels in different countries and settings. The findings show that 16 tools used an objective approach, 9 used a subjective approach, and 1 used a mixed approach (see Table 2). The objective measurement approaches used were the Short Test of Functional Health Literacy in Adults (STOFHLA; 17 studies), REALM (7 studies), the NVS (4 studies), TOFHLA (4 studies), METER (2 studies), the NVS self-administered questionnaire (NVS [SAQ]; 1 study), the Basic Skills Assessment Initial Test (BSAIT; 1 study), the High Blood Pressure–Health Literacy Scale (HBP-HLS; 1 study), the Chinese version of HBP-HLES (C-HBP-HLS; 1 study), the Functional Health Literacy (FHL) measurement (1 study), Nutritional Literacy Scale (NLS; 1 study), Stroke Awareness Questionnaire (SAQ; 1 study), the Mandarin version of the Short-form Health Literacy (SHEAL) Scale (1 study), a heart disease knowledge assessment questionnaire (1 study), and a stroke literacy questionnaire (1 study). Three studies used at least two or more HL measurement tools (Aranha et al., 2015; Ibrahim et al., 2008; Mattson et al., 2015)

--------------------INSERT TABLE 2 ABOUT HERE-------------------------

The reported tools that used a subjective approach were the Heart Failure-Specific Health Literacy Scale (HF-Specific HL Scale; 3 studies), the Taiwan Health Literacy Scale (THLS; 1 study), the Subjective Health Literacy Screener (SHLS; 1 study), the Health Literacy Questionnaire (HLQ; 1 study), the Dutch version of the Set of Brief Screening Questions (D-SBSQ; 1 study), the Brief Health Literacy Screening (BHLS; 1 study), a short screening questionnaire (1 study), and a short health questionnaire (1 study).

The study analyzed the tools according to the domain they measured. The findings of the review showed that the studies measured print literacy only (n = 28), print literacy and numeracy (n = 15), print literacy, oral literacy, and numeracy (n = 5), print literacy and oral literacy (n = 4), or oral literacy only (n = 1).

Discussion

This scoping review aimed to provide a better understanding of current cardiovascular HL measurement tools in the literature. The discussion of results is handled under four categories: approaches used in the HL tools, common tools, measurement mode, and cultural settings.

Objective, Subjective, or Mixed Approach

The findings of the research show that the majority of the studies used an objective approach for the measurement of HL in the CVH context. An advantage of using an objective approach is that it avoids the responses being subjected to a social desirability bias, which decreases the validity of the measurement (Cho et al., 2008; McNaughton et al., 2013; Reading et al., 2017).

However, the research shows that tools with a subjective measurement approach often address wider domains of HL such as patient–provider encounters; interaction with the health care system; rights and responsibilities; health information-seeking; understanding, processing, and using health care information; and communication with health care professionals (Begoray & Kwan, 2012).

A mixed-measurement approach was only detected in one tool from the screened studies (Williams et al., 2012). The mixed-measurement approach may portray the advantages of both objective and subjective approaches (Wu et al., 2010). The instruments used in objective and subjective approaches are different in their administration, methodology, and construct meaning; thus, researchers should expect inconsistencies in the ways in which they measure the varied constructs of health literacy (Peterson et al., 2011; Battersby et al., 1989; (Parker et al., 1995).

Implications from Commonly Used Tools

The results of the study reported that the most commonly used tool in the measurement of HL in the CVH context was STOFHLA developed by Parker, Baker, Williams, and Nurss (1995). The original version, the TOFHLA, also developed by Parker et al. (1995), was also widely used. The TOFHLA is composed of two major sections, namely reading comprehension and numeracy. TOFHLA reading comprehension requires respondents to read three health-related passages and fill in missing words as they read along in 12 minutes. The numeracy session takes 10 minutes to complete and involves respondents reading numerical information and answering 17 questions using simple math skills related to prescription labels, appointment cards, simple directions, and financial information. The STOFHLA, which is an abbreviated version of the TOFHLA reading comprehension section, consists of only two passages and 36 fill-in-the-blanks and takes only 7 minutes (Parker et al., 1995).

Both TOFHLA and STOFHLA are validated in English and Spanish and have been used in a wide variety of clinical settings and cardiac populations (Peterson et al., 2011). However, according to Hickey, Sciacca, Gonzalez, Castillo, and Frulla (2015), they are not easily administered in the clinical arena. TOFHLA and STOFHLA may be too long or tedious for patients to complete in a busy clinical setting. Taking into consideration the suitability of the tool for use in everyday clinical settings is essential so that screening patients for low HL in clinical practices can be feasible, low cost, and clinically advantageous. By identifying patients with low HL, doctors can give them additional time and resources to support their understanding of health information, best treatment options, and adherence to treatment.

