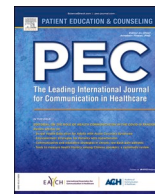




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eHealth literacy in prostate cancer: A systematic review

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ABSTRACT

Objective: This systematic review (PROSPERO ID: CRD42022226375) aimed to identify the eHealth literacy of men with prostate cancer, and their caregivers.**Methods:** 8 databases (MEDLINE, SCOPUS, EMBASE, Web Of Science, PsycINFO, ERIC, CINAHL, Cochrane CENTRAL) and grey literature sources (e.g. Google Scholar) were searched from inception to December 2023. Articles were included if assessing eHealth/digital literacy of men with prostate cancer, or their carers', and health outcome associations. Formats such as case reports, and review papers were excluded. Records and full texts underwent independent screening and data extraction. Author disagreements were resolved by discussion. The Mixed Methods Appraisal Tool (MMAT) was used to appraise included literature, with narrative synthesis of results.**Results:** 21,581 records were retrieved, with 7 articles satisfying inclusion criteria. A heterogenous field was characterised with lack of modern eHealth literacy measurement tools identified. Results suggest novice eHealth literacy using web 1.0 technologies. Non-validated measures of literacy demonstrate mixed results, while health outcome effects limited in scope and reliability.**Conclusion:** Prostate cancer survivors' eHealth literacy levels is likely novice, and requires further investigation.**Practice Implications:** Digital technologies/resources implemented as part of patient communication practices should be vetted for quality, and tailored to patients' eHealth literacy abilities and/or needs.

1. Introduction

eHealth (electronic health) is a broad field and idea which first appeared in research literature in the year 2000 [1]. eHealth is most commonly defined according to Eysenbach: "an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies" [2]. Since the year 2000 this field has undergone an exponential rise in research output and interest, as an attractive, scalable, and low cost solution to reduced burden on medical systems, improve care quality, and empower participants within the

health care system [3]. Most commonly, the health care consumer is the centre focus of eHealth strategy – empowering individuals to self-manage their care.

With the surge in interest in eHealth, electronic health literacy has arisen as an increasingly important area of clinical research [4]. This is due to concerns of clinicians and eHealth stakeholders for the ability of individuals to access, interact, and function within increasingly complex and often de-centralised eHealth systems [4]. The concept of eHealth literacy was first developed as the Lily Model by Norman and Skinner in 2006 [5,6]. It is most commonly described as a meta-literacy comprised of 6 components (traditional literacy, information literacy, media

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literacy, health literacy, computer literacy and scientific literacy), and 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’ [5]. As a rapidly evolving and dynamic field, there is disagreement about definition, however this model has recently been expanded and defined by Bautista and Paige: “[eHealth literacy]. involves the interplay of individual and social factors in the use of digital technologies to search, acquire, comprehend, appraise, communicate and apply health information in all contexts of healthcare with the goal of maintaining or improving the quality of life throughout the lifespan” [7–9].

eHealth solutions provide an attractive solution to the ballooning costs of global cancer care – estimated to reach \$25.2 trillion by 2050 [10]. Prostate cancer is the most commonly diagnosed cancer in men worldwide, affecting > 1.3 million men every year [11]. More than 375,000 men die of prostate cancer per year, with global survivors expected to double to 2 billion by 2050 [11–13]. Whilst alarming numbers of men alone, the effects of prostate cancer ripple further, affecting the caregivers, families, friends and communities who live with, through and beyond this cancer diagnosis [14]. Due to this burden, eHealth is viewed as an efficient and cost effective means to improve prostate cancer care [15]. This has resulted in numerous prostate cancer eHealth interventions being developed – covering realms such as education, decision making, public health monitoring, and post-therapeutic outcome tracking [15].

Men with prostate cancer are a unique cohort when considering both eHealth and eHealth literacy. Both age and sex have been associated with differing technology utilisation rates and eHealth literacy levels [16]. Multiple studies have demonstrated that increasing age negatively correlates with eHealth literacy [16,17]. This is likely due to the rapidly evolving nature of eHealth technologies, the necessity of ongoing skill improvement for maintenance of eHealth literacy, and the known impacts of ageing on cognitive and functional decline [17]. Gender-specific differences have also been demonstrated between male and female technology users – with differences in utilisation and engagement which suggest effects of eHealth literacy or psychosocial differences in eHealth engagement [18–20]. Finally, there are well known and documented modulatory effects of prostate cancer partners or family caregivers on men’s decision making and prostate cancer survivorship experience – commonly acting as information gatherers, primary caregivers, and major sources of emotional and practical support [21]. eHealth literacy has been linked with caregiver efficacy, and burden; while social support has been identified as an influencer of cancer patient eHealth literacy [22–24]. These factors together make prostate cancer populations unique, as a male only cancer cohort.

1.1. Prior Work

Previous works have evaluated eHealth or digital literacy in older adults or patient groups with long-term conditions [25,26]. To our knowledge there are no systematic reviews which have evaluated eHealth literacy in prostate cancer patients or their caregivers.

