

Computer Use by Older Adults: A Review of the Literature

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Abstract

Background: Patient engagement standards promoted by the US government's EHR Incentive Program promote patient interaction with the healthcare system using health information technology (HIT) such as patient portals and secure messaging, yet older adults may be ill equipped to participate in this way. This integrative literature review sought to identify research on the use of HIT by older adults and to examine the state of the science in this area.

Methods: 14 studies published in peer-reviewed, English-language journals between 2007 and 2013, focusing on the computer/internet usage patterns of US adults aged >65 were included when they included a measurement of the participant's health literacy. Articles were read and examined multiple times using matrixes and data displays to enhance analysis. A level of knowledge label and a determination of congruence were applied to each study to assess the quality of studies and state of the science in this area.

Results: A variety of designs were used (1 experimental, 1 quasi-experimental, 1 qualitative, 11 non-experimental) in various community settings. Health literacy was defined in a variety of ways with multiple instruments. Computer/internet users are younger, healthier, and more educated than non-users. Only half of adults >65 and less than 34% of users >75 used the computer. Non-Hispanic Whites were more likely than any other ethnic/racial group to use HIT. Use is enhanced with social support and reduced by limitations in computer skills, health literacy, physical condition, and cognition. Older adults used the computer/internet primarily to send emails. Interventions promoting HIT to improve health outcomes have low rates of use. The state of the science remains at a descriptive exploratory level.

Conclusion: Older adults are less likely than other age cohorts to access the internet for health information despite the fact that they bear the greatest burden of chronic disease and limited health literacy. There are significant gaps in our knowledge regarding HIT use in this population, making the success of national programs aimed at engaging patients through its use questionable.

Keywords Computer use; Older adults; Health literacy

Introduction

Patient engagement has received an unprecedented amount of attention as various stakeholders seek to promote the national quality agenda of improved population health, an enhanced patient care experience, and control or reduction in the per capita cost of care [1,2]. Patient engagement is most commonly defined as the "actions individuals must take to obtain the greatest benefit from the health care services available to them" [3]. The ten specific behaviors that engaged patients perform are (i) find good care, (ii) communicate with health care professionals, (iii) organize health care, (iv) pay for health care, (v) make good treatment decisions, (vi) participate in treatment, (vii) promote health, (viii) get preventative care, (ix) plan for the end of life, and (x) seek health knowledge [3]. There is evidence that engaged patients enjoy better health outcomes and cost the system less money [4-6].

Achieving patient engagement and activating helpful behaviors may be a significant challenge for older adults, particularly those who have multiple chronic diagnoses and limited health literacy [7,8]. In the United States, currently more than 1 in 10 individuals, over 38 million

people, are 65 years of age or older. The Centers for Disease Control project that by 2030, this number will almost double to 71 million people. While aging may be accompanied by robust health, it is commonly associated with one or more chronic diseases. About 80% of older adults have one chronic condition, and 50% manage at least two chronic conditions [9]. They may require multiple medications, complex treatment plans and elaborate care coordination efforts [10]. Furthermore, two decades of research indicate that at the most fundamental level, as many as 90 million American adults do not understand the information provided to them via oral or written methods [11,12]. This is referred to as health literacy, defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" [12]. Health literacy is a complex construct that describes more than the ability to read. Instead it describes sophisticated skills, including the way we evaluate information for credibility and quality, analyze relative risks and benefits, calculate drug dosages, interpret test results, or locate health information [13]. Researchers have shown that older adults with limited health literacy have more hospitalizations and emergency care visits and have a lower probability of receiving preventative services such as immunizations [14]. Health literacy rates are lower among older adults, the socioeconomically disadvantaged, certain racial and

ethnic minorities, immigrants, and residents of rural communities [12,14,15]. Older adults with multi-morbidities and limited health literacy may not be able to perform the sophisticated behaviors required of engaged patients.

The American Reinvestment and Recovery Act (ARRA) [16] of 2009 introduced the Electronic Health Record (EHR) Incentive Program [17]. Two of the overriding principles of the EHR Incentive Program are to engage patients and families in their healthcare and to improve care coordination. To help reach those goals, the Stage 1 Meaningful Use rule [18] mandates the provision of a computer-generated clinical summary to patients at the conclusion of their health care encounter. The clinical summary serves to document the plan of care and contains several elements critical to care coordination (Table 1). Stage 2 of the Meaningful Use rule [19] requires patients to log on to a practice-based web portal to retrieve and review the clinical summary instead of receiving a paper copy at the conclusion of the visit. Patients are invited to transfer (electronically forward) their personal health information to other members of their health care team and to use secure messaging to email their providers with questions. The EHR incentive program has cost American taxpayers \$33 billion to date [20], yet little evidence suggests that distributing

clinical summaries electronically will facilitate patient engagement or improve the health of older adults. In fact, current research reveals that only about half of all adults over the age of 65 in the US use a computer [21]. Seven in ten (71%) non-users said they were not willing to use the computer to access the internet, citing non-interest (46%), lack of time (11%), technical inaptitude (9%), concerns about privacy (4%), and the expense (4%). In 2012, Pew researchers [22] reported that 53% of US adults over the age of 65 were online, although internet use among those over the age of 75 is still low, at 34%. Of the adults aged 65 or older currently using the internet, 86% do so primarily in order to email, with 48% checking email daily. About a third of them use social media websites such as Facebook or LinkedIn. Older adults reportedly use the internet for a variety of other reasons including researching topics of interest (57%), making purchases (44%) or travel reservations (41%), banking (34%), and reading the news (31%), but are still less likely than any other age group to use the internet. Neither researcher reported participant health-related information seeking behavior, a key activity embedded in patient-centered care initiatives as well as national plans for health reform.

