Navigating the digital divide: A systematic review of eHealth literacy in underserved populations in the United States

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eHealth provides an important mechanism to connect medically underserved populations with health information, but little is known about gaps in eHealth literacy research in underserved adult populations within the U.S. Between June and July 2013, three systematic literature reviews of five databases were conducted and a subsequent hand search was completed. Identified literature was screened and studies meeting exclusion and inclusion criteria were synthesized and analyzed for common themes. Of the 221 articles critically appraised, 15 met these criteria. Thirty-five of these studies were excluded due to international origin. Of the articles meeting the inclusion criteria, underserved populations assessed included immigrant women, the elderly, low-income, the un- and underemployed, and African-American and Hispanic populations. eHealth literacy assessments utilized included one or two item screeners, the eHEALS scale, health information competence and cognitive task analysis. Factors examined in relation to eHealth literacy, included age, experience, overall health literacy, education, income and culture. The majority did not assess the impact of locality and those that did were predominately urban. These data suggest that there is a gap in the literature regarding eHealth literacy knowledge for underserved populations, and specifically those in rural locations, within the U.S.

Keywords Access to healthcare, eHealth literacy, rural populations, systematic review, underserved populations

INTRODUCTION

Within the past 10 years, eHealth has emerged as a readily accessible resource for obtaining health information. The World Health Organization defines eHealth as the “transfer of health resources and health care by electronic means,” enabling health professionals and consumers to disseminate and obtain health information (1). eHealth is comprised of two separate domains: Health 1.0 and Health 2.0. While Health 1.0 is comprised of health information seeking in the traditional sense, Health 2.0 is the interactive component of eHealth which includes social networking, participation, apomediation, collaboration and openness (2). eHealth is a valuable resource to both obtain

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information and connect with resources and data suggest that it is a prevalent practice. Research estimates that 52–80% of internet users have obtained health information online with number of estimated users only increasing with time (3–5).

Despite its frequent utilization, data suggests that there is some variability in the quality of information available online. In a systematic review of empirical studies evaluating the quality of health information online, the majority of studies (70%) determined that quality was a problem (6). Included among the problems cited in the study were a lack of completeness and accuracy and difficulty finding high quality cites. Data suggest that while people realize that Internet health information may not necessarily be trusted, they may not be able to adequately discern between trustworthy and untrustworthy information (7,8). Quality evaluation is also important for social support (such as seeking advice from fellow patients on an interactive blog). Research suggests that distinguishing professional from non-professional advice is an important component of properly utilizing Health 2.0 applications (9). Without this ability, there is the possibility for the dissemination of inaccurate or dangerous information (10–12). The variability in content and quality is significant because inappropriate information has been found to be associated with some harm. Although looking up health information online is associated with a low risk, a review of cases of harm associated with use of health information on the internet found that there were cases of emotional distress and even one death after finding misinformation on the internet (13). Even when quality information is provided, misunderstandings associated with low readability may occur (12). While quality tools may provide some assistance in the evaluation of health information online, it is important to enable people to obtain the skills to locate the right resources (10).

These skills, in sum, are known as eHealth literacy, a term which is defined in the literature as “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” (14). There are several levels on which eHealth literacy can occur. The lower level is comprised of operational and navigational skills, while the higher level requires the ability to choose and critically evaluate the available information (15–17). eHealth literacy can be further divided into six core literacies: traditional literacy, health literacy, information literacy, scientific literacy, media literacy, and computer literacy (14). Each of these contributes to the ability to find and assess the quality of health information online and a deficiency in any may result in inadequate health literacy and prevent individuals from accessing quality eHealth resources.

eHealth literacy may be particularly important for underserved populations, which may have both decreased access to health infrastructure and lower levels of competence in the six core literacies. Although the definition of underserved populations is variable, the general consensus is that within the U.S. it is defined as individuals “who do not have adequate access to health care services. They share one or more of these characteristics: they may be poor; uninsured; have limited English language proficiency and/or lack familiarity with the health care delivery system; or live in locations where
providers are not readily available to meet their needs” (18). While minority race or ethnicity, in and of itself, is not necessarily a characteristic of an underserved population it is often an associated variable. Location is an important indicator variable for several reasons. Individuals who are separated from health resources by geographic distance are at a disadvantage due to a lack of health infrastructure (19) which can result in worsened health outcomes (20,21). Furthermore, rural locations are comprised of populations which are at an increased risk for low eHealth literacy including the elderly, low income and low education. (22,23). Because underserved populations are both more likely to have decreased access to health infrastructure and decreased opportunity to access technology, they represent an important population in which to assess and intervene on eHealth literacy.