1.2. Goals of Study

This paper aims to provide an overview of current literature, allowing us to understand the current relevance of eHealth literacy in prostate cancer care. A mixed methods format was initially selected to provide patient perspectives alongside quantitative findings and provide comprehension not possible through measured outcomes [27]. The objectives of this study were:

- 1) Identify the level of eHealth literacy and digital literacy of men with prostate cancer, and their caregivers.
- 2) Identify the instruments which have been used to assess this eHealth and digital literacy; and,

- 3) Identify the effects which eHealth and digital literacy have on health-related outcomes among men with prostate cancer.

2. Methods

Our review is reported per the 2020 PRISMA statement and reporting standards (see [supplementary material](#) [28]). The review protocol was designed with guidance of mixed method and systematic review literature and registered with the International Prospective Register for Systematic Reviews (PROSPERO; ID number: CRD42022226375) [29–31]. The quality appraisal tool was refined since registration to allow all included study types to be appraised consistently with a single tool, and to facilitate quality comparison across varied study designs.

eHealth literacy is understood broadly, based upon Norman and Skinner’s conceptual model [32]. Measurement must include competencies. As eHealth literacy is a concept not introduced until 2006, digital literacy was specifically included and expanded to include self-reported digital competency (i.e. computer, internet or technological skill/s, capacity, knowledge, ability, capability, mastery, etc) in a health setting. This was due to our team’s experience that both digital and eHealth literacy are often used interchangeably when technology is discussed in a health care context, and the known historically limited representation of digital literacy through its functional domain [4].

2.1. Information sources and search strategy

Searches were completed on eight databases (MEDLINE ALL in Ovid, SCOPUS [Elsevier], EMBASE in OvidSP, Web of Science [Clarivate], CINAHL in EBSCOHost, ERIC in OvidSP, PsycINFO in Ovid, and CENTRAL [Cochrane Trials Registry] via Cochrane Library Website) including records from inception until December 2023. Publications addressing prostate cancer and eHealth/digital literacy were sought using search terms derived through a combination of deductive reasoning, inductive analysis of existing literature, and guidance of a university librarian who helped test and modify the search strategy across the included primary databases. Initial search strategy design occurred in MEDLINE, with subsequent database search strategy modified dependent on database functionality and indexing. The strategy included Medical Subject Heading (MeSH) terms (e.g. prostatic neoplasms, and health literacy), and/or keywords (cancer*, prostat*, literacy, digital, etc). The search strategy for all primary databases are shown in Supplementary 1.

A grey literature search was undertaken from inception until December 2023, across 5 sources (Australian Clinical Trials, The System for Information on Grey Literature, ClinicalTrials.gov, ClinicalTrialsRegister.eu, and Google™ Scholar). Considering the absence of MeSH terms and known search limitations of grey literature sources, grey literature was identified using only keywords directly related to eHealth or digital literacy with available Boolean operators, dependent on platform functionality and testing performance [33–35]. The System for Information on Grey Literature in Europe database was removed from the internet in 2020, however an archived 2018 copy of this database was searched via use of the Data Archiving and Networked Services platform [36]. Google™ Scholar results were obtained by extracting the first 50 results from each search, ordered by relevance. All other grey literature searches were executed using each source’s inbuilt website search platform. All grey search strategy are provided in Supplementary 2.

2.2. Screening process

All record title and abstracts were exported to and managed through Endnote (X9) [37], Covidence [38], and Microsoft Excel [39]. Endnote is a reference management and citation formatting tool. Covidence is a systematic review management and analysis tool, which was also used for initial automated duplicate removal. Microsoft Excel is a spreadsheet

program which was used for data visualisation and analysis. After automated duplicate removal by Covidence, studies were considered for full text review and inclusion according to the following criteria:

2.2.1. Eligibility criteria

- a) Men diagnosed with prostate cancer (if mixed cancer group – prostate cancer patient data must be able to be separated), and/or caregivers (family member, close friend, indicated carer, or partner) of men with prostate cancer.
- b) English language publications.

AND.

- a) Quantitative studies:
 - o eHealth literacy or digital literacy assessed.
 - Digital literacy including self-reporting of digital competency (i.e. computer, internet or technological skill/s, capacity, knowledge, ability, capability, mastery, etc.)
 - o Measured health-related outcomes associated with eHealth or digital literacy.

OR.

- b) Qualitative studies:
 - o Must explicitly state eHealth literacy or digital literacy as a subject of interest.
 - o Findings must describe the impact of limited eHealth literacy or digital literacy on health outcomes.

Studies were excluded according to the following criteria:

2.3. Exclusion criteria

- a) Case reports, review papers, conference proceedings, opinion pieces, editorials, letters to the editor, dissertations/theses, book chapters, protocols.

One author screened all records (SJ), a second screening > 99% (PY), and third < 1% (DA). Disagreements were resolved through discussion (SJ and PY). Systematic reviews with a focus on eHealth literacy or digital literacy identified during screening underwent visual scanning of their reference lists and included studies (SJ, and PY). Full texts of all published studies considered for inclusion were sought for full text review. Investigators of relevant grey literature registered trial records identified during screening were also contacted to obtain available data for inclusion as part of full text review. All full text records obtained were independently reviewed for eligibility by two authors (SJ and PY). Visual scanning of reference lists of included studies were undertaken.

