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Editorial

The Open Access Advantage

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Related Articles:

Comment on: Eysenbach G. Citation Advantage of Open Access Articles. PLoS Biol. 2006;4(5) p. e157 http://dx.doi.org/10.1371/journal.pbio.0040157

Comment on: MacCallum CJ, Parthasarathy H. Open Access Increases Citation Rate. PLoS Biol. 2006;4(5) p. e176 http://dx.doi.org/10.1371/journal.pbio.0040176

Abstract

A study published today in PLoS Biology provides robust evidence that open-access articles are more immediately recognized and cited than non-OA articles. This editorial provides some additional follow up data from the most recent analysis of the same cohort in April 2006, 17 to 21 months after publication. These data suggest that the citation gap between open access and non-open access papers continues to widen. I conclude with the observation that the “open access advantage” has at least three components: (1) a citation count advantage (as a metric for knowledge uptake within the scientific community), (2) an end user uptake advantage, and (3) a cross-discipline fertilization advantage. More research is needed, and JMIR is inviting research on all aspects of open access. As the advantages for publishing open access from a researchers' point of view become increasingly clear, questions around the sustainability of open access journals remain. This journal is a living example that "lean publishing" models can create successful open access journals. Open source tools which have been developed by the Public Knowledge Project at the University of British Columbia with contributions from the Epublishing & Open Access group at the Centre for Global eHealth Innovation in Toronto are an alternative to hosting journals on commercial open access publisher sites.

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KEYWORDS

Knowledge translation; open access; bibliometrics; open source

Citation Advantage of Open Access Articles

PLoS Biology today publishes a study authored by JMIR founding editor and publisher Gunther Eysenbach on the impact of publishing papers as open access articles, concluding that open access articles have a clear citation advantage over non–open access articles (see [1] and Multimedia Appendix 1).

The study, already referred to as a landmark study by colleagues, is the first publication providing robust evidence for a citation advantage of articles published “originally” as open access articles (so-called “gold road” to open access) compared with articles published in the same journal as non-immediate open access articles. This kind of comparison became possible because the journal *PNAS (Proceedings of the National Academy of Sciences),* under the visionary leadership of the late Nicholas Cozzarelli, started an experiment in mid-2004 offering authors the option of paying an additional fee to make their article freely available immediately after publication. *PNAS* became one of the first “hybrid” journals. The resulting mix of open access and non–open access articles published in *PNAS* represents an ideal study cohort. The study published today in *PLoS* [1] is the first of a series of papers that will follow up this cohort over several years, with today's paper describing the citation behavior over the early period of up to 16 months after publication, collecting citation data every 6 months.

Figure 1 and Table 1 are updated versions of the figures presented in the *PLoS Biology* article, with the most recent study point of April 2006 being added (representing a follow-up time of up to 21 months after publication). It shows the (unadjusted) citation advantage of open access articles over non–open access articles, with the gap continuing to widen. This citation advantage remains significant even when adjusted in multivariate regression models to correct for differences in article and author characteristics (not shown here, see [1] and Multimedia Appendix 1 for details).

Table 1. Updated version of Table 2 in the Eysenbach study [1], with the most recent study point April 2006 added, showing unadjusted citation rates of PNAS articles published in the second half of 2004

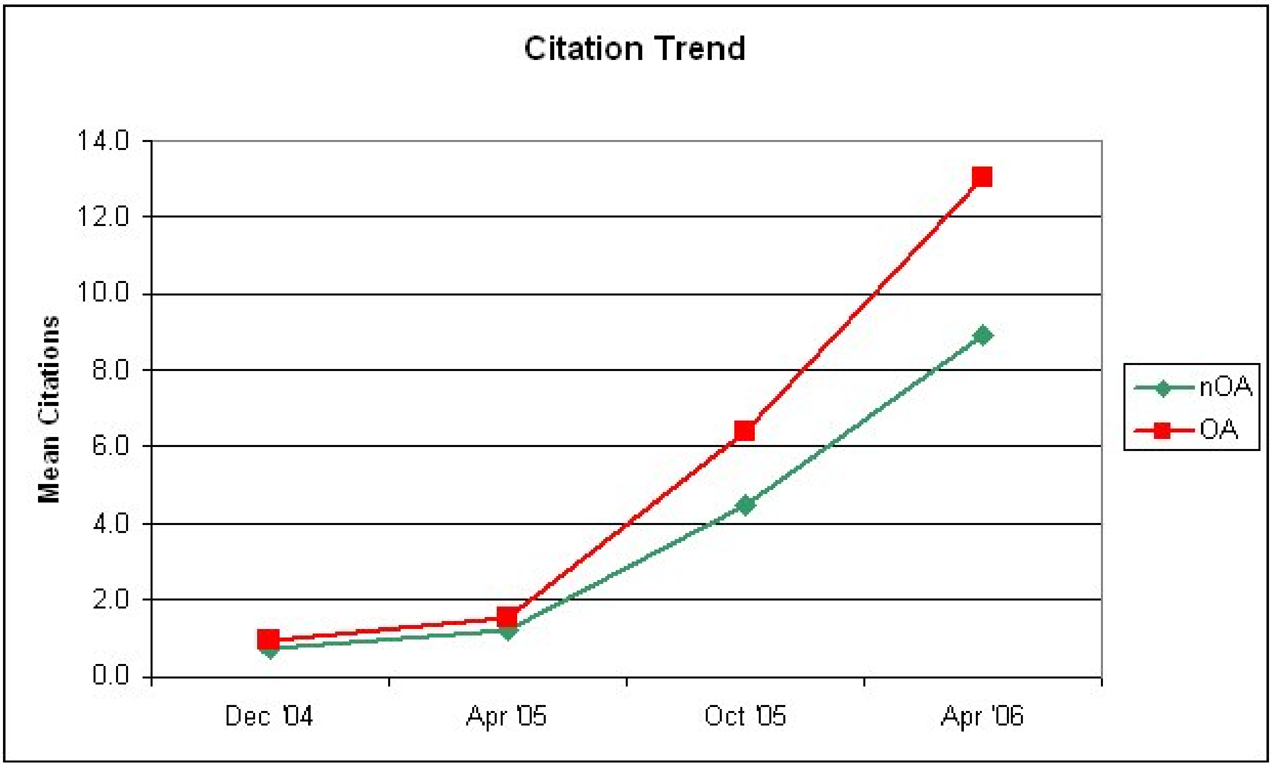
	Non–Open Access (n = 1280)	**Open Access (n = 212)**	**RR[*] (95% CI)**	***P* value**
Uncited Articles				
December 2004 (%)	1056 (82.5)	170 (80.2)	1.0 (1.0-1.1)	$P = .44$[†]
April 2005 (%)	627 (49.0)	78 (36.8)	1.3 (1.1-1.6)	$P = .001$[†]
October 2005 (%)	172 (13.6)	11 (5.2)	2.6 (1.4-4.7)	$P < .001$[†]
April 2006 (%)	70 (5.5)	3 (1.42)	3.9 (1.2-12.2)	$P = .009$
			% Difference	
Mean Number of Citations				
December 2004 [median] (SD)	0.7 [0] (2.0)	0.9 [0] (2.8)	29	$P = .35$[‡]
April 2005 [median] (SD)	1.2 [1] (2.0)	1.5 [1] (2.5)	25	$P = .002$[‡]
October 2005 [median] (SD)	4.5 [3] (4.9)	6.4 [4] (10.4)	42	$P < .001$[‡]
April 2006 [median] (SD)	8.9 [7] (8.5)	13.1 [9] (20.4)	47	$P < .001$

[*] RR = relative risk for non–open access articles not being cited by the time of analysis

[†] Comparing the proportion of uncited articles in the open access group with the proportion of uncited articles in the non–open access group (Fisher's exact test)

[‡] Comparing the (ranked) number of citations between the groups (Wilcoxon rank test)

Figure 1. Citation trend in terms of mean number of citations at different points in time (for PNAS publications published in the second half of 2004)



Claims of an “open access impact advantage” may sound familiar, as open access “archivangelists” have talked about such an advantage for years [2]; however, this previous evidence is scientifically weak [1,3], comes primarily from the “self-archiving” (“green road”) variant of open access articles, and has failed to convince open access critics such as Jeffrey Aronson, chairman of the editorial board of the subscription journal *British Journal of Clinical Pharmacology*, who wrote in the *BMJ* that “there is no evidence that this [increasing citations] will happen” [4]. Indeed, previous studies were mostly cross-sectional and largely ignored possible confounders (ie, differences in other characteristics between open access and non–open access articles that may be independently responsible for citation differences). These previous studies culminated in less than credible, sweeping conclusions such as “open access increases the impact of articles in [subject x] by x%.” By stratifying their observations by subjects, the authors of such statements implicitly acknowledged that the subject is an important confounder, but they failed to consider other confounders, such as the number of authors, which may be independent predictors for citation counts and which may differ between the groups. Multivariate analysis allows for control of these factors, that is, determining the influence of open access status if all these other factors are held constant.

The other aspect that has been previously ignored is the time factor (ie, time after publication) as a covariate that determines the actual strength of the citation advantage. It is unrealistic to assume that the open access advantage, as measured as the rate ratio of new citations per time period (per year or per month), is the same 1 year, 3 years, 5 years, 20, or 100 years after publication. Rather, what can be expected is that, after a sharp increase of the open access advantage shortly after publication, over time, the citation advantage is likely to diminish. Figure 1 shows that the rate of new citations (the steepness of the slope) is still larger in the open access group, even in the April '06 analysis, 17 to 21 months after publication. However, ultimately both lines will become parallel, indicating an equal citation rate in both groups, as *PNAS* articles in the nOA group are now also freely accessible (note that one can not expect the citation rates to become equal immediately after 6 months, when articles from both groups are free, as it often takes months or years before a manuscript gets published and the bibliography of that published manuscript shows up in the ISI database. Hence, the effect of authors citing preferentially an open access article in late 2004/early 2005 can still be observed today).

The cohort study published today [1] provides robust evidence showing the independent effect of publishing an article in an open access journal, while allowing us to track the citation behavior over a number of years after publication. As discussed in the article [1] and the accompanying editorial [3], the observed citation advantage has significant policy implications, but bibliometrics (counting citations) only tells one part of the story and is only one component of the construct we call open access advantage.

Beyond Citations

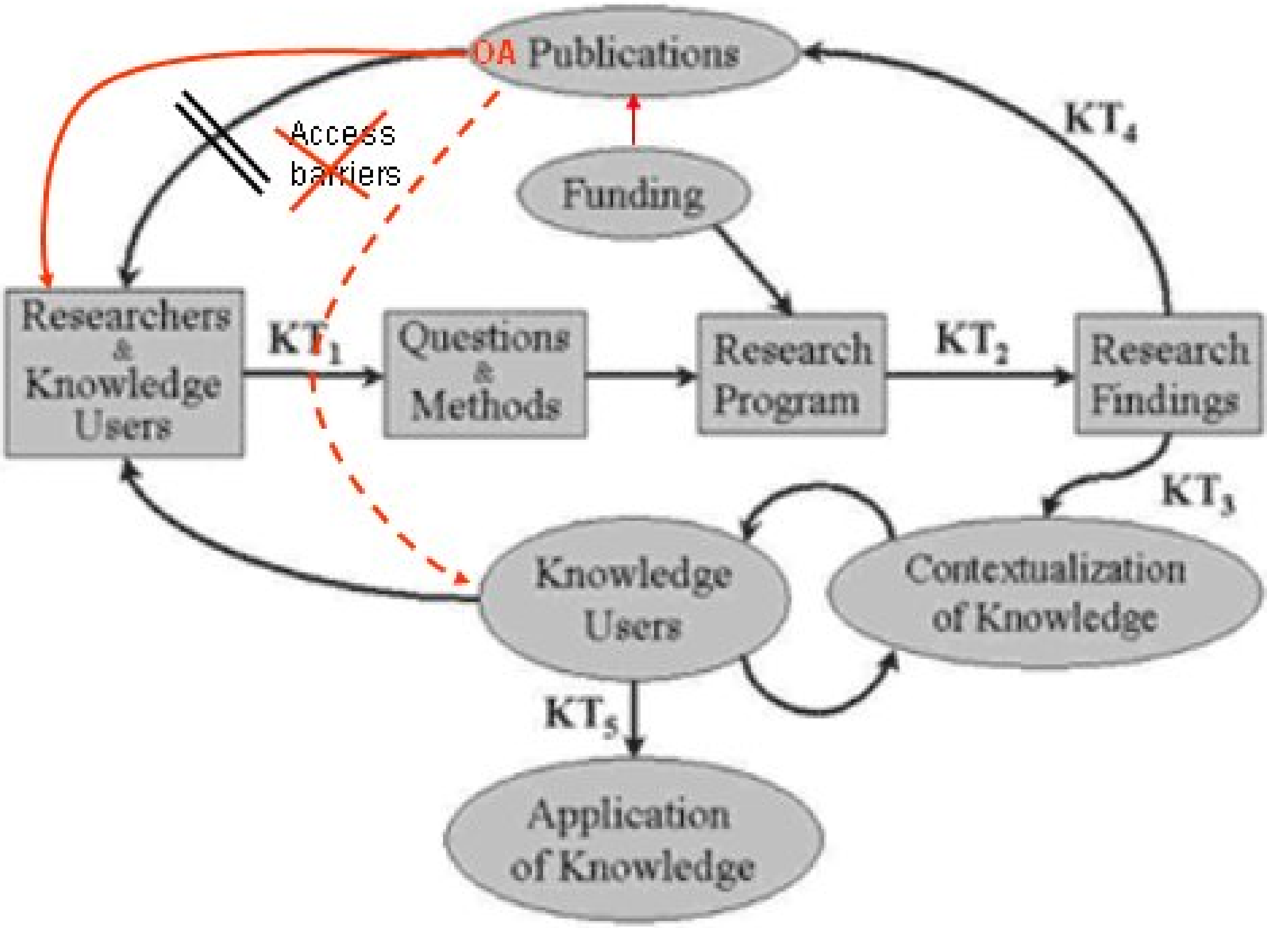
The traditional knowledge translation cycle (Figure 2) actually consists of two separate cycles: (1) the translation process (in the upper part of the figure) that takes place within the scientific community, mainly through scientific publications, and (2) the translation process of research to the end-user (in the lower part of the figure) that is facilitated by other mechanisms. This diagram illustrates the implicit assumption that, traditionally, knowledge users who are not researchers (policy makers, consumers, journalists) do not necessarily read scientific publications. In our 7 years of experience with this journal (*JMIR*), we have received many anecdotal reports from authors and research users testifying that open access publication can help to bridge this gap. Policy makers and end-users are much more likely to "google" for evidence than to do a formal literature search [5,6], and even if they come across a subscription-based scientific paper through Google, they are unlikely to actually order it. Only if a publication is open access will end-users skim and eventually read it, or contact the author, after they discovered that it is relevant to the policy (or practical) question at hand. We know that *JMIR* is used as much by patients and other nonresearchers (eg, policy makers) as it is by eHealth researchers, and we know from our authors that they are often contacted by "atypical" readers (knowledge end-users) who bumped into their article by pure chance, which they would never have done had the article been published in a subscription-based scholarly journal.

Another aspect of the open access advantage is that open access may increase the chance for what I call "cross-discipline fertilization" within the scientific community. I first made this observation when analyzing the journals in which *JMIR* articles are cited. Other than traditional subscription-based journals from the health informatics field, *JMIR* articles are more likely to be cited in general medical journals or specialist medical journals (ie, articles are not only cited within the medical informatics community). In contrast, articles in traditional medical informatics journals tend to be cited mainly in other medical informatics journals, rarely crossing the boundaries of their narrow discipline. While this may also have to do with the broader scope of *JMIR*, this observation was an early indicator for the open access cross-discipline fertilization advantage. Preliminary (yet unpublished) analysis of cited articles from the *PNAS* cohort seems to corroborate this observation.

In summary, I conclude that the open access advantage really has at least three components: (1) a citation count advantage (as a metric for knowledge uptake within the scientific community), (2) an end user uptake advantage, and (3) a cross-discipline fertilization advantage. In the case of preprints and self-archiving, one may add a quality advantage to this list, as prepublication discussion of articles may lead to quality improvements [7,8]. All of these advantages are of course the result of greater visibility within and beyond the scientific community.

Note that this view differs from how previous researchers have characterized the open access impact advantage in the context of self-archiving [2]. The *PNAS* cohort confirms the citation count advantage; however, the other aspects of the open access advantage are more difficult to measure, and further research into the more qualitative advantages of publishing in an open access journal, namely cross-discipline fertilization and uptake by end-users, is needed.

Figure 2. The Knowledge Translation Cycle (Source: Canadian Institutes of Health Research), illustrating (in red) the impact of open access.



More Research Needed: A Call for Papers

It is clear that much more rigorous research is required in this field. One question that arises for researchers is where to publish this kind of research. Traditional scientometrics and information science journals are all subscription based and only read by a few specialist researchers. A suitable publication outlet for this kind of research should of course be open access.

PLoS Biology has made it clear in their editorial that it does not intend to make *PLoS* a home for bibliometric studies [3]—even if they are about open access. So where should researchers send their best research on open access? We would like to offer *JMIR* as a peer-reviewed outlet for such research, even if it transcends the health sector. After all, the original mission of *JMIR* was to publish research on the impact of the Internet on medical and scientific communication and information. Open access would not be possible without the Internet. Thus, we are very interested in receiving submissions (in particular, those with original data) on the effects and ramifications of open access, and the many aspects that surround this issue.

Sustainability

As the advantages for publishing open access from a researchers' point of view become increasingly clear, questions around the sustainability of open access journals remain. Open access giants such as PLoS or Biomed Central are often mentioned as *the* representatives of the open access publishing movement, and it is quickly pointed out that the way they operate is not sustainable. What is often forgotten is that these publishers are not the only open access publishers (they were not even the first open access publishers - with publishers like *BMJ*, *Medscape*, or *JMIR* being the true pioneers), and they are certainly not typical representatives. The majority of open access journals operate using a lean publishing model, and many of them are financially sustainable. This journal is a living example that lean publishing models can create successful open access journals. In the light of growing concern and disgruntlement among editors with commercial open access giants such as BioMed Central [9], we wish to remind researchers that open source tools for publishing open access journals are readily available and have become increasingly sophisticated. The Epublishing & Open Access group at the Centre for Global eHealth Innovation, under the technical leadership of MJ Suhonos and scientific direction of Gunther Eysenbach, has not only been a user, but also a major contributor to open source tools such as Open Journal Systems originally developed by the Public Knowledge Project [10]. Bringing these tools up to speed in terms of XML publishing compatible with the NLM-DTD has been a major contribution of the group, which not only publishes *JMIR*, but also donates tools, technology, software, and experience to the scientific community, that is, to anyone who wants to create a new open access journal (see http://www.jmir.org/?Start_a_new_journal for details). While we are convinced that open access is the future, and with all of our sympathies for PLoS and BMC, we also hope that the future of open access does not solely rely on a quasi-monopoly of only two large open access publishers.