Elements contained in the Meaningful Use clinical summary include
Updated medication list
Updated vital signs
Reason for the visit
Current symptoms
List of current problems/diagnosis
List of procedures
Labs and other orders
Instructions given to the patient based on clinical discussions that took place during the visit
Summary of topics discussed
The times and locations of upcoming tests and appointments
Recommended patient decision aids (e.g. patient education)
Recent test results

Table 1: Elements contained in the clinical summary

This combination of elements: the massive cohort of older adults, the sheer amount of chronic disease and limited health literacy present in this population, and the acceleration in the use of health information technology, creates a perfect storm whereby an already vulnerable group [23-25] may be ill equipped to fully participate in a future health care system defined by patient engagement.

Conceptual Framework

This review was guided by the public health approach, a conceptual framework described by former US Surgeon General Satcher for eliminating disparities in health [26]. Public health is defined as “what we, as a society, do collectively to assure the conditions for people to be healthy” [26] whereby those conditions relate to the determinates of

health, including environmental factors, biology, genetics, human behavior and access to quality health care. The public health approach involves defining and measuring the problem, determining the cause or risk factors for the problem, determining how to prevent or ameliorate the problem, implementing effective strategies on a larger scale, and evaluating the impact [26]. It allows for aggressive targeting of groups suffering disproportionately, such as older adults with limited health literacy that may need a computer to access important information about their health, plan of care, and health care services. In the current healthcare environment, patients are encouraged to perform many of these behaviors using health information technology (HIT). The American Medical Association [27] defines HIT as “a wide range of products and services, including software, hardware and infrastructure, designed to collect, store and exchange patient data

throughout the clinical practice of medicine.” This review will focus on HIT interfaces that patients are encouraged to use, such as patient portals, personal health records, and educational websites.

The aim of this literature review was to identify and analyze research focused on the use of web-based HIT used by older adults with varying levels of health literacy in order to (a) describe the characteristics and patterns of computer/internet use by a vulnerable and underserved population, and (b) examine the characteristics of the literature, or state of the science, in this area.

Methodology

This integrative review was conducted according to the design described by Whittemore and Knafl [28], who outline a five-stage process of problem identification, literature search, data evaluation, data analysis and presentation. Integrative reviews allow for the inclusion of diverse methodologies and therefore facilitate the presentation of a wide variety of perspectives, which can be helpful to developing knowledge and practice. A review of the sample in this research is discussed following a review of the methods used to analyze the studies.

This integrative review covered a six-year period between 2007 and 2013. The databases searched were CINAHL (EBSCO Information Services, Ipswich, MA), PsychInfo (American Psychological Association, Washington, DC), Web of Science (Thomson Reuters, Philadelphia, PA), and JSTOR (ITHAKA, New York, NY). Key words

for searches were “older adults” or “elderly” and “patient portal” or “personal health record” or “website” or “internet” and “health literacy” and “usage” or “utilization”. Recent studies published in peer-reviewed, English-language journals that described the behavior of adults over the age of 65 were targeted. Studies performed in countries outside of the United States were excluded because of the variation in environmental and cultural-political influences guiding HIT use in other countries. Studies performed prior to 2007 were excluded due to the rapidly changing availability of HIT and recent US policy mandates guiding its use.

The literature search revealed 32 articles meeting initial inclusion criteria. 19 studies were excluded because the study took place in a foreign country (n=4, 13%), were duplicative (n=7, 22%), described a younger population (n=2, 6%), was a literature review (n=1, 3%) or were not relevant to the research question (n=5, 16%). One article was identified by hand searching reference lists. The remaining 14 studies consisted of 13 quantitative and one qualitative research articles.

Each article was read multiple times. A matrix was created with key research components so that cross-case comparisons about design, sample, setting, and results could be made. From the matrix and articles multiple data displays [29] were created to enhance analysis of sampling issues, the sample, variables and measures, reliability and validity, results, purpose, research design, and congruence. The level of knowledge label and a determination of congruence [30,31] (Table 2) were applied to each study to describe the current state of the science and assess the quality of studies [30,32,33].

Level of Knowledge	Research Purpose
Identification	Identification and naming of phenomena of interest
Description	Prevalence, characteristics, frequency, dimensions, importance of phenomena
Exploration	Factors related to the phenomena, its antecedents, full nature, process by which phenomena is experienced or evolves
Prediction and Control	Causation, directionality, prevention or control of phenomena
Explanation	Underlying causes, causal pathway, presence of a theoretical explanation, how does phenomena work and occur, mean, why does phenomena exist

Table 2: Level of knowledge hierarchy and corresponding research purpose [30]

Results

All 14 articles were compared by using various data matrixes to sort and analyze the results. Frequencies and summaries were tabulated as appropriate. Cross case analysis was conducted first, followed by a within case analysis of congruence. Synthesis of findings using a content analysis approach [34] was used to answer the research questions.