The study found that the second widely used tool for the measurement of HL among patients with cardiovascular problems was REALM. REALM was developed by Davis et al. (1993) involving respondents reading out loud a list of 66 medical words arranged in increasing order of difficulty. The REALM score is calculated by awarding one point for each correctly pronounced words and nothing for each mispronounced or skipped word (Huang et al., 2015). It takes 2–3 minutes to complete. The relative speed and ease of administering REALM compared to TOFHLA and STOFHLA means that it has the potential to serve as a screening tool in everyday clinical practice. However, it is not self-administered. REALM requires patients to read a list of words aloud, and a practitioner must be present to score pronunciation accuracy.

Another concern with REALM administration is the potential embarrassment of low-literacy patients from struggling to read the words in front of another person, as patients with low literacy have reported a feeling of shame concerning their reading problems (Parikh, Parker, Nurss, Baker, & Williams, 1996). In addition, ambiguities in scoring (e.g., mispronunciations due to speaker's accent or other conditions like throat infections) might be another practical concern.

The findings of this study show that the most commonly used HL measurement tools in the literature are TOFHLA, STOFHLA, and REALM (Parker, 2000). Despite the comparability provided by these commonly used HL measurement tools, the administration methods for these tools have some practical limitations for use in clinical settings that should be taken into account in the development of a new tool in the future. For example, the STOFHLA is the most frequently used measure of HL, but it only measures reading fluency, leaving out key domains in HL, and is often not feasible for use in clinical settings due to limited time and resources for administering and scoring the measure.

Measurement Mode

The findings of this scoping review show that the majority of the tools focus on the measurement of print literacy and reading comprehension. Less attention is paid to the measurement of numeracy or oral literacy. Research has pointed out a lack of recognition of communication skills (oral literacy) in the HL measurement construct in many tools (Pleasant, McKinney, & Rikard, 2011). The incorporation of CVD HL can expand HL measurement to a broader and more comprehensive understanding considering the communicative and interactional requirements of health care, thus increasing the validity of the tool.

Furthermore, 24 of the studies in the review were presented as multi-dimensional measurements. Given the fact that HL is a multi-dimensional construct that encompasses print literacy, oral literacy, numeracy, and so on, the use of one-dimensional measurement modes prevalent in HL measurement should be subjected to further evaluation. In addition, despite 24 of the tools being presented as multi-dimensional measurements, the majority of tools principally assessed print literacy. REALM, for instance, only tests recognition and pronunciation of medical words and, thus, has limited ability to measure the full concept of HL.

As discussed earlier, tools with an objective approach generally tend to use a one-dimensional measurement mode.

Another finding is that despite the attempt to measure HL in the context of CVH, in many cases the tools used were general HL measurement tools, such as TOFHLA, STOFHLA, REALM, and some other tools, like NVS and METER. Although these are widely used tools for the measurement of HL, they assess HL with a broad and extensive scope rather than disease- or context-specific HL (Battersby et al., 1989).

More recent developments have attempted to measure HL specific to the context of CVD. Such tools, however, tended to measure a specific type of CVD. For example, the SAQ was developed with the aim of examining the knowledge of stroke risk factors and warning signs in the adult populations (Hickey, Holly, McGee, Conroy, & Shelley, 2012). Additional studies could be beneficial to develop more comprehensive tool/s to capture HL within the specific context of CVH. It is important to develop tools consisting of very short questions or few questions because application of the instruments will take a long time to complete due to the intensive work pace in clinics and the busy schedules of the health professionals working in these clinics.

Limitations of the Study

First, a systematic review of the available literature on cardiovascular HL measures was not conducted, so there is no information available on the quality of the studies selected. Second, the search was only conducted in Medline and EMBASE, which means that studies that were not registered on either database were not included. Third, only English and Chinese articles were included, and thus important studies in other languages may have been missed. Fourth, the results of the study are limited to the key search terms used in the research.

Conclusion

The results of this scoping review show that STOFHLA, TOFHLA, and REALM are widely used cardiovascular HL measurement tools. There is no gold standard instrument currently available to adequately assess the more global concept of CVD HL, including the interactions among different abilities. Commonly used tools are based heavily on reading skills, word recognition, and numeracy, and some tools measure general HL rather than CVH literacy specifically, while others narrowly measure knowledge of one CVD.

As a final word, CVH literacy is seen as central to lifelong engagement with health, building cognitive and social skills, and the motivation necessary to navigate health care systems, disease prevention, and health promotion throughout one's life. The current measurement of cardiovascular HL is fragmented; researchers should focus on the development of more comprehensive and reliable HL measurement tool/s specific to CVH to assist health care providers to more effectively and accurately identify people with CVDs who have inadequate HL in busy clinical settings. The tools that are developed should be sensitive enough to measure changes resulting from interventions.