Multimedia Appendix 1

Full text of the Eysenbach study [1] [PDF file, 116 KB - jmir_v8i2e8_app1.pdf]

Multimedia Appendix 2

Full text of the accompanying editorial [3] [PDF file, 76 KB - jmir_v8i2e8_app2.pdf]

Multimedia Appendix 3

PLoS Press Release [PDF file, 84 KB - jmir_v8i2e8_app3.pdf]

References

1. Eysenbach G. Citation Advantage of Open Access Articles. PLoS Biol 2006;4(5):e157 [FREE Full text] [doi: 10.1371/journal.pbio.0040157] [Medline: 16683865]
2. Harnad S. Open Access Impact Advantage = EA + (AA) + (QB) + QA + (CA) + UA. URL: http://eprints.ecs.soton.ac.uk/12085/ [accessed 2006 May 10] [WebCite Cache ID 5FmNCQS8N]
3. MacCallum CJ, Parthasarathy H. Open Access Increases Citation Rate. PLoS Biol 2006;4(5):e176 [FREE Full text] [doi: 10.1371/journal.pbio.0040176] [Medline: 16683866]
4. Aronson JK. Open access publishing: too much oxygen? BMJ 2005 Apr 2;330(7494):759 [FREE Full text] [Medline: 15802718] [doi: 10.1136/bmj.330.7494.759] [PMC: 15802718]
5. Douw K, Vondeling H, Eskildsen D, Simpson S. Use of the Internet in scanning the horizon for new and emerging health technologies: a survey of agencies involved in horizon scanning. J Med Internet Res 2003 Mar 31;5(1):e6 [FREE Full text] [Medline: 22631140] [doi: 10.2196/jmir.5.1.e6]
6. Willinsky J. Policymakers' Use of Online Academic Research. Education Policy Analysis Archives 2003;11(2) [FREE Full text]

7. Eysenbach G. Challenges and changing roles for medical journals in the cyberspace age: electronic pre-prints and e-papers. J Med Internet Res 1999 Dec 31;1(2):E9 [FREE Full text] [Medline: 21577983] [doi: 10.2196/jmir.1.2.e9]
8. Eysenbach G. The impact of preprint servers and electronic publishing on biomedical research. Curr Opin Immunol 2000 Oct;12(5):499-503. [Medline: 20460416]
9. Blackman S. BioMedCentral faces angry editors. The Scientist. URL: http://www.the-scientist.com/news/display/23352/ [accessed 2006 May 11] [WebCite Cache ID 5Fnzj55v9]
10. Willinsky J. Open Journal Systems: An example of Open Source Software for journal management and publishing. Library Hi-Tech (in press) [FREE Full text]

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Review

Why Are Health Care Interventions Delivered Over the Internet? A Systematic Review of the Published Literature

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Comment in: Griffiths F. Health Care Interventions Delivered Over the Internet: How Systematic was the Review? - Author's Reply. J Med Internet Res. 2006 Jun 30;8(2) p. e12 http://www.jmir.org/2006/2/e12/

Abstract

Background: As Internet use grows, health interventions are increasingly being delivered online. Pioneering researchers are using the networking potential of the Internet, and several of them have evaluated these interventions.

Objective: The objective was to review the reasons why health interventions have been delivered on the Internet and to reflect on the work of the pioneers in this field in order to inform future research.

Methods: We conducted a qualitative systematic review of peer-reviewed evaluations of health interventions delivered to a known client/patient group using networked features of the Internet. Papers were reviewed for the reasons given for using the Internet, and these reasons were categorized.

Results: We included studies evaluating 28 interventions plus 9 interventions that were evaluated in pilot studies. The interventions were aimed at a range of health conditions. Reasons for Internet delivery included low cost and resource implications due to the nature of the technology; reducing cost and increasing convenience for users; reduction of health service costs; overcoming isolation of users; the need for timely information; stigma reduction; and increased user and supplier control of the intervention. A small number of studies gave the existence of Internet interventions as the only reason for undertaking an evaluation of this mode of delivery.

Conclusions: One must remain alert for the unintended effects of Internet delivery of health interventions due to the potential for reinforcing the problems that the intervention was designed to help. Internet delivery overcomes isolation of time, mobility, and geography, but it may not be a substitute for face-to-face contact. Future evaluations need to incorporate the evaluation of cost, not only to the health service but also to users and their social networks. When researchers report the outcomes of Internet-delivered health care interventions, it is important that they clearly state why they chose to use the Internet, preferably backing up their decision with theoretical models and exploratory work. Evaluation of the effectiveness of a health care intervention delivered by the Internet needs to include comparison with more traditional modes of delivery to answer the following question: What are the added benefits or disadvantages of Internet use that are particular to this mode of delivery?

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KEYWORDS

Internet; intervention studies; literature review

Introduction

The Internet is still a relatively new medium for seeking and delivering health care, although this use is increasing rapidly [1,2] and includes health information seeking [3], Internet-based peer support groups [4], online health consultations [5], and delivery of health interventions [6]. Some pioneer researchers have published studies that evaluate health interventions delivered directly to the users via the Internet for their ability to improve the health status of their users. In this paper we review their work, focusing on the reasons why these authors chose to use the Internet for delivery of a health care intervention. Our aim was to consolidate the findings from these early research papers to inform the development of future research. We include only health interventions in which the networking provided by the Internet is a component of the intervention. This is to distinguish them from other media such as print material, CD-ROM, and video. We reflect on the drivers to using the Internet for the delivery of health care. This paper does not review the outcomes of the interventions.

Methods

Identification of Studies

The initial identification of studies used five sources: three existing systematic reviews of eHealth interventions [7-9], a hand search of JMIR (vol 1(1) to vol 8(1)), and our own previous qualitative review of the literature concerning the Internet and consumer health information [10]. This latter review involved collation and identification of relevant literature through systematic searches of electronic bibliographic databases covering health and social sciences literature (1990 to December 2003, including Medline, HMIC, CINAHL, Sociological Abstracts, Sociofile, and Web of Science). We used search terms such as “Internet,” “electronic mail,” “computer communication networks,” and “health information,” “communication,” or “health informatics.” Two investigators reviewed the list to identify potentially relevant articles. We worked in pairs, reviewing the search results to identify relevant intervention studies. We did not set out to identify every published eHealth intervention paper, but aimed to search the majority of the available literature in a systematic way for a meaningful overview of the field.

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were applied to the studies identified from the three sources described above. We included only peer-reviewed full research papers. We defined intervention studies as the use of information and communication technology to deliver a specific health intervention to a client or patient group. The study had to include a health-related outcome as part of evaluating the intervention, and the intervention had to include use of the networking provided by the Internet. Networked features included the use of email to contact a therapist, the use of chat rooms or bulletin boards by client/patient groups, or the transfer of personal health data via the Web between a health care site and personal network access (eg, between a clinic and patient’s home). Studies with no networked features, such as computer-based decision support systems delivered from a CD or interventions where there was no use of the Internet beyond delivery (ie, they could have been delivered by a CD), were excluded. A further key characteristic of the Internet is its accessibility via a networked computer anywhere and anytime. Hence, we excluded studies in which access to the intervention was provided only in the clinical setting as use of the intervention is restricted in place and time. It is also possible that effectiveness may be influenced by the clinical setting.

Our review focused on the use of the Internet for delivery of the interventions and therefore did not include non-Internet based telemedicine studies. The focus was on specific interventions for specific health problems, so we excluded interventions involving the provision of general Internet access such as home computers, Internet kiosks, or training in use of the Internet even if the outcomes included health related measures. We only included interventions in which the individuals using them were known to the health care professional or organization delivering the intervention to be sure that the participants were using their real identity and responding in a genuine way to the intervention. This cannot be ensured for a study that recruits participants solely via the Web, with no direct contact between investigators and participants. We excluded studies that solely involved the placing of health information on the Web for public access, even when there was opportunity for interaction or feedback.

Analysis

When there were several papers concerning the same intervention (eg, a pilot study followed by a full evaluation), we grouped these papers together and treated them as one study. For each study, all the reasons given for delivering the health care intervention on the Internet were listed. These were the reasons the authors of the papers gave for choosing the Internet as the mode of delivery, rather than post hoc reasoning given in the discussion of the study results. We then categorized the reasons; one study could be categorized in a number of different groups. Again, we worked in pairs, comparing results and resolving any discrepancies through further examination of the papers and discussion among team members.

Results

Types of Interventions

We found full evaluations of 28 interventions and a further 9 interventions for which only pilot work had been published (Multimedia Appendix). All the papers were from Europe, North America, or Australia. The interventions were aimed at a wide range of conditions, including cancer (3 studies), HIV/AIDS (3 studies), diabetes (3 studies), mental health (1 study), eating disorders (2 studies), and back pain (1 study). Some targeted health promotion issues such as smoking cessation (1 study), physical activity (1 study), and obesity (3 studies). Other interventions aimed to support caregivers, for example caregivers of people with Alzheimer's disease (3 studies), stroke patient caregivers (1 study), new or young mothers (2 studies), and parents of children in intensive care (1 study). One intervention aimed at supporting rural women with chronic illness. One study reported the delivery of cognitive behaviour therapy (CBT) for a number of disorders, including headache, tinnitus, and panic disorders; two other studies reported CBT delivery for depression and one for post-traumatic stress disorder. Three interventions offered education and/or communication with specialist nurses for cardiac patients. Three interventions were specifically for young people or children: one for pain self management by children in hospital, one for those with cystic fibrosis, and one for the management of encopresis.

Reasons for Internet Delivery of Interventions

The reasons cited for using the Internet to deliver health interventions included the unique advantages of the Internet technology, reducing cost and increasing convenience for users, reducing health service costs, reaching isolated or stigmatized groups, timeliness of access to the Internet, need for user or supplier control of the intervention, and research-related reasons (Textbox).

Not all the studies in the early research papers mentioned the reasons for use of the Internet. Therefore, in the following analysis, the papers referenced are the papers for which the reason for Internet use was mentioned.

Textbox 1. Summary of findings

Reasons for Internet delivery:

- Reducing cost and increasing convenience for users
- Reduction of health service costs
- Reduction of isolation of users
- The need for timely information
- Reduction of stigma
- Increased user and supplier control of the intervention

Possible drawbacks of Internet interventions:

- Potential for reinforcing the problems the intervention was designed to help
- May overcome isolation of time, mobility, and geography, but may be no substitute for face-to-face contact

Elements of future evaluations:

- Incorporate the cost not just to the health service, but also to users and their social networks
- Be alert to unintended effects of Internet delivery of health interventions, and include a comparison with more traditional modes of delivery

Unique Advantages of the Internet Technology

There were 13 interventions studied [6,11,16,20,24,32,35, 37,41,45,52,57,60,67,71-73] for which the reason for Internet use was connected with the nature of the technology: reaching many people with just one posting, easy storage of large amounts of information, ease of updating information, providing personalized feedback, and the possibilities of broadband and video transmission. Two of these 13 studies [57,16] expressly valued the Internet for its ability to reach a maximum number of people at minimum cost. All these studies also give other reasons for Internet use.

Reducing Cost and Increasing Convenience for Users

Reducing cost and increasing convenience for the user was given as a reason for delivery over the Internet in 20 of the interventions studied [20-23,29,32,39,43-48,50,52,53,56-58, 60-63,65,66,75]. These studies targeted a range of health issues. Various aspects of increased convenience to the user were mentioned, including saving the user time, requiring less effort from the user, being more accessible, and not requiring the user to attend a particular facility. One US study [43], reporting an intervention for women with breast cancer, stated users' lack of money for a second opinion as one of the reasons for Internet delivery. Two studies advocated use of the Internet as it may reduce the loss of users from their maintenance programs for obesity [46,47].

Reducing Health Service Costs

By using Internet delivery, 14 of the interventions studied [11,12,14,15,24,28-30,39,41,42,46,48, 57,58,60,65,67,68,72-75] aimed to reduce costs to health services or address a lack of provision. Of these, two studies, one on linking parents with their low-birth-weight babies in intensive care [41], and the other on the management of encopresis [60], specified reduction in health service cost as a reason for Internet use. The cost of service provision was also given as a reason by a number of other studies, but with slightly different emphases. One study saw the Internet as a cost-effective way of delivering an intervention to encourage physical activity in a broad range of people in many places [58]. Five of the interventions studied gave a lack of health service resources as their reason, two citing a lack of practitioners in CBT [11,12,42] and the others a lack of support for caregivers of those with Alzheimer's disease

[24,39] and AIDS [28-30]. All the above studies discussed a general lack of these services. None of the studies gave a specific localized service failure as the reason for Internet delivery, but two mentioned service failure more generally. One study [60] gave the lack of physicians trained in the treatment of encopresis as the reason for Internet delivery, while another study [67] aimed to reduce barriers to nutrition education due to general practitioners' lack of skills and time. The authors of one other study [48] argued for Internet delivery because patients with diabetes have been found to have poor control despite specialist care, and their control may become even worse after the devolution of diabetes care to primary care services.

In six of the interventions studied, researchers wanted to avoid the cost to the health service of providing the intervention face-to-face, including psychological interventions for the treatment of depression [42], eating disorders[71-75],obesity [46-66], lack of physical activity [57,58], and a range of conditions (headache, tinnitus, panic attacks, and insomnia) [11-13].The authors of the latter intervention studied also argued that Internet delivery increases access to an otherwise costly therapy [14,15]. Another study [19] explicitly addressed inequalities of health care, suggesting that Internet delivery helped to overcome inequalities of access to health services.

Reaching Isolated Groups

Dimensions of isolation were given as reasons for using the Internet in 13 of the interventions studied [18,19,21,25-30, 33,34,37,43,49,52,53,75]; 5 stated geographical isolation as their reason. These studies included interventions for rural women with chronic disease [33] or diabetes [34], an intervention for women with breast cancer [43], a cognitive behavioral program for eating disorders [75], an intervention for people with post-traumatic stress disorder [53], and an intervention for children with cystic fibrosis [52]. The authors of the latter study also mentioned the advantage of providing peer support without the risk of cross infection that can be life threatening for children with cystic fibrosis.

In other studies, the cause of the isolation was not geographical. One [28-30] stated the isolation of people living with HIV/AIDS as a reason for Internet delivery. Several studies cited the isolation of caregivers who were unable to easily go out, such as those living with an Alzheimer's sufferer [21,25-27] and young mothers with children at home [37]. The physical immobility of individuals, including fatigue and disability, was mentioned in interventions focused on people with HIV/AIDS [28] or breast cancer [43] and on children with cystic fibrosis [52].

Several studies mentioned that Internet delivery enabled users to be in contact with people with similar health issues and so receive support. The implication was that this would be unlikely to happen otherwise as the condition was rare or restricting, for example, children in pain [49], children with cystic fibrosis [52], young mothers [37], people living with AIDS [28-30,43], and people with type 2 diabetes [18,19].

Reaching Stigmatized Groups

The researchers of 11 interventions saw the Internet as a way of reaching people suffering from conditions that caused them to feel embarrassed or stigmatized [18,19,22,24, 28,30,31,37,43,45,46,57,60,73-75]. The anonymity of Internet delivery was a reason for using the Internet in the following interventions: an intervention for mental health problems [31], in which the authors considered stigma to be a problem; an intervention for people living with type 2 diabetes [18,19], in which the authors suggested that anonymity prevented people from being judged on the basis of their appearance; two interventions to improve the self-care of people living with AIDS [28,30,45]; an intervention for young women at risk of eating disorders [73-75]; and a support intervention for young mothers [37]. Three studies suggested that Internet delivery avoids embarrassment about the health issue for which the intervention was used. One of these was for breast cancer [43], the second referred to embarrassment about failure to lose weight in an obesity intervention [46], and the third was aimed at child encopresis [60]. One study of a support system for caregivers of patients with Alzheimer's disease [22,24] and one study of an intervention to encourage physical activity [57] suggested that Internet delivery encourages openness of communication.

The Timeliness of Access to the Internet

Several interventions [12,21,22,25,28-30,37,43] mentioned the need for timely information and advice as a reason for Internet delivery, including interventions to support Alzheimer's caregivers [21,22,25], people with AIDS [28-30], young mothers [37], those with breast cancer [43], headache sufferers [12], and an intervention encouraging physical activity [57,58]. The suggestion was that people need information or advice at a time of crisis, for example, when their child is ill or when they are making a decision such as a change in treatment or their own behavior. The continuous access provided by the Internet was seen as helpful in these situations.

User Control of the Intervention

Many authors advocated use of the Internet because users could take control of the intervention [11,21,32,37,45,48,58,60, 63,67,72,74], tailoring the information they received to their own needs. This included interventions for Alzheimer's caregivers [21], those with HIV/AIDS [45], a glucose modeling tool for type 1 diabetes [48], and an intervention promoting physical activity [58]. Other studies advocated use of the Internet because users could use the intervention at their own pace. These included CBT for depression [32] or tinnitus [11], an educational program for cardiac patients [63], peer support interventions providing young mothers with support [37] or facilitating weight loss [67], an intervention for those at risk of eating disorders [72,74], and an intervention for encopresis [60].

Supplier Control of the Intervention

For some interventions that delivered CBT as a self-help program, the Internet was seen as a potentially appropriate mode of delivery for such a structured, evidence-based intervention [12-15,32,42,57, 58,66,71-74]. One author stated that Internet delivery was superior to professional psychologists in delivering structured and standardized interventions [42]. However, in delivering these structured programs, the studies supplemented the standardized intervention through individualized email feedback, tailored information, online peer support, or a combination of the three.

