



Health Sciences – Master's thesis

*State of the art: An overview of
assessment tools for measuring
(digital) Health Literacy*

A systematic scoping review

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Abstract

Background: As the modern healthcare system changes rapidly, the demand to possess adequate (digital) health literacy increases. By using assessment tools in routine early assessment of patients' (digital) health literacy, provided healthcare might be tailored to the patients' (digital) health literacy. Through assessment, patients with limited health literacy can be recognized and supported with tailored healthcare which might prevent negative consequences such as (re-)hospitalization. Multiple assessment tools have been developed, however, it is not clear which are most used and suitable in the hospital. This systematic scoping review aims to create an overview of assessment tools for measuring the (digital) health literacy of patients that are suitable for use by nurses to assess patients' (digital) health literacy in a hospital setting. Focusing on the use of assessment tools by nurses in the hospital setting and consideration of the importance of (digital) health literacy assessment, the researchers strived to answer the following research question: *"Which assessment tools have been developed for the assessment of (digital) health literacy, and can be administered by nurses in the routine early assessment of patients' (digital) health literacy in the hospital?"*

Method: The databases used in this systematic review were PubMed, Scopus, Web of Science, and CINAHL. The process used for extraction and selection of articles followed the PRISMA guidelines. Search strings were developed fitting the research question. Studies were included when fitting the following eligibility criteria: "An assessment tool to measure health literacy was used", "Participants were patients or caregivers", "Health literacy was measured in a hospital setting". Studies were excluded when they met one of the following criteria: "Studies including children/adolescents as participants", "Assessment tools measuring only numeracy, literacy, mental literacy or oral literacy", "Studies published in languages besides English or Dutch", "Studies that are not empirical, such as review and opinion studies", "Assessment tools developed to use only in specific patient groups", and "Studies of which the full text was not available". All studies were screened by two researchers on title and abstract individually. The studies in the full-text selection were divided between the two researchers. The full text of these studies was read and data were extracted. Differences were solved through discussion. When necessary, the third and fourth researchers were consulted. The original validation study of each assessment tool was obtained to extract characteristics such as the year of publication, design, number of items, administration time, mode of administration, and objective or subjective assessment. The purpose of assessment, stated by the developers of each assessment tool, was extracted and summarized under six domains of health literacy: "Access", "Understand", "Appraise", "Apply", "Numeracy" and "Digital". Interviews were conducted with nurses (n=4) to determine their experiences with (digital) health literacy and their expectations and demands of the implementation of an assessment tool. The nurses mentioned the desire for a short administration time of a maximum of five minutes, early assessment in the care pathway, easiness to understand and use of the assessment tool, and the possibility to upload the results to the Electronic Health Record (EHR).

Results: 5612 studies were extracted from the databases, of which 1742 studies were duplicates and therefore excluded. The remaining 3870 studies were screened on title and abstract which left 286 studies for full-text reading. The final selection left 208 studies, of which the result is an overview of 37 assessment tools for the assessment of health literacy. Each tool is presented with its original validation study and the number of studies using the tool in research. There were three implementation studies, where the tools were implemented as routine early assessment tools in the hospital. The REALM-SF, BHLS, and EBHLS were used in these studies. The vast majority of studies used the tools in association, validation, evaluation, or comparison studies. The four tools that were reported most often, with more than twenty studies using the tool, were the NVS, used in 47 studies, the (S)TOFHLA, used in 32 studies, the BHLS, used in 25 studies, and the HLQ, used in 23 studies. The tools with the shortest administration time, take one minute to administer and the longest tools take over twenty minutes to administer. The smallest tools consist of a single item, compared to the largest tools consisting of 82 items. Fifteen objective tools assess health literacy through tests, whereas, 21 subjective tools assess health literacy through interpretive questions applicable to the patient's personal life. The eHLA is a toolkit consisting of both subjective and subjective tools. Seventeen tools were administered through interviews requiring

the presence of an administrator and were also administered self-reported without requiring the presence of an administrator. Twelve tools were administered in self-reported form only without requiring the presence of an administrator, followed by six tools that were administered through interviews, and two administered through computer-based and self-reported. The Understanding domain is assessed the most, by all 37 assessment tools, followed by the Access domain and Appraise domain, each assessed by 22 tools. Seventeen tools assess the Access, Understand, and Apply domain, and eleven tools assess the Access, Understand, Appraise and Apply domain. Nine assessment tools assess the Numeracy domain. The least assessed domain is the Digital domain assessed by five assessment tools. There are no tools that assess all six domains. Based on the year of publication and the number of domains, there is a difference between the earliest developed assessment tools and the latest developed tools. Where the latest developed tools all assess four domains the earliest assess one or two domains.

Discussion: Where all 37 assessment tools are available and validated for assessment of health literacy, not every tool is fit for the routine early assessment of the (digital) health literacy of patients. The REALM-SF, the BHLS, and EBHLS have already successfully been implemented for routine early assessment of patients' health literacy in the hospital, administered by nurses. The interviewed nurses stated the desire for an assessment tool with a short administration time of a maximum of five minutes, early assessment in the care pathway, easiness to understand and use of the assessment tool, and the possibility to upload the results to the EHR. Mode of administration, self-reporting or interview, and subjective or objective assessment all have their advantages that should be considered when selecting an assessment tool. Preferably, as each domain of health literacy is important, an assessment tool should assess as many domains as possible. However, there are no tools that assess all domains and only four that assess five domains. Considering that the REALM-SF, BHLS, and EBHLS have all previously been used in the hospital, are short in administration time, easy to use, and can be administered through the EHR, they are feasible options. However, they only assess a maximum of three domains. Each situation requiring health literacy assessment has its own best fitting assessment tool. Based on this review, through the overview of tools and the characteristics and domains, a tool for each situation can be selected.

Other: This review was not registered. No protocol was used that has been uploaded before conducting the study. No financial support has been provided for this review. There was no conflict of interest. Data can be found in the reference list and the Appendix.

Keywords: *Health literacy, Digital, Hospital, Nurses, Assessment tool, Review, Overview*

Background

Over the years, the focus of the healthcare sector has changed towards patient-centeredness. This can also be seen in the hospital setting. The quality of care became more important, resulting in a broader focus on patient outcomes and experiences which was reflected in research as well. An aspect of these experiences is how the provided care is tailored to the patients' needs and level of understanding. This level of understanding can be interpreted as health literacy.

Health literacy is a broad concept, which differs through multiple slightly different definitions and domains. These definitions have been summarized through review as follows: *"Health literacy is the ability to access, understand, appraise and apply health information in the domains of healthcare, disease prevention, and health promotion"* (1). In these times of digitization, the search for health information increasingly takes place on the internet as healthcare providers, such as hospitals, put more and more health information on websites. This brings us to an additional point of interest concerning health literacy: digital health literacy. Where health literacy is broadly formulated, digital health literacy focuses more on the digital aspect of the definition: *"The ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem"* (2). A person with adequate digital health literacy is capable of properly using digital devices, such as computers, smartphones, the internet, electronic blood pressure devices, or blood sugar devices. As the digital age brings more and more innovation in healthcare, patients must have adequate digital health literacy so they can keep up with the change. However, a person with limited (digital) health literacy has difficulties in properly accessing, understanding, appraising, and applying health information and is therefore exposed to risks leading to more frequent hospital visits and admissions (3-6). To address limited (digital) health literacy and, where possible, prevent the risks, it might be important to assess the level of health literacy in the hospital. Considering the risk of more frequent hospital visits and admissions, these patients come into contact with the hospital more often and might be detected through early assessment in the hospital. As the interest in health literacy grew, so did the interest in consequences of limited health literacy, leading to the development of multiple assessment tools for the assessment of health literacy. However, it is not clear which are most used and most suitable for use in the hospital.

Over the past decade, multiple studies into the topic of health literacy across the world have been performed (7-10). Looking at the frequency of peer-reviewed studies published in 2011, it is noticeable that the United States, Australia, the United Kingdom, Canada, the Netherlands, and Germany were leading in this field of research (9). Studies in the United States and Europe show that the average number of citizens with an inadequate, problematic, basic, or in other words, limited level of health literacy lies around forty percent of the population (7, 8). Inadequate health literacy is problematic, because it can result in patients underestimating the consequences of multiple common risk factors for diseases, such as cardiovascular diseases, and might therefore be more likely to be exposed to these risk factors (4). Furthermore, research has shown that a limited level of health literacy increases the risk of poor patient self-care, insufficient treatment adherence, higher healthcare costs, (re-)hospitalization, mortality, and comorbidity (3, 4). Persons with limited health literacy are more likely to have an older age, a lower level of education, a lower income, and/or an increased rate of chronic conditions (11). A consequence is that persons with a limited level of health literacy are less likely to use health information tools, such as patient portals, fitness apps, and activity trackers, as the required health information is deemed private and the trust in safe processing of the health information by the government or health institutions is low (12). However, as these apps can be useful in health management and healthcare is being digitized more and more, this might lead to an increase

in the digital divide within the population (13). Persons with a high level of digital health literacy are more active consumers of internet-based information and scrutinize the information. This leads to positive outcomes in the area of self-management of healthcare needs, health behavior, use of health insurance, and communication with physicians. Unfortunately, this digital division creates inequality, as it becomes harder for persons with a limited level of digital health literacy to gain the same positive outcomes, without using the health information tools (13). Considering the risks, characteristics, and more frequent hospital visits and admissions of persons with limited health literacy, routine early assessment of patients' (digital) health literacy in the hospital might be a means to address limited (digital) health literacy.

Hospital based routine (digital) health literacy assessment

Routine early assessment of patients' (digital) health literacy might increase effective communication between patients and healthcare professionals, and prevent negative consequences such as poor treatment adherence and (re-)hospitalization.