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Table 1. Chronological Overview of the Studies

Authors	Title	Year	Aim	Sample	n	Tool/ Domain Measured
Williams, Baker, Parker, & Nurss	Relationship of functional health literacy to patients' knowledge of their chronic disease: A study of patients with hypertension and diabetes	1998	To examine the relationship between functional HL level and knowledge of chronic disease and treatment among patients with hypertension or diabetes	Patients with hypertension or diabetes	402	TOFHLA Print literacy, numeracy
Fang, Machtinger, Wang, & Schillinger	Health literacy and anticoagulation-related outcomes among patients taking warfarin	2006	To assess how HL is associated with warfarin knowledge, adherence, and control	Anticoagulated English- or Spanish-speaking patients	179	STOFHLA Print literacy
Gazmararian et al.	Factors associated with medication refill adherence in cardiovascular-related diseases: A focus on health literacy	2006	To examine the relationship between HL and medication refill adherence among Medicare managed care enrollees with cardiovascular-related conditions	New Medicare managed care enrollees 65 or older	206	STOFHLA Print literacy
Laramee, Morris, & Littenberg	Relationship of literacy and heart failure in adults with diabetes	2007	To assess the prevalence of limited literacy in patients with heart failure	Patients with heart failure and diabetes	172	STOFHLA Print literacy
Persell, Osborn, Richard, Skripkauskas, & Wolf	Limited health literacy is a barrier to medication reconciliation in ambulatory care	2007	To assess the relationship between HL, patient recall of antihypertensive medications, and reconciliation between patient self-report and medical records	Adults with hypertension at three community health centers	119	STOFHLA Print literacy
Wallace et al.	Can screening items identify surgery patients at risk of limited health literacy?	2007	To determine if screening items can identify surgery patients at risk of limited HL	English-speaking adults attending a university-based	100	REALM-R Print literacy

Author	Title	Year	Purpose	Population	N	Tool
				vascular surgery clinic		
Ibrahim et al.	Validation of a health literacy screening tool (REALM) in a UK population with coronary heart disease	2008	To validate a US-developed HL screening tool for use in the UK against the UK's general literacy screening tool	Adult patients admitted to the hospital for investigation of coronary heart disease	300	REALM-R BSAIT Print literacy
Kollipara et al.	Relation of lack of knowledge about dietary sodium to hospital readmission in patients with heart failure	2008	To determine what risk factors were associated with such gaps in knowledge and to determine if these gaps in knowledge would increase the risk for heart failure readmission	Hospitalized patients with heart failure < 48 hours before discharge	97	TOFHLA Print literacy, numeracy
Levinthal, Morrow, Tu, Wu, & Murray	Cognition and health literacy in patients with hypertension	2008	To examine the role of cognitive and sensory abilities as mediators of age and education in determining functional HL among patients with hypertension	Patients with hypertension	492	STOFHLA Print literacy
Cordasco, Asch, Franco, & Mangione	Health literacy and English language comprehension among elderly inpatients at an urban safety-net hospital	2009	To evaluate the relationship between HL and age in chronically-ill inpatients in a safety-net hospital	Patents with congestive heart failure or coronary artery disease	399	TOFHLA Print literacy, numeracy
Ussher, Ibrahim, Reid, Shaw, & Rowlands	Psychosocial correlates of health literacy among older patients with coronary heart disease	2010	To examine psychosocial correlates of HL scores among older patients with coronary heart disease	Patients with coronary heart disease	321	REALM-R Print literacy
Daley	A hybrid transitional care program	2010	To assess the effectiveness of the transitional heart failure program for older adults who have complex medical conditions after hospital discharge	High-risk heart failure patients	89	NVS Print literacy, numeracy

Rawson et al.	The METER: A brief, self-administered measure of health literacy	2010	To develop and validate a brief, self-administered measure of HL, the METER	Patients from an outpatient cardiology program at an urban hospital	155	METER Print literacy
Bergman, Reeve, Moser, Scholl, & Klein	Development of a comprehensive heart disease knowledge questionnaire	2011	To describe the two-phase development of a novel heart disease knowledge questionnaire	Under-graduates	854	Heart disease knowledge assessment questionnaire Print literacy, numeracy
Chen, Yehle, Plake, Murawski, & Mason	Health literacy and self-care of patients with heart failure	2011	To examine the relationship between HL and self-care of patients with heart failure	Patients with heart failure	49	STOFHLA Print literacy
Macabasco-O'Connell et al.	Relationship between literacy, knowledge, self-care behaviors, and heart failure-related quality of life among patients with heart failure	2011	To examine the relationship between literacy and heart failure-related quality of life and to explore whether literacy-related differences in knowledge, self-efficacy, and/or self-care behaviour explained the relationship	Patients with heart failure	605	STOFHLA Print literacy
Naik, Street, Castillo, & Abraham	Health literacy and decision making styles for complex antithrombotic therapy among older multimorbid adults	2011	To evaluate the effect of functional HL on preferences for decision-making and among those initially preferring a passive decision-making role, to explore how preferences change if their physician actively encourages their involvement	Older adults with CVD receiving complex antithrombotic therapy	100	STOFHLA Print literacy