2.4. Data extraction

Covidence software was used by two independent reviewers (SJ and PY) to extract data from all papers and check for accuracy. Data on included study characteristics (author, year, country study undertaken, setting, design, aims/objectives, inclusion/exclusion, recruitment procedure, eHealth literacy and/or digital literacy measure/s used, and how limited literacy defined), sample (age range/mean/SD, sex ratio, cancer stage/grade, cancer site, number of participants and number of eligible participants if mixed group, and treatments received), outcomes (as reported in individual studies, measures used and effect of eHealth literacy or digital literacy on these) and qualitative methods used, data analysis procedures, key themes and findings and participant quotes.

2.5. Quality appraisal

The Mixed Methods Appraisal Tool (MMAT) was used to appraise all included literature and allow direct comparison [40]. The MMAT is a critical appraisal tool that is designed for the appraisal stage of systematic mixed studies reviews. Scores are given out of 5, with a point awarded for each 'Yes' answer, and no points awarded for 'No' or 'Can't Tell'. Included studies were considered higher quality if they scored $\geq 4/5$. Covidence software was used by two independent reviewers (SJ and PY) to appraise all papers with the MMAT. At all stages, disagreements were resolved through discussion.

2.6. Data synthesis

As qualitative components of included studies did not match inclusion criteria, the remainder of this paper only relates to quantitative data of identified works. Pooling of data was not performed due to the inclusion of varied study designs, outcomes, assessment measures and stratification methods used to identify participants with varying literacy. As a result, narrative synthesis was undertaken. Studies were tabulated based on review objectives. These structured tables were used to examine variation in results across studies.

3. Results

A total of 21,581 records were retrieved from the searches and imported to Covidence (Fig. 1). After automated removal of duplicates, 14,746 records were screened by title and abstract, with 3365 additional duplicates removed manually. The investigators of 4 grey literature registered trials were contacted for data relevant to inclusion, however, no data was obtained. Full texts of 105 published papers were reviewed for eligibility, with 7 articles satisfying the criteria for inclusion.

3.1. Description of analysed studies

The 7 articles were from the USA ($n = 5$) [41–45], and Canada ($n = 2$) [46,47], encompassing 2411 participants (or dyads) (Table 1). The earliest study was published in 2004 [41], with the remainder published from 2015 to 2021. Four studies aimed to develop and/or test new eHealth interventions [41,42,45,47], of which 3 were mixed methods studies [41,45,47]. Remaining study designs included a randomised controlled trial ($n = 1$) [42], and 3 cross-sectional surveys [43, 44,46].

Five studies examined men with prostate cancer [41,42,44–46], 1 the partners of men diagnosed with prostate cancer [43], and 1 prostate cancer survivors (a mixed population of prostate cancer patients and caregivers of men with prostate cancer) [47]. Of men with prostate cancer, most studies included men with localised disease ($n = 6$) [41,42, 44–47], while men with advanced or metastatic disease were included in 2 works [45,47]. The study of Lixin et al., which focussed exclusively on partners of men diagnosed with prostate cancer, reported that all corresponding men with prostate cancer had localised disease [43]. Of the 5 studies which reported men's cancer treatment [41,42,44,46,47], the most common reported were surgery, external beam radiation therapy, and androgen deprivation therapy.

There was variation in quality of included studies as assessed by the MMAT, with scores ranging from 0–4 of a total of 5 points (Supplementary 3). Three articles were assessed as higher quality (scored $\geq 4/5$) [42,43,47].

3.2. eHealth literacy and digital literacy levels (Objectives 1 and 2)

Out of 7 published articles, 2 studies used the concept based eHealth Literacy Scale (eHEALS) [43,47], 1 partially validated a single eHealth confidence item derived from the eHEALS [46], and 1 a 5-item eHealth literacy domain assessment [47]. Five articles measured digital literacy