Research-Related Reasons

Almost all authors justified the evaluation of Internet-delivered interventions by saying that they need evaluating or adapting for specific populations. Six studies give this as their only reason [38,40,54,55,59,61]. Most studies give examples of successful Internet-delivered interventions to support their own research. However, one study gives, as its only reason for Internet-delivered intervention, that the intervention or a similar intervention had been useful in other studies [40]. One study [54] questions whether face-to-face and online support groups for those with breast cancer would work together, and gives this question as the only reason for delivering the intervention via the Internet.

A few studies did not give a research-related reason for evaluating an Internet-delivered intervention. These studies were descriptive accounts of an intervention [33,48,51] or were evaluating the use of an Internet-delivered intervention that was in response to a specific health service–related problem [60].

Other Reasons

The following reasons, alongside others mentioned above, were also given for delivery of an intervention via the Internet:

- poor information received by patients from health professionals [48]
- novelty [57,58]
- attractiveness of the Internet to young people and children [51]
- online communication as one of the main forms of communication used by young people [60]

Discussion

We have reviewed many pioneering studies evaluating Internet use for the delivery of health care interventions and found a variety of reasons for delivering interventions through the Internet. All the interventions have been, or could be, delivered by other means. For example, support groups for isolated individuals can use more established means of communication such as telephones and post, and therapeutic programs can be delivered face-to-face. The key differences between non-Internet delivered interventions and those delivered via the Internet relate to time and place. For example, Internet support groups enable quick communication between many isolated individuals, and Internet-delivered therapeutic interventions can be taken up at any time and anywhere with Internet access.

Our literature search strategy was designed to systematically identify the majority of eHealth intervention studies meeting our inclusion criteria. However, as a qualitative analysis that aimed to explore the motivations for delivering such interventions online, it was not necessary to undertake an exhaustive search for every single eHealth study ever published in any language. This contrasts with the methodology of quantitative meta-analysis, which requires the identification of all possible studies to produce one summary result. We believe that our qualitative thematic approach met our objective and was both rigorous and repeatable. Qualitative methods of research synthesis are a relatively new area and can be very valuable in identifying lessons for future work, particularly as they do not focus solely on the results on previous studies, but also consider other factors such as the researchers' motivations. Our criteria for inclusion and exclusion of studies were designed to maintain the focus of the review on the added value from use of the Internet. Hence, they took account of the key characteristics of the Internet, particularly its networking potential and accessibility. Thus, our criteria differed from definitions of *eHealth*, for example, by excluding telemedicine [76] and general public access [77].

At this early stage of development, researchers should give careful thought to the reasons for using the Internet for any particular intervention. We should try to understand the unique advantages and disadvantages of Internet delivery of health care and in what circumstances Internet use could contribute most effectively to improving health. For example, why might speedier communication and flexibility of location enhance the effectiveness of the intervention? Answers may include, for example, overcoming inequalities of access to health services or encouraging openness of communication. However, to clarify the added contribution of Internet delivery over more traditional forms of delivery, evaluations should include a direct comparison between Internet-delivered interventions and those delivered by the most effective of available conventional means. Such evaluations will enable us to understand the effect of the real differences between the interventions. Few studies in our review undertook such a direct comparison.

Failing to undertake such a direct comparison may result in the failure to identify and quantify situations where face-to-face delivery is better than Internet delivery. For example, among the many studies of structured behavioral programs using Internet delivery, only one intervention [46,47] compared the benefits of this delivery method with time-intensive face-to-face therapy, and another compared it with a classroom-based intervention [70,72]. A systematic review comparing the effectiveness of Web-based and non-Web–based interventions [9] included, apart from the above two interventions, no other trials in which Web-based interventions had been compared to intensive face-to-face interventions. Undertaking an evaluation of Internet-delivered intervention without comparison may inappropriately encourage a reduction of the availability of the effective face-to-face intervention. This would work against the original motivation of the research to increase access to an effective intervention.

The design, delivery, and evaluation of an Internet-delivered intervention also need to consider the following questions: What may be the unintended harmful consequences of Internet delivery? What may be the negative effects of speedier communication and flexibility of location? For example, it is possible that providing low-cost Internet-based support for groups that are not currently provided with adequate support, such as caregivers of those with Alzheimer's disease, may reinforce the low priority of these groups for health and social services and thus increase their isolation. Providing an intervention via the Internet for individuals living with a health problem they feel is stigmatized could have the unintended consequence of the issue being less talked about outside the anonymity of the Internet and thus reinforcing the stigma (see Textbox). Although identifying such unintended consequences was not an aim of this study, it was notable that we did not identify any reports of such consequences in the papers reviewed.

Evaluations of Internet-delivered interventions should aim to ensure that they include both the benefits and potential harms of the mode of delivery for all those affected by it. For example, an economic evaluation should include not only the cost of the Internet intervention, but also costs to health services, specific services, users, and their social networks. The studies reviewed rarely included an evaluation of such indirect costs.

Although the Internet can overcome isolation of time, mobility, and geography, it may be a poor substitute for face-to-face contact with real people. The balance between use of the Internet and face-to-face contact should be carefully considered in each circumstance. This applies to structured interventions such as CBT as well as to more flexible interventions such as peer-to-peer support. In designing an evaluation, researchers should be aware that Internet-based contact may be providing something different than face-to-face contact and should seek to assess these potentially different effects (see Textbox).

A number of studies gave no reason for use of the Internet as the mode of delivery beyond stating that it exists and needs evaluating. Now that the field of Internet- delivered interventions is established, future researchers should carefully consider how the networking provided by Internet delivery may enhance the effect of an intervention. This should involve exploratory work and more explicit use of existing theory and modeling [78].

The pioneering researchers who undertook the studies reviewed in this paper were often looking to the Internet for a way to help resolve some of the current difficulties and dilemmas of health care. These included the provision of equal access to health care, limitations on resources for health care, changing roles of health professionals, and changing needs for particular skills. Exploring the possible benefits of using the Internet to address these issues is important, but it is also important to make a meaningful comparison between using the Internet and using other more traditional ways of addressing the issues. Future research will hopefully shed more light on the benefits and disadvantages of Internet use particular to this mode of delivery.

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Conflicts of Interest

None declared.

Appendix 1

Table 1. Summary table of reviewed studies

Author	Year	Ref	Country	Health Condition	Description of Intervention	Networked Features	Reasons Given by Authors for Using Internet
Andersson Andersson Andersson Carlbring Carlbring Strom Strom	2004 2003 2002 2001 2003 2000 2004	[11] [12] [13] [14] [15] [16] [17]	Sweden	Tinnitus Headache Tinnitus Panic disorder Panic disorder Headache Insomnia	**CBT for headache, tinnitus, panic disorder, insomnia:** 6-module online self-help program based on cognitive behavioral therapy with email support from a trained therapist	Participants complete online progress reports; therapist responds by email	Advantage of technology Cost for health services User control of intervention Cost for health services Supplier control of intervention Timely information/advice Supplier control of intervention Cost for health services Supplier control of intervention Cost for health services Supplier control of intervention Advantage of technology Research related only
Barrera Glasgow McKay	2002 2003 2002	[18] [19] [20]	United States	Type 2 diabetes	**D-net:** Internet-based self management program for type 2 diabetes with online feedback, professionally moderated but peer-directed message board, and access to professional coach	Message boards, chat facility (peer-to-peer and peer-to-professional)	Reaching isolated groups Reaching stigmatized groups Cost for health services Reaching isolated groups Reaching stigmatized groups Advantage of technology Cost for users
Bass Brennan Brennan Brennan Brennan Casper McClendon	1998 1991 1992 1994 1995 1995 1998	[21] [22] [23] [24] [25] [26] [27]	United States	Alzheimer's disease	**ComputerLink for Alzheimer's caregivers:** information, communication, and resource center with nurse-led online support group (message board) with email facility, decision support system, encyclopedia, and links to quality websites	Message boards, email facility (peer-to-peer and peer-to-professional)	Cost for users Reaching isolated groups Timely information/advice User control of intervention Cost for users Reaching stigmatized groups Timely information/advice Cost for users Advantage of technology Cost for health services Reaching stigmatized groups Reaching isolated groups Timely information/advice Reaching isolated groups Reaching isolated groups

Author	Year	Ref	Country	Health Condition	Description of Intervention	Networked Features	Reasons Given by Authors for Using Internet
Brennan	1991	[28]	United States	HIV/AIDS	**ComputerLink for people living with AIDS:** information, communication, and resource center with nurse-led online support group (message board) with email facility, decision support system, encyclopedia, and links to quality websites	Message boards, email facility (peer-to-peer and peer-to-professional)	Cost for health services Reaching isolated groups Reaching stigmatized groups Timely information/advice
Brennan	1994	[29]					Cost for users Cost for health services Reaching isolated groups Timely information/advice
Flatley-Brennan	1998	[30]					Cost for health services Reaching isolated groups Reaching stigmatized groups Timely information/advice
Chang	2001	[31]	United States	Mental health	**Mental health support for Asian-American men:** online support group moderated by Asian-American counselor	Message boards	Reaching stigmatized groups
Christensen	2002	[32]	Australia	Depression	**MoodGym:** online self-help program based on cognitive behavioral therapy	Participants complete online feedback sheets	Advantage of technology Cost for users User control of intervention Supplier control of intervention
Christensen	2004	[6]					Advantage of technology
Cudney	2000	[33]	United States	Chronic illness	**Women to Women:** nurse-led online support group for rural women with chronic illness; 1 subgroup with diabetes only	Message boards, email and chat facility to other peers and nurse	Reaching isolated groups
Smith	2001	[34]					Reaching isolated groups
Delgado	2003	[35]	Canada	Heart disease	Heart failure Internet communication tool	Email between patients and health professionals	Advantage of technology
Wu	2005	[36]					Research related only
Dunham	1998	[37]	Canada	Young mothers	**Support for young mothers:** peer-led online support group	Message boards, email facility, and teleconferencing	Advantage of technology Reaching isolated groups Reaching stigmatized groups Timely information/ advice User control of intervention
Feil	2003	[38]	United States	Smoking cessation	**Smoking cessation:** Web-based structured intervention and support program hosted by a paraprofessional ex-smoker	Message boards, email and ask-an-expert facility	Research related only
Glueckauf	2003	[39]	United States	Alzheimer's disease	**Support for Alzheimer's caregivers:** Web- and phone-based caregiver education and support program	Video-linked classes, peer-to-peer chat, and message boards	Cost for users Cost for health services Reaching isolated groups
Gomez	2002	[40]	United Kingdom/ Spain	HIV/AIDS	**Self-monitoring tool for people with AIDS:** Web-based recording and feedback system to enable self-care at home	Email ask-an-expert function based on patient-entered data	Research related only
Gray	2000	[41]	United States	Low-body-weight infants	**BabyCareLink:** education and communication tool for parents of children in intensive care	Reports/images of child, parent- ICU staff communication	Advantage of technology Cost for health services
Greist	2000	[42]	United States/ United Kingdom	Depression	**COPE:** Web-based (computer-enabled interactive voice response system) cognitive behavioral therapy for depression	Sends records and emergency signals to clinician	Cost for health services Supplier control of intervention

Author	Year	Ref	Country	Health Condition	Description of Intervention	Networked Features	Reasons Given by Authors for Using Internet
Gustafson Gustafson	1993 2001	[43] [44]	United States	Breast cancer	**CHESS:** integrated information, referral, decision, and social support program for women with breast cancer	Facilitated online support group, ask-the-expert function	Cost for users Reaching isolated groups Reaching stigmatized groups Timely information/advice Cost for users
Gustafson	1999	[45]	United States	HIV/AIDS	**CHESS:** integrated information, referral, decision, and social support program for people with AIDS	Facilitated online support group, ask-the-expert function	Advantage of technology Cost for users Reaching isolated groups Reaching stigmatized groups User control of intervention
Harvey-Berino Harvey-Berino	2002 2002	[46] [47]	United States	Weight loss	**Weight loss program:** Web-based weight maintenance program following classroom-based weight loss intervention	Meetings with video-linked educator, chat room, message board, email facility	Cost for users Cost for health services Reaching stigmatized groups Cost for users
Hejlesen	2000	[48]	Denmark	Type 1 diabetes	**DIASNet:** Web version of online modeling device used for self-management, communication, and education	Can be jointly used by patients and health professionals	Cost for users Cost for health services User control of intervention Poor info from professionals
Holden	2002	[49]	United States	Pain in children	**StarbrightWorld:** commercially developed interactive computer network for hospitalized children	Peer-to-peer emails, video links, chat rooms, bulletin boards	Reaching isolated groups
Hudson	1999	[50]	United States	Young mothers	**Social support for young mothers:** nurse-led email network providing health information and support	Email network (peer-to-peer and peer-to-nurse)	Cost for users Reaching isolated groups
Iafusco	2000	[51]	Italy	Type 1 diabetes	**Support group for teenagers with type 1 diabetes:** chat room with weekly meetings moderated by diabetologist	Chat room	Attractive to young people
Johnson	2001	[52]	United States	Cystic fibrosis	**Teen Central:** online support group for teenagers with cystic fibrosis	Moderated message boards, free “graffiti wall,” email facility	Advantage of technology Cost for users Reaching isolated groups
Lange	2003	[53]	Netherlands	Post-traumatic stress disorder	**Interapy:** Internet-based cognitive behavioral writing program for people suffering from post-traumatic stress	Communication with therapists who read submitted writings and tailor standardized feedback	Advantage of technology Cost for users Reaching isolated groups
Lieberman	2003	[54]	United States	Breast cancer	**Support group for women with breast cancer:** electronic support group led by experienced cancer support facilitator	Weekly sessions, newsgroup, 24-hour chat room facility	Research related only
Lorig	2002	[55]	United States	Back pain	**Support group for back pain:** email discussion group with 2 professional moderators and 3 content experts	Email listserv	Research related only
Mahoney	1998	[56]	United States	Alzheimer’s disease	**Reach for TLC:** computer-mediated voice mail system to provide support and education for caregivers	Voice mail bulletin board, ask-the-expert facility	Cost for users

Author	Year	Ref	Country	Health Condition	Description of Intervention	Networked Features	Reasons Given by Authors for Using Internet
Marshall Napolitano	2003 2003	[57] [58]	United States/ Australia	Physical activity	**Physical activity program:** online, workplace-based interactive behavioral change program	Email based on motivational stage and personalized goals	Advantage of technology Cost for health services Reaching stigmatized groups Timely information/advice Supplier control of intervention Novelty Cost for users Cost for health services Timely information/advice User control of information Supplier control of information Novelty
Pierce	2002	[59]	United States	Stroke	**Caring-Web:** nurse-led Web-based support group for caregivers of stroke victims	Email contact to nurse, email listserv (peers and nurse)	Research related only
Ritterband	2003	[60]	United States	Encopresis	**U-Can-Poop-Too:** Web-based enhanced toilet training for children with encopresis and their parents	Personalized homepage, follow-up sessions based on modules completed	Cost for users Cost for health services Reaching stigmatized groups User control of intervention Attractive to children
Robinson	2001	[61]	United Kingdom	Bulimia	**E-mail therapy for bulimia:** email treatment conducted by 2 clinicians experienced in eating disorders	Participants emailed diaries to which therapists responded	Research related only
Ross	2004	[62]	Canada	Heart disease	**Web-based Online Medical Record:** access to records and communication tool for patients with congestive heart failure	Messaging system between patients and cardiac nurses	Cost for users
Southard	2003	[63]		Heart disease	**Web-based educational program:** nurse-led educational program for secondary prevention of heart disease	Messaging between patients and nurses/dietitians	Cost for users User control of intervention
Takahashi	1999	[64]	Japan	Smoking cessation	**Quit Smoking Marathon:** smoking cessation program delivered through daily guidance emails	Message forum for participants, doctors and ex-smokers	None – description only
Tate Tate	2001 2003	[65] [66]	United States	Weight loss	**Weight loss program:** Web-based behavioral weight loss program with email follow-up for those at risk of diabetes	Message board; participants submit diaries and weight; counselors respond by email	Cost for users Advantage of technology Cost for users Cost for health services Supplier control of intervention
Verheijden	2004	[67]	Netherlands	Weight loss	**Weight loss program:** peer support intervention to reduce fat consumption in those at risk of heart disease	Bulletin board for peer-to-peer communication and social support	Advantages of technology Cost for health service User control of intervention
Winzelberg	2003	[68]	United States	Breast cancer	**Support group for women with breast cancer:** Web-based social support group moderated by mental health professional	Message board with weekly discussion topic	Cost for users Supplier control of intervention

Author	Year	Ref	Country	Health Condition	Description of Intervention	Networked Features	Reasons Given by Authors for Using Internet
Dev	1999	[69]	United States	Eating disorders	**Student Bodies:** CD-ROM behavioral program plus Web-based counselor-led support group for students at risk of eating disorders	Moderated weekly discussion group (message board or email)	Research related only
Celio	2000	[70]					Research related only
Winzelberg	1998	[71]					Advantage of technology Cost for health services
Winzelberg	2000	[72]					Supplier control of intervention
Zabinski	2001	[73]					Advantage of technology Cost for health services
Zabinski	2001	[74]					User control of intervention Supplier control of intervention
Zabinski	2003	[75]					Advantage of technology Cost for health services Reaching stigmatized groups Supplier control of intervention
							Cost for health services Reaching stigmatized groups User control of intervention Supplier control of intervention
							Advantage of technology Cost for users Cost for health services Reaching stigmatized groups Reaching isolated groups