Osborn, Paasche-Orlow, Bailey, & Wolf	The mechanisms linking health literacy to behaviour and health status	2011	To examine the mechanisms linking HL to physical activity and self-reported health	Patients with hypertension	330	STOFHLA Print literacy
Peterson et al.	Health literacy and outcomes among patients with heart failure	2011	To evaluate the association between low HL and all-cause mortality and hospitalization among outpatients with heart failure	Patients with heart failure	2156	Three brief screening questions Print literacy
Robinson et al.	Assessing health literacy in heart failure patients	2011	To assess HL in heart failure patients.	Patients with heart failure	50	STOFHLA Print literacy
Shibuya et al.	The relation between health literacy, hypertension knowledge, and blood pressure among middle-aged Japanese adults	2011	To examine the relationship between HL, hypertension knowledge, and blood pressure level	Japanese adults who visited the clinic from August 2009 to February 2010 for an annual health check-up	338	FHL measurement Print literacy, numeracy
Eckman et al.	Impact of health literacy on outcomes and effectiveness of an educational intervention in patients with chronic diseases	2012	To study impact of HL on educational intervention for patients living with coronary artery disease	Patients with coronary artery disease	187	REALM-R Print literacy
Giuse, Koonce, Storrow, Kusnoor, & Ye	Using health literacy and learning style preference to optimize the delivery of health information	2012	To study the effect of using health literacy and learning style preferences to optimize the delivery of health information	Participants with two blood pressure measure-ments of 140/90 mmHg or higher while in the emergency department	87	STOFHLA Print literacy

Kim et al.	Development and validation of the high blood pressure-focused health literacy scale	2012	To develop and test a novel HL scale for individuals with high blood pressure	Korean Americans with high blood pressure	192	HBP-HL Print literacy, numeracy
Schapira et al.	The development and validation of the hypertension evaluation of lifestyle and management knowledge scale	2012	To develop and validate a scale of hypertension knowledge that can be used to assess effectiveness studies of interventions and improve chronic disease management	Veterans who belonged to community veteran's organizations, including the Veterans of Foreign Wars and the American Legion	404	REALM-R Print literacy
Williams, DeSorbo, Noble, & Gerin	Child-mediated stroke communication: findings from Hip Hop Stroke	2012	To assess whether child-mediated stroke communication could improve stroke literacy of parents of children enrolled in a school-based stroke literacy program called Hip Hop Stroke	Parents of children aged 9 to 12 years from two public schools in Harlem, New York City	102	Assessment of parent/care-giver stroke knowledge and communication Print literacy, oral literacy
Ingram & Ivanov	Examining the association of health literacy and health behaviors in African American older adults: Does health literacy affect adherence to antihypertensive regimens?	2013	To examine the association of HL and adherence behaviors in African American older adults with hypertension using a descriptive correlational design	African American older adults with hypertension	121	REALM-R Print literacy

McNaughton et al.	Low numeracy is associated with increased odds of 30-day emergency department or hospital recidivism for patients with acute heart failure	2013	To evaluate the relation between both numeracy and HL with 30-day recidivism	Patients with acute heart failure	668	The subjective numeracy scale and the subjective HL scale Print literacy, numeracy
Wu et al.	Low literacy is associated with increased risk of hospitalization and death among individuals with heart failure	2013	To study the relationship between literacy and adverse outcomes in heart failure	Ambulatory patients with heart failure	595	STOFHLA Print literacy
Lim et al.	Stroke literacy in Singapore: Data from a survey of public housing estate residents	2014	To evaluated the level of stroke literacy in Singapore	Singaporean citizens	687	SAQ Print literacy
Tung et al.	Health literacy impact on elderly patients with heart failure in Taiwan	2014	To determine the prevalence of inadequate HL in elderly patients suffering from heart failure in Taiwan	Inpatients diagnosed with heart failure	98	THLS Print literacy
Vosbergen et al.	An online survey to study the relationship between patients' health literacy and coping style and their preferences for self-management-related information	2014	To evaluate patients' preferences for message features and assess their relationships with HL, monitor–blunter coping style, and other patient-dependent characteristics	Patients with coronary heart disease	213	D-SBSQ Print literacy, oral literacy
Warren-Findlow et al.	Assessing health literacy of hypertensive patients in a primary care setting using a self-administered questionnaire	2014	To examine the feasibility of using the NVS (SAQ) in a low-income, primary care setting	Adult hypertensive patients	238	NVS (SAQ) Print literacy, numeracy