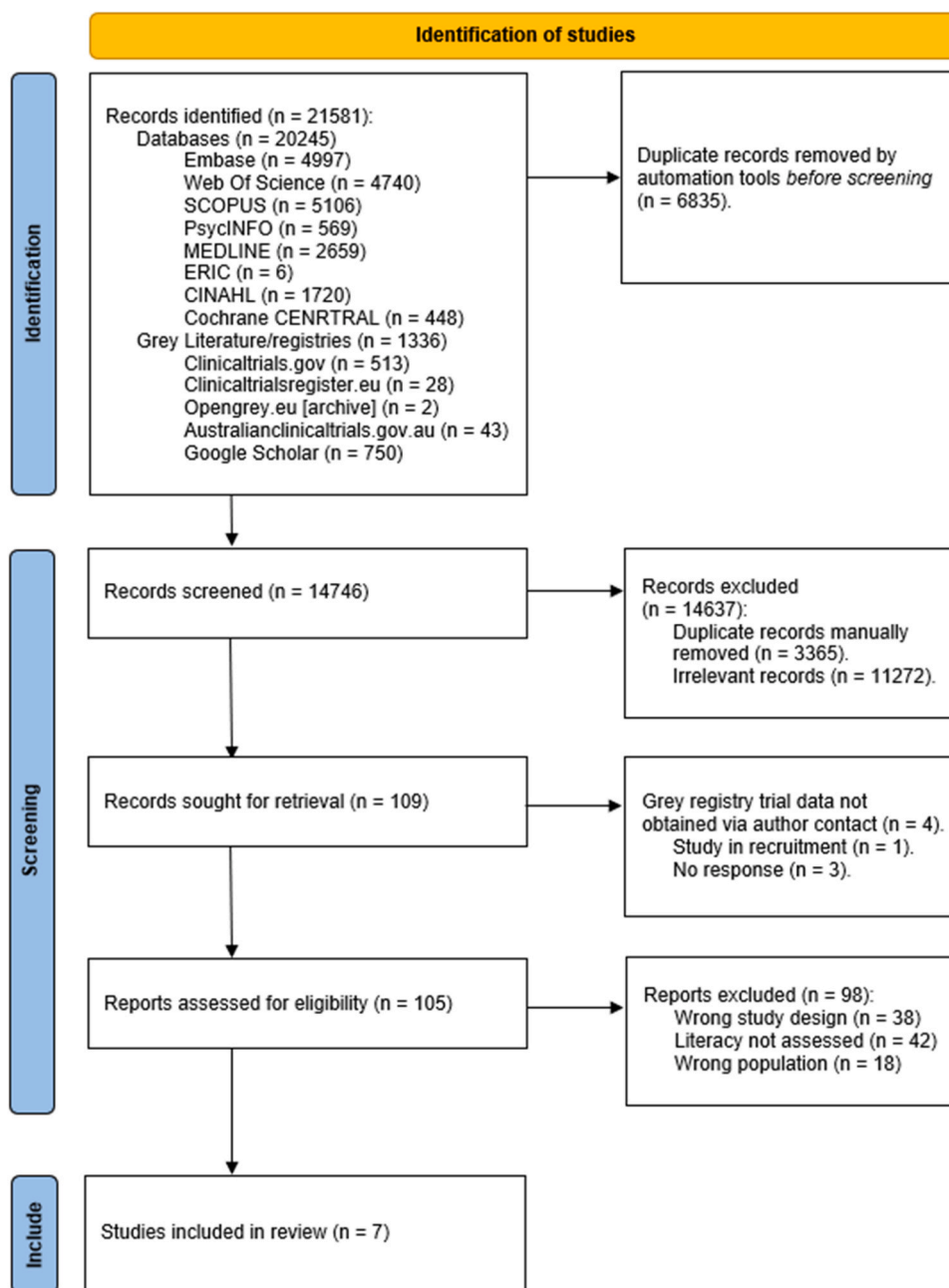


Fig. 1. PRISMA Diagram.

via various single item measures of self-reported digital competency [41, 42,44,45,47].

Bender et al. (prostate cancer survivors) and Lixin et al. (partners of prostate cancer patients) employed the eHEALS with divergent reporting of their outcomes [43,47]. When investigating the before and after effects of a digital peer navigation program, Bender et al. demonstrated eHEALS pre- and post-test means of 3.69 (SD0.65) and 4.20 (SD0.52; $p < 0.0001$), respectively [47]. Comparatively, Lixin et al. reported a baseline eHEALS summative mean of 28.5 (range 8–40) [43] whilst investigating effects of partner eHealth literacy on prostate cancer patient decision making outcomes.

In 2019 [46], Bender et al. modified a single item from the eHEALS to create an eHealth confidence variable which measured 'confidence using the internet as a health resource' on a 6-point Likert scale. eHealth literacy construct validity was demonstrated for this item, with up to 40.2% (n = 521) of men with prostate cancer demonstrating eHealth

confidence; 33.5% (n = 386) disagreeing or undecided about their confidence, and 26.3% (n = 341) abstaining as non-internet users.

In their 2021 work, Bender et al. assessed eHealth literacy via a competency based, non-validated 'Health information technology and eHealth literacy' domain comprised of 5 items (Likert scale 0–100% from not confident to completely confident). This was employed alongside the eHEALS instrument, and demonstrated pre- and post-test summary statistic means of 67.6 (SD22.8) and 89.4 (SD7.6; $p < 0.0001$), respectively [47].

There were no multi-item or validated instruments identified in this review which conceptually measured 'digital literacy'. All included studies utilised non-standardised survey items of self-reported digital capacity in a health context (Table 1). This occurred as follows:

- b) Digital literacy level [45]
- c) Internet confidence or comfort [42,44]

Table 1
a. Included studies – eHealth Literacy.