To our knowledge, this is the first systematic review to address eHealth literacy in underserved populations in the U.S. While previous systematic reviews have addressed eHealth literacy in college populations (23), eHealth literacy tools (24), online health literacy interventions (25), computer-based interventions and applications (26–28), the definition of eHealth (29), online decision aids (30) and eHealth policy issues (31), but none have synthesized empirical evidence of eHealth in underserved populations within the U.S. Two systematic reviews addressed eHealth in rural populations, however these were predominantly international in scope (32,33). The objective of this systematic review was to assess the current body of empirical knowledge regarding eHealth literacy and its associated factors in underserved populations in the U.S. in order to identify gaps and areas for potential future research.

METHODS

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta Analyses (34). Between June and July 2013, we conducted a systematic literature review completing three distinct searches of five databases using combinations of relevant search terms and Boolean operators. The initial search was conducted using PubMed, CINAHL, ERIC, Cochrane Library and PsycINFO and the search terms “eHealth literacy,” “Telemedicine,” “literacy,” and “eHealth.” One hundred one citations were identified prior to the removal of duplicates. We then conducted a search using two categories of keywords: (category a) “eHealth literacy,” “eHealth,” “ecare,” “computer literacy,” “information storage and retrieval,” and “digital divide; and (category b) “deprived area,” “underserved populations,” “medically underserved area,” “poverty,” “socioeconomic factors,” and “rural population.” For every search, one term was selected from each category. A total of 36 searches were completed and 99 additional articles were identified prior to the removal of duplicates. A search of all health literacy articles from 2010 to 2013 was conducted using PubMed, CINAHL, ERIC, Cochrane Library and PsycINFO and the search terms “United States” and “health literacy.” These articles were screened for eHealth literacy content and 15 additional articles were identified prior to the removal of duplicates. All searches were restricted to articles pertaining to adults in the English language. A hand search was completed of all pertinent systematic
reviews identified in the previously described searches. The inclusion and exclusion criteria were as follows:

**Inclusion**
- Measures eHealth literacy
- Evaluates underserved population
- Empirical studies

**Exclusion**
- Pediatric studies
- International studies
- Review/discussion papers
- Case studies, tool development and medical education studies

Two reviewers independently assessed all studies against the inclusion criteria with any disagreement discussed and resolved by a third reviewer. Using NVivo 9.0 (QSR International, AUS), investigators revised and refined preliminary codes, leading to the consolidation and extraction of themes, followed by iterative discussion and analysis. To promote inter-coder reliability, coding discrepancies were resolved through group discussion until consensus was reached (18,22). A flow diagram of the article selection process is detailed in Figure 1. eHealth literacy measures, characteristics of the target populations, data collection and results data were extracted by two review authors. Articles were not excluded based on methodological quality criteria because this review was intended to review all empirical research in the subject area. No meta-analysis was conducted. Authors created a numerical quality assessment score for each of the final studies to further interpret the overall impact of the published studies (35,36). Criteria were established using a framework similar to the criteria used for a systematic review of health literacy studies conducted by the Agency for Healthcare Research and Quality (AHRQ) in 2010 (37). We rated the studies as good quality, fair quality and poor quality. Two independent reviewers assigned quality ratings for each study based on the criteria listed in Table 1. Disagreements were discussed and resolved by consensus of the full study team. Studies that met all criteria were rated good quality. Studies which received a fair quality rating if they did not report fully report methods and we were unable to assess a criteria or if they did not adequately fulfill the criteria. If a study had a fatal flaw (such as lack of rigorous methods or incomplete information for our team to assess) with one or more of the criteria, then it was rated as poor quality.