References

1. Kwankam SY. What e-Health can offer. Bull World Health Organ 2004 Oct;82(10):800-802. [Medline: 101890575]
2. Berry LL, Seiders K, Wilder SS. Innovations in access to care: a patient-centered approach. Ann Intern Med 2003 Oct 7;139(7):568-574 [FREE Full text] [Medline: 22891660]
3. Fox S, Rainie L. The online care revolution: how the Web helps Americans take better care of themselves. 2000 Nov 26. 2000 Nov 26. URL: http://www.pewinternet.org/PPF/r/26/report_display.asp [accessed 2006 Jun 10] [WebCite Cache ID 5GPva9MPD]
4. Eysenbach G. The impact of the Internet on cancer outcomes. CA Cancer J Clin 2003;53(6):356-371 [FREE Full text] [Medline: 23397027]
5. Slack WV. A 67-year-old man who e-mails his physician. JAMA 2004 Nov 10;292(18):2255-2261. [Medline: 15536113] [doi: 10.1001/jama.292.18.2255]
6. Christensen H, Griffiths KM, Jorm AF. Delivering interventions for depression by using the internet: randomised controlled trial. BMJ 2004 Jan 31;328(7434):265 [FREE Full text] [Medline: 14742346] [PMC: 14742346] [doi: 10.1136/bmj.37945.566632.EE]
7. Eysenbach G, Powell J, Englesakis M, Rizo C, Stern A. Health related virtual communities and electronic support groups: systematic review of the effects of online peer to peer interactions. BMJ 2004 May 15;328(7449):1166 [FREE Full text] [Medline: 15142921] [PMC: 15142921] [doi: 10.1136/bmj.328.7449.1166]
8. Murray E, Lo B, Pollack L, Donelan K, Catania J, Lee K, et al. The impact of health information on the Internet on health care and the physician-patient relationship: national U.S. survey among 1.050 U.S. physicians. J Med Internet Res 2003 Aug 29;5(3):e17 [FREE Full text] [Medline: 22879616] [doi: 10.2196/jmir.5.3.e17]
9. Wantland DJ, Portillo CJ, Holzemer WL, Slaughter R, Mcghee EM. The effectiveness of Web-based vs. non-Web-based interventions: a meta-analysis of behavioral change outcomes. J Med Internet Res 2004 Nov 10;6(4):e40 [FREE Full text] [Medline: 15631964] [doi: 10.2196/jmir.6.4.e40]
10. Powell JA, Lowe P, Griffiths FE, Thorogood M. A critical analysis of the literature on the Internet and consumer health information. J Telemed Telecare 2005;11 Suppl 1(1):41-43. [Medline: 16035990] [doi: 10.1258/1357633054461642]

11. Andersson G, Kaldo V. Internet-based cognitive behavioral therapy for tinnitus. J Clin Psychol 2004 Feb;60(2):171-178. [Medline: 14724924] [doi: 10.1002/jclp.10243]
12. Andersson G, Lundström P, Ström L. Internet-based treatment of headache: does telephone contact add anything? Headache 2003 Apr;43(4):353-361. [Medline: 22544233] [doi: 10.1046/j.1526-4610.2003.03070.x]

. Andersson G, Strömgren T, Ström L, Lyttkens L. Randomized controlled trial of internet-based cognitive behavior therapy for distress associated with tinnitus. Psychosom Med 2002;64(5):810-816. [Medline: 22232066] [doi: 10.1097/01.PSY.0000031577.42041.F8]

14. Carlbring P, Nilsson-ihrfelt E, Waara J, Kollenstam C, Buhrman M, Kaldo V, et al. Treatment of panic disorder: live therapy vs. self-help via the Internet. Behav Res Ther 2005 Oct;43(10):1321-1333. [Medline: 16086983] [doi: 10.1016/j.brat.2004.10.002]
15. Carlbring P, Ekselius L, Andersson G. Treatment of panic disorder via the Internet: a randomized trial of CBT vs. applied relaxation. J Behav Ther Exp Psychiatry 2003 Jun;34(2):129-140. [Medline: 22782210] [doi: 10.1016/S0005-7916(03)00026-0]
16. Ström L, Pettersson R, Andersson G. A controlled trial of self-help treatment of recurrent headache conducted via the Internet. J Consult Clin Psychol 2000 Aug;68(4):722-727. [Medline: 20421152] [doi: 10.1037/0022-006X.68.4.722]
17. Ström L, Pettersson R, Andersson G. Internet-based treatment for insomnia: a controlled evaluation. J Consult Clin Psychol 2004 Feb;72(1):113-120. [Medline: 14756620] [doi: 10.1037/0022-006X.72.1.113]
18. Barrera M, Glasgow RE, Mckay HG, Boles SM, Feil EG. Do Internet-based support interventions change perceptions of social support?: An experimental trial of approaches for supporting diabetes self-management. Am J Community Psychol 2002 Oct;30(5):637-654. [Medline: 22175316]
19. Glasgow RE, Boles SM, Mckay HG, Feil EG, Barrera M. The D-Net diabetes self-management program: long-term implementation, outcomes, and generalization results. Prev Med 2003 Apr;36(4):410-419. [Medline: 22536406] [doi: 10.1016/S0091-7435(02)00056-7]
20. Mckay HG, Glasgow RE, Feil EG, Boles SM, Barrera JM. Internet-based diabetes self-management and support: initial outcomes from the Diabetes Network project. Rehabil Psychol 2002;47(1):31-48. [doi: 10.1037/0090-5550.47.1.31]
21. Bass DM, McClendon MJ, Brennan PF, Mccarthy C. The buffering effect of a computer support network on caregiver strain. J Aging Health 1998 Feb;10(1):20-43. [Medline: 98618378]
22. Brennan PF, Moore SM, Smyth KA. ComputerLink: electronic support for the home caregiver. ANS Adv Nurs Sci 1991 Jun;13(4):14-27. [Medline: 91282421]
23. Brennan PF, Moore SM, Smyth KA. Alzheimer's disease caregivers' uses of a computer network. West J Nurs Res 1992 Oct;14(5):662-673. [Medline: 92410709]
24. Brennan PF, Moore SM. Networks for home care support: the ComputerLink project. Caring 1994 Aug;13(8):64-70. [Medline: 94363855]
25. Brennan PF, Moore SM, Smyth KA. The effects of a special computer network on caregivers of persons with Alzheimer's disease. Nurs Res 1995;44(3):166-172. [Medline: 95281428]
26. Casper GR, Calvitti A, Brennan PF, Overholt JL. ComputerLink: the impact of a computer network on Alzheimer's caregivers' decision-making confidence and skill. Medinfo 1995;8:1546. [Medline: 8591497]
27. McClendon MJ, Bass DM, Brennan PF, McCarthy C. A computer network for Alzheimer's caregivers and use of support group services. J Ment Health Aging 1998;4(4):403-419.
28. Brennan PF, Ripich S, Moore SM. The use of home-based computers to support persons living with AIDS/ARC. J Community Health Nurs 1991;8(1):3-14. [Medline: 91140213] [doi: 10.1207/s15327655jchn0801_1]
29. Brennan PF, Ripich S. Use of a home-care computer network by persons with AIDS. Int J Technol Assess Health Care 1994;10(2):258-272. [Medline: 94307832]
30. Flatley-Brennan P. Computer network home care demonstration: a randomized trial in persons living with AIDS. Comput Biol Med 1998 Sep;28(5):489-508. [Medline: 99078500] [doi: 10.1016/S0010-4825(98)00029-8]
31. Chang T, Yeh CJ, Krumboltz JD. Process and outcome evaluation of an online support group for Asian American male college students. J Couns Psychol 2001;48(3):319-329. [doi: 10.1037/0022-0167.48.3.319]
32. Christensen H, Griffiths KM, Korten A. Web-based cognitive behavior therapy: analysis of site usage and changes in depression and anxiety scores. J Med Internet Res 2002 Feb 15;4(1):e3 [FREE Full text] [Medline: 21953331] [doi: 10.2196/jmir.4.1.e3]
33. Cudney SA, Weinert C. Computer-based support groups. Nursing in cyberspace. Comput Nurs 2000;18(1):35-43. [Medline: 20138770]
34. Smith L, Weinert C. Telecommunication support for rural women with diabetes. Diabetes Educ 2000;26(4):645-655. [Medline: 21021592]
35. Delgado DH, Costigan J, Wu R, Ross HJ. An interactive Internet site for the management of patients with congestive heart failure. Can J Cardiol 2003 Nov;19(12):1381-1385. [Medline: 14631472]
36. Wu RC, Delgado D, Costigan J, Maciver J, Ross H. Pilot study of an Internet patient-physician communication tool for heart failure disease management. J Med Internet Res 2005 Mar 26;7(1):e8 [FREE Full text] [Medline: 15829480] [doi: 10.2196/jmir.7.1.e8]

37. Dunham PJ, Hurshman A, Litwin E, Gusella J, Ellsworth C, Dodd PW. Computer-mediated social support: single young mothers as a model system. Am J Community Psychol 1998 Apr;26(2):281-306. [Medline: 98358564] [doi: 10.1023/A:1022132720104]
38. Feil EG, Noell J, Lichtenstein E, Boles SM, Mckay HG. Evaluation of an Internet-based smoking cessation program: lessons learned from a pilot study. Nicotine Tob Res 2003 Apr;5(2):189-194. [Medline: 22631392]
39. Glueckauf RL, Loomis JS. Alzheimer's Caregiver Support Online: lessons learned, initial findings and future directions. NeuroRehabilitation 2003;18(2):135-146. [Medline: 22750219]
40. Gómez EJ, Cáceres C, López D, Del Pozo F. A web-based self-monitoring system for people living with HIV/AIDS. Comput Methods Programs Biomed 2002 Jul;69(1):75-86. [Medline: 22083749] [doi: 10.1016/S0169-2607(01)00182-1]
41. Gray JE, Safran C, Davis RB, Pompilio-weitzner G, Stewart JE, Zaccagnini L, et al. Baby CareLink: using the internet and telemedicine to improve care for high-risk infants. Pediatrics 2000 Dec;106(6):1318-1324 [FREE Full text] [Medline: 20553905] [doi: 10.1542/peds.106.6.1318]
42. Greist JH, Osgood-Hynes DJ, Baer L, Marks IM. Technology-based advances in the management of depression: focus on the COPE^{TM} program. Disease Management & Health Outcomes 2000;7(4):193-200. [doi: 10.2165/00115677-200007040-00003]
43. Gustafson D, Wise M, Mctavish F, et al. Development and pivotal evaluation of a computer-based support system for women with breast cancer. J Psychosoc Oncol 1993;11(4):69-93. [doi: 10.1300/J077V11N04_05]
44. Gustafson DH, Hawkins R, Pingree S, Mctavish F, Arora NK, Mendenhall J, et al. Effect of computer support on younger women with breast cancer. J Gen Intern Med 2001 Jul;16(7):435-445. [Medline: 21412029] [doi: 10.1046/j.1525-1497.2001.016007435.x]
45. Gustafson DH, Hawkins R, Boberg E, Pingree S, Serlin RE, Graziano F, et al. Impact of a patient-centered, computer-based health information/support system. Am J Prev Med 1999 Jan;16(1):1-9. [Medline: 99111919] [doi: 10.1016/S0749-3797(98)00108-1]
46. Harvey-Berino J, Pintauro S, Buzzell P, Digiulio M, Casey Gold B, Moldovan C, et al. Does using the Internet facilitate the maintenance of weight loss? Int J Obes Relat Metab Disord 2002 Sep;26(9):1254-1260. [doi: 10.1038/sj.ijo.0802051] [Medline: 22174567]
47. Harvey-berino J, Pintauro SJ, Gold EC. The feasibility of using Internet support for the maintenance of weight loss. Behav Modif 2002 Jan;26(1):103-116. [Medline: 21658873] [doi: 10.1177/0145445502026001006]
48. Hejlesen OK, Plougmann S, Cavan DA. DiasNet--an Internet tool for communication and education in diabetes. Stud Health Technol Inform 2000;77:563-567. [Medline: 21035881]
49. Holden G, Bearison DJ, Rode DC, Kapiloff MF, Rosenberg G, Rosenzweig J. The impact of a computer network on pediatric pain and anxiety: a randomized controlled clinical trial. Soc Work Health Care 2002;36(2):21-33. [Medline: 22443081] [doi: 10.1300/J010v36n02_02]
50. Hudson DB, Elek SM, Westfall JR, Grabau A, Fleck MO. Young Parents Project: a 21st-century nursing intervention. Issues Compr Pediatr Nurs 1999;22(4):153-165. [Medline: 20286940] [doi: 10.1080/014608699265257]
51. Iafusco D, Ingenito N, Prisco F. The chatline as a communication and educational tool in adolescents with insulin-dependent diabetes: preliminary observations. Diabetes Care 2000 Dec;23(12):1853 [FREE Full text] [Medline: 21012155]
52. Johnson KB, Ravert RD, A Everton H. Teen central: assessment of an Internet-based support system for children with cystic fibrosis. Pediatrics 2001;107(2) art.no.e24. [Medline: 11158498]
53. Lange A, Rietdijk D, Hudcovicova M, Van De Ven JP, Schrieken B, Emmelkamp PMG. Interapy: a controlled randomized trial of the standardized treatment of posttraumatic stress through the internet. J Consult Clin Psychol 2003 Oct;71(5):901-909. [doi: 10.1037/0022-006X.71.5.901] [Medline: 22879528]
54. Lieberman MA, Golant M, Giese-davis J, Winzlenberg A, Benjamin H, Humphreys K, et al. Electronic support groups for breast carcinoma: a clinical trial of effectiveness. Cancer 2003 Feb 15;97(4):920-925. [doi: 10.1002/cncr.11145] [Medline: 22456322]
55. Lorig KR, Laurent DD, Deyo RA, Marnell ME, Minor MA, Ritter PL. Can a Back Pain E-mail Discussion Group improve health status and lower health care costs?: A randomized study. Arch Intern Med 2002 Apr 8;162(7):792-796. [Medline: 21924399] [doi: 10.1001/archinte.162.7.792]
56. Mahoney DF, Tarlow B, Sandaire J. A computer-mediated intervention for Alzheimer's caregivers. Comput Nurs 1998;16(4):208-216. [Medline: 98340639]
57. Marshall AL, et al. Print versus website physical activity programs: a randomized trial. Am J Prev Med 2003 Aug;25(2):88-94. [Medline: 12880874]
58. Napolitano MA, Fotheringham M, Tate D, Sciamanna C, Leslie E, Owen N, et al. Evaluation of an internet-based physical activity intervention: a preliminary investigation. Ann Behav Med 2003;25(2):92-99. [Medline: 22590053] [doi: 10.1207/S15324796ABM2502_04]
59. Pierce LL, Steiner V, Govoni AL. In-home online support for caregivers of survivors of stroke: a feasibility study. Comput Inform Nurs 2002;20(4):157-164. [Medline: 22097714] [doi: 10.1097/00024665-200207000-00012]

60. Ritterband LM, Cox DJ, Walker LS, Kovatchev B, Mcknight L, Patel K, et al. An Internet intervention as adjunctive therapy for pediatric encopresis. J Consult Clin Psychol 2003 Oct;71(5):910-917. [doi: 10.1037/0022-006X.71.5.910] [Medline: 22879529]
61. Robinson PH, Serfaty MA. The use of e-mail in the identification of bulimia nervosa and its treatment. European Eating Disorders Review 2001;9(3):182-193. [doi: 10.1002/erv.411]
62. Ross SE, Moore LA, Earnest MA, Wittevrongel L, Lin CT. Providing a web-based online medical record with electronic communication capabilities to patients with congestive heart failure: randomized trial. J Med Internet Res 2004 May 14;6(2):e12 [FREE Full text] [Medline: 15249261] [doi: 10.2196/jmir.6.2.e12]
63. Southard BH, Southard DR, Nuckolls J. Clinical trial of an Internet-based case management system for secondary prevention of heart disease. J Cardiopulm Rehabil 2003;23(5):341-348. [Medline: 22874529] [doi: 10.1097/00008483-200309000-00003]
64. Takahashi Y, Satomura K, Miyagishima K, Nakahara T, Higashiyama A, Iwai K, et al. A new smoking cessation programme using the Internet. Tob Control 1999;8(1):109-110 [FREE Full text] [Medline: 99395325]
65. Tate DF, Wing RR, Winett RA. Using Internet technology to deliver a behavioral weight loss program. JAMA 2001 Mar 7;285(9):1172-1177 [FREE Full text] [Medline: 21154341] [doi: 10.1001/jama.285.9.1172]
66. Tate DF, Jackvony EH, Wing RR. Effects of Internet behavioral counseling on weight loss in adults at risk for type 2 diabetes: a randomized trial. JAMA 2003 Apr 9;289(14):1833-1836 [FREE Full text] [doi: 10.1001/jama.289.14.1833] [Medline: 22571311]
67. Verheijden M, Bakx JC, Akkermans R, Van Den Hoogen H, Godwin NM, Rosser W, et al. Web-based targeted nutrition counselling and social support for patients at increased cardiovascular risk in general practice: randomized controlled trial. J Med Internet Res 2004 Dec 16;6(4):e44 [FREE Full text] [Medline: 15631968] [doi: 10.2196/jmir.6.4.e44]
68. Winzelberg AJ, Classen C, Alpers GW, Roberts H, Koopman C, Adams RE, et al. Evaluation of an internet support group for women with primary breast cancer. Cancer 2003 Mar 1;97(5):1164-1173. [doi: 10.1002/cncr.11174] [Medline: 22486299]
69. Dev P, Winzelberg AJ, Celio A, Taylor CB. Student bodies: psycho-education communities on the Web. Proc AMIA Symp 1999:510-514. [Medline: 10566411]
70. Celio AA, Winzelberg AJ, Wilfley DE, Eppstein-Herald D, Springer EA, Dev P, et al. Reducing risk factors for eating disorders: comparison of an Internet- and a classroom-delivered psychoeducational program. J Consult Clin Psychol 2000 Aug;68(4):650-657. [Medline: 20421145] [doi: 10.1037/0022-006X.68.4.650]
71. Winzelberg AJ, Taylor CB, Sharpe T, Eldredge KL, Dev P, Constantinou PS. Evaluation of a computer-mediated eating disorder intervention program. Int J Eat Disord 1998 Dec;24(4):339-349. [Medline: 99031302] [doi: 10.1002/(SICI)1098-108X(199812)24:4<339::AID-EAT1>3.0.CO;2-J]
72. Winzelberg AJ, Eppstein D, Eldredge KL, Wilfley D, Dasmahapatra R, Dev P, et al. Effectiveness of an Internet-based program for reducing risk factors for eating disorders. J Consult Clin Psychol 2000 Apr;68(2):346-350. [Medline: 20242408] [doi: 10.1037/0022-006X.68.2.346]
73. Zabinski MF, Pung MA, Wilfley DE, Eppstein DL, Winzelberg AJ, Celio A, et al. Reducing risk factors for eating disorders: targeting at-risk women with a computerized psychoeducational program. Int J Eat Disord 2001 May;29(4):401-408. [Medline: 21181716] [doi: 10.1002/eat.1036]
74. Zabinski MF, Wilfley DE, Pung MA, Winzelberg AJ, Eldredge K, Taylor CB. An interactive internet-based intervention for women at risk of eating disorders: a pilot study. Int J Eat Disord 2001 Sep;30(2):129-137. [Medline: 21341938] [doi: 10.1002/eat.1065]
75. Low KG, Charanasomboon S, Lesser J, Reinhalter K, Martin R, Jones H, et al. Effectiveness of a computer-based interactive eating disorders prevention program at long-term follow-up. Eat Disord 2003;14(1):17-30. [Medline: 16757446] [doi: 10.1080/10640260500403816]
76. Pagliari C, Sloan D, Gregor P, Sullivan F, Detmer D, Kahan JP, et al. What is eHealth (4): a scoping exercise to map the field. J Med Internet Res 2005 Mar 31;7(1):e9 [FREE Full text] [Medline: 15829481] [doi: 10.2196/jmir.7.1.e9]
77. Wyatt JC, Sullivan F. eHealth and the future: promise or peril? BMJ 2005 Dec 10;331(7529):1391-1393. [Medline: 16339252] [doi: 10.1136/bmj.331.7529.1391]
78. Campbell M, Fitzpatrick R, Haines A, Kinmonth AL, Sandercock P, Spiegelhalter D, et al. Framework for design and evaluation of complex interventions to improve health. BMJ 2000 Sep 16;321(7262):694-696 [FREE Full text] [PMC: 10987780] [Medline: 20444068]

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Viewpoint

eHealth Literacy: Essential Skills for Consumer Health in a Networked World

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Abstract

Electronic health tools provide little value if the intended users lack the skills to effectively engage them. With nearly half the adult population in the United States and Canada having literacy levels below what is needed to fully engage in an information-rich society, the implications for using information technology to promote health and aid in health care, or for eHealth, are considerable. Engaging with eHealth requires a skill set, or *literacy*, of its own. The concept of eHealth literacy is introduced 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. In this paper, a model of eHealth literacy is introduced, comprised of multiple literacy types, including an outline of a set of fundamental skills consumers require to derive direct benefits from eHealth. A profile of each literacy type with examples of the problems patient-clients might present is provided along with a resource list to aid health practitioners in supporting literacy improvement with their patient-clients across each domain. Facets of the model are illustrated through a set of clinical cases to demonstrate how health practitioners can address eHealth literacy issues in clinical or public health practice. Potential future applications of the model are discussed.