Nurses are often the first healthcare professionals patients come into contact with when visiting the hospital. They are involved throughout the patients' entire care pathway. However, research shows that nurses often overestimate the level of (digital) health literacy of patients (14, 15). As the nurses overestimate the level of (digital) health literacy, a limited level of (digital) health literacy will not be recognized and thus not recorded in the patient records. Recording the level of (digital) health literacy in the patient records might be helpful, as physicians have to explain treatment and revalidation plans following surgeries to the patient. Based on the (digital) health literacy level, physicians and nurses can then apply interventions such as "the teach-back method" to the consultation (16). Research has shown that besides nurses, physicians are also prone to overestimation of patients' health literacy (17, 18). Currently, physicians have limited prior knowledge of patients' (digital) health literacy when providing healthcare and consultations to the patients and can experience difficulty in tailoring their consultations to the patient's health literacy level (19).

As patients can experience a lower threshold when talking with nurses, compared to talking with physicians, nurses could play an important factor in recognizing the level of (digital) health literacy (20). If an early assessment of (digital) health literacy is performed by nurses, this could support the provision of tailored healthcare. This is one of the reasons why assessment tools for the measurement of the level of health literacy have been developed and implemented during the last two decades (20-22). In these implementation studies, nurses assess the level of (digital) health literacy during admission intake (21, 22). After the assessment, the level of (digital) health literacy is included in the EHR, which in turn made it easier for physicians to tailor provided healthcare to the patients' level of (digital) health literacy.

Despite the benefits of early assessment of (digital) health literacy through assessment tools, few studies report on using the assessment tools in routine early assessment in the hospital. A potential reason might be that there is a lack of suitable assessment tools for the routine early assessment of (digital) health literacy. It might be that the majority of the assessment tools are developed solely for research purposes. In the period from 2014 until the end of 2018, four reviews have been published describing available assessment tools (23-26). However, these reviews have a few limitations. First and foremost, the reviews focused on usability in both research and practice, whereas for routine early assessment in the hospital, assessment tools usable in practice are the most interesting. The assessment tools usable in routine early assessment should have a short administration time, as this might prevent additional workload for nurses and increase the uptake of

assessment. In only one of these four reviews, the administration time is taken into account. However, the tools included in this review often have no reported administration time, have a large number of items, are disease-specific, or are focused only on numeracy (23). Similarly, the other three reviews also included disease-specific tools and tools with a narrow focus on reading ability or numeracy (24-26). This leaves only a few tools suitable for routine early assessment, as in the hospital setting a broad tool usable in all departments should be preferred. Lastly, the authors decided to exclude tools that assess eHealth literacy and did not consider the importance of digital health literacy in healthcare. This might be due to the recent change in digitization in the past few years. Besides, as these reviews were published between 2014 and 2018, new assessment tools suitable for routine early assessment might have been missed. This sparks an interest for an additional review. The authors concluded that the assessment tools measure different aspects of health literacy which led to large variation between assessment tools and made it difficult to compare the instruments (27).

Digital health literacy and health literacy are still often seen as two separate definitions. However, it would be preferable to combine them in assessment, as digital skills become an increasing necessity to function adequately in the current healthcare system. Therefore, it is deemed important to conduct a review study of assessment tools without excluding digital health literacy assessment tools.

Objective

This systematic scoping review aims to create an overview of assessment tools for measuring the (digital) health literacy of patients that are suitable for use by nurses in the hospital. These assessment tools should be usable by nurses early in the care pathway, so other nurses and physicians can tailor provided healthcare to the patients' (digital) health literacy level. With a focus on the use of assessment tools by nurses in the hospital and consideration of the importance of both digital health literacy and health literacy, we searched multiple databases, to answer the main research question: *"Which assessment tools have been developed for the assessment of (digital) health literacy, and can be administered by nurses in the routine early assessment of patients' (digital) health literacy in the hospital?"*

Method

This systematic scoping review is conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (28). Following the PRISMA guidelines, the following framework has been created which has been filled during the process.

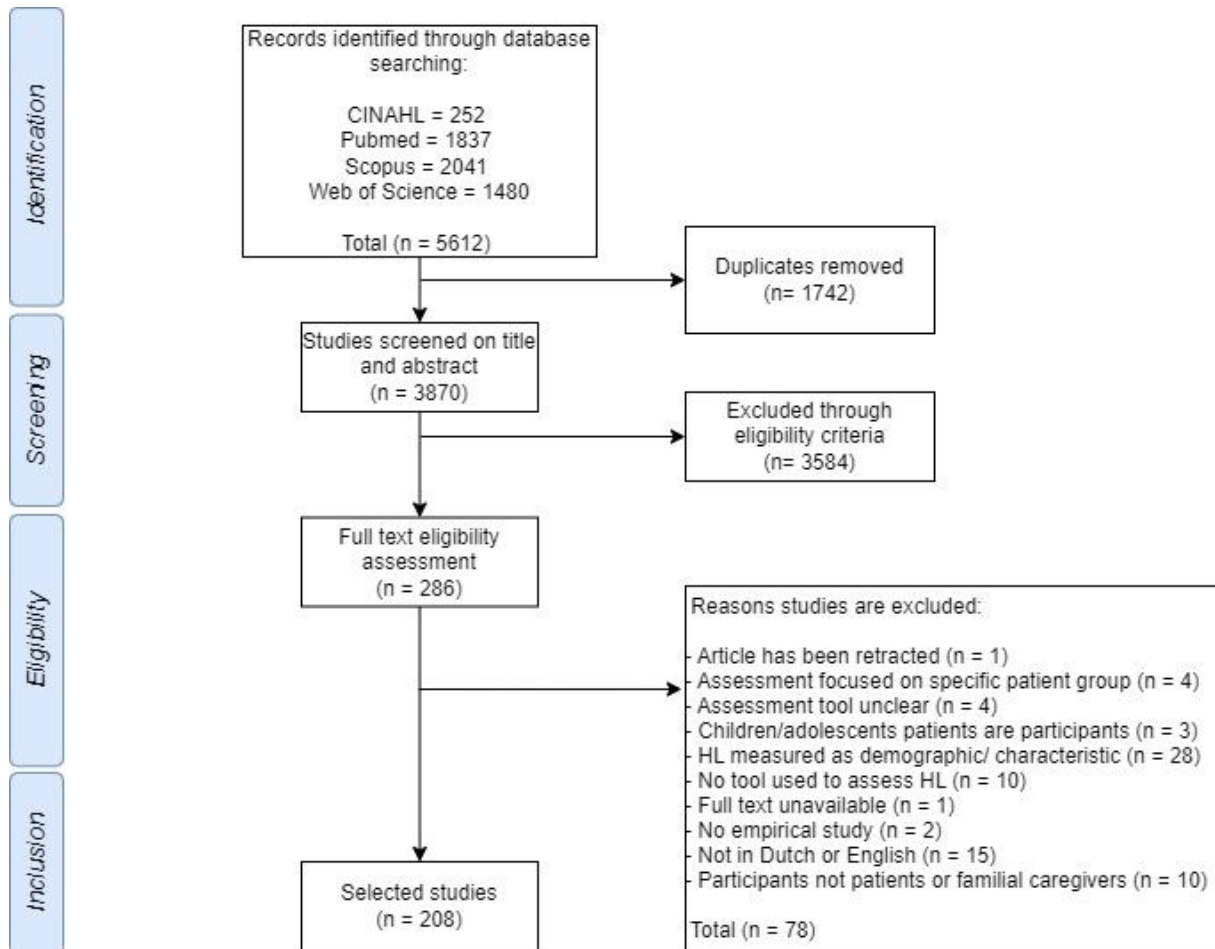


Fig 1: PRISMA flowchart of the literature search and study selection

Search strategy

Search strings were developed for the databases PubMed, Scopus, Web of Science, and CINAHL. The search strings for Scopus, Web of Science, and CINAHL were based on the search string for PubMed. The PubMed search string was stated in three blocks combined through the Boolean operators “OR” and “AND”. The first block contained the following terms for healthcare professionals in the primary or hospital care: “nurses”, “health care professional”, “healthcare professional”, “health care provider”, “healthcare provider”, “health care worker”, “healthcare worker”, “caregiver”, “health personnel”, “physician”, “clinical staff”, “health staff” and “patient-professional communication”. The second block contained the following terms for (digital) health literacy: “health literacy”, “health competence”, “eHealth literacy”, “e-health literacy” and “digital literacy”. The third block contained the following terms for assessment tools: “Assessment”, “assessment tool”, “questionnaire”, “scale”, “screening tool”, “survey”, “literacy screen”, “measure”, and “tool”. In these blocks, the researchers focused on the title and abstract for the search terms. The search strings per database can be found in the appendix.

In this selection, no restriction was placed on the publication date. The selection was extracted in 2021, on the 17th of June from PubMed, the 19th of June from Scopus and Web of Science, and on the 5th of July from CINAHL. The researchers extracted 5612 studies, which were combined in a single EndNote library, EndNote X9, and duplicate studies were excluded through EndNote based on author, title, year, and journal. Duplicates missed by EndNote were manually excluded.

Study selection

As can be seen in figure 1, The researchers, ED, WB have individually screened all studies on title and abstract. Studies were included when they met the following eligibility criteria: [1]“An assessment tool to measure health literacy was used”, [2]“Participants were patients or caregivers”, [3]“Health literacy was measured in a hospital setting”. Studies were excluded when they met one of the following criteria: [1]“Studies including children/adolescents as participants”, [2]“Assessment tools measuring only numeracy, literacy, mental literacy or oral literacy”, [3]“Studies published in languages besides English or Dutch”, [4]“Studies that are not empirical, such as review and opinion studies”, [5]“Assessment tools developed to use in specific patient groups”, and [6]“ Studies of which the full text was not available”. Differences between the individual selection were solved through consensus meetings. When there still was disagreement, the researchers screened the method sections of the concerned studies. When necessary, a third and fourth researcher, CD, CD, were consulted to reach a consensus.