**RESULTS**

**Study selection**
Overall, 159 articles were identified using the primary exclusion criteria after 60 duplicates were removed (Figure 1). One hundred fifteen articles were
Figure 1. Flow diagram of the selection process of articles for a systematic review of eHealth literacy in underserved populations in the U.S.

Table 1. Criteria for assessment and scoring of eHealth literacy studies.

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<th>Number</th>
<th>Criterion</th>
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<tr>
<td>1.</td>
<td>Was the study a randomized control trial?</td>
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<td>2.</td>
<td>Was the study powered appropriately (adequate sample)?</td>
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<td>3.</td>
<td>Were the results generalizable?</td>
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<td>4.</td>
<td>Was there a validated eHealth literacy tool?</td>
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excluded due to international origin; evaluating a pediatric population or being a review, discussion paper, case study, tool development or medical education study. Of the 44 remaining studies, 13 remained after evaluation of the full-texts for the inclusion of an eHealth literacy measure of an underserved population. Two additional studies were included after a hand search of pertinent systematic reviews. In total, 14 peer reviewed articles and 1 doctoral dissertation were included in this systematic review. No studies met the qualifications to be a fair or a good study, therefore all were considered poor in quality. One study met the criteria for being a random controlled trial (38). Few studies had a powered sample size and several studies used a validated eHealth literacy tool. Most studies were only conducted at one site. Study setting, rurality (urban, rural or undisclosed), sample size, underserved population evaluated, data collection method, eHealth literacy measure and key findings were noted for each of these studies (Table 2). Two articles were based on the same study and were thus analyzed together for the purposes of this review (39,40).

Study populations
The majority of the studies (7; 50%) were conducted in a single city (41–47). The remainder was statewide (4; 29%) (38,48–50), multi-state (2; 14%) (39,40) and nationwide (1; 7%) (51). Regionally, six studies took place in the Northeast (38,41,42,46,47,49), one in the Great Lakes region (39,40), two in the South (43,48), one in the Southeast (45) and one in the Midwest (44). Regarding rurality, three studies were specifically urban (41,42,47), one focused on both urban and rural populations (39,40) and six were undisclosed (38,43–46,48). One of the studies took place in the rural Midwest and the majority (75%) of those specifying their locality were urban (n = 3).

Sample sizes ranged from 8 to 3582 participants. Lower sample sizes were utilized in studies which recorded eHealth literacy observationally, such as through cognitive task analysis and web-based task performance (42,46,48). Larger studies included nationally representative and/or cross-sectional samples (39,40,43–45,47,50,51). The majority of studies used one or two question eHealth literacy screeners (n = 6; 43%) (39–41,44,47,49,51). Several others utilized the eHEALS scale to assess eHealth literacy (n = 4, 29%) (38,43,45,50). Three studies including an intervention (38–40,49). One was a randomized control trial (38). The other two studies utilized convenience samples, creating the potential for biased enrollment.

Of the underserved populations evaluated, six included minority populations (43%) (39–41,44,46,48,49), two of which were specifically focused on medically underserved populations (44,48). Elderly populations were targeted in four of the studies (38,43,45,51). Other evaluated underserved populations included those with low income (n = 7; 50%) (39,40,42,43,45,46,50), low education (n = 4; 29%) (45,47,49,51), low overall literacy or numeracy (n = 3; 24%) (42,46,47,50), rural residence (n = 2; 7%) (39,40,51), unemployment (n = 1; 7%) (47), immigrant status (n = 1; 7%) (41), and the disabled and homebound (n = ; 7%). Of the studies that targeted individuals with specific medical conditions, one evaluated women with breast cancer (39,40,43), one targeted caregivers of children with asthma (47), and one targeted caregivers of children with special needs (50).
Table 2. Summary of eHealth literacy studies conducted with underserved populations (n = 15): information is provided where available.