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KEYWORDS

Internet; literacy; public health; health care; electronic health information; evaluation of electronic resources; electronics; telecommunications; consumer health information; patient education; educational status; computer network

Introduction

Access Barriers to eHealth

What if we created tools to promote health and deliver health care that were inaccessible to over half of the population they were intended for? Consumer-directed eHealth resources, from online interventions to informational websites, require the ability to read text, use information technology, and appraise the content of these tools to make health decisions. Yet, even in countries with high rates of absolute access to the Internet, such as the United States and Canada, over 40% of adults have basic (or prose) literacy levels below that which is needed to optimally participate in civil society [1,2]. A multi-country study of information technology use and literacy found that as literacy skill levels rise, the perceived usefulness of computers, diversity and intensity of Internet use, and use of computers for task-oriented purposes rise with it, even when factors such as age, income, and education levels are taken into account [3]. If eHealth is to realize its potential for improving the health of the public, the gap between what is provided and what people can access must be acknowledged and remedied.

Greater emphasis on the active and informed consumer in health and health care [4] in recent years has led to the realization that ensuring the public has both access to and adequate comprehension of health information is both a problem [5] and an achievable goal for health services [2,3]. A recent report from the US Institute of Medicine (IOM) entitled *Health Literacy: A Prescription to End Confusion* looked at the relationship between health and literacy and found that those with limited literacy skills have less knowledge of disease management and health promoting behaviors, report poorer health status, and are less likely to use preventive services than those with average or above average literacy skills [6].

Health Literacy

The IOM report focuses largely on health literacy, using the following definition (originally proposed by Ratzan and Parker [7]): "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" [7].

This definition underscores the importance of contextual factors that mediate health information and the need to consider health literacy in relation to the medium by which health resources are presented. Within a modern health information environment, this context includes the following: interactive behavior change tools, informational websites, and telephone-assisted services, which are all being deployed globally to promote health and deliver health care (eg, [8-[11]). However, even among North American adolescents, the highest Internet-use population in the world, many teens report that they lack the skills to adequately engage online health resources effectively [12]. There is a gap between the electronic health resources available and consumers' skills for using them. By identifying and understanding this skill set we can better address the context of eHealth service delivery [13].

As we witness the impact that basic literacy has on health outcomes, questions arise about how literacy affects eHealth-related outcomes and experiences [14]. But unlike literacy in the context of paper-based resources, the concept of literacy and health in electronic environments is much less defined. Consumer eHealth requires basic reading and writing skills, working knowledge of computers, a basic understanding of science, and an appreciation of the social context that mediates how online health information is produced, transmitted, and received—or what can be called *eHealth literacy*. A definition and model of eHealth literacy is proposed below that describes the skills required to support full engagement with eHealth resources aimed at supporting population health and patient care.

eHealth Literacy Model

The Lily Model

Eng (2001) defines eHealth as "the use of emerging information and communication technology, especially the Internet, to improve or enable health and health care [15]; this is one of many published definitions currently in use [16]. Taken in the context of the IOM's definition of health literacy stated above, the concept of eHealth literacy is proposed. Specifically, 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. Unlike other distinct forms of literacy, eHealth literacy combines facets of different literacy skills and applies them to eHealth promotion and care. At its heart are six core skills (or literacies): traditional literacy, health literacy, information literacy, scientific literacy, media literacy, and computer literacy. The relationship of these individual skills to each other is depicted in Figure 1. Using the metaphor of a lily, the petals (literacies) feed the pistil (eHealth literacy), and yet the pistil overlaps the petals, tying them together.

Within the lily model, the six literacies are organized into two central types: *analytic* (traditional, media, information) and *context-specific* (computer, scientific, health). The analytic component involves skills that are applicable to a broad range of information sources irrespective of the topic or context (Figure 2), while the context-specific component (Figure 3) relies on more situation-specific skills. For example, analytic skills can be applied as much to shopping or researching a term paper as they can to health. Context-specific skills are just as important; however, their application is more likely to be contextualized within a specific problem domain or circumstance. Thus, computer literacy is dependent upon what type of computer is used, its operating system, as well as its intended application. Scientific literacy is applied to problems where research-related information is presented, just as health literacy is contextualized to health issues as opposed to shopping for a new television set. Yet, both analytic and context-specific skills are required to fully engage with electronic health resources.

eHealth literacy is influenced by a person's presenting health issue, educational background, health status at the time of the eHealth encounter, motivation for seeking the information, and the technologies used. Like other literacies, eHealth literacy is not static; rather, it is a process-oriented skill that evolves over time as new technologies are introduced and the personal, social, and environmental contexts change. Like other literacy types, eHealth literacy is a discursive practice that endeavors to uncover the ways in which meaning is produced and inherently organizes ways of thinking and acting [17,18]. It aims to empower individuals and enable them to fully participate in health decisions informed by eHealth resources.

Figure 1. eHealth literacy lily model

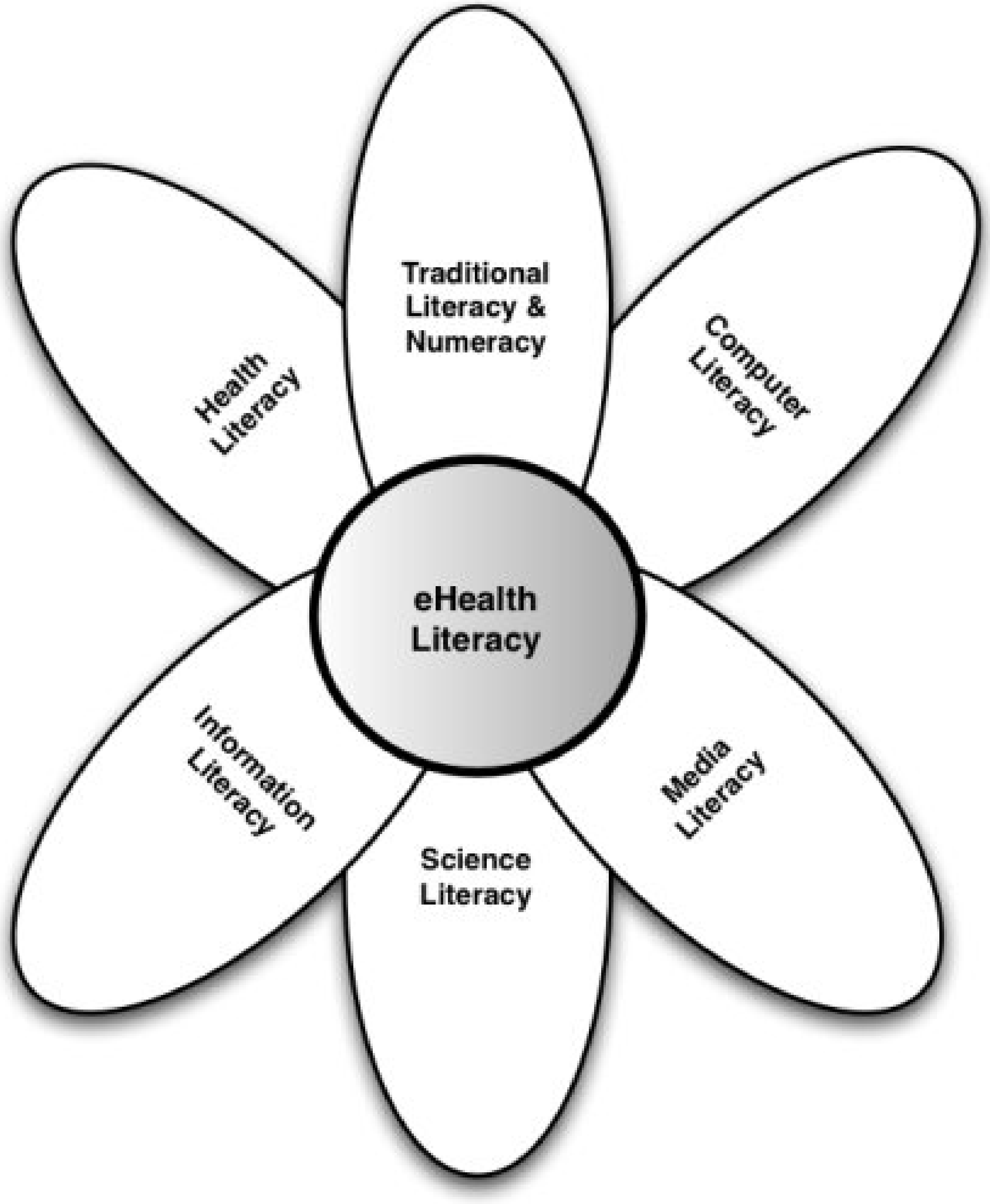


Figure 2. eHealth literacy analytic model

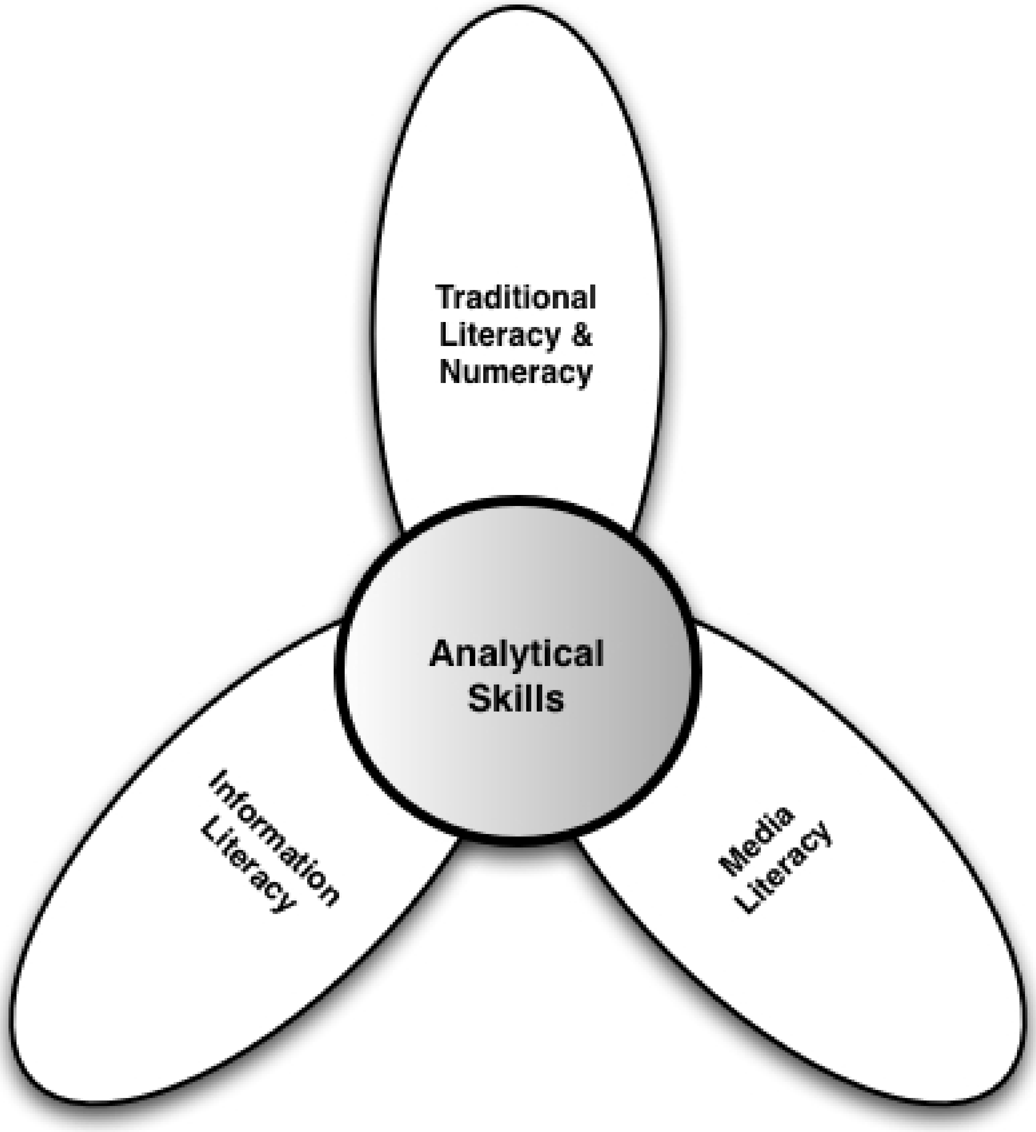
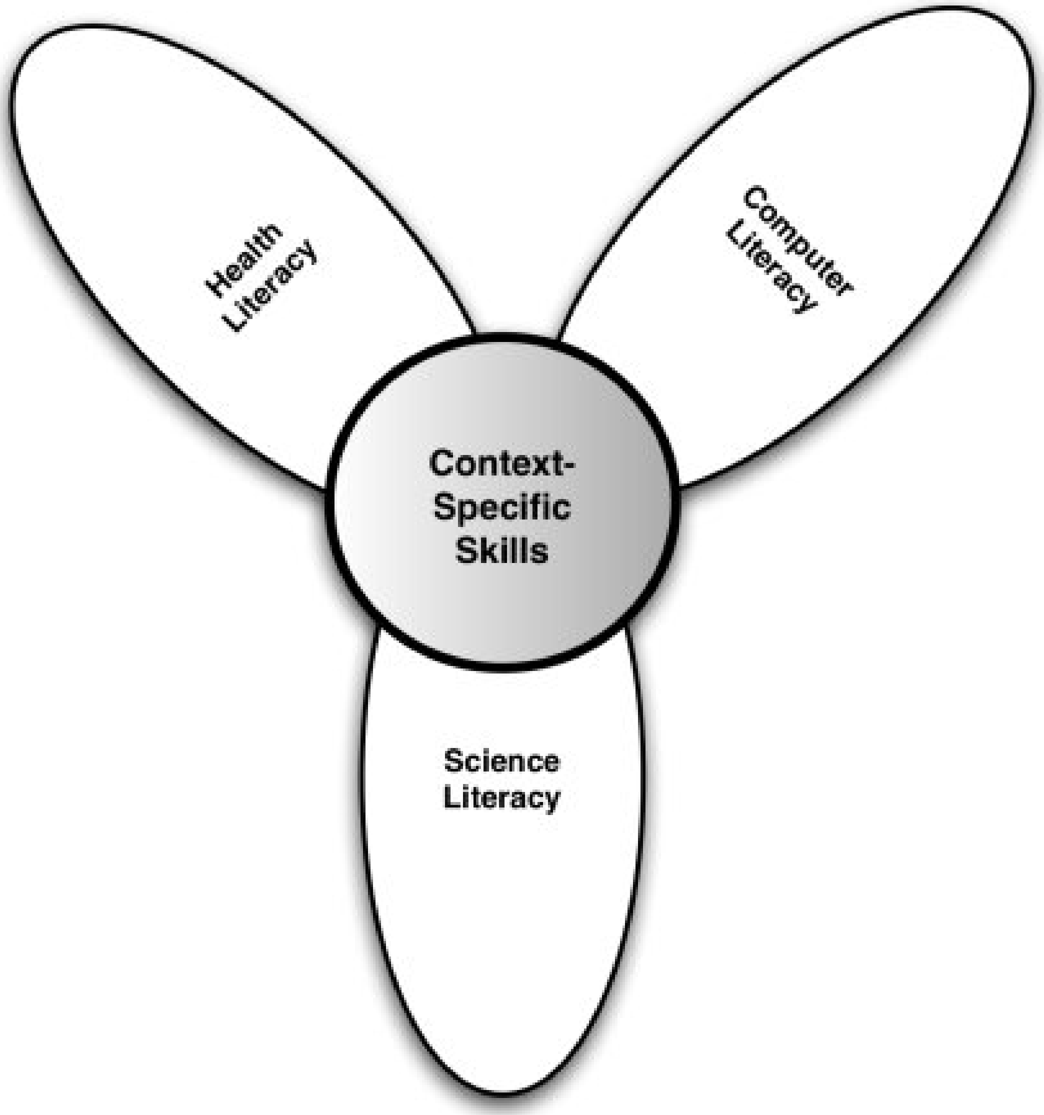


Figure 3. eHealth literacy context-specific model



The six components of the eHealth literacy model are briefly outlined below.