The studies that were included after the title and abstract screening were divided between both researchers and assessed through full-text reading. During this assessment phase, the researchers assessed the relevance by applying the eligibility criteria to the full text. The researchers solved cases of doubt through discussion meetings. If these cases of doubts were not solved through discussion, the third and fourth researchers were consulted. As can be seen in figure 1, 28 studies have been excluded where health literacy was solely measured as a characteristic or sociodemographic of the participants (29-56). No in-depth information about the assessment tool was available in these studies.

Interviews

To discover healthcare professionals' experiences with health literacy, in practice, and their opinion and expectations of systematically using an assessment tool, four semi-structured interviews were conducted with nurses. The respondents include nurses of the oncology department, the cardiology department, the geriatrics department, and a nurse chief information officer. The interviews were semi-structured, following a predetermined interview schedule that contained relevant topics such as “Experiences with patients with limited health literacy”, “Expectations and ideas for implementation of an assessment tool”, and “Recording (digital) health literacy in the EHR”. Besides these topics, there still was room for additional questions and information.

All respondents mentioned the desire for a short administration time of a maximum of five minutes, early assessment in the care pathway, easiness to understand and use of the assessment tool, and the possibility to upload the results to the EHR. Furthermore, the respondents mentioned that the domains of health literacy they deemed most important were “The ability to communicate with a physician”, “Patient participation in shared decision making about their treatment plan” and “Understanding the importance of taking medication as prescribed by their physician”. Besides, the respondents also mentioned that it is important that patients know their way around the healthcare

system and where to find correct information on the internet. The respondents also emphasized that it is important that patients understand the importance of following the revalidation plans and understand how adherence will help in the prevention of complications. In addition, the respondents stated that, if patients participate in shared decision-making, it seems that patients understand the provided information and treatment options, as the patient makes a decision based on the provided options. This can, in the respondents' experience, be interpreted as an indicator of adequate health literacy.

Data extraction

Based on the interviews, the points of interest in the selected studies are the administration time, the design, the mode of administration, the scales used in the assessment, the number of items in the assessment tool, and if the assessment tool is subjective or objective in assessment. Subjective assessment tools require patients to interpret the items, which are presented as statements and respond with their degree of agreement with these items. Based on the degree of agreement the patient's level of (digital) health literacy is scored. Objective assessment tools are tests with items that only have one correct response, such as calculations or fill in the blank and/or multiple-choice questions. Based on the summed number of correct responses, the patient's level of (digital) health literacy is scored. These points of interest can be considered as the characteristics of the assessment tools. Previous research also stated the importance of the consideration of the style of administration, the purpose of assessment, and the capacity of time and resources when selecting an instrument (27).

The purpose of assessment can be seen as the domains of health literacy the assessment tool is meant to assess. To compare the assessment tools, health literacy is summarized through four domains, as stated in the definition of health literacy used in this review: Access, Understand, Appraise and Apply (1). Access refers to the ability to seek, find and obtain health information. Understand refers to the ability to comprehend the health information that is accessed, Appraise describes the ability to interpret, filter, judge, and evaluate the health information that has been accessed. Apply refers to the ability to communicate and use the information to decide to maintain and improve health (1). Besides these four domains and digital health literacy, Numeracy is also a domain of interest. Numeracy refers to the ability to perform calculations in a health setting, for example regarding doses of medication intake (57). As these domains give a broad representation of the goal of the assessment, this review will strive to represent the assessment tools based on the domains that are assessed.

Content Comparison

Due to the variation in measured aspects of the definition of health literacy in each assessment tool, it is difficult to compare the assessment tools on assessed content (27). To address this difficulty, the assessment tools have been compared based on the content they were meant to assess, or, in other words, the purpose of assessment. To compare the purpose of assessment for each assessment tool, we obtained the original validation studies, where the authors state the purpose of assessment for the developed assessment tool. However, these purposes of assessment are stated slightly differently in each study, and each tool assesses different aspects of the definition of health literacy which the developers deemed most important for assessment at the time. This leads to the developers stating different aspects fitting the purpose of assessment of their assessment tools, which leads to a vast array of slightly different phrased assessed content. To address these differences, we created an overview in which the different phrased assessed content could be summarized into six domains of health literacy: Access, Understand, Appraise, Apply, Numeracy and Digital. The researchers assigned

each assessment tool to one or more domains, fitting the purpose of assessment as stated in the development studies of each assessment tool. Where there was doubt, the third and fourth researchers were consulted to reach a consensus.

Through the resulting overview, we strive to compare the assessment tools not only on the characteristics, such as administration time but also on the domains of health literacy assessed through the assessment tools. Considering that each hospital is different and might have different experiences on the topic of health literacy and within the six domains, hospitals might differ in selecting the assessment tools deemed most suitable for routine early assessment in their organization. Where most hospitals might have the same expectations and desires based on the characteristics, the assessed content might be the reason why hospitals choose different assessment tools. Through these six domains, the definitions of health literacy and digital health literacy can be combined. All six domains cover important abilities patients should possess to adequately solve their health problems. Therefore, we deem it important to show the domains assessed through the assessment tools.

Results

After all phases, 208 studies were included. These studies differed in the study design for which the assessment tools were used. 152 studies were using assessment tools in researching the association and correlation of health literacy with experiences such as patient-provider interaction, or the effect of the level of health literacy on health outcomes. 26 studies evaluated or compared the assessment tools, describing the benefits and advantages of the tools. 27 studies were either explorative, describing the levels of health literacy in a patient group, or validating the assessment tools. Three studies implemented an assessment tool for routine early health literacy assessment of patients by nurses in the hospital (21, 22, 58).

The result of the studies is an overview of 37 assessment tools for the assessment of health literacy presented through two tables. Table 1 shows the characteristics of the 37 assessment tools included in the selection. The characteristics consist of the year of publication, design, broad description including the number of items, the administration time, mode of administration, objective or subjective assessment, and the number of studies using the assessment tool. These tools have been sorted on the year of publication of the development study with an exception for variants of the original assessment tools, which are placed next to the original assessment tool. Table 2 is sorted similarly and describes the content comparison with each tool being assigned to one or more of the six domains of health literacy: Access, Understand, Appraise, Apply, Numeracy and Digital. The assigned domains correspond with the tools' purpose of assessment stated in the original validation study.

Characteristics of included (digital) health literacy assessment tools

In table 1 we see that the assessment tools differ in administration time, number of items, mode of administration, and objective or subjective assessment. The shortest assessment tools take one minute to administer compared to the longest which takes over twenty minutes to administer. Twelve assessment tools have a short administration time of five minutes or less, five assessment tools take around ten minutes to administer, three take eighteen minutes or longer to administer. For seventeen assessment tools, the administration time was not specified. Fifteen objective tools assess health literacy through tests, containing items with only one correct response. The number of correct responses is summed and represents the health literacy level. These objective items have different forms such as fill in the blank based on multiple-choice embedded answers (Cloze), reading out loud, and calculative questions. Subjective assessment tools have no singular correct response and use a Likert-type scale for example. 21 subjective tools assess health literacy through questionnaires with items, consisting of statements that respondents have to interpret and apply to their personal life. The responses are given based on the level of agreement with the statement, which represents the health literacy level based on the level of capability. The eHLA can be used as both objective and subjective assessment, as the eHLA is an assessment toolkit containing seven different tools. In the 37 assessment tools, we see that the smallest assessment tools, the (S)BHLS and the SILS, consist of a single item, compared to the largest, the Health LiTT, which consists of 82 items.

In the selected 208 studies, we saw that seventeen assessment tools were administered through interview form requiring the presence of an administrator. These seventeen tools could besides through interview form also be administered in a self-reported form without requiring the presence of an administrator. Twelve tools were administered only in self-reported form. Six tools were administered only through interview form and two tools were administered self-reported using

a computer. The four tools that were used most often, with more than twenty studies using the tool, are the NVS, developed in 2006 and used in 47 studies, the (S)TOFHLA, developed in 1999 and used in 32 studies, the BHLS developed in 2004 and used in 25 studies, and the HLQ developed in 2010 and used in 23 studies. Each of the 37 health literacy assessment tools has been validated.

Several original tools have been altered into variants. Over time the REALM, TOFHLA, BHLS, SAHLSA_50, Health LiTT, and HLS-EU-Q47 were all altered to make the assessment tools shorter in administration time and the number of items while striving to preserve the purpose of assessment of the assessment tool. The BHLS on the other hand consisted originally of an itemset of sixteen screening questions, of which three items performed best (59). The BHLS has been abbreviated in a single screening question and elaborated into a form that consists of four and five screening questions.

Eighteen assessment tools have only been used in one or two studies. Additional information was derived of the following assessment tools: The TSOY-32 is an abbreviated version of the Turkish HLS-EU-Q47, the HLS-EU-Q6 consists of six items of the HLS-EU-Q16 and the HLS-EU-Q47, the EBHLS was specifically developed for feasibility in an implementation study, the Health LiTT and the (S)Health LiTT require a computer and software for the questionnaire in administration, the (S)MHLS consist of items available in Mandarin, the (S)KHLS and the (S)KHLT consists of items available in Korean, the eHLA is a toolkit consisting of seven assessment tools and the READHY has 65 items with a focus on readiness for health technology. The eHLQ and READHY both have a major focus on digital health literacy assessment and the capability to use digital services. Further information can be found in the summary of each assessment tool in the appendix.