<table>
<thead>
<tr>
<th>References, setting and underserved population</th>
<th>Sample and underserved population</th>
<th>Data collection: method and eHealth measurement</th>
<th>eHealth literacy</th>
<th>Key findings</th>
<th>Associated factors</th>
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<tr>
<td>Changrani and Gany (2005), New York City, NY and Urban</td>
<td>N = 60 and Caribbean immigrant women</td>
<td>Cross-sectional questionnaire, comfort in using the Internet and Internet use for health information seeking</td>
<td>The majority (51%) were “extremely” or “quite” confident in using the Internet. Of the 31 women reporting high levels of confidence in using the Internet, only two (6%) had used the Internet in the past six months for health information seeking. Barriers to accessing the internet included long website addresses and a reported inability to differentiate between URLs.</td>
<td>Comfort in using the Internet was inversely associated with age.</td>
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<td>Chan (2010), New York City, NY and Urban</td>
<td>N = 20 and Low income population, low numeracy</td>
<td>Cognitive task analysis, performance on six eHealth literacy tasks</td>
<td>Overall health literacy was positively correlated with task performance (Spearman’s rho = 0.78). Income, education and having searched for health information online were associated with total score. (Spearman’s rho = 0.63, 0.54, 0.58, respectively)</td>
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<tr>
<td>Choi and DiNitto (2013), Austin, TX and Undisclosed</td>
<td>N = 980 and Low-income,</td>
<td>Face-to-face or telephone surveys, eHEALS scale</td>
<td>Self-rated eHealth literacy was neutral/undecided for both age</td>
<td>eHEALS scores were inversely associated with age and computer/Internet use once a</td>
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<th>References, setting and rurality</th>
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<tr>
<td>Fagnano et al. (2012), Rochester, NY and Urban</td>
<td>N = 304 and Unemployed, low education, limited overall health literacy</td>
<td>Verbally administered cross-sectional survey, ease of reading and understanding health information found on the Internet</td>
<td>The majority of caregivers had used the Internet to access health information (52%). The proportion of caregivers responding the information found online was easy to read and understand was 90% and 85%, respectively.</td>
<td>Overall health literacy was significantly and positively associated with health information seeking online in the past year (OR = 2.31; 95% CI = 1.24, 4.30) and to have ever looked up health information online (OR = 2.00; 95% CI = 1.16, 3.44). Intervention participation was significantly associated increased levels of information competence when compared with the population based control group (p = 0.001). Results eight regressions for each of the eHEALS scale statements indicate that parental language, parental lower educational attainment and older parental age were all</td>
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<td>Gustafson et al. (2005), Shaw et al. (2008), Detroit and rural Wisconsin</td>
<td>N = 229 and Low income (&lt;250% of the official poverty line)</td>
<td>Population based survey, health information competence scale</td>
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<td>Knapp et al. (2011), Florida and Undisclosed</td>
<td>N = 2371 and Low income, low education</td>
<td>Cross-sectional telephone survey, eHEALS scale</td>
<td>The statement “I know how to use the health information I find on the Internet to help my child” had the highest level of agreement (74%). The two statements relating to confidence in using</td>
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<td>disabled and homebound adults</td>
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information received from the Internet to make health decisions (23.4%) and ability to distinguish between high and low quality information (21.3%) had the highest level of disagreement.

Lustria et al. (2011), Nationwide (USA) and Urban and rural

N = 3582 and Rural, low education, elderly

Nationally representative survey, numeracy and internet access

The majority of respondents had assessed the Internet from home (90.1% of respondents) and expressed high levels of numeracy (63.0% of respondents).

Education, age and home Internet access were significant factors associated with using the Internet first during their most recent search for health information.

Individuals who expressed ease at understanding medical statistics were almost twice as likely to have accessed the Internet compared to those that expressed more difficulty (OR = 1.973; CI: 1.541–2.528).

Generation Y individuals were eight times more likely to assess the Internet than those in older generations (OR = 8.475).

Urban residents were significantly more likely to have accessed the Internet than rural residents (OR = 1.741; CI = 1.338–2.265).