Design

The 14 articles were evaluated for their design and the level of knowledge sought. There were: one (7%) experimental [35], one (7%) quasi-experimental [36], eleven (78%) non-experimental [37-47], and one (7%) qualitative designs [48]. Six studies (43%) were at the descriptive level [38,39,44,45,47,48], four (29%) at the exploration level [40,42,46,49], and four (29%) at the explanation level [35-37,41].

Setting

All of the research in this review was performed in community settings, including national telephone surveys [35,37-39,44,46,47] (n=7, 50%), ambulatory care practices [36,40,48-50] (n=5, 36%), and community centers [35,42] (n=2, 14%).

Sample

The sample in this study consists of the 14 articles reviewed. Multiple factors related to the quality of articles assessed are addressed subsequently.

Demographic characteristics

An aim of this literature review was to describe the characteristics and patterns of HIT use by older adults with varying levels of health literacy. Database search parameters defined an older adult as someone 65 years of age or older. However, a clear definition for “older adult” was often lacking. The 14 articles reviewed included

adults from the age of 18 to 100. Only two research teams [38,39,47] had a sample exclusive to adults aged 65 or older. Selected demographic characteristics useful in describing the population are presented (Table 3). Sample size ranged from 46 to 7,674. Three researchers [35,36,42] did not report the racial/ethnic composition of the study population and one [37] separated whites from non-whites only. The studies described participants who were predominately white, female, married, and more educated. Of the studies, six (43%) had mostly low-income populations [35,39,42,48], one (7%) had low-median40 and one (7%) had median-high [49].

Power analysis

Researchers who use statistical tests to reject the null hypothesis and conclude their interventions had effect must be reasonably certain to avoid Type I errors, or finding a difference between groups when one does not actually exist, and Type II errors, the failure to detect a

difference when one exists. The power analysis is performed to ensure that statistical tests avoid Type II error by obtaining a power probability of 0.8 or greater [51]. A power analysis was missing entirely from each of the quantitative articles reviewed. One (7%) qualitative study [48] did not describe the rationale for or justify the size of its sample.

Random sampling and assignment

Six (43%) articles did not use random sampling techniques, instead opting for convenience samples [35,39,40-43,]. Six (43%) studies [36-38,44,45,47] used random sampling. Three (21%) authors who performed secondary data analysis on previously collected national survey data [38,44,45] did not summarize the original sampling strategy, referencing original sampling procedures instead.

Study	Age (%)	Race/Ethnicity (%)	Education (%)	Gender (%)	Income (%)	Marital Status (%)	Summary
Bennett [37]	N=2668 65-74=1439 (54) 75-84=988 (37) 85+=241 (9)	W=2037 (76) B=352 (13) H/L=209 (8) O=70 (<1)	<HS=888 (33) HS=78 (30) >HS=987 (40)	M=1036 (38) F=1632 (62)	Below 175%=584 (22) 100-175%= 594 (22) Above 175%=141 (5)	n/c	Predominately low income white sample, all ≥65, more F participants
Choi [38]	N=6680 65-69=2006 (30) 70-74=1743 (26) 75-79=1291 (20) 80-84=968 (14) 85+=672 (10)	W=5410 (81) B=536(8) H/L=467 (7) O=267 (4)	<HS= (21.43) HS= (27.08) >HS= (51.49)	M=2953 (44) F=3727 (56)	n/c	M=3984 (60) N/M=2696 (40)	Predominately white, well educated, married sample, all ≥65, large sample
Choi [39]	N=980 >60=763 (78)	W=323 (42**) B=272 (35**) H/L=161 (21**) O=7 (0.9**)	n/c	M= (28.8**) F= (71.2**)	Median income to needs ratio: 1.21	M= (18.9**) N/M= (81.1**)	Many more unmarried, F participants, sample includes people <65, low income sample
Geller [36]	N=319 (177 comp & 142 int) 50-60=144 (45) 61-70=107 (34) 71-80=64 (20)	n/c	<HS=38 (12) HS=134 (42) >HS=138 (43)	M=131 (41) F=188 (59)	n/c	n/c	At least half the sample <65, highly educated
Glasgow [40]	N=270 Avg 58+9	W=124 (46) B=49 (18) H/L=59 (22) O=38 (14)	<HS=54(20)	M=140 (52) F=130 (48)	<49,999=122 (45) 50-90,000=49 (18)	n/c	Low-median income sample, sample includes those <65, predominately white
Jensen [41]	N=131 Avg 42.9	W=78(60) B=34 (26) H/L=12 (9) O=7 (6)	<HS=25 (19) HS=72 (55) >HS=34 (26)	M=34 (26) F=97 (74)	<200%=131 (100)	n/c	Predominately white, low income, young sample with HS education, many more F participants
Kim [42]	N=70 21-50=12 (17) 51-60=14 (20) 61-70=27 (39) 71-80=5 (7) 81-90=7 (10)	n/c	n/c	M=18 (25) F=52 (75)	Below 100-250%=70	n/c	Very low income sample, majority of sample <65