Table 1: Characteristics of the included (digital) health literacy assessment tools

(d)HL tool^A	Publ. Year	Full name	Design	Broad description	Time^{B,(60)} (min.)	Mode of administration	Objective/ Subjective	Included studies (n=208)^C
REALM⁽⁶¹⁾	1991	Rapid Estimate of Adult Literacy in Medicine	Word recognition and pronunciation test	66 items; General list of medical words in increasing levels of difficulty	2.5	Interview	O	18 ⁽⁶²⁻⁷⁸⁾
REALM-R⁽⁷⁹⁾	2003	Rapid Estimate of Adult Literacy in Medicine - Revised	Word recognition and pronunciation test	8 items; General list of medical words in increasing levels of difficulty, revised	2	Interview	O	5 ⁽⁸⁰⁻⁸⁴⁾
REALM-SF⁽⁸⁵⁾	2007	Rapid Estimate of Adult Literacy in Medicine - short form	Word recognition and pronunciation test	7 items; General list of medical words in increasing levels of difficulty, shortened	1	Interview	O	4 ^(21, 86-88)
TOFHLA⁽⁸⁹⁾	1995	Test of Functional Health Literacy for Adults	Test	67 items; 50 cloze type reading comprehension, and 17 numerical ability tests	22	Interview / Self-reported	O	8 ^(11, 64, 78, 90-94)
(S)TOFHLA⁽⁹⁵⁾	1999	Short Test of Functional Health Literacy in Adults	Test	40 items; 36 cloze type reading comprehension, 4 calculations	Max. 7-12	Interview / Self-reported	O	32 ^(66, 67, 80, 81, 96-123)
BHLS⁽⁵⁹⁾	2004	Brief Health Literacy Screener	Questionnaire	3 items; 5 point Likert type scale	1	Interview / Self-reported	S	25 ^(22, 82, 112, 121, 124-144)
(S)BHLS⁽¹⁴⁵⁾	2008	Short Brief Health Literacy Screener	Question	1 item; 5 point Likert type scale	1	Interview / Self-reported	S	4 ^(67, 102, 146, 147)
BRIEF⁽¹⁴⁸⁾	2009	Brief Health Literacy Screening Tool	Questionnaire	3 items of BHLS + 1 item; 5 point Likert type scale	2	Interview / Self-reported	S	3 ⁽¹⁴⁹⁻¹⁵¹⁾
EBHLS⁽¹⁵²⁾	2014	Expanded Brief Health Literacy Screening Tool	Questionnaire	3 items of BHLS + 2 items; 5 point Likert type scale	2	Interview	S	1 ⁽⁵⁸⁾

(d)HL tool^A	Publ. Year	Full name	Design	Broad description	Time^{B,(60)} (min.)	Mode of administration	Objective/ Subjective	Included studies (n=208)^C
NVS⁽¹⁵³⁾	2005	Newest Vital Sign	Ice cream nutrition label comprehension test	6 items; General health literacy test using an ice cream nutritional label.	3-4	Interview	O	47 ^(10, 69, 80, 81, 87, 110, 111, 115, 135, 146, 154-190)
eHEALS⁽¹⁹¹⁾	2006	eHealth Literacy Scale	Questionnaire	8 items; with 5 point Likert type scale	NS ^E	Self-reported	S	8 ⁽¹⁹²⁻¹⁹⁹⁾
SAHLSA_50⁽²⁰⁰⁾	2006	Short Assessment of Health Literacy for Spanish Adults	Word recognition and comprehension test	50 items; For every item, the respondent gets presented two words, they have to choose which one is meaningfully related to the term	3-6	Interview / Self-reported	O	3 ^(158, 185, 201)
SAHL (S&E)⁽²⁰²⁾	2010	Short Assessment of Health Literacy - Spanish & English	Word recognition and comprehension test	18 items; For every item, the respondent gets presented two words, they have to choose which one is meaningfully related to the term	2-3	Interview / Self-reported	O	8 ^(11, 159, 169, 201, 203-206)
SILS⁽²⁰⁷⁾	2006	Single Item Literacy Screener	Question	1 item; 5 point Likert type scale and categorized as inadequate or adequate	1	Interview / Self-reported	S	4 ^(80, 110, 150, 158)
FCCHL⁽²⁰⁸⁾	2008	Functional Communicative Critical Health Literacy	Questionnaire	14 items; 4 point Likert type scale; 5 on Functional, 5 on Communicative, 4 on Critical	NS	Interview / Self-reported	S	15 ^(118, 209-222)
PHLKS⁽²²³⁾	2008	Public Health Literacy Knowledge Scale	Test	17 items; General health knowledge statements, true or false response	NS	Self-reported	O	1 ⁽²²⁴⁾
Health LiTT⁽²²⁵⁾	2009	Health Literacy Assessment Using Talking Touchscreen Technology	Computer based test	82 items: 3 domains; reading comprehension cloze type; identify and interpret information in graphs/tables; numerical operations	18	Computer based & Self-reported	O	2 ^(215, 217)

(d)HL tool^A	Publ. Year	Full name	Design	Broad description	Time^{B,(60)} (min.)	Mode of administration	Objective/ Subjective	Included studies (n=208)^C
(S)Health LiTT⁽²²⁶⁾	2014	Short Form Health Literacy Assessment Using Talking Touchscreen Technology	Computer based test	14 items; 6 cloze type reading comprehension, 6 understanding/ interpretation, 2 numerical operations	NS	Computer based & Self-reported	O	1 ⁽²²⁷⁾
(S)MHLS⁽²²⁸⁾	2012	Short-form Mandarin Health Literacy Scale	Test	11 items; 8 reading tests, 3 numerical tests, multiple choice cloze type response	NS	Self-reported	O	2 ^(229, 230)
EHILS⁽²³¹⁾	2012	Everyday Health Information Literacy Screening Tool	Questionnaire	10 items; 5 point Likert type scale	NS	Self-reported	S	1 ⁽²³²⁾
(S)KHLS⁽²³³⁾	2013	Korean Health Literacy Scale short form	Test	12 items; 7 comprehension and numeracy, 5 health-related	10	Interview / Self-reported	O	1 ⁽²³⁴⁾
HeLMS⁽²³⁵⁾	2013	Health Literacy Management Scale	Questionnaire	29 items; (1) 4 on patient attitudes towards their health, (2) 4 on understanding health information, (3) 4 on social support, (4) 3 on socioeconomic considerations, (5) 4 on accessing GP healthcare services, (6) 3 on communication with health professionals, (7) 3 on being proactive, (8) 4 on using health information. 5 point Likert scale	NS	Self-reported	S	1 ⁽²³⁵⁾
HELP⁽²³⁶⁾	2013	Health Education Literacy of patients with chronic musculoskeletal diseases	Questionnaire	18 items; (1) 6 on comprehension of medical information, (2) 5 on the application of medical information, (3) 7 on communicative competence in provider interactions	NS	Self-reported	S	2 ^(236, 237)

(d)HL tool^A	Publ. Year	Full name	Design	Broad description	Time^{B,(60)} (min.)	Mode of administration	Objective/ Subjective	Included studies (n=208)^C
HLQ⁽²³⁸⁾	2013	Health Literacy Questionnaire	Questionnaire	44 items; 4 point & 5 point Likert type scale; 9 domains (1) 4 on feeling understood and supported by healthcare providers, (2) 4 on having sufficient information to manage health, (3) 5 on actively managing my health, (4) 5 on social support for health, (5) 5 on the appraisal of health information, (6) 5 on the ability to actively engage with healthcare providers, (7) 5 on navigating the healthcare system, (8) 5 on the ability to find good health information, (9) 5 on understanding health information well enough to know what to do	7.5	Interview / Self-reported	S	23 ^(150, 196, 238-258)
HLS⁽²⁵⁹⁾	2013	Health Literacy Scale	Questionnaire	25 items; 5 point Likert type scale; 4 domains; 5 items on accessing (range: 5-25), 7 items on understanding (range: 7-35), 8 items on appraising (range: 8-40), 5 items on applying (range: 5-25) health information	NS	Interview / Self-reported	S	1 ⁽²⁶⁰⁾
HLS(-14)⁽²⁶¹⁾	2013	Health Literacy Scale-14	Questionnaire	14 items; 5 point Likert type scale; 3 subscales including 5 functional literacy items, 5 communicative literacy items, and 4 critical literacy items.	NS	Interview / Self-reported	S	2 ^(184, 262)
HLS-EU-Q47⁽²⁶³⁾	2013	European Health Literacy Survey Questionnaire	Questionnaire	47 items; 4 point Likert type scale; 22 items on the healthcare domain, 13 items on the disease prevention domain, 11 on the health promotion domain. The second section consists of sociodemographics /economics, health behavior, health status, health service use, community participation.	20-30	Interview / Self-reported	S	5 ^(177, 264-267)

(d)HL tool^A	Publ. Year	Full name	Design	Broad description	Time^{B,(60)} (min.)	Mode of administration	Objective/ Subjective	Included studies (n=208)^C
HLS-EU-Q16⁽²⁶⁸⁾	2014	16 items short European Health Literacy Survey Questionnaire	Questionnaire	16 items; 4 point Likert type scale; selected from the HLS-EU-Q47, assessing the same domains.	10	Interview / Self-reported	S	5 ^(192, 269-272)
HLS-EU-Q6⁽²⁶⁸⁾	2014	6 items short-short European Health Literacy Survey Questionnaire	Questionnaire	6 items; 4 point Likert type scale; selected from the HLS-EU-Q47, assessing the same domains.	NS	Interview / Self-reported	S	1 ⁽²¹⁸⁾
AHLS⁽²⁷³⁾	2014	Adult Health Literacy Scale	Test	22 items on drug use and health information, and a figure for pointing out the location of organs in the human body, 13 yes–no, 4 fill-in-the-blanks, 4 multiple choice, 2 matching questions on a scale	NS	Self-reported	O	2 ^(274, 275)
TSOY-32⁽²⁷⁶⁾	2016	Turkish Health Literacy Scale-32	Questionnaire	32 items; 4 point Likert type scale	NS	Interview	S	1 ⁽²⁷⁷⁾
(S)KHLT⁽²⁷⁸⁾	2017	Short Form of the Korean Functional Health Literacy Test	Test	8 items; 4 numeracy, 4 reading comprehension	NS	Self-reported	O	2 ^(279, 280)
eHLA⁽²⁸¹⁾	2018	Electronic Health Literacy Assessment Toolkit	Toolkit consisting of seven tools	44 items; divided over 7 tools; (1): 10 on functional HL, (2): 9 on self-assessed HL, (3): 5 on familiarity with health and disease, (4): 6 on knowledge of health and disease, (5): 6 on digital familiarity, (6): 4 on digital confidence, (7): 4 on digital incentives	NS	Self-reported	O/S	1 ⁽²⁸²⁾
eHLQ⁽²⁸³⁾	2018	eHealth Literacy Questionnaire	Questionnaire	35 items; 4 point Likert type scale; 7 dimensions; (1), 5 on using technology to	7	Self-reported	S	2 ^(257, 282)