Traditional Literacy

This concept is most familiar to the public and encompasses basic (or prose) literacy skills such as the ability to read text, understand written passages, and speak and write a language coherently[19]. Technologies such as the World Wide Web are still text dominant, despite the potential use of sound and visual images on websites. Basic reading and writing skills are essential in order to make meaning from text-laden resources. A related issue is language itself. Over 65% of the World Wide Web's content is in English[20], meaning that English-speakers are more likely to find an eHealth resource that is understandable and meets their needs.

Information Literacy

The American Library Association suggests that an information literate person knows "how knowledge is organized, how to find information, and how to use information in such a way that others can learn from them" [21]. Like other literacies, this definition must be considered within the context of the social processes involved in information production, not just its application [19]. An information literate person knows what potential resources to consult to find information on a specific topic, can develop appropriate search strategies, and can filter results to extract relevant knowledge. If one views the Web as a library, with search tools (eg, Google) and a catalogue of over eight billion resources, the need for Web users to know how to develop and execute search strategies as well as comprehend how this knowledge is organized becomes imperative.

Media Literacy

The wide proliferation of available media sources has spawned an entire field of research in the area of media literacy and media studies. Media literacy is a means of critically thinking about media content and is defined as a process to "develop metacognitive reflective strategies by means of study" [22] about media content and context. Media literacy is a skill that enables people to place information in a social and political context and to consider issues such as the marketplace, audience relations, and how media forms in themselves shape the message that gets conveyed. This skill is generally viewed as a combination of cognitive processes and critical thinking skills applied to media and the messages that media deliver [23].

Health Literacy

As discussed earlier, health literacy pertains to the skills required to interact with the health system and engage in appropriate self-care. The American Medical Association considers a health literate person as having "a constellation of skills, including theability to perform basic reading and numerical tasks required to function in the health care environment. Patients with adequate health literacy can read, understand, and act on health care information" [24]. Consumers need to understand relevant health terms and place health information into the appropriate context in order to make appropriate health decisions. Without such skills, a person may have difficulty following directions or engaging appropriate self-care activities as needed.

Computer Literacy

Computer literacy is the ability to use computers to solve problems[25]. Given the relative ubiquity of computers in our society, it is often assumed that people know how to use them. Yet, computer literacy is nearly impossible without quality access to computers and current information technology. For example, it is not helpful to learn PC-based commands on a Mac, to learn Windows 98 if one requires Windows XP, or be trained on a laptop when a personal digital assistant (PDA) is required for a task. Computer literacy includes the ability to adapt to new technologies and software and includes both absolute and relative access to eHealth resources. To illustrate this, Skinner and colleagues found that while nearly every Canadian teenager has access to the Internet, far fewer have the quality of access or the ability to fully utilize it for health [26,27].

Scientific Literacy

This is broadly conceived as an understanding of the nature, aims, methods, application, limitations, and politics of creating knowledge in a systematic manner [28]. The latter-mentioned political and sociological aspects of science are in response to earlier conceptions of science as a value-free enterprise, a position that has been vigorously challenged [28-30]. For those who do not have the educational experience of exposure to scientific thought, understanding science-based online health information may present a formidable challenge. Science literacy places health research findings in appropriate context, allowing consumers to understand how science is done, the largely incremental process of discovery, and the limitations—and opportunities—that research can present.

The Six Literacy Types

Taken together, these six literacy types combine to form the foundational skills required to fully optimize consumers' experiences with eHealth. A profile of each literacy type with examples of the problems patient-clients might present is summarized in Table 1. Also included is a list of resources, many of them Web-based, that can be consulted to help health practitioners support patient-clients in improving their literacy skills across each domain. Although it would not be unexpected to find that older adults and those from nonindustrialized countries report greater difficulties in certain domains, particularly those that are context-specific, it is the authors' experience that few assumptions about which groups or individuals are likely to encounter difficulties can be made. As work with highly Internet-connected populations (like North American adolescents) shows, many of whom we would expect to be skilled users, there is a lack of skills, opportunity, and environments to use eHealth to its fullest potential [12,26,27].

Table 1. Profile of literacy skills as related to health care practice

	Identifying Problems	**Potential Resources**
Analytic	Analytic literacy skills can be generically applied to a number of sources and circumstances. These are foundational skills that are required to participate in daily informational life. Training aids are commonly found in many countries.	

Traditional Literacy and Numeracy	• Inability to read simple language
	• Difficulty understanding printed materials in day-to-day interactions (eg, street signs)
	• Inability to perform basic mathematical functions such as addition, subtraction, division, and multiplication with small whole numbers
	• Difficulty in balancing a check book or calculating bank balances
	• Difficulty reading maps or understanding simple charts
		• Many countries have national organizations that can provide free services for learners and professionals. Some examples include the following:
		  • Frontier College (Canada) [31]
		  • the National Literacy Trust (UK) [32]
		  • National Research and Development Centre for Adult Literacy and Numeracy (UK) [33]
		  • National Center on Adult Literacy (US) [34]

Media Literacy	• Lack of awareness of media bias or perspective • Inability to discern both explicit and implicit meaning from media messages • Difficulty in deriving meaning from media messages	• The Office of Communications strategy for enhancing media literacy (UK) [35] • The National Institute of Adult Continuing Education (NIACE) media literacy guide (UK) [36] • The Media Awareness Network (Canada) [37]
Information Literacy	• Inability to see connections between information from various sources such as books, pamphlets, or Internet websites • Lack of familiarity with libraries and other information repositories available in the community • Inability to frame search questions in a manner that produces desired answers	• The American Library Association has a resource page including toolkits and reference sources to aid in instruction and research [38]. • Local libraries can provide support for information searches and self-directed learning; details are available through The Chartered Institute of Library and Information (UK) [39].
Context-Specific	Context-specific literacy skills are centered on specific issues, problem types, and contexts. These skills often require more specialized training than analytical literacy skills. Finding local resources may require more focused searches.	
Computer Literacy	• Unfamiliarity with basic computer terms such as *email, mouse, keyboard*, and so forth • Inability to use a mouse or other input devices • Lack of exposure to computers in everyday life	Computer training courses are widespread; however, accessibility is an issue for those on fixed incomes. Many libraries offer special programs to teach patrons both computer and search skills for little or no cost. Some countries have job training centers that provide basic computer courses as part of their core mandate.
Science Literacy	• Lack of understanding about the cumulative impact of scientific knowledge • No awareness that science can be understood by nonscientists • Unfamiliarity with science terms, the process of discovery, or the application of scientific discoveries to everyday life	Few widespread resources exist to teach people science literacy. The most common approach to learning about science is through formal education; however, many science institutions such as universities and colleges have open lectures and educational events for the public on a regular basis. In Canada, the Royal Institute for the Advancement of Science holds monthly lectures on science topics to educate the public, as does the Royal Society in the UK.
Health Literacy	• Difficulty following simple self-care directions or prescription instructions • Fear of taking medications without assistance • Unfamiliarity or lack of understanding of basic health care terms	Two instruments have been developed and validated for use in assessing health literacy: The Test of Functional Health Literacy in Adults (TOFHLA) and the Rapid Estimate of Adult Literacy in Medicine (REALM). Both have been widely used and are designed to assess health literacy within 30 minutes. The TOFHLA has 67 items and includes a numeracy component (the ability to read and understand numbers) and a reading comprehension component. The REALM has 66 items. Fostering health literacy is a challenge; however, attending to people's media preferences (text, video, audio) and using plain language in interactions is a place to begin.

These six skill types illustrate the challenges that eHealth presents to those with low literacy in any one area. Although one need not have mastery in all these areas to benefit from eHealth resources, it can be argued that without moderate skills *across* these literacies, effective eHealth engagement will be unlikely. Using a specific health-related issue (smoking prevention and cessation) as an example, Table 2 illustrates how these literacy issues may present within the context of primary care while suggesting possible intervention strategies. Unlike other areas of health care, there is no "best practice" solution to addressing problems of literacy that fits into a single session or neatly packaged brief intervention. Rather, improving literacy is a process that requires coordinated remediation and education, involving partnerships among patient-clients, practitioners, educators, and community health organizations over time. It is as much a process as it is an outcome.

Table 2. Case scenarios: tobacco use and the six literacy types

Case Study	Literacy Type(s) Required
A group practice has decided to provide smoking prevention resources for teens and their parents on its website. The resources are to be approved by a patient advisory committee. The three sites put forward are Phillip Morris USA's smoking prevention material site [40], The Smoking Zine by TeenNet at the University of Toronto [41], and Health Canada's Quit4Life program [42].	**Media Literacy:** Teens need to know the difference between the perspectives presented on each site to make an informed decision. One site belongs to a tobacco company with a vested interest in selling cigarettes, and it advocates prevention strategies not supported by the best evidence. The other two sites are from a teen-focused research project at a public university and from a government health agency. These three sites together encourage discussion about media issues and allow for exploration with patient-clients the ways in which information on one issue can be presented differently. The Media Awareness Network [37] has resources for working with children and youth in enhancing media literacy that can aid in fostering this discussion.
A 60-year-old man with little formal education and no experience using computers presents with concerns about continuing to smoke. He has made many unsuccessful quit attempts and has been told there are Internet resources available that can help him. He is interested in trying something different to help him stop using tobacco.	**Traditional Literacy:** A basic literacy assessment should be undertaken before recommending use of the Internet as a resource. This may be done by having the patient read a few simple text passages from consumer health materials or the newspaper or by asking the patient directly if he has difficulties reading. If basic text materials are difficult, the person is likely to require assistance in using the Web or other Internet resources even at a rudimentary level. **Computer Literacy:** If the man has limited experience with computers, specific training through a local library, community center, or other community program might be necessary to provide him with the means to use Web-assisted tobacco interventions. This requires that the practitioner arrange and assist the patient in connecting with one of these community resources or inquire if there are family members or friends who can assist him in getting online.
A 35-year-old woman presents with an interest in finding information on smoking to share with her teenage daughter. She uses email at work and regularly visits a local website for news, but otherwise does not surf regularly and does not know how to find Internet resources easily.	**Information Literacy:** A referral to the local library or on-staff librarian (if available) is the simplest strategy. A short tutorial on the use of search engines, search strategies, and health databases can provide the basics on how to navigate the Internet for health information. Once basic search strategies have been established, the patient may wish to use evidence-supported resources for evaluating consumer health information, available through tools such as the DISCERN Project websites [43,44].
A 24-year-old mother of two small children and current smoker challenges the claim that second-hand smoke is harmful to her children, citing research she found on the Internet.	**Science Literacy:** This scenario presents a teachable moment to outline some of the issues that address science literacy, such as how evidence changes over time and issues of quality. In this case, it may be useful to direct the patient to reference sources outlining contrary views and encourage a dialogue around what makes good science. It is possible the research she has referred to is out of date, contested, or heavily biased (eg, tobacco-industry sponsored).
A 45-year-old patient has been prescribed nicotine replacement therapy (NRT) using an inhaler. The patient is unsure when to use the inhaler and under what conditions and reports behaviors that indicate he is not using the inhaler as originally prescribed.	**Health Literacy:** The presenting patient is following the product instructions. It is worth exploring the context around this behavior to see if it is a matter of fit between the NRT delivery method and the person or whether it is an issue of literacy. Patient instructions should be reviewed to ensure that they are written in plain language. Practitioners may also wish to explore whether there are other media tools available from the manufacturer or local health unit that can be used to supplement the written instructions, such as visual aids or videos to reduce the amount of required reading.

Discussion

Literacy is as much a process as an outcome and requires constant attention and upgrading. The key is to reach a level of fluency at which one can achieve working knowledge of the particular language (or skill), enough to function at a level conducive to achieving health goals. Knowledge, information, and media forms are context-specific, and context dictates what skills and skill levels are required to access health resources. For example, technical jargon may be appropriate in academic discourse provided it allows for a more precise explanation of certain concepts. However, when directed at nontechnical consumers or those outside of a particular research or practice culture, technical language may need to undergo a translation process in order to convey a message properly[45]. Whereas a scientist may be interested in acetylsalicylic acid, a patient requiring pain relief knows this substance only as Aspirin or ASA.

As the World Wide Web and other technology-based applications become a regular part of the public health and health care environment, viewing these tools in light of the skills required for people to engage them becomes essential if the power of information technology is to be leveraged to promote health and deliver health care effectively. The eHealth literacy model presented here is the first step in understanding what these skills are and how they relate to the use of information technology as a tool for health. The next step is to apply this model to everyday conditions of eHealth use—patient care, preventive medicine and health promotion, population-level health communication campaigns, and aiding health professionals in their work—and evaluate its applicability to consumer health informatics in general. Using this model, evaluation tools can be created and systems designed to ensure that there is a fit between eHealth technologies and the skills of intended users. By considering these fundamental skills, we open opportunities to create more relevant, user-friendly, and effective health resources to promote eHealth for all.

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Conflicts of Interest

None declared.

References

1. ; National Center for Educational Statistics. National Assessment of Adult Literacy (NAAL): A First Look at the Literacy of America's Adults in the 21st Century. Washington, DC: Institute of Education Sciences, US Department of Education; 2005.
2. ; Statistics Canada. Building on Our Competencies: Canadian Results of the International Adult Literacy and Skills Survey, 2003. Ottawa, ON: Human Resources and Skills Development Canada and Statistics Canada; 2005.
3. Veenhof B, Clermont Y, Sciadas G. Literacy and Digital Technologies: Linkages and Outcomes. Ottawa, ON: Statistics Canada; 2005. URL: http://www.statcan.ca/bsolc/english/bsolc?catno=56F0004MIE2005012 [accessed 2006 Jun 16] [WebCite Cache ID 5GgNVxIDu]
4. Barbot J. How to build an "active" patient? The work of AIDS associations in France. Soc Sci Med 2006 Feb;62(3):538-551. [Medline: 16046248] [doi: 10.1016/j.socscimed.2005.06.025]
5. Rootman I. Literacy and health in Canada: is it really a problem? Can J Public Health 2003;94(6):405-406. [Medline: 23061744]
6. ; Institute of Medicine. Health Literacy: A Prescription to End Confusion. Washington, DC: The National Academies Press; 2004.
7. Ratzan SC, Parker RM. Introduction. In: Seldon CR, Zorn M, Ratzan SC, Parker RM, editors. National Library of Medicine Current Bibliographies in Medicine: Health Literacy. NLM Pub. No. CBM 2000-1 ed. Washington, DC: National Institutes of Health, US Department of Health and Human Services; 2000.
8. Lai CKY, Arthur DG, Chau WWH. Implication of Internet growth on enhancing health of disadvantaged groups in China: a global perspective. J Clin Nurs 2004 Sep;13(6B):68-73. [Medline: 101969709]
9. Pillon S, Todini AR. eHealth in Antarctica: a model ready to be transferred to every-day life. Int J Circumpolar Health 2004 Dec;63(4):436-442. [Medline: 101954547]
10. Rodrigues RJ, Risk A. eHealth in Latin America and the Caribbean: development and policy issues. J Med Internet Res 2003 Mar 31;5(1):e4 [FREE Full text] [Medline: 22631138] [doi: 10.2196/jmir.5.1.e4]
11. Tatsumi H, Mitani H, Haruki Y, Ogushi Y. Internet medical usage in Japan: current situation and issues. J Med Internet Res 2001 Mar 17;3(1):E12 [FREE Full text] [Medline: 21578019] [doi: 10.2196/jmir.3.1.e12]
12. Gray NJ, Klein JD, Noyce PR, Sesselberg TS, Cantrill JA. The Internet: a window on adolescent health literacy. J Adolesc Health 2005 Sep;37(3):243. [Medline: 16109345] [doi: 10.1016/j.jadohealth.2004.08.023]
13. Norman CD, Chirrey S, Skinner HA. Consumer perspectives on e-Health. In: Skinner HA. Promoting Health through Organizational Change. San Francisco, CA: Benjamin Cummings; 2002:315-334.
14. Mccray AT. Promoting health literacy. J Am Med Inform Assoc 2005;12(2):152-163. [Medline: 15561782] [doi: 10.1197/jamia.M1687] [PMC: 15561782]
15. Eng TR. The e-Health Landscape: A Terrain Map of Emerging Information and Communication Technologies in Health and Health Care. Princeton, NJ: The Robert Wood Johnson Foundation; 2001.
16. Oh H, Rizo C, Enkin M, Jadad A. What is eHealth?: a systematic review of published definitions. World Hosp Health Serv 2005;41(1):32-40. [Medline: 102125492] [doi: 10.2196/jmir.7.1.e1]
17. Friere P. Pedagogy of the Oppressed. New York: Continuum; 1970.
18. Lankshear C, McLaren PL, editors. Critical Literacy: Politics, Praxis, and the Postmodern. Albany, NY: SUNY Press; 1993.
19. Tyner K. Literacy in a Digital World. Mahwah, NJ: Lawrence Erlbaum Associates; 1998.
20. ; Global Reach. Global Internet Statistics: Sources& References 2005.
21. ; American Library Association Presidential Committee on Information Literacy. Final Report. Washington, DC: American Library Association; 1989. URL: http://www.ala.org/ala/acrl/acrlpubs/whitepapers/presidential.htm#opp [WebCite Cache ID 5GgPfd0A2]
22. Feuerstein M. Media literacy in support of critical thinking. Journal of Educational Media 1999;24(1):43-54.
23. Potter WJ. Theory of Media Literacy: A Cognitive Approach. Thousand Oaks, CA: Sage; 2004.