	91-100=5 (7)						
Longo [48]	N=46 Avg 61 (48-77)	W= 32 (70) B=10 (2) H/L=0 O=4 (<1)	<HS=5 (11) HS=24 (52) >HS=17 (37)	M=17 (36) F=29 (64)	<15,000=17(38) 15-29,000=8 (17) 30-49,000=8 (17) 50-74,000=8 (17) 75,000+=5 (11)	M=26 (57) U/M=20 (43)	Adequate sample size, predominately low income white with HS education, majority F and married
Mayberry [43]	N=61 Avg 56.9±8.8	W=47(77) N/W=25 (41)	<HS=0 HS=10 (16) >HS=48 (79)	M=10(16) F=51 (84)	<10,000=5 (8) 10-29,000=4 (7) 30-59,000=23(38) >60,000=25 (41)	M=40 (66) N/M=21 (34)	Predominately married, white and highly educated, median-high income, young sample, small sample
Miller [44,45]	N=928 Ages>18	W=670 (81) B=58 (7) H/L=54 (7) O=46 (5)	n/c	n/c	n/c	n/c	Predominately white sample, unclear what % of sample is >65
Nahm [46]	N =36 dyads (72) CG=Avg 56+12 CR=Avg 74+11	W=24 (67) CG and 24 (67) CR	>HS=20(56) CG and 16(44) CR	M=18 (50) CG and 12 (33) F=18 (50) CG and 24 (67) CR		M=22 (61) CG and 17 (47) CR N/M=14 (39) CG and 19 (52) CR	Small, predominately white sample, fairly well educated sample
Wen [47]	N=7674 >65=860(11)	W=637(74*) B=77 (9*) H/L=86 (10*) O=60 (7*)	<HS=241 (28*) >HS=619 (72*)	M=404 (47*) F=456 (53*)	n/c	n/c	Predominately white, educated sample, majority of sample <65
Xie [35]	N=118 Avg 68 + 9	n/c	<HS=9 (7) HS=37 (30) >HS=73 (59)	M=36 (31) F=82 (69)	< 20,000=29 (25) 20-29,000=12 (10) 30-39,000=12 (10) 40-49,000=7 (6) 50-59,000=11 (9) 60-69,000=9 (8) 70-99,999=3(3) 100,000+=3(3)	n/c	Predominately low income, high education sample, many more F participants, small sample

All percentages calculated on total sample unless otherwise noted. *Absolute number of those <65 extrapolated from % of total sample (aged 18+) provided. **Percentage reported was calculated only on sample >60. n/c=Not collected or not calculable from author's paper (due to analysis on subset of one variable, etc.), CG=Caregiver, CR=Care recipient. Race/Ethnicity: W=Non-Hispanic White, B=African American, H/L=Hispanic or Latino, O=Other. Education: <HS=Less than high school, HS=High school, >HS=more than high. Gender: M=Male, F=Female. Income: Below %=below % of federal poverty level school. Marital Status: M=Married, U/M=Unmarried.

Table 3: Description of Sample

Design

One (7%) study had an experimental design with random assignment to one of four various groups [35]. Two (14%) articles contained procedural descriptions that did not facilitate reader understanding of sample assignment to experimental conditions [46,48].

Data Collection and Measurement

There were large differences in the way that researchers defined their variables, particularly related to health literacy (Table 4). Seven (50%) researchers [36,40,41,43-45,48] used a traditional definition of

health literacy: “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” [12]. Health literacy was measured with the sTOFHLA [40,41], REALM [37], SILS [36,43-45], and three author-created scales [37,42,48]. It is generally accepted that health literacy includes a numeracy component, however health literacy was measured by three researchers with additional health literacy instruments aimed at targeting numeracy skills specifically: (a) the numeracy sub-set of the sTOFHLA [40], (b) the SNS [43], and (c) an author-created item [37]. A component of health literacy called eHealth literacy is defined 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” and

measured specifically by the eHealth Literacy Scale (eHEALS) [50]. The eHEALS was used by three authors [35,39,46]. Other authors used different instruments to assess eHealth literacy or computer literacy including the (a) Attitudes Toward Computers Scale [39], (b) Computer Anxiety Rating Scale [49], and (c) various author-created tools [38,42,47,48].