(d)HL tool^A	Publ. Year	Full name	Design	Broad description	Time^{B,(60)} (min.)	Mode of administration	Objective/ Subjective	Included studies (n=208)^C
				process health information, (2), 5 on the understanding of health concepts and language, (3), 5 on the ability to actively engage with digital services, (4), 5 on feeling safe and in control, (5), 5 on motivation to engage with digital services, (6), 4 on access to digital services and (7), 6 on digital services that suit individual needs				
HLS-SF12⁽²⁸⁴⁾	2019	Short Form Health Literacy Questionnaire	Questionnaire	12 items; 4 point Likert type scale; 4 domains: assessing (items 1, 5, 9), understanding (items 2,6,10), appraising (3,7,11), and applying (items 4,8,12), which can further be categorized into three domains: healthcare HL (HC-HL), disease prevention HL (DP-HL), and health promotion HL (HP-HL)	3-5	Interview / Self-reported	S	3 ^(147, 285, 286)
READHY⁽²⁸⁷⁾	2019	Readiness and Enablement Index for Health Technology (READHY)	Questionnaire	65 items; 4 points Likert type scale 13 dimensions; 4 from heiQ, 2 from HLQ, and 7 from eHLQ	NS	Self-reported	S	1 ⁽²⁸⁷⁾
HELIA^{D(288, 289)}	2014 2020	Health Literacy for Iranian Adults/Health Literacy Instrument for Adults	Questionnaire	33 items; 5 point Likert type scale 4 on reading comprehension, 6 on accessing, 7 on understanding, 4 on evaluation, 12 on decision making and behavior	NS	Self-reported	S	6 ⁽²⁹⁰⁻²⁹⁵⁾

Footnote: (A) (digital) health literacy assessment tool; (B) Average administration time in minutes, discovered from original validation studies or health literacy toolshed; (C) Multiple studies use multiple assessment tools in their study; (D) HELIA, originally developed to assess health literacy in Iranian adults in 2014. In 2020 has been developed to assess health literacy in adults; (E) Not specified in included studies

Content comparison

Table 2 gives an overview of the assessed content of each assessment tool. The assessed content of each assessment tool has been divided into the six domains of health literacy: Access, Understand, Appraisal, Application, Numeracy, and Digital. The Understanding domain is assessed the most, by all 37 assessment tools, followed by the Access domain and Appraise domain, each assessed by 22 tools. Seventeen tools assess the Access, Understand, and Apply domain, and eleven tools assess the Access, Understand, Appraise and Apply domain. Nine assessment tools assess the Numeracy domain. The least assessed domain is the Digital domain assessed by five assessment tools. Of these five assessment tools, the eHEALS is the oldest, published in 2006 in a study where the authors were one of the first to address the importance of assessment of digital health literacy in healthcare. In 2012 the EHILS was published, and the eHLQ, EHLA, and READHY were all three published in 2018 or 2019. There are no tools that assess all six domains. The eHEALS, EHILS, eHLA, and eHLQ are tools that assess five domains, with the eHEALS assessing the five domains with a focus on electronic health information.

Looking at the year of publication and the number of assessed domains, there is a difference between the earliest developed assessment tools, the REALM, and the TOFHILA, and the latest developed tools, the HLS-SF12, READHY, and HELIA. Where the latest developed tools all assess four domains, the REALM, and the TOFHILA assess one to two domains.

Tables 1 and 2, show that the BHLS and its variants are short in administration time, and often used. In assessed content, we see that the BHLS assesses two domains which, with the addition of extra items, has been broadened to three assessed domains in the EBHLS.

Table 2: Content comparison of included (digital) health literacy assessment tools

(d)HL tool	Publ. Year	Access^A	Understand^B	Appraise^C	Apply^D	Numeracy^E	Digital^F
REALM ⁽⁶¹⁾	1991		Yes				
REALM-R ⁽⁷⁹⁾	2003		Yes				
REALM-SF ⁽⁸⁵⁾	2007		Yes				
TOFHLA ⁽⁸⁹⁾	1995		Yes			Yes	
(S)TOFHLA ⁽⁹⁵⁾	1999		Yes			Yes	
BHLS ⁽⁵⁹⁾	2004	Yes	Yes				
(S)BHLS ⁽¹⁴⁵⁾	2008		Yes				
BRIEF ⁽¹⁴⁸⁾	2009	Yes	Yes				
EBHLS ⁽¹⁵²⁾	2014	Yes	Yes		Yes		
NVS ⁽¹⁵³⁾	2005		Yes			Yes	
eHEALS ^{G(191)}	2006	Yes	Yes	Yes	Yes		Yes
SAHLSA_50 ⁽²⁰⁰⁾	2006		Yes				
SAHL (S&E) ⁽²⁰²⁾	2010		Yes				
SILS ⁽²⁰⁷⁾	2006		Yes				
FCCHL ⁽²⁰⁸⁾	2008	Yes	Yes		Yes		
PHLKS ⁽²²³⁾	2008	Yes	Yes		Yes		
Health LiTT ⁽²²⁵⁾	2009	Yes	Yes			Yes	
(S)Health LiTT ⁽²²⁶⁾	2014	Yes	Yes			Yes	
(S)MHLS ⁽²²⁸⁾	2012	Yes	Yes		Yes	Yes	
EHILS ⁽²³¹⁾	2012	Yes	Yes	Yes	Yes		Yes
(S)KHLS ⁽²³³⁾	2013		Yes			Yes	
HeLMS ⁽²³⁵⁾	2013	Yes	Yes		Yes		
HELP ⁽²³⁶⁾	2013		Yes		Yes		
HLQ ⁽²³⁸⁾	2013	Yes	Yes	Yes	Yes		
HLS ⁽²⁵⁹⁾	2013	Yes	Yes	Yes	Yes		
HLS(-14) ⁽²⁶¹⁾	2013	Yes	Yes		Yes		
HLS-EU-Q47 ⁽²⁶³⁾	2013	Yes	Yes	Yes	Yes		
HLS-EU-Q16 ⁽²⁶⁸⁾	2014	Yes	Yes	Yes	Yes		
HLS-EU-Q6 ⁽²⁶⁸⁾	2014	Yes	Yes	Yes	Yes		
AHLS ⁽²⁷³⁾	2014		Yes				
TSOY-32 ⁽²⁷⁶⁾	2016	Yes	Yes	Yes	Yes		
(S)KHLT ⁽²⁷⁸⁾	2017		Yes		Yes	Yes	
eHLA ⁽²⁸¹⁾	2018	Yes	Yes		Yes	Yes	Yes
eHLQ ⁽²⁸³⁾	2018	Yes	Yes	Yes	Yes		Yes
HLS-SF12 ⁽²⁸⁴⁾	2019	Yes	Yes	Yes	Yes		
READHY ⁽²⁸⁷⁾	2019		Yes	Yes	Yes		Yes
HELIA ^(288, 289)	2014/ 2020	Yes	Yes	Yes	Yes		

Footnote: (A) Access refers to the ability to seek, find and obtain health information; (B) Understand refers to the ability to comprehend the health information that is accessed; (C) Appraise describes the ability to interpret, filter, judge, and evaluate the health information that has been accessed; (D) Apply refers to the ability to communicate and use the information to make decisions to maintain and improve health; (E) Numeracy refers to the ability to perform calculations in a health setting, for example, doses in medication intake; (F) Digital refers to the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to address or solve a health problem; (G) eHEALS, assesses consumers' combined knowledge, comfort, and perceived skills at finding, evaluating, and applying electronic health information to health problems.

Discussion

Over two decades of health literacy research, 208 studies and 37 assessment tools provide us with an answer to the research question. Where each tool can be used to assess health literacy and has been validated accordingly, not every tool is suitable for use in the routine early assessment of the (digital) health literacy of patients in the hospital. We saw that 152 studies in this review use assessment tools in association and correlation research of health literacy. The other 56 studies evaluated the assessment tools through validation and comparison with other assessment tools, and three of these studies described the process of implementation. The four tools that were used most often are the NVS, the (S)TOFHLA, the BHLS, and the HLQ. These four tools differ on important aspects, such as the administration time, which differs from one minute with the BHLS to 7.5 minutes with the HLQ. The four tools differ in design and objective or subjective assessment, with the NVS and the (S)TOFHLA both as an objective test and the BHLS and HLQ as a subjective questionnaire. There is a difference in the number of items, three items in the BHLS to 44 in the HLQ. The review showed us that the four tools had no set mode of administration, as the tools were administered requiring the presence of an administrator through interview and self-reported without requiring the presence of an administrator. The NVS was of these four tools, the only tool that was only administered through interviews requiring the presence of an administrator. Besides the characteristics of the tools, they also differ on assessed domains of health literacy. The HLQ is the broadest, assessing four domains, whereas the other three assess two domains each. We see that the four tools used most in this review already differ on these important points, which starts the debate on what aspects decide suitability for routine early assessment.