Author, year, location	Study Design	Population description	Number of participants, age mean (range, median, SD), % female	Number of prostate cancer patients (%), prostate cancer caregivers (%), cancer patients (%), cancer caregivers (%)	Cancer stage/ grade (%)	Cancer treatments received (%)	eHealth literacy outcome measure	Additional Outcomes/ Variables	Associations of eHealth literacy	Quality (MMAT score)
Bender, 2021, Canada	Mixed methods study	Men with prostate cancer, and caregivers of men with prostate cancer	28 66.4 (NR, NR, 6.9) ≤ 14.3 (based on caregiver cohort)	24 (85.7) 4 (14.3) 0 0	'Localised' 89.2 'Metastatic' 10.7	Surgery 71.4 EBRT 28.6 AS 25.0 ADT 2.1 Brachytherapy 7.0 Chemotherapy 7.0 High frequency ultrasound therapy 3.0	eHEALS > Pre-test mean = 3.69 (SD0.65) > Post-test mean = 4.20 (SD0.52; p < 0.0001) Non-standardised domain assessment of 'Health information technology and eHealth literacy' > Pre-test mean = 67.6 (SD22.8) > Post-test mean = 89.4 (SD7.6; p < 0.0001) Limited literacy not defined.	Sociodemographics Understanding of learning objectives Self- efficacy of core competencies Satisfaction with the training program Training program usability Course utilisation	N/A	4/5
Bender, 2019, Canada	Population wide, cross-sectional, closed answer survey;	Men with prostate cancer	1320 69.5 (43-95, NR, 8.2) 0	1320 (100) 0	N/A	Surgery 40.3 EBRT 31.4 ADT 25.2 Brachytherapy 17.6 AS 15.4 Watchful waiting 11 Chemotherapy 2 Complementary and alternative therapy 2.3 High-frequency ultrasound therapy 1.4 Cryotherapy 0.9 Immune therapy 0.1 Other 6.3 I don't know 19 (1.4)	Self reported confidence in using the internet as a health resource (single modified item from eHEALS assessed on 6-point likert scale, including option to abstain if non-internet user) > Confident: n = 521 (40.2) > Undecided/disagreed: n = 386 (33.5) > Non-user: n = 341 (26.3)	Internet use and access patterns Factors associated with health-related internet use (inc. demographics) What men with prostate cancer want in a website.	Positively correlation with: > frequency of internet use (P = 0.003) > health related internet use (P = <0.001) Negative correlation with eHealth components framed as barriers: > not being comfortable using a computer or mobile device (P < .001) > not knowing how to judge the quality of the information or what information to trust (P < .001) > not knowing how what information applied to me (P < .001) > not knowing how or where to search for information (P < .001) > having difficulty finding information that I could understand [(P < .001)	3/5
Lixin, 2017, USA	Cross sectional survey.	Partner/Spouse of man diagnosed with localised prostate cancer within last 3 months.	142 61.4 (NR, NR, NR) 100	0 142 (100) 0 0	Localised' 100 (prostate patients only formed dyad - with partners)	NR	eHEALS > Summative mean = 28.5; range 8-40 Limited literacy not defined.	Activities of caregiver involvement in treatment decision making. Size of social support network of partner. Patient's and partners demographics	Higher partner eHealth literacy was significantly associated with decision making activities: > Involvement in seeking a second opinion (p < 0.01). > Partner awareness of treatment options	4/5

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Table 1 (continued)

Author, year, location	Study Design	Population description	Number of participants, age mean (range, median, SD), % female	Number of prostate cancer patients (%), prostate cancer caregivers (%), cancer patients (%), cancer caregivers (%)	Cancer stage/grade (%)	Cancer treatments received (%)	Digital literacy outcome measure	Additional Outcomes/Variables	Associations of digital literacy	Quality (MMAT score)
Bender, 2021, Canada	Mixed methods study	Men with prostate cancer, and caregivers of men with prostate cancer	28 66.4 (NR, NR, 6.9) ≤ 14.3 (based on caregiver cohort)	24 (85.7) 4 (14.3) 0 0	Localised' 89.2 'Metastatic' 10.7	Surgery 71.4 EBRT 28.6 AS 25.0 ADT 2.1 Brachytherapy 7.0 Chemotherapy 7.0 High frequency ultrasound therapy 3.0	Self reported confidence in using the internet > n = 26 (92.8%) very confident/ confident in using computers and the internet.	Sociodemographics Understanding of learning objectives Self- efficacy of core competencies Satisfaction with the training program Training program usability Course utilisation	N/A	4/5
Tran, 2020, USA	Mixed methods study	Men receiving treatment for prostate cancer	29 NR (45-70, 55, NR) 0	29 (100) 0 0 0	Localised' 86 'Advanced' 14	NR (Unreported mix of newly diagnosed patients, and patients following up after non-specified treatment)	Self reported digital literacy (high vs. low) > High: n = 8 (27%) > Low: n = 21 (73%) Computer Comfort' and 'internet comfort' indicated on 5-point likert scale (0-4) Computer comfort - mean (SD) - no significant difference between groups > CHES 3.10 (1.06), Mentor only 3.17 (1.07), CHES+mentor 2.84 (1.21) Internet comfort - mean (SD) - no significant difference between	Sociodemographics Health related quality of life (HRQOL) Acceptability of the app Feasibility of the app Quality of life Emotional wellbeing Functional wellbeing Prostate cancer patient functioning Cancer information competence Health care competence Social support Positive coping Bonding with other patients User vs non-user	N/A	0/5
Hawkins, 2017, USA	Randomised controlled trial	Men with stage 1 or 2 prostate cancer, within 2 months of diagnosis	130 60 (NR, NR, NR) 0	130 (100)	Stage 1 or 2 (proportions not recorded)	Surgery 9 (6.9) Nil treatment 121 (93.1)	Self reported digital literacy (high vs. low) > High: n = 8 (27%) > Low: n = 21 (73%) Computer Comfort' and 'internet comfort' indicated on 5-point likert scale (0-4) Computer comfort - mean (SD) - no significant difference between groups > CHES 3.10 (1.06), Mentor only 3.17 (1.07), CHES+mentor 2.84 (1.21) Internet comfort - mean (SD) - no significant difference between	Sociodemographics Health related quality of life (HRQOL) Acceptability of the app Feasibility of the app Quality of life Emotional wellbeing Functional wellbeing Prostate cancer patient functioning Cancer information competence Health care competence Social support Positive coping Bonding with other patients User vs non-user	N/A	4/5