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<td>McCleary et al. (2013), Oklahoma City, OK and Undisclosed</td>
<td>N = 88 and African-American residents in a “low-wellness score” zip code</td>
<td>Descriptive cross-sectional survey, seven question IT usage survey and a single item literacy screener</td>
<td>The majority of participants owned a computer and most frequently accessed the computer at home (83% and 79.5%, respectively). Most participants rated their computer skills as “good” (39.8%) and had used a computer to access health information (64.8%). The majority of participants self-reported adequate health literacy levels (81.8%).</td>
<td>Willingness to use eHealth applications was negatively associated with age (p = 0.004), positively associated with education (p &lt; 0.001) and overall health literacy (p = 0.016).</td>
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<td>Moore et al. (2009), Texas and Undisclosed</td>
<td>N = 8 and Medically underserved Hispanic individuals</td>
<td>Usability testing of a website designed for Hispanic audiences, five-point scale ranking six web-based tasks from very easy to very difficult</td>
<td>Of the 48 total tasks (six tasks for eight participants), 38 (79%) were attempted and 27 (71%) were completed successfully. Of the six tasks, one was rated below neutral in difficulty, three were rated neutral, one was rated easy and one was rated very easy.</td>
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<td>Noblin et al. (2012), Orlando, FL and Undisclosed</td>
<td>N = 562 and Elderly, low education, low income</td>
<td>Cross-sectional survey of a convenience</td>
<td>Individuals with high self-reported levels of eHealth literacy were more likely to intend to adopt</td>
<td>Patients identified as at risk for low health literacy included the elderly (7% of the study population),</td>
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Two eHEALS statements (“I know how to use the Internet to answer questions about my health” and “I know how to use the health information I find on the Internet to help me”) were closely correlated with intention to adopt a PHR ($p < 0.01$).

Despite these risk factors, the majority of individuals in these populations were both interested in adopting a PHR and perceived themselves to have high levels of health literacy.

Intervention participation was associated with significantly greater gains in perceived knowledge of computers at post-test ($p < 0.05$).

Multivariate repeated measures analyses found that, computer knowledge, Web knowledge, procedural skills and eHealth literacy efficacy improved significantly from pre- to post-intervention.

Univariate repeated measures analyses revealed significant improvement from pre- to post-intervention on each of these four measures ($p < 0.001$ in all four cases).

Effect sizes (measured by Cohen’s $d$) with regard to gains from
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<td>Zarcadoolas et al. (2002), Providence, RI and Not disclosed</td>
<td>$N = 24$ and Low literacy, low income, ethnic minorities</td>
<td>Ethnographically based, semistructured observation protocol and survey interview, Web-navigation skills</td>
<td>Participants divided whether to trust information they found on the Web, While 11 individuals said that people should not trust everything on the Web, 9 said that people should trust everything. Participants were unsure of how to determine what information they could trust. Reasons participants offered for trusting Web information included the level of detail in the information, the number of links to other information and Web sites, whether or not the information sought is discovered, truth-checking information found on the Web against personal experiences/perceptions of the world.</td>
<td>pre- to post-intervention in computer and Web knowledge, skills and eHealth literacy efficacy ranged from 0.88 to 2.25. The statistical power of these measures reached 1.00 even at the alpha = 0.01 level. There were a large number of similarities in basic navigation skills across the participants from different cultures. Spelling represented a particular challenge to Hispanic participants.</td>
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eHealth literacy in underserved populations in the U.S.

There were a number of variables which were not only common to underserved populations but also associated with eHealth literacy. These included experience, education, numeracy and overall health literacy, income and rurality. Regarding experience, several studies found that having previously searched for health information online was associated with higher levels of eHealth literacy (42,47). Other studies suggested a similar association for computer and Internet use and access in general (43,51). Level of education was also consistently associated with eHealth literacy (42,44,45,50,51). Overall health literacy (42,44) and specifically numeracy (51) were associated with eHealth literacy in underserved populations including those with low income, residing in a “low-wellness score” zip code and a those within a nationally representative sample. Income may present a particular challenge to underserved populations due to preventing both accesses to technology and traditional health resources. In several studies, eHealth literacy was negatively associated with income (42,45). Although the impact of rurality was seldom studied, Lustria et al. found that urban residents were significantly more likely to have Internet access (38,47–51). A challenge to rural internet access is a lack of broadband internet connection; legally, providers of broadband service are not required to provide service to all locations (52). Demographic differences and a lack of choices about ways to access the internet also contribute to the disparity in internet access between rural and urban populations (53).