24. ; Health literacy: report of the Council on Scientific Affairs. Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs, American Medical Association. JAMA 1999 Feb 10;281(6):552-557. [Medline: 99144710] [doi: 10.1001/jama.281.6.545]
25. Logan RK. The Fifth Language: Learning a Living in the Computer Age. Toronto, ON: Stoddart; 1995.
26. Skinner H, Biscope S, Poland B. Quality of internet access: barrier behind internet use statistics. Soc Sci Med 2003 Sep;57(5):875-880. [Medline: 22736020] [doi: 10.1016/S0277-9536(02)00455-0]
27. Skinner H, Biscope S, Poland B, Goldberg E. How adolescents use technology for health information: implications for health professionals from focus group studies. J Med Internet Res 2003 Dec 18;5(4):e32 [FREE Full text] [Medline: 14713660] [doi: 10.2196/jmir.5.4.e32]
28. Laugksch RC. Scientific literacy: a conceptual overview. Science Education 2000;84(1):71-94.
29. Claeson B, Martin E, Richardson W, Schoch-Spana M, Taussig KS. Scientific literacy: what it is, why it is important, and why scientists think we don't have it. In: Nader L, editor. Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge. New York: Routledge; 1996:101-116.
30. Gregory J, Miller S. Science in Public: Communication, Culture, and Credibility. New York: Plenum; 1998.
31. ; Frontier College. Home page. URL: http://www.frontiercollege.ca/english/main.htm [accessed 2005 Dec 18] [WebCite Cache ID 5CisP4YiW]
32. ; National Literacy Trust. Home page. URL: http://www.literacytrust.org.uk/ [accessed 2005 Dec 18] [WebCite Cache ID 5Gcfm6i4u]
33. ; National Research and Development Centre for Adult Literacy and Numeracy. Home page. URL: http://www.nrdc.org.uk/ [accessed 2005 Dec 18] [WebCite Cache ID 5Gcfl6vwv]
34. ; National Center on Adult Literacy. Home page. URL: http://ncal.literacy.upenn.edu/ncal.html [accessed 2005 Dec 18] [WebCite Cache ID 5Gcfk1bQA]
35. Office OCSFEMLITUK. Home page. URL: http://www.ofcom.org.uk/consult/condocs/strategymedialit/ [accessed 2005 Dec 18] [WebCite Cache ID 5GcfisEg4]
36. ; National Institute of Adult Continuing Education (NIACE). Media guide. URL: http://www.niace.org.uk/alw/2006/Themes/media.htm [accessed 2006 Jan 5] [WebCite Cache ID 5Cit7AbQk]
37. ; Media Awareness Network. Home page. URL: http://www.media-awareness.ca/english/index.cfm [accessed 2005 Dec 18] [WebCite Cache ID 5Gcfhjodc]
38. ; American Library Association. Information Literacy. URL: http://www.ala.org/ala/acrl/acrlstandards/informationliteracycompetency.htm [accessed 2005 Dec 18] [WebCite Cache ID Om5]
39. ; Chartered Institute of Library and Information. Home page. URL: http://www.cilip.org.uk/ [accessed 2005 Dec 18] [WebCite Cache ID 5GcfgHhjg]
40. ; Phillip Morris USA. Home page. URL: http://www.phillipmorrisusa.com/ [accessed 2005 Dec 18] [WebCite Cache ID 5GcffBn0F]
41. ; TeenNet Research Program. The Smoking Zine. URL: http://www.smokingzine.org/ [accessed 2005 Dec 18] [WebCite Cache ID O91]
42. ; Health Canada. Quit 4 Life. URL: http://www.quit4life.com/ [accessed 2005 Dec 18] [WebCite Cache ID 5GcfcqzEJ]
43. ; DISCERN. Home page URL: http://www.discern.org.uk/ [accessed 2005 Dec 18] [WebCite Cache ID 5GcfanyQ3]
44. Griffiths KM, Christensen H. Website quality indicators for consumers. J Med Internet Res 2005;7(5):e55 [FREE Full text] [Medline: 16403719] [doi: 10.2196/jmir.7.5.e55]
45. Davis D, Evans M, Jadad A, Perrier L, Rath D, Ryan D, et al. The case for knowledge translation: shortening the journey from evidence to effect. BMJ 2003 Jul 5;327(7405):33-35 [FREE Full text] [PMC: 12842955] [doi: 10.1136/bmj.327.7405.33] [Medline: 22726066]

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Original Paper

Formative Evaluation and Three-Month Follow-Up of an Online Personalized Assessment Feedback Intervention for Problem Drinkers

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Abstract

Background: In recent years, online services for problem drinkers have been developed. This paper describes ongoing efforts to improve one of these services, the Alcohol Help Center.

Objective: This report summarizes new modules added to the Check Your Drinking (CYD) screener, a component of the Alcohol Help Center, to make the CYD screener more useful to periodic heavy drinkers, as well as to regular alcohol consumers. Participants' initial reactions to the CYD screener and the changes in their drinking habits at a three-month follow-up are presented.

Methods: The CYD screener provides a free personalized Final Report that compares the user's drinking to that of others in the general population of the same age, gender, and country of origin. Current alcohol consumption and demographic characteristics are collected as part of the CYD screening process. After users were presented with a customized Final Report, they were hot-linked to a volunteer feedback survey. The voluntary feedback survey asked about impressions of the CYD Final Report. Respondents agreeing to participate were sent a follow-up survey after three months.

Results: We recruited 388 volunteers (69% female) who were registered users of another free-to-consumer online eHealth service. Of the 343 respondents agreeing to participate in the three-month follow-up, 138 accessed the survey, and 97 provided complete data (participation rate = 40%; completion rate = 70%). Compared to moderate drinkers, current problem drinkers judged the Final Report to be more useful (34% vs. 69%, $\chi^2_1 = 41.5$, $P < .001$) and accurate (43% vs. 76%, $\chi^2_1 = 36.0$, $P < .001$). Respondents who participated in the three-month follow-up displayed reductions in drinking compared to baseline ($F_{4,76} = 12.2$, $P = .001$).

Conclusions: Improvements can still be made to make the CYD screener more relevant to specific populations, particularly periodic heavy drinkers. There is a need to further tailor algorithms that can present questions only relevant to specific populations. There also appears to be a need to further customize the Final Report for respondents who identify themselves as infrequent heavy drinkers. These improvements will be made, and a randomized controlled trial is planned to conduct a rigorous evaluation of the CYD screener as an intervention to help problem drinkers.

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KEYWORDS

Alcohol; Web-based; self-help; Internet

Introduction

Hazardous alcohol consumption has been identified as one of the five leading contributors to the global burden of disease, and it results in enormous economic costs [1-7]. Yet very few people with alcohol problems ever seek treatment; the estimated ratio of treated to untreated problem drinkers ranges from 1:3 to 1:14 in Canada and the United States [8,9-11]. This is due, in part, to concerns about stigma and a desire to deal with their concerns on their own [12,13]. If the majority of people with alcohol concerns do not access traditional treatment programs, would brief, anonymous, 24-hour accessible Internet-based services be more appealing to them? Many problem drinkers have an interest in self-help tools to help them evaluate their drinking [14,15]. Problem drinkers have identified computerized interventions as being particularly attractive [16]. Given this interest, and the high level of online access by problem drinkers (75% in a recent survey) [17], providing tools to problem drinkers on the Internet may promote access to help.

There have been a number of reports of online services for problem drinkers (reviewed in [18,19]). Many of these services would benefit from revisions to take into account the demographic characteristics and the feedback of participants, and to take advantage of the increasing options available to provide sophisticated tools for problem drinkers. A case in point is one of the early online tools for problem drinking, Evaluate Your Drinking [20], a program that provided personalized assessment reports to participants. Preliminary research utilizing a survey hot-linked to the participants' assessment report found that, while reactions to the assessment reports were generally positive, the report was judged to be less useful by infrequent drinkers as compared to frequent drinkers. In order to increase the usefulness of this online feedback tool, a new version of this program, the Check Your Drinking (CYD) screener (part of the Alcohol Help Center) [21], was created. In addition to updating the normative feedback components using the most recent general population data available, the CYD Final Report incorporates new modules that should appeal to infrequent heavy drinkers. This report describes these improvements and summarizes a preliminary evaluation of the updated intervention.

In order to provide a preliminary outcome evaluation of the CYD screener, a three-month follow-up survey was also conducted. Two hypotheses were tested in this outcome evaluation. Hypothesis one predicted that respondents would be drinking less at three months' follow-up as compared to baseline. Second, previous research has indicated that respondents' perceived risk might be an important incentive to adopt health protective behaviors (e.g., [22]). Thus, it would be expected that, as people reduce their drinking, their perceptions of the risk associated with their drinking should also be reduced. Hypothesis two predicted that respondents who displayed reductions in their perceived risk of health consequences from drinking would be more likely to have also reduced their drinking from baseline to three months' follow-up as compared to respondents who reported no reductions or who reported increased ratings of their perceived risk.

Methods

Baseline Survey

Recruitment for this pilot study was conducted by an email invitation sent to registered users of a separate free-to-consumer website program, the Stop Smoking Center [23]. A stand-alone version of the CYD screener was posted on a closed-access website that was custom programmed exclusively for this study. Participants were identified by a randomly generated and anonymous unique variable assigned to each registered user of the Stop Smoking Center. Participants could complete the survey only once, their anonymous user ID being automatically blocked after responding to the survey's final question. To maximize user privacy, cookies were not used. Volunteers who responded to the email solicitation were taken to a Web page that described the purpose of the study. A full copy of the baseline survey is included in Appendix 1. Because respondents were recruited from the Stop Smoking Center, they were first asked some brief questions about their current smoking status (results reported elsewhere [24]) and whether they currently drank alcohol. Those respondents who were current drinkers were asked to complete the CYD screener and receive their personalized Final Report, while those who indicated that they abstained from alcohol consumption were thanked for their participation and were not asked to complete the CYD screener. At the end of the Final Report, respondents were asked if they were willing to participate in a three-month follow-up, and they were provided with a hot-link button that took them to a voluntary survey that asked if they found the Final Report useful (not at all useful; slightly useful; somewhat useful; extremely useful), if anything was surprising in the Final Report (no; surprised how much more drank than others; surprised how much less drank than others; something else surprising), if they felt the Final Report was an accurate summary of their drinking (yes; no, infrequent drinker; no, drinking varies over time), and to what extent they believed they would personally be at risk of getting hurt or sick because of their drinking (0 = no risk; 10 = high risk). Respondents were also provided with pictures of each of the three main drinking summary graphs (see description below) and were asked to place a check mark under the graphs they found useful (or, if they found none useful, to not check any of the graphs). Finally, text boxes were available for respondents to provide written comments, but written comments were not mandatory. Survey items were not presented in random order. The maximum number of survey items was eight on one page, and the survey was distributed over 10 pages. The survey employed client-side and server-side error checking, required field validation, and server-side data validation. Participants could not proceed through the survey until they had responded to all mandatory questions on each page. Although the majority of questions were static and mandatory, some questions requested the participant's opinion (not mandatory). Until survey completion, participants were able to review and change their answers by clicking the back button on their browser or the back button inserted at the bottom of each survey page.

The study was approved by the standing ethics committee of the Centre for Addiction and Mental Health. The email invitation described the purpose of the survey, how long it would take (about 10 minutes), and that the use and storage of the data would ensure anonymity. Responding to the email invitation was taken as informed consent. The design of the survey followed international guidelines set forth to protect privacy [25,26]. The survey was pre-tested for usability and technical functionality prior to release. Details of the survey research methods have been presented in compliance with the checklist for reporting results of Internet e-surveys (CHERRIES) [27].

Three-Month Follow-up Survey

The same survey methods were employed for the three-month follow-up survey as for the baseline survey. A full copy of the follow-up survey is available in Appendix 2. First, respondents were asked about their current smoking status, whether they currently drank alcohol, and to what extent they currently perceived themselves to be at risk of getting hurt or sick because of their drinking (1 = no risk; 10 = high risk). Respondents who were current drinkers were then asked the same items from the CYD screener (see below), this time with respect to their drinking in the last three months. Results from the follow-up survey were linked to the baseline survey using respondents' unique user ID number.

Statistical Analysis

Univariate comparisons were made of the baseline survey results, comparing respondents who did or did not complete the voluntary feedback survey at baseline and also comparing problem and nonproblem drinkers. A repeated-measures multivariate analysis of variance was employed to test hypotheses one and two. Differences in drinking from baseline to follow-up were compared for respondents who did or did not report reductions in their perceived risk associated with drinking between the baseline and follow-up time points.

The Check Your Drinking Screener

The CYD screener is available for public access [21]. The survey first asks respondents their gender, age, country of origin, weight, and how much money a drink usually costs them. The respondents are also asked their reason for taking the CYD screener (for yourself; for someone you know; you are just checking out the CYD test to see what the results look like), which provides an option for participants to indicate that they are researchers or health professionals (so researcher data can be removed from the sample). The first page contains a description of the CYD screener with a link to a sample Final Report, and it describes the uses to which the data will be applied. After submitting the first page, respondents complete an 18-item survey that asks about details of their drinking. The screener includes the Alcohol Use Disorders Identification Test (AUDIT) [28,29], a well-validated measure that distinguishes between problem and nonproblem drinkers (cut-off score of eight or more on the AUDIT indicates a current problem with alcohol). Respondents are also asked to estimate how much they drink on each day of a typical week [30,31] and to report the highest number of drinks they consumed on a single occasion. The CYD survey concludes by asking respondents if they have experienced any of six psychosocial consequences as a result of their drinking in the last year: harmful effect on (1) friendships/social life; (2) physical health; (3) home life or marriage; (4) outlook on life (happiness); (5) work, studies, or employment opportunities, or (6) financial position [32].

Final Report

The Final Report begins with a summary pie chart that compares the respondent's drinking in a typical week to that of others of the same age group (six different age groups), gender, and country of origin. Recent population comparison data are currently available for Canada and the United States; UK data have been added since this study and data from other countries will be added at a later date [33-36]. The respondents are then provided with an estimate of the percentage of days they drank in the last year, the number of drinks they consumed in the last year, and the greatest number of drinks they consumed on one occasion. To heighten the impact of this customized information, estimates are provided of the amount of money spent on drinking and the number of calories consumed, including an estimate of the amount of weight added in the past year as a result of drinking.

The Final Report then continues with two drinking feedback graphs—a bar chart comparing the respondent's drinking on each day of the week to that of others of the same age group and gender (data only available from Canada), and a pie chart comparing the frequency of heavy-drinking days (five or more drinks on one occasion) to that of others of the same age, gender, and country of origin. This last graph, in particular, was added with the specific intent to provide useful feedback to infrequent drinkers. Respondents who drink five or more drinks on one occasion once per month or more are alerted to the increased risks associated with this type of consumption [37]. A list of the actual psychosocial consequences the respondent endorsed is also provided. Next, a dose-response chart is presented that describes the chances of experiencing negative consequences as a result of the weekly alcohol consumption (generated using data from the 2004 Canadian Addiction Survey [33]). A chart graphically depicting the respondent's AUDIT score is also provided along with an explanation of what different AUDIT scores indicate. The Final Report continues with an estimate of the amount of time it takes respondents to metabolize one, four, and ten drinks (based on weight), and it calculates how many hours they were under the influence of alcohol in the past year. The report concludes with sensible drinking guidelines provided by the Centre for Addiction and Mental Health [38], a summary of the health effects of alcohol, and a list of the different things a respondent could do in order to reduce the risks associated with drinking. A complete example of a Final Report can be found in Appendix 3.

Results

Baseline Survey

Email invitations were sent out to 7741 registered users of the Stop Smoking Center who registered between October 27, 2004 and July 27, 2005 and had active email accounts. Of these potential participants, 1085 recipients hot-linked to the survey using the unique link provided in each email (participation rate = 14%). Of these, 973 started the baseline survey; 9 respondents were removed because they said they were taking the test for someone else; 231 were removed because they identified themselves as nondrinkers, and 1 respondent did not complete the CYD survey, resulting in a final sample size of 732. Of these 732 respondents, 388 (53%) completed the voluntary feedback survey to give their impressions of the Final Report (completion rate = 40%). Table 1 presents the demographic and drinking characteristics of respondents who completed and respondents who did not complete the voluntary feedback survey. There were no significant differences in any of the demographic or drinking characteristics between survey completers and noncompleters.

Table 1. Demographic and drinking variables of users of the Check Your Drinking screener

	Completed Volunteer Survey	**Did Not Complete Voluntary Survey**	***P***
	n = 388	**n = 344**	
Mean age (years) (SD)	40.3 (11.3)	38.9 (11.8)	.12
Female (%)	68.8	66.6	.57
Country of Origin			
United States (%)	62.6	61.7	
Canada (%)	18.0	14.0	
Other (%)	19.3	24.3	.14
Mean number of drinks/typical week (SD)	9.5 (10.9)	10.6 (12.3)	.21
Mean AUDIT score (SD)*	7.2 (6.1)	7.4 (5.8)	.61
Mean number of alcohol consequences (SD)†	1.2 (1.8)	1.2 (1.8)	.62

[*] Problem drinking defined as a score of eight or more on the Alcohol Use Disorders Identification Test (AUDIT) [28,39]

[†] Has drinking ever affected (1) friendships/social life; (2) physical health; (3) home life or marriage; (4) outlook on life (happiness); (5) work, studies, or employment opportunities; or (6) financial position [32]

Table 2. Voluntary feedback survey, comparing problem and nonproblem drinkers

	Nonproblem Drinkers	**Problem Drinkers***	***P***
	n = 258	**n = 130**	
Mean age (years) (SD)	41.5 (11.8)	37.9 (9.7)	.001
Female (%)	74.0	58.5	.003
Country of Origin			
United States (%)	67.1	53.8	
Canada (%)	20.2	13.8	
Other (%)	12.8	32.3	.001
Mean number of drinks/typical week (SD)	4.6 (4.6)	19.1 (13.2)	.001
Mean number of alcohol consequences (SD)†	0.3 (0.8)	2.8 (2.1)	.001
Mean perceived risk (SD)‡	0.7 (1.0)	4.7 (3.0)	.001
Impressions of Feedback			
Feedback somewhat/extremely useful (%)	34.1	69.2	.001
Surprised how much more drink than others (%)	13.6	50.0	.001
Summary captures drinking (%)	43.4	76.2	.001
Typical week graph useful (%)	28.7	42.3	.01
Days of week summary useful (%)	23.6	38.5	.003
Frequency 5+ drinks graph useful (%)	13.6	16.2	.60

[*] Problem drinking defined as a score of eight or more on the Alcohol Use Disorders Identification Test (AUDIT) [28,39]

[†] Has drinking ever affected (1) friendships/social life; (2) physical health; (3) home life or marriage; (4) outlook on life (happiness); (5) work, studies, or employment opportunities; or (6) financial position [32]

[‡] To what extent do you believe that you are personally at risk of getting hurt or getting sick because of your own drinking (0 = no risk; 10 = high risk) [40]

Table 2 presents demographic and drinking characteristics and impressions of the Final Report for problem drinkers (defined as an AUDIT score of eight or more) and moderate drinkers who completed the voluntary feedback survey. Problem drinkers were younger ($t = 3.2$, $P = .001$) and more likely to be male ($\chi^2_1 = 9.1$, $P = .003$) compared to current moderate drinkers. Problem drinkers were also more likely than moderate drinkers to live outside the United States or Canada ($\chi^2_2 = 21.3$, $P < .001$). Further inspection of the country of origin revealed that 48% of the respondents who lived outside of the United States or Canada lived in the United Kingdom. As expected, problem drinkers consumed more alcohol in a typical week ($t = 12.2$, $P < .001$) and experienced more drinking consequences ($t = 12.8$, $P < .001$) compared to moderate drinkers. Problem drinkers also rated themselves as significantly more likely to get hurt or sick because of their drinking compared to moderate drinkers ($t = 14.7$, $P < .001$).