(continued on next page)

Table 1 (continued)

Table 1b. Included studies – Digital Literacy.										
Rising, 2015, USA	Cross sectional survey.	Men with prostate cancer	289 64.91 (40-89, NR, SD 8.34) 0	289 (100) 0 0	N/A	Prostatectomy 126 (43.6) Hormone therapy 99 (34.3) Radiation—external beam 93 (32.2) Watchful waiting/active surveillance 61 (21.1) Radiation—brachytherapy (implants) 29 (10.0) Chemotherapy 21 (7.3) Proton beam therapy 10 (3.5) Cryotherapy 5 (1.7)	groups > CHESS 3.13 (1.08), Mentor only 3.23 (1.06), CHESS+mentor 2.95 (1.21) Limited literacy not defined. Self reported internet comfort levels (4-point likert, 1-4), group mean > Younger men (< 65 years) 3.85 (SD0.39) > Older men (>65 years) 3.72 (SD0.49) Limited literacy not defined.	Sociodemographics Prostate Cancer Characteristics Internet behaviour and experience Reasons to use eHealth for information support Psychosocial indicators	> Higher rates of internet use correlated with internet comfort (p < 0.001) > Higher rates of internet access correlated with internet comfort (p = 0.001) > Greater difficulty of prostate cancer information seeking correlated with decreased internet comfort (P = 0.02) > No correlation with positive or negative psychosocial indicators, level of applicability of prostate cancer information on internet to personal situation, trust in online information about prostate cancer, or rate of internet use to find prostate cancer information. > Younger men more likely to be comfortable using the internet (p = 0.01)	2/5
Diefenbach, 2004, USA	Mixed methods study design using focus groups and baseline survey	Men with localised prostate cancer (spouses present during focus group only)	473 66 (35-75, NR, 8) 0	473 0 0	Localised 473 (100)	External beam radiation 340 72% Surgery 105 22% Brachytherapy 28 6%	Self reported computer experience, reported as computer literacy (4-point likert scale) > Slightly experienced 39% > Moderately experienced 18% > Very experienced 11% > Expert 2% * (30% unaccounted for - ? non-response/ inexperienced)	Evaluation of PIES program Sociodemographics	NR	0/5

- d) Computer experience or comfort [41,42]
- e) Computer and internet confidence [47]

These outcomes were measured with 4- and 5-point Likert scales with varying stratification systems (e.g. slightly experienced, moderately experienced, very experienced, expert), or dichotomous variables (e.g. high vs. low). Results are heterogenous, presented as representative proportions or group means.

3.3. Effects of eHealth and digital literacy on health-related outcomes (Objective 3)

Three studies included in this review investigated effects of eHealth or digital literacy on health-related outcomes of prostate cancer patients [43,46,48] (Table 2).

In a 2015 study exploring eHealth perceptions among 289 men with prostate cancer, Rising et al. demonstrated that lower levels of digital literacy were correlated with a greater difficulty of prostate cancer information seeking (p = 0.02) [48]. No correlation was demonstrated regarding psychosocial indicators, ability to apply prostate cancer information on the internet to personal circumstance, trust in online information about prostate cancer, or rate of internet use to find prostate cancer information.

In 2017, Lixin et al. examined the impact of eHealth literacy of 142

Table 2

Categories of health-related outcomes, and their associations with eHealth and digital literacy. *PCI: Prostate cancer information; PI: Partner involvement; DM: decision making; SE: side effects. ^a The association between health outcomes and eHealth literacy: + = positive association; - = negative association; o = no association.

Health Outcome Category	Health Outcomes	Correlation with eHealth literacy ^a	Correlation with digital literacy ^a	
Physical	Prostate cancer treatments[47]	O	NA	
	Health status[47]	O	NA	
Behavioural	PCI* seeking[48]	NA	+	
	Rate of internet use to find PCI[48]	NA	O	
	PI* in seeking second opinion[43]	+	NA	
	PI in gathering information for DM*[43]	O	NA	
	PI in attending doctor visits with partner[43]	O	NA	
	Health related internet use[47]	+	O	
	Information seeking role [47]	O	NA	
	DM role of prostate cancer patient[47]	O	NA	
	Psychosocial	Positive psychosocial indicators[48]	NA	O
		Negative psychosocial indicators[48]	NA	O
Size of partner social network for information and support in DM[43]		O	NA	
PI in providing emotional support during DM[43]		O	NA	
Unmet supportive care needs[47]		O	NA	
Cognitive		Applicability of PCI to personal situation[48]	NA	O
	Trust in online PCI[48]	NA	O	
	Partner awareness of treatment options[43]	+	NA	
	Partner awareness of treatment risks and SE*[43]	O	NA	

partners of men with prostate cancer on involvement in the treatment decision making process of their dyad partner [43]. Higher partner eHealth literacy was significantly correlated with their involvement in seeking a second opinion (p < 0.01), higher awareness of available treatment options (p < 0.05), and the size of the social network that was used to obtain additional information and support for treatment decision making (r = 0.2, p < 0.05). eHealth literacy of partners was not associated with gathering prostate cancer information for decision making, attending doctor visits with their partner, providence of emotional support during treatment decision making, or awareness of treatment risks and side effects. Partners with higher eHealth literacy demonstrated a tendency for active discussion of treatment options with patients, however this did not reach significance (p < 0.06).