There were some specific challenges which were common to underserved populations. With regard to trust in website content, Zarcadoolas et al. found that the ability of low literate adults to assess a website’s trustworthiness varied, and participants had difficulty determining how to evaluate website quality (41–46). Several factors, including the detail of websites and application of the website’s content to real life, were reported as being mechanisms for determining website quality. While challenges with navigation skills and spelling were similar for individuals of the same culture in this study, Moore et al. (48) reported a greater variability in the capacity of a medically underserved Hispanic population to complete web-based tasks. Among Caribbean immigrant women, while participants reported confidence in using the internet they did not frequently report using it to find health content and had difficulty differentiating between URLs (41). Language barriers may have contributed to this difficulty. A study by Knapp et al. found that among low income parents of children with special needs, parental language was associated with lower eHealth literacy and less confidence in their ability to use the Internet to make health decisions and distinguish between high and low quality information (38,46–50).

While increased age was one factor which contributed to lower levels of eHealth literacy, there was some variability in elderly populations. Self-reported or perceived levels of eHealth literacy ranged from neutral (43) to high (45). Despite this variability, advanced age was consistently associated with lower levels of eHealth literacy (41,43,44,50,51). Even individuals who perceived themselves to have high eHealth literacy were interested in adopting a personal health record (38). These individuals also demonstrated significant gains in eHealth literacy following an intervention relative to the
control group in a randomized control trial. Other populations for which intervention had a significant impact on eHealth literacy included parents of children enrolled in Headstart and low income women in both rural Wisconsin and urban Detroit (39,40,49).

DISCUSSION

Studies of eHealth literacy in underserved populations in the U.S.

These findings provide insight into the levels of eHealth literacy and associated factors in underserved populations. eHealth literacy provides a vital resource with which to connect underserved populations with health information resources. The manner in which levels of eHealth literacy were evaluated in the underserved populations reviewed within this systematic review was inconsistent. Many populations self-reported high levels of eHealth literacy. These skills, when put into practice, were often inadequate to appropriately locate, understand and evaluate quality health information. There was great variability in the methodological strength of both the assessments of eHealth literacy and overall study design. The majority of studies represented preliminary assessments of levels of eHealth literacy and associated factors in underserved populations. Of these studies, seven were cross-sectional surveys. Only four of these studies included a validated assessment of eHealth literacy (38,43,45,50). There is a need for further studies utilizing validated measures, particularly to assess level of eHealth literacy encompassing the six core literacies (14). Additionally, there are inherent limitations with the current measurement tools used for assessment of health literacy and health numeracy. As has been previously reported, most of the tools are lacking. Health literacy and numeracy assessment tools were developed to allow health professionals and health educators to assess the patient’s ability to understand health advice (8).

Four studies utilized an observational evaluation of eHealth literacy skills in practice. While these results may be a more accurate representation of actual levels of eHealth literacy among the individuals involved in the study, the studies were limited to a small sample size due to feasibility constraints associated with their resource and time intensive nature (9). Due to the small sample sizes of said studies, their interpretability is greatly limited.

Only two studies evaluated an intervention to improve eHealth literacy in underserved populations (38–40). Only one of these studies employed a randomized control trial study design (38). Of the other two studies, one, while utilizing a control group, was limited by programmatic regulations regarding the equitable distribution of interventions and thus enrolled subjects with a "first come, first serve" policy (49). While this policy was intended to ensure a fair chance of enrollment in the intervention group, it is possible that differences between the earlier enrolled intervention group and the later enrolled control group might bias the results of this study. One intervention utilized a population based control group as the comparison group and thus there might be other additional confounding factors which limit the interpretability of its results (39,40). A systematic review of interventions for enhancing consumers’ online health literacy also supported the need for rigorous studies of eHealth literacy interventions (25). There is a need for additional studies of
eHealth literacy in underserved populations with sufficient rigor and generalizability.