Study	Health Literacy related variable(s)	Operational Definition	Reliability	Validity
Bennett [37]	Health literacy: author-defined prose literacy Health literacy: author-defined document literacy Health literacy: author-defined quantitative literacy	1. Author-created item: reading a consent form 2. Author-created item: filling out insurance form 3. Author-created item: calculating a bill	1. Not reported 2. Not reported 3. Not reported	1. Face 2. Face 3. Face
Choi [38]	1. eHealth literacy: author-defined as establishing internet use through computer or cell phone, purpose for use (ie: seeking health information), and computer literacy	1. Author-created items; 6 questions with yes/no responses	1. Not reported	1. Content
Choi [39]	eHealth literacy Computer literacy	1. The eHealth Literacy Scale (eHEALS) + supplement 2. Attitudes Toward Computers Scale (ATCS)	1. Cronbach alpha=0.93 2. Cronbach alpha=0.85 (under age 60) & Cronbach alpha=0.92 (age 60+)	1. Construct 2. Criterion
Geller [36]	1. Health literacy: author-defined as related to needing help to read materials/forms, frequency of book reading, preference for questions about health (ie: read to you or read yourself)	1. Single Item Health Literacy Screener (SILS-3 questions) and author-created questions, 2 items with 1 open ended and one 2-item responses	1. Not reported	1. Face
Glasgow [40]	1. Health literacy	1. sTOFHLA	1. Cronbach's alpha=0.68 for the numeracy items and 0.97 for the prose passages	1. Construct
Jensen [41]	Health literacy Health numeracy	1. REALM 2. sTOFHLA (subset)	1. Not reported 2. Not reported	1. Construct 2. Construct
Kim [42]	eHealth literacy and Computer literacy: using the PHR without assistance Health literacy: the use of health information, e.g. sharing PHR with friends/family, using the PHR to provide more information to PCP & specialist, make visits more efficient, feeling more prepared for emergencies and in control	1. Author-created item; system log evaluation 2. Author-created items; 6 items	1. Not reported 2. Not reported	1. Face 2. Face
Longo [48]	1. Health literacy and Computer literacy	1. Author-created items, 2 questions regarding where people access health information and how they use it with list and open ended responses	1. Dependability established through single expert moderator conducting focus groups	1. Credibility established through collaborative analysis
Mayberry [43]	Health literacy Health numeracy Computer literacy	1. Modified Single Item Health Literacy Screener (SILS-3 questions) 2. Subjective Numeracy Scale (SNS) 3. Computer Anxiety rating scale (CARS)	1. Not reported 2. Not reported 3. Not reported	1. Construct 2. Construct 3. Construct
Miller [44]	1. Health literacy: author-defined as related to confidence in filling out forms, requiring help to read, difficulty understanding written information	1. Single Item Health Literacy Screener (SILS-3 questions)	1. Cronbach alpha=0.61	1. Face
Miller [45]	1. Health literacy: author-defined as related to confidence in filling out forms, requiring help to read, difficulty understanding written information	1. Single Item Health Literacy Screener (SILS-3 questions)	1. Not reported	1. Face
Nahm [46]	1. eHealth literacy	1. The eHealth Literacy Scale (eHEALS)+supplement	1. Cronbach alpha=0.89	1. Construct
Wen [47]	1. eHealth literacy: author-defined as use of internet for seeking health information and computer literacy	1. Author-created item; 1 question with yes/no response	1. Not reported	1. Face

Xie [35]	eHealth literacy e-Health literacy Skills: author-defined as participant ability to correctly identify the quality of 20 health websites according to the National Library of Medicine tutorial (10 sites gathered from the Medical Library Association's recommended sites & 10 from commercial sites advertised on a commercial web search engine)	1. The eHealth Literacy Scale (eHEALS)+supplement 2. Author scored; 1 point for each correctly identified site (e.g.: NLM site is recorded as high-quality and advertisement sites are recorded as low-quality)	1. Not reported 2. Not reported	1. Construct 2. Face
Note: While the Cronbach's alpha cut-off for social science research is generally set at 0.70, Garson has suggested that scores as low as 0.60 to a high of 0.90 are acceptable.				

Table 4: Data Collection Instruments

Reliability was reported in only one instance using an author-created scale [44], and in only two instances using the eHEALS [39,46] with a Cronbach alpha. Validity was assessed by reviewing author descriptions of data collection instruments used and matching them to descriptions of validity found in Shaddish et al. [51] (e.g.: the label construct validity was applied when the measure was tested against something else logically or theoretically related to the construct). In the absence of any explicit description and when study procedures were described sufficiently, the label of face validity was applied. Many (n=6, 43%) used author-created instruments with basic face validity to

assess at least one aspect of health literacy. Only one (7%) explicitly [46] and three (21%) [36,40,43] partially (e.g. "instruments were previously validated") reported the validity of the tools used (Table 5). The presumed validity of instruments was as follows: six (43%) researchers [35-37,42,44,45] described tools with face validity, one [38] (7%) with content validity, and three [40,49,50] (21%) with construct validity. The author of the qualitative study [48] did not specify the manner in which dependability (reliability) and credibility (internal validity) were established [29].

Study	Reliability Reported	Validity Reported	Publishing Journal
Bennett [37]	No	No	Annals of Family Medicine
Choi [38]	No	No	Journal of Medical Internet Research
Choi [39]	Yes	No	Journal of Medical Internet Research
Geller [36]	No	Partially	Medical Care
Glasgow [40]	No	Partially	Journal of Medical Internet Research
Jensen [41]	No	No	Journal of Aging and Health
Kim [42]	No	No	Journal of Medical Internet Research
Longo [48]	No	No	Annals of Family Medicine
Mayberry [43]	No	Partially	Diabetes, Technology & Therapeutics
Miller [45]	No	No	Journal of Telemedicine and Telecare
Miller [44]	Yes	No	Medical Care
Nahm [46]	Yes	Yes	Nursing Research
Wen [47]	No	No	Journal of Medical Internet Research
Xie [35]	No	No	Journal of the American Society for Information Science and Technology

Table 5: Publication Analysis of Reliability and Validity Reporting

Researchers used a substantial amount of author-created questions to measure other study variables having only face validity and no reported reliability for the current sample. Author-created tools were

used to measure variables related to computer use and acceptance. Multiple standardized instruments were used to measure a variety of clinical outcomes (Table 6).