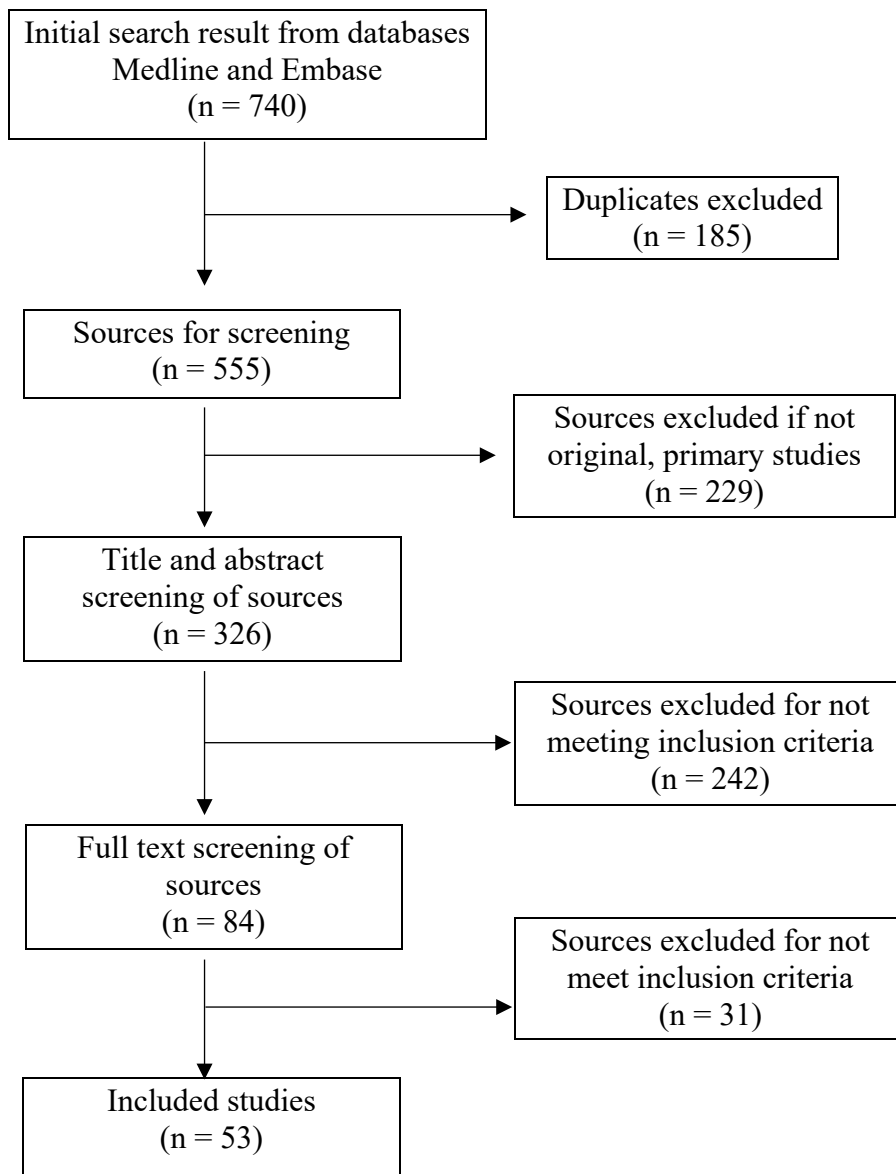|						
Aranha, Patel, Panaich, & Cardozo	Health literacy and cardiovascular disease risk factors among the elderly: A study from a patient-centered medical home	2015	To determine the HL level of elderly patients and establish whether an association exists between HL and CVD risk factors	Elderly patients seeking care at a patient-centered medical home	150	STOFHLA NLS Print literacy, numeracy, oral literacy
Bay et al.	Stroke awareness and knowledge in an urban New Zealand population	2015	To assess the awareness of stroke risk, symptoms, detection, and prevention behaviors in an urban New Zealand population	People from Auckland, New Zealand	850	A stroke literacy questionnaire Print literacy, oral literacy
Hickey, Sciacca, Gonzalez, Castillo, & Frulla	Assessing health literacy in urban patients with implantable cardioverter defibrillators and pacemakers	2015	To evaluate functional HL in a primarily older, urban-dwelling implantable cardioverter/pacemaker population	Patients from an urban implantable cardioverter/pacemaker clinic	113	STOFHLA Print literacy
						TOFHLA Print literacy, numeracy
Huang et al.	Validation of the short-form Health Literacy Scale in patients with stroke	2015	To determine the extent to which the impact of an interactive voice recognition-based intervention to improve medication adherence appeared to vary by participants' HL level	Patients with stroke	87	SHEAL Print literacy, numeracy
Mattson, Rawson, Hughes, Waechter, &	Health literacy predicts cardiac knowledge gains in cardiac rehabilitation participants	2015	To evaluate whether HL would predict gains in knowledge after completion of patient education in cardiac rehabilitation	Patients in cardiac rehabilitation	191	METER STOFHLA Print literacy