Finally, in 2021, Bender et al. investigated factors associated with the use of the internet as a source of health information among 1320 Canadian men with prostate cancer [46]. Their construct validated eHealth confidence variable demonstrated positive correlate with health-related internet use in men with prostate cancer (p ≤ 0.001). Univariable logistic regression analyses found no association with reported prostate cancer treatments, personal information seeking and decision-making roles, health status, or unmet supportive care needs.

4. Discussion and Conclusion

4.1. Discussion

This is the first systematic review which demonstrates the eHealth and digital literacy of both men with prostate cancer, and their caregivers. Despite a broad search, the eHEALS was the only validated tool identified for the specific purpose of measuring eHealth or digital literacy. This tool was utilised in two studies, demonstrating the eHealth literacy of prostate cancer survivors (patients and caregivers) and caregivers, respectively [43,47]. Remaining assessments of eHealth or digital literacy were comprised of single item or previously non-validated measures with heterogenous results.

The eHEALS is an 8-item measure of eHealth literacy developed by Norman and Skinner to measure consumers' knowledge, comfort, and perceived skills at identifying, evaluating, and applying electronic health information to their health problems [32]. The tool was originally validated in a cohort of adolescents, however it is now the most widely used, translated and validated eHealth literacy instrument in cancer and non-cancer populations [49]. Considering the previous interpretations of eHEALS, our results suggest a novice level of eHealth literacy within these included populations [50]. However, whilst the eHEALS is a popular instrument to assess eHealth literacy, it has been criticised recently for its content validity – primarily due to the evolving social functions of eHealth technology and digital information systems [51]. This is a limitation acknowledged by creators Norman and Skinner, with their suggestion that the eHEALS instrument is a more suited instrument for assessing competence with Web 1.0 related technologies (i.e. basic information website interaction and retrieval) [52]. Whilst reliably measuring eHealth literacy domains, similar to Norman and Skinner, we hold concern that current eHEALS results may not reflect the modern conceptualisations of eHealth literacy, or eHealth technology usage patterns of modern-day populations. This is a particularly important short-coming of the tool, considering the proliferation and dominance of interactive and social online prostate cancer resources and support groups of the last decade.

Despite prominence, the eHEALS is not considered a gold standard [4]. New tools have been developed to assess eHealth literacy due to critique of the eHEALS, and in response to the modern dynamic expression of eHealth use and interaction. The eHEALS itself has been revised as the eHEALS-E (eHealth Literacy Scale-Extended) [53]. Other second-generation instruments such as the e-HLS: electronic health literacy scale; DHLI: digital health literacy instrument; eHLA: eHealth literacy assessment toolkit; eHLQ: eHealth literacy questionnaire; and,

Table 3

Suggested outcomes for investigation related to eHealth literacy in prostate cancer cohorts. *HRQOL: Health related quality of life.

Physical	Behavioural	Psychosocial	Cognitive
HRQOL*	Health behaviours	Distress	Prostate cancer knowledge
Prostate Cancer Functional outcomes	Therapy adherence	Depression	Health attitudes
Prostate Cancer specific Quality of life	Self-Care	Anxiety	Health literacy
Stage at diagnosis	Disease monitoring	Suicide	Cancer literacy
Disease progression	Peer advocacy	Self-Care Efficacy	Decision making
Mortality	eHealth utilisation	Decision regret	Trust
Health status/Morbidity	Decision role	Access to care	Satisfaction
Disability status	Communication	Relationships	Technology knowledge
	Healthcare utilisation	Financial outcomes	
	Appointment Keeping	Clinician Choice	

TeHLI: transactional eHealth literacy instrument, have also been developed to directly address the rise of social media and mobile centric eHealth technologies (i.e. Web 2.0) [49]. These tools are in their infancy, and yet to undergo rigorous validation across both cancer and non-cancer cohorts.

Based on this review, no Web 2.0 eHealth literacy instruments have been tested in a prostate cancer specific cohort, and thus require further investigation. Of other available cancer-based literature, investigation of these tools is also in fundamental stages. This is largely focused on establishing base population eHealth literacy means [54–56], and exploration of previously defined Web 1.0 eHealth literacy demographic predictors (e.g. age, gender, income) within modern Web 2.0 eHealth literacy models [55,56]. One notable study by Vasquez et al. (utilising the TeHLI) has demonstrated that individuals with cancer appear to have similar eHealth literacy to their surrogate information seekers, though different means of credibility appraisal [56]. This may suggest that cognitive, psychological or structural challenges differ between these groups, and illustrates a need for further investigation due to the known psychological/emotional impacts of cancer on information seeking, processing, and decision making [57–59]. These effects are particularly relevant in prostate cancer populations, where treatment modalities often have functional sequelae balanced against treatment needs and patient preference.

Effects of eHealth or digital literacy on patient's prostate cancer health-related outcomes are limited in scope. Only 3 articles provide data corresponding to health-related outcomes of prostate cancer patients, of which only one was deemed high quality [43,47,48]. This is likely reflective of the juvenile nature of the field, though we note that other cancer based reviews have demonstrated similar limited data sets in the past [60]. Positive associations were primarily demonstrated between eHealth/digital literacy levels and utilisation of the internet as part of information seeking related to health care and prostate cancer. Lixin et al. demonstrated these activities in relation to caregiver eHealth literacy, revealing association with decision making processes of prostate cancer patients [43]. These associations are similar in type to previous reviews examining eHealth literacy in other cancer and chronic condition populations, where health behaviour effects are a common theme [25,60].