**Underserved populations studied**

The results of this systematic review suggest that there is a gap in the literature regarding eHealth literacy in underserved populations in the U.S. While the studies reviewed included ethnic minority; immigrant; low overall health literacy, income, education and numeracy; rural and urban; and unemployed populations there was a gap in the availability of studies in rural locations. The majority were located in the urban or undisclosed Northeast (38,41,42,46,47). Of those remaining, only one specifically included rural populations (39,40). In addition, only one was based in the Midwest (44). These represent an important gap in the literature. While levels of eHealth literacy have been more extensively studied, a nationwide study of eHealth literacy suggested that rurality was significantly associated with decreased Internet access (51). This is significant as research suggests that patients living in a rural location may also be at a disadvantage regarding their ability to play an active role in clinical decision-making. One reason for this disadvantage is a lack of healthcare infrastructure. An estimated 11% of America’s physicians practice in rural areas where ~20% of the country’s population lives (19). Within rural areas, these factors may make diagnosis and management of a rare disease particularly difficult; in fact, research has found that cases of the rare disease gastric cancer increasing the density of general practitioners and gastroenterologists resulted in a decrease in delay of diagnosis in rural locations (20). In addition, several studies have found a positive association between hospital volume and cancer survival (20,21). Thus ensuring adequate eHealth literacy is particularly important for those individuals that have disease conditions requiring increased access to the healthcare system.

Decreased access to healthcare infrastructure continues to be common to rural locations, in which patients may encounter several barriers to healthcare including financial difficulties, sociocultural issues, structural features and geographical distance (54). Because of these factors, individuals in these conditions may be less adept at navigating the healthcare system. Research has found that individuals from rural populations exhibit lower levels of health literacy than urban patients (55). For these individuals, evaluating the levels of and intervening to increase eHealth literacy is particularly important. In a philosophical analysis of eHealth literacy in rural locations, Bauer suggested that Daniels’ notion of species-typical functioning and Rawl’s principle of equal opportunity support the provision of eHealth services to individuals in rural locations according to the principles of distributive justice (56). Providing individuals in rural locations with the opportunity for “fair standards that make quality healthcare available and accessible in an efficient manner” is critical to ensuring distributive justice and ethicality. eHealth provides and important mechanism by which these opportunities can be provided.

**Review limitations**

This review is the first to critically evaluate eHealth literacy in adult populations in the U.S.; however, it may not be without its limitations. Our search
strategy may not have covered all potential studies from the appropriate databases. Additionally, the unpublished literature searching was limited. We may have missed studies reported at conferences with a primary focus on international eHealth literacy. Although an effort was made to be as inclusive as possible, there may have been some selection bias. Thirty-five articles were excluded due to international origin. This was intentional, as eHealth has been more extensively studied internationally and the structure of underserved populations and healthcare infrastructure often differs extensively by location. Although international research was used to establish the precedence for eHealth literacy research, the main focus on domestic studies was utilized to demonstrate the disparity in and need for this type of research. While the inclusion of only U.S. studies in the systematic review was deliberate, it does limit the generalizability of these findings. In future work, a comparison of eHealth in international locations to that in the U.S. may provide important insight as regarding the future directions for this research. Despite these limitations, this review summarizes what is currently known in the literature and targets gaps in the literature.

**Implications for research and practice**

Throughout the course of time, as eHealth resources become more readily available the importance of eHealth literacy only increases. Underserved populations represent important targets for the assessment of and intervention on eHealth literacy. Due to their traditionally marginalized status, providing those in underserved populations with the skills to find and critically evaluate health information is essential. This is particularly true for individuals in rural locations which not only are at a disadvantaged regarding location but also frequently containing populations with other factors considered to be characteristic of underserved populations.

The emerging availability of eHealth resources provides important avenues for healthcare providers in patient education today. Within rural populations, primary care providers are at the forefront of caring for underserved populations. These providers, however, may have limited interactions with these patients. It is therefore necessary to have an efficient and effective process to educate patients and to improve their eHealth literacy. Providing patients with the skills necessary to navigate and evaluate health information enables them to invest in their healthcare. While research with rigorous methodology is needed within the U.S. currently available research suggests that eHealth literacy interventions can be effective in underserved populations. Evaluating eHealth literacy and its associated factors within specific underserved populations will assist in the creation of effective and innovated interventions and provide a mechanism for ensuring the distributive justice of eHealth and healthcare overall. Although the design and implementation of these interventions is not well known, some possibilities include: assessing community support and education for low literate patients, educating patients in group settings in underserved populations, educating family medicine physicians about credible electronic resources for patients with low literacy, and providing appropriate resources through national networks. It is through efforts such as these that it may be possible to improve eHealth literacy in underserved populations in the U.S.
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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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