Variable	Operational Definition
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Cognition	Brief Test of Adult Cognition by Telephone [35] Mini Mental State Examination [46]
Dietary fat intake	National Cancer Institute Percent Energy From Fat Screener [40]
Physical activity	Community Health Activities Model Program for Seniors [40] Self-Efficacy for Exercise Scale [46] Yale Physical Activity Scale [46]
Medication adherence	Hill-Bone Compliance [40] Self-Efficacy for Osteoporosis Medication Adherence [46]
Web site usability	Perceived Health Web Site Usability Questionnaire [46]
Caregiver strain, coping, and social support	Caregiver Strain Index [46] Rhode Island Stress and Coping Inventory [46] Items from the Computer-Mediated Social Network Scale [46]
Patient satisfaction	Patient Satisfaction Questionnaire [44]

Table 6: Standardized Instruments Measuring Various Clinical and Satisfaction Outcomes

Study Findings

Computer users

Six descriptive studies (43%) sought to examine the characteristics of older adults who used the internet to seek health information. Four used large data sets: N=980 [44,45], N=6680 [38], and N=7674 [47]. The qualitative study [48] had 46 participants, large by qualitative standards [52,53]. Although 69% of US households reported using the internet, users were younger, healthier, perceived their health as better and had more education than non-users [38,45,47]. Non-Hispanic Whites were more likely to use the internet than members of any other racial/ethnic group. In fact, no African American or Hispanic/Latino older adult reported using the computer/internet at all in one large study [45]. Less than 15% of current internet users in another were over the age of 70 [39]. Older age and being black or Hispanic/Latino was significantly associated with never having used the internet, and Hispanic/Latinos were three times more likely to discontinue use of the internet [39] than other racial/ethnic groups. Hispanic/Latinos using the internet had higher health literacy scores than Hispanic/Latinos who did not [45].

Reasons for computer/internet use

Internet users were more likely to visit private websites (vs. public ones), but they did so infrequently, with 23-50% of the sample accessing the website more than once a month [38,45]. Older adults do access personal health records (PHR) online, but PHR use is predicted by higher levels of education [47]. They use the internet mostly to send emails (43%), pay bills (20%), shop (14%), and search for health information (16%) [38]. Older adults perceive the PHR and health information exchanges as very important (Hispanic/Latinos more so than non-Hispanic Whites), but only 15% use one to track their health information [47]. Instead, older adults create their own “information web” through the passive receipt of health information and personal relationships with others that help them understand, cope, and use health information [43,48]. Researchers found that older adults with higher levels of health literacy used the computer to research diabetes-

specific medications and treatments with greater frequency than low health literacy users [43].

Relationship to outcomes

A website aimed at educating and engaging older adults in the care of diabetes failed to improve engagement outcomes (self-monitoring behavior, action plan use, etc.) compared with non-web user controls, and use was infrequent (three hours over four months) by the disproportionately female, obese and ethnic sample [40]. Another website aimed at providing education about post-hospitalization care of hip fractures for caregivers and care recipients also found low rates of use (accessed modules three times over eight weeks) and showed improvements in caregiver strain, coping, social support, care recipient self-efficacy for exercise and medication adherence that were not significant. Caregiver post-test eHealth literacy scores improved significantly from pre-test scores [46].

Factors influencing computer/internet use

One research team tested an older adult’s willingness to utilize a PHR by providing free computers, internet access, and nursing student assistance to residents of a low-income housing facility. Although all participants were trained (N=70), only 13% used the system more than once. Usage was highly correlated with the availability of assistance; 77% of use occurred while assistance was available. Use was limited by user’s computer skills, health literacy, and limited physical/cognitive abilities [42].

Two explanatory studies (14%) measured the impact of classroom-based training [35] and a tablet-based educational intervention [36] on health literacy and health outcomes, respectively. One researcher looked at the impact of various learning methods (collaborative, individualistic) and information channels (visual only, visual plus auditory) when teaching older adults to use the computer. Pre-post eHealth literacy scores did improve significantly but no effect was detected between learning methods or information channels [35]. A tablet-based software application that educated patients about colon cancer screening was used by adults aged 50-80 prior to their visits

with a health care provider to increase patient knowledge, perceived importance of colon cancer screening and their willingness to screen. Intervention patients reported talking about screening with their physicians, being offered screening in general and with colonoscopy specifically, and reported planning to be screened more often than controls [36]. Ninety five percent of patients found the tablet easy to use.

Health literacy as a mediator

Health literacy is significantly positively correlated with disparities in health status and education (whereby those with low health literacy have worse health status, less education, and receive fewer preventative services), male gender, minority race/ethnicity (Whites are more health literate), and with email and internet use (whereby people with higher health literacy scores are more likely to use both) [37,41,43]. Older white females have higher health literacy scores (more health literate) than older blacks or Hispanic/Latinos [41]. Health literacy was found to mediate the relationship between age and online health information seeking, but not with education, gender, or race/ethnicity

and online information seeking [41]. Health literacy was found to mediate the relationship between race/ethnicity and self-rated health status as well as the receipt of some preventative services (the influenza vaccine) but not others [37]. Health literacy also mediated the relationship between education and self-related health status and receiving the influenza vaccine [37]. Health literacy mediated the relationship between education and mammography and dental care preventative services [37].

Within-Case Analysis

Individual studies were assessed for their level of congruence. In the nursing literature, congruence speaks to the ability of the selected study design to answer the research question appropriately, according to the level of knowledge sought [30,31]. In 11 out of 14 (79%) studies, the designs were appropriate for the level of knowledge sought, according to the author's stated purpose and description of methods. The descriptive studies assessing the use of HIT by older adults were found to have designs that were congruent.