Rosnec k						
Perez	Acculturation, health literacy, and illness perceptions of hypertension among Hispanic adults	2015	To examine the relationship among acculturation, HL, and illness perceptions of hypertension among Hispanics	Hispanic adults with a self-reported diagnosis of hypertensio n	144	NVS Print literacy, numeracy
Rao et al.	The effect of numeracy level on completeness of home blood pressure monitoring	2015	To investigate the relationship between numeracy level and completeness of home blood pressure reporting and to identify factors that mediate this possible relationship with a specific focus on demographic and socioeconomic characteristics	Participants from 12 primary care clinics in central North Carolina	420	REALM-SF Print literacy
Yue, Zhang, Lu, & Jin	Translation and psychometric evaluation of the Chinese version of the Heart Failure-Specific Health Literacy Scale	2016	To translate the HF-Specific HL Scale into Chinese and test the reliability and validity of the Chinese version	Inpatients with heart failure	164	HF-Specific HL Scale Print literacy, numeracy, oral literacy
Cox et al.	Association between health literacy and 30-day healthcare use after hospital discharge in the heart failure population	2017	To assess 30-day readmissions and emergency department visits based on HL evaluated by the BHLS in an acute care heart failure population	Patients with a diagnosis of heart failure	264	BHLS Oral literacy
Matsuo ka, Kato, et al.	Development and validation of a Heart Failure-Specific Health Literacy Scale	2016	To develop an instrument for measuring functional, communicative, and critical levels of HL in patients with heart failure	Outpatients with heart failure	191	HF-Specific HL Scale Print literacy, numeracy, oral literacy

Matsuoka, Tsuchihashi-Makaya, et al.	Health literacy is independently associated with self-care behavior in patients with heart failure	2016	To determine the relationship between functional, communicative, and critical HL and self-care behavior in heart failure patients.	Patients with heart failure	249	HF-Specific HL Scale Print literacy, numeracy, oral literacy
Nafradi, Galimberti, Nakamoto, & Schulz	Intentional and unintentional medication non-adherence in hypertension: The role of health literacy, empowerment and medication beliefs	2016	To assess the socio-demographic, clinical, and psychological determinants of intentional and unintentional non-adherence	Hypertension patients	109	NVS Print literacy, numeracy
Yehle, Plake, Nguyen, & Smith	Health-related quality of life in heart failure patients with varying levels of health literacy receiving telemedicine and standardized education	2016	To examine the effect of telemonitoring plus education by home healthcare nurses on health-related quality of life in patients with varying HL levels diagnosed with heart failure	Patients with a diagnosis of heart failure	35	STOFHLA Print literacy
Zhang et al.	Cross-cultural validation of the High Blood Pressure Health Literacy Scale in a Chinese community	2016	To translate and validate the HBP-HLS into Chinese and evaluate its psychometric properties in the Chinese context	Hypertensive patients belonging to the Han and Kazakh-Chinese communities in Urumqi, Xinjiang, China	242	C-HBP-HLS Print literacy, numeracy
Cajita et al.	Health literacy in heart transplantation: Prevalence, correlates and associations with health behaviors-Findings from the international BRIGHT study	2017	(1) To explore and compare the prevalence of inadequate HL among heart transplant recipients internationally (2) To determine the correlates of HL (3) To assess the relationship between HL	Heart transplant recipients	1365	SHLS Print literacy, oral literacy