This review discovered a lack of implementation studies, where assessment tools were incorporated in the hospital organization to have nurses routinely assess patients' health literacy early in the care pathway. In the vast majority of the studies in this review, the used health literacy assessment tool was used in a research setting, aimed at assessing the level of health literacy in specific patient groups and investigating associations and correlations between health literacy and other patient characteristics. There were only three studies that focused on incorporating routine health literacy assessment (and registration) in the clinical hospital setting by nurses. These studies described the process of incorporation of the REALM-SF, BHLS, and the EBHLS (21, 22, 58). The studies report an acceptable average uptake of eighty percent or higher. To reach this uptake, the researchers emphasize the requirement of training and ways of promoting the negative consequences of limited health literacy, combined with the benefits of properly addressing the problem of limited health literacy through health literacy assessment. The researchers further emphasize identifying key stakeholders in the incorporation process and showing them the importance of health literacy assessment. In all three studies, the assessment tools have been administered through the EHR. Which has multiple benefits, such as a pop-up message when the assessment has not yet been performed and also a warning for providers if they come into contact with a patient with limited health literacy. By adding the results of the assessment to the EHR, all hospital personnel with access to the EHR will be aware of the level of health literacy of a patient and, when the health literacy is limited, can use interventions such as the teach-back method to tailor their provided care to the patient's health literacy (16). As almost all hospitals are working with an EHR, we would advise an assessment tool that can be administered through the EHR. This decreases the administrative burden, as filled-in pen and paper questionnaires or interview transcripts will not have to be uploaded to the EHR (296).

Besides the importance of administration through the EHR, we discovered two important points of attention in selecting a suitable assessment tool: a short administration time and easy to use design. The nurses interviewed during this review also mentioned these three points in their expectations of an assessment tool. The interviewed nurses stated that a short administration time of five minutes is important to make an assessment tool suitable for early routine assessment of (digital) health literacy. This was also confirmed by studies in this review that implemented an assessment tool in the hospital setting for routine early assessment of patients' health literacy level (21, 22, 58). The administration time is influenced by the size of an assessment tool, as the number of items influences the assessment tool's administration time, depending on the design of the assessment tool. The REALM for example has 66 items but takes only 2,5 minutes to administer as it is scored on the pronunciation of words read out loud. Whereas, the HLS-EU-Q47 consists of 47 items but takes twenty to thirty minutes to administer as it is scored by statements and the patient's degree of agreement with each statement. An easy-to-use design also influences the administration time, as it takes less time to explain to a patient. Besides, studies in this review using different assessment tools explicitly mentioned the importance of easiness of use and understanding of the assessment tools (21, 22, 58, 73, 80, 98, 139, 151, 169, 177, 196). Lastly, in the studies implementing and incorporating the assessment tools in the hospital setting, all assessment tools and scores were implemented in the EHR, supporting the recommendation of the interviewed nurses (21, 22, 58). The authors, who also coordinated the incorporation process, chose the REALM-SF, BHLS, and the EBHLS to use in routine early health literacy assessment, as these tools were easy to use, had a short administration time, a short number of items, and could all effectively be administered through the EHR. The authors did mention the importance of including key stakeholders, such as department managers, educating nurses in the administration of the tool, and making them understand the necessity of assessing the health literacy level (21, 22, 58). Besides the REALM-SF, the BHLS, and the EBHLS, the tools that have these characteristics are the (S)BHLS, the BRIEF, the NVS, the SAHL (S&E), the SILS, and the HLS-SF12, as they all have a short administration time, are easy to administer and can all be administered through the EHR. Which gives them preference based on these three important points of attention.

The mode of administration is also an important point in determining the suitability of an assessment tool. There are two main modes of administration, self-reporting without requiring the presence of an administrator, and interview which requires the presence of an administrator. Self-reporting can be performed through digital questionnaires, on the internet or electronic devices, or pen and paper questionnaires with various response scales. Seventeen tools could be administered in both forms, with and without the required presence of an administrator. Twelve tools were administered only in self-reported form. Six tools were administered only through interview form and two tools, the Health LiTT and the (S)Health LiTT, were administered self-reported using a computer that was placed in a waiting area. Both modes of administration come with advantages and disadvantages. The advantage of self-reported administration is that it does not require the presence of an administrator and can be administered in a waiting area. If a tool has to be administered through an interview setting, this does demand the presence of an administrator, which might create an additional workload. However, both modes of administration have advantages. Where the presence of an administrator increases workload, as it is an extra assessment that has to be conducted, it can be used to replace current ways of assessing information on reading skills, writing skills, language, and preference for instructions, for instance, verbal, written or through video format (22). This replacement can also apply to self-reporting. However, self-reporting is often based on statements the

patient has to apply to their personal life through a degree of agreement, which can lead to over-or underestimation of health literacy level. To avoid this over-or underestimation it is necessary to look at the design of the assessment tools. Objective assessment tools are tests in which patients often do not realize that their health literacy level is being assessed. The items in these tests are not answered through interpretation and application to the personal situation. Therefore, there is no risk of over-or underestimation of the patient's health literacy level.

Of the 37 assessment tools, there are fifteen objective assessment tools and 21 subjective assessment tools. The eHLA can be used as both objective and subjective assessment, as the eHLA is an assessment toolkit containing objective and subjective tools. The subjective assessment uses interpretation and application to a patient's personal life, and an administrator cannot verify the given responses to prevent over-or underestimation of the health literacy levels of the patient. Studies in this review stated that subjective assessment is vulnerable to social desirability bias, and overestimation as a consequence of shame (142, 196, 210, 212, 214-217, 230, 236, 280). This increases the risk of incorrect health literacy levels, defines the disadvantages of using subjective self-reported assessment tools. With objective assessment, no such recurring disadvantages were found beside the staff requirement, however, that can be refuted as health literacy assessment can replace current ways of assessing information on skills, language, and preference for instruction (22). Therefore, the preferred design of an assessment tool is an objective assessment tool that can be administered self-reported as it can replace current ways of information assessment and does not require an administrator in assessment besides processing the result. This does not create an additional workload and can even decrease the current workload.

The assessment tools were compared based on the six domains. We saw that all tools assess the Understanding domain. The Access and Appraise domains were each assessed by 22 tools. Seventeen tools assess the Access, Understand, and Apply domain, and eleven tools assess the Access, Understand, Appraise and Apply domain. Nine assessment tools assess the Numeracy domain. The least assessed domain is the digital domain assessed by five assessment tools. The difference in assessed content between the early developed tools, and the latest developed tools might have an explanation in the used definition of health literacy in the respective development studies. Considering the broad definition of health literacy, and the importance of every single domain of health literacy in a patient's health management and proper use of the modern healthcare system, we deem it important that as many domains as possible are assessed in health literacy assessment. When focusing on the individual domains, it becomes clear that these domains cover the necessary base skills of navigating the modern healthcare system. Considering the importance of each domain, the assessment tools assessing the most domains are preferred, in this case, the eHLA, the eHLQ, the EHLS, and the eHEALS. These four tools each assess five domains. However, the eHEALS primarily focuses on assessing health literacy through the five domains, excluding Numeracy, through items assessing confidence and capability of using the Internet, such as: *"I know how to find helpful health resources on the Internet"* (191). A patient might be inexperienced with computers and the Internet, and therefore score low on the eHEALS, but have an adequate health literacy level through the other five domains. The skills assessed through the items of the eHEALS can be transferred to the skills assessed in the other domains when a patient shows a high rate of agreement with the assessed skill. However, they cannot be transferred to the other domains when the respondent shows disagreement of possessing the assessed skills, which leads to a risk of incorrect assessment of health literacy level when using the eHEALS. This risk of incorrect assessment through a focus on the digital domain is a

disadvantage of using the eHEALS as an assessment tool for the routine early assessment of health literacy in the hospital. The assessed content of each assessment tool provides additional information besides the characteristics of each assessment tool and might help the reader in deciding which tool is useful in their setting. Our advice is to use an assessment tool that assesses health literacy through as many domains as possible, in this case, the eHLA, eHLQ, and the EHILS. However, as this narrows the selection down to three tools, of which one is a toolkit, tools assessing four domains should not be omitted, for each patient population and hospital is different and might differ in placing priority to certain domains of the six domains in the assessment of health literacy.

Looking at the year of publication, it seems that the tools developed after 2012 assess more domains than the tools developed before 2012. In 2012 the HL-EU Consortium conducted a systematic review into all available definitions for health literacy, to create a broad comprehensive definition which has also been used in this study (1). When using this definition in development, the four domains of Access, Understand, Appraise and Apply are included. It might be that the studies published after this review into the definitions used this broader definition in the development of the assessment tool for the assessment of health literacy. At least for the HLS-EU-Q47, and the tools based on the HLS-EU-Q47 as can be seen in the appendix, this is the case, as these tools were developed through the HL-EU Consortium. Digital health literacy, or eHealth literacy, was historically seen as a separate definition besides health literacy. In 2006 a study was published, stating the definition of digital health literacy, and describing the importance of assessment of digital health literacy (2). In the same year, the authors published a study in which they presented the first assessment tool for the assessment of digital health literacy (191). Besides the eHEALS, three out of four of the other assessment tools assessing the digital domain use the same definition for digital health literacy in their purpose of assessment in their original validation study. Only the EHILS does not clearly state a definition for digital health literacy, as the authors chose a definition for health information literacy instead, which was defined in 2003 as follows: *“The set of abilities needed to: recognize a health information need; identify likely information sources and use them to retrieve relevant information; assess the quality of the information and its applicability to a specific situation; and use the information to make good health decisions”* (231). We see that this definition has similarities to the definition of 2006: *“the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to address or solve a health problem”*(2). Both definitions are similar in assessing the four domains of Access, Understand, Appraise and Apply in a digital context. Therefore, we can conclude that all five assessment tools assessing the Digital domain assess digital health literacy through the same purpose of assessment. When looking at assessment tools developed after 2012 that includes the Digital domain in assessed content, we see that the number of assessed domains consist of a minimum of four and a maximum of five domains in the eHLQ. With five domains assessed, the eHLQ looks the most promising based on assessed content. However, the eHLQ is only used in one study in this review which might be because it was published recently in 2019. Further research is necessary using the eHLQ to assess (digital) health literacy to determine advantages and disadvantages through experience.