Study	Purpose (LOK)	Strength of findings reduced by	Congruence
Bennett [37]	Assess whether HL mediates racial/ethnic and education disparities in health status and preventative health behaviors in older adults, testing 1 hypothesis (Explanative)	Did not report reliability, Face validity only, Extensive use of author-created scales	N**
Choi [38]	Determine whether older adult internet users are different from & use internet differently than non-users based on health condition, psychological, social capital (Descriptive)	Did not report reliability of standardized instrument in sample	Y
Choi [39]	Examine internet use patterns, reasons for discontinued use, eHealth literacy and attitudes toward computer use in low income older adults (Descriptive)	5/7 scales were author-created and did not include reliability estimates	Y
Geller [36]	Test the ability of a tablet application to increase patient knowledge & willingness to screen for colon cancer in older adults, test 1 hypothesis (Explanative)	Did not report reliability of standardized instrument in sample, Extensive use of author-created scales, Intervention designed to influence patient behavior while most outcomes measured provider behavior	N*
Glasgow [40]	Calculate various indices of DM website engagement, user characteristics, and relationship to 4-mo health outcomes in 2 intervention groups (web portal with & without assistance) of 3 arm RCT (Explorative)	Low reliability for numeracy items on sTOFHLA in this sample (Cronbach's alpha=0.68), Used only 3 items from sTOFHLA, Did not define what a score of 4.8 means	Y
Jensen [41]	To examine whether low-income adults' use of internet is predicted or mediated by health literacy, numeracy, and computer assistance, testing 4 hypotheses (Explanative)	Did not report reliability of standardized instruments in sample, Presentation of results in relationship to hypotheses unclear (do not correspond directly to hypotheses)	N**
Kim [42]	User acceptance of PHR and factors related to its use in low income older adults (Explorative)	Author-created survey instrument	Y
Longo [48]	Identify how older adults with diabetes seek and use health care information (Descriptive)	Data analysis procedures not described including techniques used to generate and verify conclusions	Y
Mayberry [43]	Explore the relationship between health, numeracy & computer literacy & the usage of portals & HIE among older adults (Explorative)	Did not report reliability of standardized instruments in sample	Y
Miller [44]	Frequency with which US adults access health info from internet & their characteristics (Descriptive)	Predominately white sample may under-power r/e variations (power analysis not described), Unclear what % of sample is ≥ 65	Y
Miller [45]	Describe relationship between web usage and race/ethnicity among US adults (Descriptive)	Predominately white sample may under-power r/e variations (power analysis not described), Unclear what % of sample is ≥ 65	Y

Nahm [46]	Determine feasibility of web-based hip fracture resource center & its ability to improve health outcomes in older adults (Explorative)	Reliability on 1 author-created scale and MMSE not reported	Y
Wen [47]	Examine consumer attitudes toward PHRs and HIE & examine consumer use of PHR in sample ≥ 65 (Descriptive)	Extensive use of author-created scales	Y
Xie [35]	Define the impact of different learning methods and information channels on eHealth literacy in older adults, testing 4 one-way hypotheses (Explanative)	Unclear description of difference between experimental groups	Y
Explanatory testing of hypotheses with quasi-experimental* or non-experimental** designs			

Table 7: Within-Case Limitations and Congruence

Three exploratory studies [36,37,41] were found to be incongruent because the authors tested hypotheses with non-experimental [37] and quasi-experimental [36,41] designs. Hypothesis testing should be carried out in designs that seek to explain phenomena with experimental designs [30]. Individual study limitations are described in Table 7.

Discussion

The results of this review indicate that there are significant gaps in our knowledge regarding HIT use by older adults with limited health literacy.

Population Characteristics

The descriptive studies reviewed for this analysis (n=6, 43%) reveal common patterns of use, concluding that older adults do not generally use computers, especially those with limited health literacy and those who are Hispanic/Latino or African American. Researchers have identified these disparities as the “digital divide” [54,55]. When older adults do use computers, they do so infrequently to look for health information and typically only with assistance. While we know generally who uses computers and the internet, we do not know a great deal about specific populations that are defined by age or culture. For example, there might be a substantial difference between what 65 and 85 year olds are willing and able to do, yet only four researchers [36-38,42] attempted to break down the participants into age cohorts for further analysis. One researcher [39] indicated that older adults are very reluctant to join online discussion forums, but providing electronic social support is design feature of many innovative HIT applications [56]. We lack similar granularity for the impact of cultural factors upon computer/internet use. For example, one researcher [47] found that even when age, income, and education variables were controlled for, Hispanic/Latinos used the computer/internet less than their non-Hispanic counterparts. This finding has been replicated by others [54,55], but to date research has not explored why Hispanic/Latinos might be less willing to use the internet than members of other cultural groups. Overall, internet usage trends are improving in the population of older adults. In 2008, few researchers [17] found that 38% of adults older than 65 used the computer and internet, in 2011, the percentage increased to 41%, and 2012 estimates put computer/internet use at 53%, suggesting that even older adults are actively participating in the digital revolution. Future researchers would be wise to focus on ways to actively facilitate this conversion.