			and health-related behaviors			
Diemer et al.	Health literacy in Suriname	2017	To assess the level of HL in Suriname, a middle-income country with a high cardiovascular mortality	Patients attending a tertiary care hospital in Southern India	200	REALM-D Print literacy
Kumar et al.	Correlates of health literacy and its impact on illness beliefs for emergency department patients with acute heart failure	2017	To study the relationship between HL and socioeconomic factors, demographic factors, and disease-specific illness beliefs among patients who present to the emergency department with heart failure	Patients with hemodynamically stable acute heart failure	100	STOFHLA Print literacy
Reading et al.	Health literacy and awareness of atrial fibrillation	2017	To examine the association between HL and awareness of an atrial fibrillation diagnosis	Patients who were diagnosed with incident atrial fibrillation or atrial flutter	12517	Three questions from a health questionnaire Print literacy, numeracy
Richtering et al.	eHealth literacy: Predictors in a population with moderate-to-high cardiovascular risk	2017	To investigate the demographic, socioeconomic, technology use, and HL predictors of eHealth literacy in a population with moderate-to-high cardiovascular risk	Participants of the CONNECT study	453	HLQ, eHEALS Print literacy, numeracy, oral literacy

Note. BHLS: Brief Health Literacy Screening; BSAIT: Basic Skills Assessment Initial Test; C-HBP-HLS: Chinese version of the High Blood Pressure–Health Literacy Scale; D-SBSQ: Dutch version of the Set of Brief Screening Questions; eHEALS: eHealth Literacy Scale; FHL: Functional Health Literacy; HBP-HL: High Blood Pressure–Health Literacy Scale; HF-Specific HL Scale: Heart Failure-Specific Health Literacy Scale; HLQ: Health Literacy Questionnaire; METER: Medical Term Recognition Test; NLS: Nutritional Literacy Scale; NVS: Newest Vital Sign; NVS (SAQ): Newest Vital Sign (self-administered questionnaire); REALM: Rapid Estimate of Adult Literacy in Medicine; REALM-R: Rapid Estimate of Adult Literacy in Medicine-Revised; REALM-SF: Rapid Estimate of Adult Literacy in Medicine–Short Form; SAQ: Stroke Awareness Questionnaire; SHEAL: Short-form Health Literacy Scale–Mandarin version; SHLS: Subjective Health Literacy Screener; STOFHLA: Short Test

of Functional Health Literacy in Adults; THLS: Taiwan Health Literacy Scale; TOFHLA: Test of Functional Health Literacy in Adults.

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Figure 1. Flow diagram of the screening process for the sources.

Supplementary Online Files

Table 2. Measurement Approaches of Cardiovascular Health Literacy Tools Using Objective, Subjective, and Mixed Measurements

Tool	Tool Description	No. of Studies	Citations
Instruments with an objective approach (n = 16)			
STOFHLA	• An abbreviated version of the reading comprehension section of TOFHLA • Respondents must read two passages centred on health-related scenarios with every fifth to seventh word missing. They must choose the correct answer from a list of four possible answers (a cloze test). • 36 items • About 7 minutes	17	• Fang et al., 2006 • Gazmararian et al., 2006 • Laramee et al., 2007 • Persell et al., 2007 • Levinthal et al., 2008 • Chen et al., 2011 • Macabasco-O'Connell et al., 2011 • Robinson et al., 2011 • Naik et al., 2011 • Osborn et al., 2011 • Giuse et al., 2012 • Wu et al., 2013 • Aranha et al., 2015 • Mattson et al., 2015 • Hickey et al., 2015 • Yehle et al., 2016 • Kumar et al., 2017
REALM	• A word recognition test that asks the respondents to read aloud a list of 66 medical words • A point is awarded for correctly pronounced word	7	• Wallace et al., 2007 • Ibrahim et al., 2008 • Ussher et al., 2010 • Eckman et al., 2012 • Schapira et al., 2012 • Ingram & Ivanov, 2013
REALM-D	• The 66 medical words are in Dutch	1	• Diemer et al., 2017
REALM-R	• Similar to REALM • Consists of 11 items instead of 66	1	• Marzec et al., 2015
REALM-SF	• Respondents must read 7 medical words instead of 66	1	• Rao et al., 2015

TOFHLA	• For reading comprehension, respondents must read three health-related passages and fill in missing words as they read along. For each missing word, a list of four responses is provided. • For numeracy, respondents read numerical information and answer 17 questions using simple math skills.	4	• Williams et al., 1998 • Kollipara et al., 2008 • Cordasco et al., 2009 • Mattson et al., 2015