Some assessment tools were only used in one or two studies. This might be due to different reasons. First, available language, as seen in the TSOY-32, the (S)MHLS, the (S)KHLS, and the (S)KHLT. These might be used less, as they can only be used in their respective languages requiring a translation study if it has to be used in other languages. Second, abbreviation, looking at the HLS-EU-Q6, which consists of six items of the HLS-EU-Q16 and the HLS-EU-Q47. The HLS-EU-Q16 has been used in five studies compared to the HLS-EU-Q6 which was used only in one study. The HLS-EU-Q6 might be too

abbreviated leading to higher use of the HLS-EU-Q16 when researchers require an abbreviated version of the HLS-EU-Q47. Third, requirements for administration, the Health LiTT and the (S)Health LiTT require a computer and software for the questionnaire in administration. Fourth, altering an assessment tool to fit implementation demands. The EBHLS was specifically developed for feasibility in an implementation study and might therefore be less fitting in other studies compared to the BHLS or (S)BHLS. Fifth, being a toolkit, the eHLA consists of seven assessment tools, based on existing assessment tools such as the TOFHLA. It might be that researchers used the independent tools instead of the toolkit. Sixth, the length and focus of an assessment tool, the READHY has 65 items with a focus on readiness for health technology, based on a selection of items from the HLQ, eHLQ, and the heiQ (297). Researchers might have selected one of these three instead of the READHY. Lastly, the year of publication might also explain the low number of studies using the tool, as we see that tools developed in the last decade have been used in a small number of studies. The assessment tool in this review that is used most in the last decade, with an exception of the HLQ which is frequently used in health literacy research, is the HELIA with six studies. Assessment tools that have been used in multiple published studies have more validation studies describing more user experiences, advantages, and disadvantages of using the assessment tool compared to assessment tools used in a low number of studies. Therefore it is necessary to perform more research into assessment tools with a low number of studies using the assessment tools to gain more insight into these tools.

Considering that the REALM-SF, BHLS, and EBHLS have already been used in the hospital as routine early health literacy assessment tools used by nurses, these tools are feasible options that show uptake of over eighty percent by nursing staff. These assessment tools are all short in administration time, easy to use, and can be administered through the EHR. Unfortunately, the tools assess a maximum of three domains. The REALM-SF assesses the domain of Understanding, the BHLS assesses the domains of Access and Understanding and the EBHLS assesses the domains of Access, Understanding, and Apply. This means that of these assessment tools, the EBHLS is the broadest although it still lacks assessment of the remaining three domains. But, as has been done in the development of the EBHLS, it might be possible to add extra items to assess one or more of the remaining domains. Looking at the administration time of two minutes there is room for extra items. All six domains cover important abilities patients should possess to adequately solve their health problems. If a tool only assesses one domain, this might not be representative of the entire (digital) health literacy level, as this only shows that a patient might understand the information mentioned by a physician, but does not have the skills to apply the provided information to their personal life and will fail in treatment adherence. An easy-to-use assessment tool that can be administered through the EHR is the eHLQ. The eHLQ assesses five domains and is administered without requiring the presence of an administrator which decreases the workload for the nurse. The eHLQ combines both health literacy and digital health literacy in assessment and is a tool fit for the assessment of (digital) health literacy. However, the eHLQ takes seven minutes to administer, which is longer than the five minutes stated as a maximum. The EBHLS and the eHLQ are both subjective assessment tools. The EBHLS requires the presence of an administrator and is administered through interviews. As both assessment tools are subjective, we are aware of the risk of over- or underestimation and social desirability bias, but by being aware, it is possible to address these risks, perhaps by emphasizing the importance of patients' truthful responses in providing proper healthcare. In this review, the EBHLS has the more trustworthy credentials, as it is an expansion of the BHLS, used in 25 studies, and has previously been used in routine early assessment by nurses in the hospital. However, future research is required to add

additional items to the EBHLS as in its current form it does not assess digital health literacy. By adding additional items, it can be possible to assess the domains of Appraise, Numeracy, and Digital providing a complete assessment of the patients' level of (digital) health literacy. The eHLQ requires future research as in this review it is only used in two studies, through future research it might also be possible to decrease the administration time of seven minutes to the maximum of five minutes.

Strengths and limitations

The strengths of this review come forward in the broad overview of 37 available assessment tools, describing their characteristics and the domains of health literacy that each assessment tool assesses. To keep this broad and miss as few instruments as possible, the search strings were elaborate and focused on health literacy assessment tools in healthcare. By doing so, nine tools were discovered that might have been missed otherwise, as these tools were used in the primary care setting or included participants that were not patients. The researchers had weekly meetings throughout the entire research process, to make sure that they remained on the same page. By including the third and fourth researchers in moments of doubt, the room for error during the screening and selection process was kept to a minimum. In these meetings we decided to narrow our focus on the hospital setting and the nine tools were excluded in the final inclusion. One of the excluded nine assessment tools did catch our attention, as it requires no administration time and no administrator. It is an algorithm that assesses secure messages between healthcare providers and patients. Based on the written text this algorithm then decides the level of health literacy of the patient (298-300). This tool is interesting for future studies because it can assess health literacy without self-reporting or interviews and removes the previously stated disadvantages for both modes of administration.

The interviews helped to ascertain nurses' experiences with patients with limited (digital) health literacy and their expectations and demands of a health literacy assessment tool feasible for use in the hospital. These expectations and demands provided us with points of interest to keep in mind and were, in this review, supported by the included studies.

Where previous research stated difficulties comparing assessment tools, we created an overview with the six important domains including the Digital domain which becomes increasingly important in the current healthcare system. Additional characteristics that might complement future comparison are ways of validation of the assessment tools and languages in which the assessment tools are available. The CONsensus-based Standards for the selection of health Measurement INSTRUMENTS (COSMIN) checklist, a checklist that can be used in validation comparison, might be interesting to use in future comparisons (301). This comparison was not done in this study as the objective was to create an overview of available instruments.

Practice implications

This review adds to the existing literature in creating a broad overview of available assessment tools. In future studies, it might be interesting to compare the assessment tools in ways of validation, for example through the COSMIN checklist, and find out in which languages the assessment tools are available. This might supplement the comparison of this study which is based on assessed content and characteristics.

Conclusion

Through this review, the reader has been provided with an overview of 37 assessment tools for the assessment of health literacy. Each assessment tool has been validated and used in research, some assessment tools are used more often than others due to reasons such as available language, abbreviation, requirements for administration, altering to fit implementation demands, being a toolkit, number of items, and focus of the assessment tool. The REALM-SF, EBHLS, and BHLS have been previously implemented in the hospital setting and show important focus points to take into account when implementing an assessment tool in routine early health literacy assessment in the hospital setting. Of these three the EBHLS assesses three domains, however the EBHLS does not assess the Digital domain and is therefore not able to assess (digital) health literacy. Future research is necessary to expand the EBHLS to include assessment of the Digital domain and if possible the other domains. As the administration takes two minutes, there is room for adding additional items. The eHLQ is capable of assessing five of the six domains of health literacy and able to combine the assessment of health literacy and digital health literacy in one assessment. However, as it takes seven minutes in administration and is reported in two studies in this review future research is relevant to decrease the administration time and report experiences and advantages and disadvantages of using the eHLQ.

We have provided the reader with points of attention to keep in mind when selecting an assessment tool, such as short administration time, easiness to understand and use, mode of administration, objective or subjective assessment, number of items, and the assessed domains of health literacy. Each situation where routine early health literacy assessment is a point of interest, might it be in a research setting or implementation in the hospital setting, has different demands and expectations. Based on the criteria, characteristics, and assessed content of each assessment tool in this study, it is up to the reader to decide which tool best fits their demands and expectations.

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Other information

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Appendix 1: Search strings per database

1. PubMed search string

((((((((((nurs*[Title/Abstract]) OR (health care professional*[Title/Abstract])) OR (healthcare professional*[Title/Abstract])) OR (health care provider*[Title/Abstract])) OR (healthcare provider*[Title/Abstract])) OR (health care worker*[Title/Abstract])) OR (healthcare worker*[Title/Abstract])) OR (caregiver*[Title/Abstract])) OR (health personnel*[Title/Abstract])) OR (physician*[Title/Abstract])) OR (clinical staff*[Title/Abstract])) OR (health staff*[Title/Abstract])) OR (patient professional communication[Title/Abstract])

AND

(((((Health literacy[MeSH Terms])) OR (Health literacy[Title/Abstract])) OR (Health competence[Title/Abstract])) OR (Ehealth literacy[Title/Abstract])) OR (E-health literacy[Title/Abstract])) OR (Digital literacy[Title/Abstract])

AND

((((((((Assessment[Title/Abstract]) OR (Assessment tool[Title/Abstract])) OR (Questionnaire*[Title/Abstract])) OR (Scale[Title/Abstract])) OR (Screening tool[Title/Abstract])) OR (Survey[Title/Abstract])) OR (Literacy Screen[Title/Abstract])) OR (Measure*[Title/Abstract])) OR (Tool*[Title/Abstract])

2. Scopus search string

TITLE-ABS-KEY ((nurs* OR professional OR provider) AND ("health literacy" OR "digital literacy") AND ("assessment tool" OR questionnaire OR survey OR "literacy scale"))

3. Web of Science search string

TS=((nurs* OR professional OR provider) AND ("health literacy" OR "digital literacy") AND ("assessment tool" OR questionnaire OR survey OR "literacy scale"))

4. CINAHL search string

((MH "Health Literacy") OR "health competence" OR ehealth OR "digital literacy") AND (assessment OR MH "Questionnaires+" OR MH "Scales" OR screening tools OR MH "Surveys+") AND MH "Nurses+"

Appendix 2: Short summary of the included assessment tools

The (S)KHLS is focused on assessing numeracy and reading comprehension of routinely used health terms in the clinical setting. In the study, a researcher was present to administer the (S)KHLS through an interview at the bedside of inpatient patients. For outpatient patients, a researcher was present to assist patients with filling in the questionnaire. Especially to assist the older patients.