Correlation was not demonstrated with physical or psychosocial outcomes as in similar reviews. This is possibly driven by the early exploratory nature of the field for prostate cancer cohorts, and/or primary authorship personnel of included articles being primarily comprised of public health, communications, and engineering experts. This is a common finding in eHealth literature due to the intersection of varying fields - the low participation rate of medical professionals in the measurement and definition of eHealth literacy is a previously suggested weakness of the eHealth literacy field [4]. Nevertheless, these aspects of patient care require urgent investigation and involvement of medical personnel. We suggest this due to the well-known physical and psychological morbidity outcomes of prostate cancer treatments, the complexity of treatment selection and decision regret, as well as the known long term survivorship issues of patients, caregivers and communities [61,62].

Overall, eHealth literacy research exploring prostate cancer cohorts appears in its infancy. Currently, we argue that due to factors such as cohort selection and recruitment, varied methodology and stratification of literacy, as well as reporting, it is difficult to come to definitive conclusions about current eHealth or digital literacy levels in prostate cancer patients or that of their caregivers. There is evidence of likely selection bias, with some studies reporting inclusion criteria selective for participants with high technological skill levels [45,47]. The immaturity of the field is perhaps most clearly illustrated by no previously validated instruments having been applied to prostate cancer patients as a cohort alone. Additional methods developed by Bender et al. require further validation, and the remaining tools identified by this review are best characterised as rudimentary non-validated measures of digital capacity in a healthcare context [46,47]. This level of investigation and development is surprising when considering the global health burden of prostate cancer, the availability of instruments which do specifically assess eHealth or digital literacy, and the high interest in use of eHealth technology for cancer patients in recent years [26]. In consideration of prostate cancer clinical care complexities, there is substantial opportunity to investigate the effects of eHealth or digital literacy across the spectrum of the prostate cancer care continuum and pathological stages (please see Table 3 for recommended relevant outcomes). These should be prioritised according to regionally specific institutional requirements, survivorship guidelines and frameworks [61].

There are several limitations to this study. Included articles were restricted to those published in English. There is evidence that selection bias affected results of included studies due to recruitment requirements, and the majority of studies were deemed lower quality. All tools identified in this review were self-reported and measure self-perceived health or digital literacy, limiting inferences to association. Only the eHEALS has been employed in mixed prostate cancer survivor and caregiver cohorts, with reliability of all other included measures yet to be established. Like other systematic reviews about eHealth literacy, meta-analysis was not possible due to considerable heterogeneity in the samples, disease stage, outcomes, and stratification of data. While this review's methodological expansion of digital literacy to digital capacity was founded by known limitations of early eHealth research and aimed to demonstrate more comprehensively the breadth of work in this field, it is largely informed and limited by modern functional domains of eHealth and digital literacy instruments [4]. Future authors should take note to avoid this when designing new prospective studies/trials exploring eHealth or digital literacy which are accepted multidimensional constructs.

4.2. Conclusion

Unless individuals have sufficient eHealth literacy, they will be unable to effectively engage with eHealth interventions and modern digital healthcare systems, to the cost of their present and future wellbeing. Unless we can reliably measure eHealth literacy, we are hampered in our ability to identify low literacy target groups and cannot develop and test interventions to effect change.

This review adds to the literature on eHealth literacy in prostate cancer populations – demonstrating the juvenile nature of the research field, and the limited understanding of eHealth literacy in prostate cancer patient and caregivers. The implication of this review is a call to action for clinicians and researchers to urgently investigate the eHealth literacy of prostate cancer populations with validated and modern eHealth literacy tools. Impacts of eHealth literacy throughout the prostate cancer care continuum require substantial inquiry using high quality quantitative and qualitative research methodologies.

4.3. Practice Implications

Considering validated measures only, it is suggested that prostate cancer survivors' eHealth literacy levels may be novice. This would fit with previous data in elderly populations who are known to be less comfortable with the internet, and to have lower levels of eHealth literacy than younger counterparts [16,17,41]. However, we have reservations about generalising this finding to men with prostate cancer currently due to the limitations of the eHEALS instrument, mixed populations and findings of other included studies. As a means of managing this currently, we would advise clinicians to continue to direct patients (and their caregivers) to vetted information resources regarding prostate cancer management, and that this should be offered in formats which are tailored to patients' abilities and/or needs. Whilst there are no web 2.0 eHealth literacy tools validated in a prostate cancer cohort, clinicians may wish to consider using these newer tools over the eHEALS if weighing implementation of social web 2.0 technologies as part of patient communication practices.

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CRediT authorship contribution statement

Jackson Stuart Robert: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Chambers Suzanne:** Writing – review & editing. **Occhipinti Stefano:** Writing – review & editing. **Armany David:** Investigation. **Yu Paul:** Investigation, Formal analysis. **Patel Manish I:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Leslie Scott:** Writing – review & editing, Supervision, Conceptualization.

Declaration of Competing Interest

None to declare by any authors.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.pec.2024.108193](https://doi.org/10.1016/j.pec.2024.108193).

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