Promotion of HIT

Stage 2 of the EHR Incentive Program mandates the use of patient portals in healthcare care settings that patients will access through the internet. The public health approach suggests that we determine how to eliminate or ameliorate non-computer use in the population of older adults with chronic disease and limited health literacy (arguably those who need access to the clinical summary more than most to successfully self-manage and communicate their needs) and implement effective strategies for increasing its use on a widespread basis. Results from this review suggest that researchers continue to struggle with methods for successfully promoting HIT use. Not even free computers, free internet access, and free assistance enticed low-income older adults to use a personal health record [42]. Culturally appropriate methods for promoting use among ethnically diverse older adults remains virtually unstudied. The existence of a close relationship with a friend or family member who can assist the older adult in using the computer is an interesting variable that appears to foster an individual’s willingness to use a computer [48,49] and warrants further research.

Health Literacy

Three articles analyzed for this review measured the mediating effects of health literacy on HIT use [9,37,41]. Health literacy was negatively correlated with age and minority race/ethnicity and positively correlated with income, education, female gender, health numeracy, and the use of preventative services [50]. Adequate health literacy predicts email and internet use [41]. Health literacy was not supported as a mediating variable on computer/internet use in two studies [37,49], suggesting that the role health literacy plays is complex and that theoretical models such as Paasche-Orlow and Wolf [57], ought to be used to carefully in the design of future research studies.

The notion of health literacy as a predictor of computer/internet use and better health outcomes suggests that we need to find ways to increase health literacy if we want and expect older adults to use HIT. We might accomplish this by increasing an individual’s capacity for literacy or by creating HIT interventions and print/electronic materials that are more “cognitively digestible” [58] and health literate [59] by design.

The community of HIT researchers included in this review did not define health literacy in the same way nor did they use the same standardized instruments to measure it, which makes advancing the state of the science difficult at best. There is disagreement in the field regarding the construct of health literacy. Some view health literacy as

a contextual functional skill, adapting to situations as required, some as a broad set of communication skills, and others would like to see health literacy divided into more granular specification (e.g. numeracy, reading, writing, verbal, and computer skills). More research is needed to identify a conceptual framework for health literacy that can guide future research by leverage knowledge gained to date in order to empirically test emerging frameworks [60].

Intervention Testing

Results from this analysis suggest that there is much more we need to understand about the relationships among variables that may promote HIT use, but some studies moved ahead with interventions aimed at explaining the effect of a particular variable on computer/internet use. One tablet-based educational intervention [36], two websites [40,46], resource availability [42], and several classroom approaches [35] were tested for their ability to increase computer/internet use, health literacy and health outcomes. This precedes the state of the science by attempting to explain a relationship rather than building knowledge in the traditional sense by first defining and testing relationships in exploratory research that could be used later to design and develop interventions. Polit and Beck [30] suggest that an adequate number of studies are needed at each level (identification, description, explanation, exploration, prediction) before progressing to the next.

Implications for the State of the Science

Disciplinary knowledge is built by identifying and describing phenomena with qualitative research, progressing up the levels of exploration, explanation, and prediction only when the evidence generated at lower levels of the hierarchy is satisfactory [30]. Similarly, the public health approach [26] to reducing disparities involves first defining and measuring the problem, then determining how to prevent or ameliorate the problem before implementing interventions on a large scale and evaluating their use. The level of knowledge and the state of the science in the use of HIT by older adults who may have limited health literacy remains at the descriptive exploratory stage. Therefore, a significant implication of this integrative review is the need for future research exploring the full nature of the phenomena and related factors with quantitative, qualitative or mixed method designs. This should be completed before designing interventions that seek to test hypotheses that explain or predict behavior so that our limited research dollars are spent testing interventions that are theoretically sound and have a greater chance at succeeding to improve computer/internet use by older adults.

Limitations

The limitations of this study include the possibility that studies were unintentionally left out of the sample through investigator error, failure to search relevant databases, a limited six-year time span, and publication bias that influenced author, reviewer, or editor description of the analysis or publisher's acceptance rates. The investigator may have been overly critical of published studies that, by adhering to reviewer's comments and page limitations, left information sought out of the final published report.

Significance

The healthcare system is moving toward an electronic infrastructure whereby patients will become sophisticated consumers

of HIT. Current research suggests that older adults may not function well in this environment. From a public health perspective, these findings imply that we are not yet prepared to effectively implement consumer HIT at a population level. This suggests at least three options for moving the state of the science forward. First, find non-technical ways of engaging older adults in their healthcare. For example, intensivists in an ICU setting discovered that augmenting the traditional discussion of do-not-resuscitate (DNR) preferences with a video-taped presentation was effective at ameliorating the impact of limited health literacy on the decision to sign DNR orders [61]. Second, fundamentally re-design technology to meet the needs of older adults with limited health literacy. For example, researchers at Northwestern found that a nurse-Avatar presented on a tablet computer used to teach patients about discharge medications and self-care was more effective at reducing hospital readmissions than nurse delivered education and that patients preferred the computerized nurse in part because "she" took "her" time and did not talk down to them [62-65]. Third, devise yet undiscovered methods for the electronic engagement of older adults in their healthcare. Either way, the speed at which new technology is introduced to the market rapidly outpaces our ability to help people make sense of new information and use HIT to improve their lives [66]. Continued research at the exploratory level will help to illuminate the processes by which older adults with limited health literacy can and will use HIT to achieve improved health outcomes.

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