The (S)KHLT is a test to assess health literacy focusing on numeracy and reading comprehension through eight items. It is an abbreviated form of the Korean Health Literacy Test (KHLT) (302). Both the (S)KHLT and the (S)KHLS were developed for the assessment of health literacy in the Korean-speaking population.

The (S)MHLS focuses on the assessment of reading comprehension and numeracy. The (S)MHLS simulates communication between patient and medical personnel and is divided into the sections outpatient dialogue and medication information. As it is used to test the individual ability to read, understand and apply health information, the researchers emphasized the importance of the patient to fill in the questionnaire on his own, without assistance. The (S)MHLS is the abbreviated form of the original MHLS which consists of fifty items and assesses the same domains. The tool is developed for the Mandarin-speaking population (303).

The (S)TOFHLA is the abbreviated form of the TOFHLA. The (S)TOFHLA gives participants a maximum of twelve minutes to complete the test when the numeracy items are included. Without the numeracy items, the maximum completion time is set at seven minutes. The cloze type reading part of the test is divided into two texts which are the same as the TOFHLA. The first text contains "Instructions for upper gastrointestinal tract radiographic procedure" and the second text contains "Rights and Responsibilities" passage from health insurance. Additionally, the test contains four numeric questions. The test is often, 23 studies out of 32 selected, applied without the four numeracy questions.

The AHLS has been developed for the assessment of health literacy in the Turkish population. It includes 22 items on drug use and health information for identifying the adult health literacy level and a figure where patients have to show the place of organs in the body.

The BHLS is used in different versions, some studies use only one or two of the three questions from the BHLS. Originally, the BHLS contains three questions: "How often do you have problems learning about your medical condition because of difficulty in understanding written information?", "How often do you have someone help you read hospital materials?", and "How confident are you filling out medical forms by yourself?". In the original validation study, the researchers showed that these questions could be used independently for the assessment of health literacy. The original BHLS has been modified as well, into the BRIEF, where a fourth item has been added: "How often do you have a problem understanding what is told to you about your medical condition". In the EBHLS a fifth item has been added: "How often do you have trouble remembering instructions from the doctor, nurse, or pharmacist (druggist) after you get home?". Through the EBHLS, the researchers sought to use an assessment tool in a hospital for early routine assessment through the EHR. They mentioned the importance of a brief health literacy assessment tool. This brought them to the original BHLS. However, they referred to literature that pointed out that verbal health literacy is also an important aspect to consider in the assessment of health literacy (304, 305). Four of the included studies use the single question "How confident are you filling out medical forms by yourself?" has been used independently.

The eHEALS is the first tool to measure digital health literacy. It consists of eight statements focusing on a patients' ability to find health information on the internet, to scrutinize the discovered

health information, and the patients' level of confidence in decision making based on the discovered health information. The patients give their level of agreement with each statement through a five-point Likert scale.

The EHILS was developed to assess the level of everyday health information literacy through ten statements where patients have to answer by giving their level of agreement with each statement. The EHILS assesses both the ability of patients to find, scrutinize, understand and act on health information in printed sources as on information discovered on the internet.

The eHLA is a Danish health literacy toolkit that contains seven tools. The developers based the tools on existing tools such as the TOFHILA and the HLS-EU-Q47. The first four tools are focused on assessing health literacy, the last three are focused on assessing digital literacy. Tool one and four are focused on functional health literacy and knowledge of health and disease. These two tools are performance tests. The remaining tools have a four-point Likert scale. In the second tool patients, the level of health literacy is assessed through self-assessment. Patients give the level of difficulty they have with each item. The third tool assesses familiarity with disease and health through the level of knowledge patients have with each item. The fifth tool assesses digital familiarity through the level of familiarity with each item. The sixth tool assesses digital confidence through the level of confidence patients have with each item. The final tool assesses the level of agreement patients have with digital incentives. The researchers mentioned that the tools could be used independently, but the most complete assessment of the health literacy level would be given by using all tools combined.

The eHLQ assesses health literacy through the seven dimensions of the eHealth Literacy Framework, as mentioned in table 1 (306).

The FCCHL is a tool that assesses three dimensions of health literacy of patients, functional, communicative, and critical health literacy, following the definition of health literacy stated by Nutbeam (307). In its original version, it was focused on assessment in diabetes patients, however, the tool could easily be adapted to be used in other patient groups. As was seen in the inclusion of this review.

The Health LiTT is one of the largest tools consisting of 82 items and is based on the TOFHILA. It consists of three dimensions. Prose, assessed by cloze-type questions which assess reading comprehension. Document, which focuses on the patient interpretation of graphs and tables and Quantitative which lets patients do arithmetic operations and measures numeracy. The Health LiTT is self-administered through a touchscreen monitor or on a computer. The developers also developed a short version of the Health LiTT consisting of fourteen items measuring the same dimensions.

The HELIA was originally developed in Persian to measure the health literacy of Iranian adults. The researchers also translated the instrument to an English version in 2020, both can be seen in table 1.

The HeLMS is developed based on six core individual abilities of health literacy within the healthcare setting: "Knowledge of where to access health information", "Verbal communication", "Being proactive", "Literacy skills", "Capacity to retain and process information" and "Application skills to manage health". These core abilities are assessed through eight dimensions.

The HELP is the result of a study in patients with chronic musculoskeletal conditions. However, the questionnaire itself is usable in other patient groups. The HELP focuses on the assessment of comprehension of medical information, the application of medical information, and communicative competence in provider interactions.

The HLQ is one of the broadest health literacy assessment tools. In the selection in the current study, it has primarily been used in the research setting. The HLQ consists of nine dimensions, and each covers an individual aspect of health literacy. The nine scales can be divided into the three domains of

Functional, Communicative, and Critical health literacy. The scales are independently usable, as was seen in the included studies as well. However, if the goal is to assess a complete level of health literacy, all nine scales should be used.

The HLS assesses health literacy through four dimensions, accessing, understanding, appraising, and applying health information. The HLS has been developed based on the framework of the HLS-EU consortium.

The HLS-14 is the FCCHL but has been altered so it can be used in non-diabetic patient groups as well. Even though it was easy to adapt the FCCHL, the HLS-14 can be applied without further adaptation.

The HLS-EU-Q47 was created through a European consortium on Health Literacy, the HLS-EU Consortium which conducted the European Health Literacy project (1). The goal of this consortium was to assess the health literacy of general populations. The HLS-EU-Q47 is a broad questionnaire and is available in English, Bulgarian, Dutch, German, Greek, Polish, and Spanish. The project concluded that health literacy can be applied through three domains, healthcare, disease prevention, and health promotion. Each domain focuses on different aspects of health literacy. The healthcare domain assesses the ability to access, understand, interpret, evaluate and apply information on medical or clinical issues. The disease-prevention domain assesses the ability to access, understand, interpret, evaluate and apply information on risk factors for health. The health promotion domain assesses the ability to access, understand, interpret, evaluate and apply information on determinants of health in the social and physical environment. The HLS-EU-Q16 and HLS-EU-Q6 are developed to be short forms of the HLS-EU-Q47. Through six(teen) items selected from the HLS-EU-Q47, these questionnaires still assess the domains the HLS-EU-Q47 intended to assess.

The HLS-SF12 is developed to be a short form of the HLS-EU-Q47, through twelve items, the HLS-SF12 still assesses the domains the HLS-EU-Q47 strived to assess.

The NVS is an assessment tool that measures health literacy objectively. Patients have to read an ice cream nutrition label and answer six questions about the contents. The assessment focuses on numeracy and understanding written information.

The PHLKS consists of seventeen general health knowledge true or false statements. Examples of the statements are as follows: "Many diseases can be prevented by washing hands before touching food (True)" and "Overall, vaccination has more risks than benefits (False)". An interesting finding in the discussion is that experts performed worse than the public.

The READHY is developed based on the HLO, eHLO, and heiQ. It contains thirteen dimensions that have been selected from the three independent tools.

The REALM is a word pronunciation test in which a patient has to read words out loud. The number of correctly pronounced words is counted and scored. Based on the scoring, patients receive a grade level. The list increases in difficulty, based on grade level. The REALM-R and the REALM-SF are short forms of the REALM administered similarly. The REALM-SF was developed after the REALM-R. The researchers mentioned significant limitations in the validation study of the REALM-R.

The SAHLSA_50 was first created as an alternative for assessing health literacy in Spanish Speaking adults based on the REALM. Patients get two words presented to them, per term of the SAHL, of which only one has a meaningful relation to the SAHLSA_50 term. Patients have to pick the correct term. Later studies altered the instrument to shorter versions, consisting of eighteen items and available in multiple languages. The SAHL S&E is the short version of the original fifty items SAHL. Which has been developed with eighteen items similarly to the original SAHLSA_50 and can be used in Spanish and English populations and is available for comparative studies in populations where Spanish and English

speaking citizens live together. The SAHLPA is the version of the SAHL S&E available in Portuguese, in the translation study the researchers created the eighteen items version as well as the fifty items version.

The SILS is a single-item question that assesses whether adults need help with printed health material. It has been based on the three questions of the BHLS, where the researchers expanded one of the questions, "How often do you have someone help you read hospital materials?". This brought them to the following question: "How often do you need to have someone help you when you read instructions, pamphlets, or other written material from your doctor or pharmacy?".

The TOFHLA consists of fifty cloze-type items with seventeen numeracy questions. The passages used in the reading comprehension part are also used in the (S)TOFHLA. Patients have a maximum time of 22 minutes to complete the TOFHLA.

The TSOY-32 is based on the Turkish version of the HLS-EU-Q47, which has been adapted and abbreviated to 32 items.