NVS	• Respondents answer six questions in relation to the nutritional content of a food label.	4	• Daley, 2010 • Mattson et al., 2015 • Perez, 2015 • Nafradi et al., 2016
NVS (SAQ)	• Generally consistent with NVS • Scoring modified for the second question	1	• Warren-Findlow et al., 2014
METER	• Respondents are given 40 medical words and 40 non-words and are asked to mark only items that are actual words. • Takes 2 minutes	2	• Rawson et al., 2010 • Mattson et al., 2015
HBP-HLS	• Respondents are asked to pronounce 30 words related to HBP care and are then asked to answer 13 items relating to self-care activities	1	• Kim et al., 2012
C-HBP-HLS	• Translated and modified with the HBP-HLS • 5 dimensions with 15 items	1	• Zhang et al., 2016
BSAIT	• Developed and validated in the UK • 72 questions testing reading comprehension using everyday scenarios such as understanding a café menu	1	• Ibrahim et al., 2008
FHL measurement	• The numeracy section assesses respondents' ability to comprehend the label on a prescription envelope. • The reading comprehension section is a five-item measure concerning an actual examination appointment sheet.	1	• Shibuya et al., 2011
NLS	• Respondents answer 24 questions in relation to the nutritional content of a nutritional label.	1	• Aranha et al., 2015
SAQ	• Face-to-face interview • Open-ended questions on stroke risk factors and symptoms	1	• Lim et al., 2014
SHEAL	• Simplified from the HLS • 11 multiple-choice items, of which 8 test comprehension abilities and 3 assess numeracy skills	1	• Huang et al., 2015

Heart disease knowledge assessment questionnaire	• A 30-item true–false questionnaire • Addresses five main domains of heart disease knowledge: dietary knowledge, epidemiology, medical information, risk factors, and heart attack symptoms	1	• Bergman et al., 2011
A stroke literacy questionnaire	• A brief face-to-face interview on awareness and knowledge of stroke • Open-ended questions to enable respondents to answer in their own words	1	• Bay et al., 2015

Instruments with an subjective approach (n = 9)			
HF-Specific HL Scale	• A self-report scale • 3 dimensions and 12 items • Rated on a scale of 1 to 4 according to applicability	3	• Yue et al., 2016 • Matsuoka, Kato, et al., 2016 • Matsuoka, Tsuchihashi-Makaya, et al., 2016
THLS	• Respondents rate 66 health-related terms on a five-point scale based on their familiarity and understanding of the terms.	1	• Tung et al., 2014
SHLS	• A self-administered survey • Respondents rate on a five-point scale on how confident they were in filling out medical forms by themselves.	1	• Cajita et al., 2017
HLQ	• Nine independent scales that assess distinct aspects of health literacy • Each scale is composed of four to six items and is scored on a four- or five-point scale	1	• Richtering et al., 2017
D-SBSQ	• Consists of three items • Rated by respondents on a four-point scale	1	• Vosbergen et al., 2014
BHLS	• Three questions rated on a five-point scale according to perceived confidence in performing the tasks	1	• Cox et al., 2017
3 brief screening questions	• Three questions scored by patients on a five-point scale according to frequency, perceived difficulty, and confidence in the three tasks	1	• Peterson et al., 2011

3 questions from the health questionnaire	• Q1: How often has someone helped you read hospital or other medical materials? • Q2: How often do you have problems learning about your medical condition because of difficulty understanding written information? • Q3: How confident are you filling out forms by yourself? • Respondents rate on a four-point scale.	1	• Reading et al., 2017
The subjective numeracy scale and the subjective health literacy scale	• Respondents are asked about their perceived abilities and attitudes related to numeracy and health literacy. • Eight written items on a six-point scale • Four regarding perceived skills using numbers and four addressing preferences regarding the use of numbers	1	• McNaughton et al., 2013
Instruments with an mixed approach (n = 1)			
Assessment of parent/caregiver stroke knowledge and communication	• 10 questions with multiple choices and open-ended questions on stroke knowledge	1	• Williams et al., 2012

Note. BHLS: Brief Health Literacy Screening; BSAIT: Basic Skills Assessment Initial Test; C-HBP-HLS: Chinese version of the High Blood Pressure–Health Literacy Scale; D-SBSQ: Dutch version of the Set of Brief Screening Questions; FHL: Functional Health Literacy; HBP-HL: High Blood Pressure–Health Literacy Scale; HF-Specific HL Scale: Heart Failure–Specific Health Literacy Scale; HLQ: Health Literacy Questionnaire; METER: Medical Term Recognition Test; NLS: Nutritional Literacy Scale; NVS: Newest Vital Sign; NVS (SAQ): Newest Vital Sign (self-administered questionnaire); REALM: Rapid Estimate for Adult Literacy in Medicine; REALM-R: Rapid Estimate of Adult Literacy in Medicine-Revised; REALM-SF: Rapid Estimate of Adult Literacy in Medicine–Short Form; SAQ: Stroke Awareness Questionnaire; SHEAL: Short-form Health Literacy Scale–Mandarin version; SHLS: Subjective Health Literacy Screener; STOFHLA: Short Test of Functional Health Literacy in Adults; THLS: Taiwan Health Literacy Scale; TOFHLA: Test of Functional Health Literacy in Adults.