There were also a number of significant differences regarding impressions of the Final Report between problem and moderate drinkers (see Table 2). Problem drinkers were more likely to find the feedback summary somewhat or extremely useful ($\chi^2_1 = 41.5$, $< .001$), to be surprised by how much more they drank than others ($\chi^2_1 = 58.1$, $P < .001$), and to feel that the summary accurately outlined and captured their drinking ($\chi^2_1 = 36.0$, $P < .001$). Because one of the main intents of updating the screener was to provide useful information for infrequent drinkers, two further analyses were conducted comparing problem drinkers who were frequent or infrequent drinkers. Compared to problem drinkers who drank more than once a week (n = 103), those who drank weekly or less (n = 27) appeared just as likely to find the Final Report somewhat or extremely useful (69.9% vs. 66.7%, $\chi^2_1 = .008$, $P = .93$). In addition, problem drinkers who consumed five or more drinks (on one occasion) once a month or more (n = 111) were just as likely to find the Final Report somewhat or extremely useful as those problem drinkers who consumed five or more drinks less than once a month (n = 19, 69.4% vs. 68.4%, $\chi^2_1 = .001$, $P = 1.0$). There was some difference in the proportion of frequent (more than weekly) and infrequent (weekly or less) problem drinkers who thought the feedback accurately depicted their drinking (81.6% vs. 55.6%, $\chi^2_1 = 6.6$, $P = .01$). However, there was no difference between frequent heavy drinkers (five or more drinks monthly or more) and infrequent heavy drinkers on how accurate they felt the Final Report to be (75.7% vs. 78.9%, $\chi^2_1 = .001$, $P = .99$).

Respondents were asked if they found the three drinking feedback charts useful (see Table 2). Compared to moderate drinkers, problem drinkers more often found the weekly drinking pie chart ($\chi^2_1 = 6.6$, $P = .01$) and the days of the week drinking bar chart useful ($\chi^2_1 = 8.6$, $P = .003$). Few problem or moderate drinkers found the frequency of heavy-drinking days pie chart useful ($\chi^2_1 = .28$, $P = .60$). One potential difficulty in interpreting respondents' ratings was that the feedback charts were generated with population data from Canada or the United States, so they would be less relevant to respondents from other countries. Analyses were conducted to explore the proportions of Canadians and Americans who endorsed each chart and were marginally higher than those reported by the full sample (not shown).

Three-Month Follow-Up Survey

Of the 343 respondents who agreed to participate in the three-month follow-up survey, 138 accessed the survey and attempted to provide responses (participation rate = 40%). Responses from 41 participants could not be used because the unique respondent ID number was not associated with the participants' data. (The email invitation to participate in the three-month follow-up contained a link to the follow-up survey that was unique to the participant. Depending on the size of the participant's email window, this link could extend over more than one line. Respondents whose link extended over more than one line were able to access the survey, but their unique ID number was not associated with their responses, making the data unusable.) This left 97 participants who provided complete follow-up data (completion rate = 70%). Finally, 16 of these respondents did not complete the baseline voluntary feedback survey and, as such, had not provided an assessment of perceived risk at baseline, leaving 81 respondents with complete data to test hypothesis two. A repeated-measures multivariate analysis of variance (MANOVA) was conducted to test both hypotheses one and two simultaneously. The two independent variables were time (baseline versus three-month follow-up) and change in perception of risk (reduction in perception of risk from baseline to follow-up versus no reduction or increase in perceived risk). Four drinking variables were included as dependent variables: number of drinks in a typical week, greatest amount drunk on one occasion, number of drinking related consequences, and AUDIT score. Baseline and follow-up values for these dependent variables are displayed in Table 3. The MANOVA revealed a main effect of time ($F_{4,76} = 12.2$, $P = .001$) and of reduction in perceived risk ($F_{4,76} = 5.3$, $P = .001$). In addition, there was a significant interaction between time and perceived risk ($F_{4,76} = 6.1$, $P = .001$). Subsequent univariate analyses exploring this interaction revealed significant interactions for the variables: number of drinks in a typical week ($F_{1,79} = 4.0$, $P = .05$), greatest amount drunk on one occasion ($F_{1,79} = 6.1$, $P = .02$), number of drinking-related consequences ($F_{1,79} = 24.5$, $P = .001$), and AUDIT scores ($F_{1,79} = 5.4$, $P = .02$). Inspection of the observed means for these variables revealed that respondents who had a reduction in their perceived risk from baseline to follow-up also had reductions in their drinking from baseline to follow-up. Respondents with no reduction or an increase in their perceived risk displayed little or no reductions in their drinking from baseline to follow-up.

Table 3. Mean alcohol consumption at baseline and three-month follow-up by reduction in perceived risk from baseline to follow-up

	Reduction in Risk* n = 24		**No Reduction in Risk n = 57**	
	Baseline	**Follow-Up**	**Baseline**	**Follow-Up**
Mean number of drinks/typical week (SD)	16.7 (10.8)	14.5 (12.2)	8.1 (11.0)	8.8 (12.9)
Mean greatest amount drank (SD)	9.3 (3.5)	6.0 (3.4)	6.4 (4.8)	5.1 (5.3)
Mean number of alcohol consequences (SD)	3.2 (2.1)	1.5 (1.9)	0.9 (1.7)	0.7 (1.6)
Mean AUDIT score (SD)	13.1 (6.5)	11.1 (6.4)	6.0 (6.1)	5.6 (6.3)

*These respondents rated their perceived risk of drinking as less at the three-month follow-up than at baseline (right after receiving their Final Report).

Discussion

Principal Results

Problem drinkers were more likely to find the Final Report useful, surprising, and accurate than moderate drinkers. As the primary target of this website is current problem drinkers, it was intended that the Final Report should be found most useful to this group (although attempts were made to make the Final Report relevant to respondents from the entire continuum of alcohol consumption, from social drinkers to those dependent on alcohol). Of the feedback elements in the Final Report, both the original typical week pie chart and the days of the week bar chart were endorsed by about a third of respondents as being useful. The frequency of five or more drinking days pie chart was not often endorsed as being useful. It was discouraging to see how few respondents found the frequency of five or more drinks pie chart useful. This element of the CYD screener was added specifically to make the Final Report more relevant to infrequent heavy drinkers. Some qualitative responses from participants also highlighted that the Final Report was considered inaccurate by irregular drinkers.

As with an evaluation of the earlier version of the CYD [20], a significant proportion of respondents were female. One of the potential advantages of online services is the ability to reach groups of people (such as females) who are less likely to seek help from traditional services. Also similar to the earlier report was the proportion of respondents who were current problem drinkers. This is despite the fact that the recruitment method for the current evaluation was unusual—an invitation to current users of an online tobacco cessation self-help service. While an excellent means of quickly recruiting a large sample to a new online service (recruitment period was one week), caution should be taken in assuming that these respondents have the same profile as those who will find the Alcohol Help Center on their own.

There was a significant reduction in drinking measures from baseline to follow-up. While this finding supports hypothesis one, it should be stressed that this finding does not confirm that the reduction in drinking was due to use of the CYD screener because there was no control group in this study. In addition, reductions in estimates of perceived risk from baseline to follow-up were associated with reduction in drinking. This finding provides support for the importance of perceived risk as a potential mediator of the impact of self-help interventions such as the CYD screener. However, as with the preliminary support that the CYD may lead to reductions in drinking, a proper randomized controlled trial is needed in order to confirm this hypothesis [41].

Limitations

Not all respondents filled out the voluntary feedback survey, suggesting that caution should be taken regarding the generalizability of the results. It should, however, be noted that there were no systematic differences between completers and noncompleters on the variables we measured. In addition, there was a substantial attrition of respondents from baseline to follow-up, again leading to cautions regarding the validity of the results [42,43]. Finally, the present study was not a randomized controlled trial, so observations of reductions in drinking can only be taken as peripheral support for the effectiveness of this online intervention.

Future Directions

An upgraded version of the CYD screener will include a modified assessment algorithm and Final Report for participants with irregular drinking patterns rather than using the same assessment and Final Report for all users. Finally, a randomized controlled trial is underway to establish whether participation in the CYD screener will result in sustained reductions in alcohol consumption.

Conflicts of Interest

Dr. Cunningham has acted as a paid consultant to Van Mierlo Communications Consulting Inc., Toronto, ON, Canada, the owner of the Alcohol Help Center software. Trevor van Mierlo is the Chairman and Founder of V-CC, which owns the Alcohol Help Center, among other community-based cognitive behavior therapy eHealth platforms.

Multimedia Appendix 1

Baseline survey. [PDF file, 764 KB - jmir_v8i2e5_app1.pdf]

Multimedia Appendix 2

Follow-up survey. [PDF file, 184 KB - jmir_v8i2e5_app2.pdf]

Multimedia Appendix 3

Sample Final Report. [PDF file, 136 KB - jmir_v8i2e5_app3.pdf]

References

1. Room R, Babor T, Rehm J. Alcohol and public health. Lancet 2005;365(9458):519-530. [Medline: 15705462] [doi: 10.1016/S0140-6736(05)17870-2]
2. English D, Holman D, Milne E, et al. The quantification of drug caused morbidity and mortality in Australia. Canberra: Commonwealth Department of Human Services and Health; 1995.
3. Mcginnis JM, Foege WH. Actual causes of death in the United States. JAMA 1993;270(18):2207-2212. [Medline: 8411605] [doi: 10.1001/jama.270.18.2207]
4. ; Institute of Medicine. Broadening the base of treatment for alcohol problems. Washington, DC: National Academy Press; 1990.
5. Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and behavioral consequences of binge drinking in college. A national survey of students at 140 campuses. JAMA 1994 Dec 7;272(21):1672-1677. [Medline: 95056364] [doi: 10.1001/jama.272.21.1672]
6. Single E, Robson L, Xie X, Rehm J. The costs of substance abuse in Canada. Ottawa, Ontario: Canadian Centre on Substance Abuse; 1996.
7. Harwood H. Updating estimates of the economic costs of alcohol abuse in the United States: estimates, update methods, and data. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2000.
8. Roizen R, Cahalan D, Shanks P. "Spontaneous remission" among untreated problem drinkers. In: Kandel DB, editor. Longitudinal research on drug use: empirical findings and methodological issues. Washington, DC: Hemisphere; 1978:197-221.
9. Cunningham JA, Breslin FC. Only one in three people with alcohol abuse or dependence ever seek treatment. Addict Behav 2004 Jan;29(1):221-223. [Medline: 14667433] [doi: 10.1016/S0306-4603(03)00077-7]
10. Hasin DS. Treatment/self-help for alcohol-related problems: relationship to social pressure and alcohol dependence. J Stud Alcohol 1994 Nov;55(6):660-666. [Medline: 95165822]
11. Burton TL, Williamson DL. Harmful effects of drinking and the use and perceived effectiveness of treatment. J Stud Alcohol 1995 Nov;56(6):611-615. [Medline: 96130448]
12. Cunningham JA, Sobell LC, Sobell MB, Agrawal S, Toneatto T. Barriers to treatment: why alcohol and drug abusers delay or never seek treatment. Addict Behav 1993;18(3):347-353. [Medline: 93343018] [doi: 10.1016/0306-4603(93)90036-9]
13. Grant BF. Barriers to alcoholism treatment: reasons for not seeking treatment in a general population sample. J Stud Alcohol 1997 Jul;58(4):365-371. [Medline: 97346700]
14. Cunningham JA, Wild TC, Walsh GW. Interest in self-help materials in a general population sample of drinkers. Drugs: Educ Prev Policy 1999;6(2):209-213. [doi: 10.1080/09687639997179]
15. Werch CE. Are drinkers interested in inexpensive approaches to reduce their alcohol use? J Drug Educ 1990;20(1):67-75. [Medline: 90271040]
16. Koski-Jänne A, Cunningham J. Interest in different forms of self-help in a general population sample of drinkers. Addict Behav 2001;26(1):91-99. [Medline: 21037726] [doi: 10.1016/S0306-4603(00)00092-7]
17. Cunningham JA, Selby P, Kypri K, Humpheys K. Access to the Internet among drinkers, smokers and illicit drug users: Is it a barrier to the provision of interventions on the World Wide Web? Med Inform Internet Med . In press.
18. Copeland J, Martin G. Web-based interventions for substance use disorders: a qualitative review. J Subst Abuse Treat 2004 Mar;26(2):109-116. [Medline: 15050088] [doi: 10.1016/S0740-5472(03)00165-X]
19. Toll BA, Sobell LC, D'arienzo J, Sobell MB, Eickleberry-goldsmith L, Toll HJ. What do Internet-based alcohol treatment websites offer? Cyberpsychol Behav 2003 Dec;6(6):581-584. [Medline: 23122311] [doi: 10.1089/109493103322725351]
20. Cunningham JA, Humphreys K, Koski-jännes A. Providing personalized assessment feedback for problem drinking on the Internet: a pilot project. J Stud Alcohol 2000 Nov;61(6):794-798. [Medline: 21031228]
21. ; Alcohol Help Center. URL: http://www.alcoholhelpcenter.net [accessed 2005 Sep 29] [WebCite Cache ID 1135197560471022]
22. Cunningham JA, Wild TC, Bondy SJ, Lin E. Impact of normative feedback on problem drinkers: a small-area population study. J Stud Alcohol 2001 Mar;62(2):228-233. [Medline: 21223836]
23. ; Stop Smoking Center. URL: http://www.stopsmokingcenter.net [accessed 2005 Sep 29] [WebCite Cache ID 95652]
24. Cunningham JA, Selby P, var Mierlo T. Integrated online services for smokers and drinkers? Use of the Check Your Drinking assessment screener by participants of the Stop Smoking Center. Nicotine Tob Res . In press.

25. ; Personal Information Protection and Electronic Documents Act (Canada). 2000 (amended 2004). URL: http://privcom.gc.ca/legislation/02_06_01_e.asp [accessed 2006 Apr 8] [WebCite Cache ID 95688]
26. ; Health Insurance Portability and Accountability Act of 1996 (United States of America). Pub L No 104-191. 1996. URL: http://www.hhs.gov/ocr/hipaa/ [accessed 2006 Apr 8] [WebCite Cache ID 95708]
27. Eysenbach G. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res 2004 Sep 29;6(3):e34 [FREE Full text] [Medline: 15471760] [doi: 10.2196/jmir.6.3.e34]
28. Babor TF, De LFMF, Saunders JB, Grant M. AUDIT - The alcohol use disorders identification test: guidelines for use in primary health care. Geneva, Switzerland: World Health Organization; 1989.
29. Saunders JB, Aasland OG, Babor TF, De La Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption--II. Addiction 1993 Jun;88(6):791-804. [Medline: 93320765] [doi: 10.1111/j.1360-0443.1993.tb02093.x]
30. Kühlhorn E, Leifman H. Alcohol surveys with high and low coverage rate: a comparative analysis of survey strategies in the alcohol field. J Stud Alcohol 1993 Sep;54(5):542-554. [Medline: 94017742]
31. Romelsjö A, Leifman H, Nyström S. A comparative study of two methods for the measurement of alcohol consumption in the general population. Int J Epidemiol 1995 Oct;24(5):929-936. [Medline: 96128720]
32. Bondy SJ, Lange P. Measuring alcohol-related harm: test-retest reliability of a popular measure. Subst Use Misuse 2000 Aug;35(9):1263-1275. [Medline: 21247319]
33. Adlaf EM, Ialomiteanu A. Canadian addiction survey: technical eguide. Toronto, Ontario: Centre for Addiction and Mental Health; 2004.
34. Grant BF, Moore TC, Shepard J, Kaplan K. Source and accuracy atatement. Wave 1. National epidemiologic survey on alcohol and related conditions (NESARC). Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2003.
35. Walker A. Living in Britain: results from the General Household Survey 2001. London, UK: TSO; 2002.
36. Singleton N, Bumpstead R, O'Brien M, Lee A, Meltzer H. Psychiatric morbidity among adults living in private households, 2000. Int Rev Psychiatry 2003;15(1-2):65-73. [Medline: 12745312] [doi: 10.1080/0954026021000045967]
37. Room R, Bondy SJ, Ferris J. The risk of harm to oneself from drinking, Canada 1989. Addiction 1995 Apr;90(4):499-513. [Medline: 95291110] [doi: 10.1111/j.1360-0443.1995.tb02185.x]
38. Ashley MJ, Ferrence R, Room R, Bondy S, Rehm J, Single E. Moderate drinking and health. Implications of recent evidence. Can Fam Physician 1997 Apr;43:687-694. [Medline: 97266191]
39. Saunders JB, Conigrave KM. Early identification of alcohol problems. CMAJ 1990 Nov 15;143(10):1060-1069. [Medline: 91028952]
40. Wild TC, Hinson R, Cunningham J, Bacchiochi J. Perceived vulnerability to alcohol-related harm in young adults: independent effects of risky alcohol use and drinking motives. Exp Clin Psychopharmacol 2001 Feb;9(1):117-125. [Medline: 21410407] [doi: 10.1037/1064-1297.9.1.117]
41. Etter JF. Comparing the efficacy of two Internet-based, computer-tailored smoking cessation programs: a randomized trial. J Med Internet Res 2005 Mar 8;7(1):e2. [Medline: 15829474] [doi: 10.2196/jmir.7.1.e2]
42. Eysenbach G. The law of attrition. J Med Internet Res 2005 Mar 31;7(1):e11 [FREE Full text] [Medline: 15829473] [doi: 10.2196/jmir.7.1.e11]
43. Koo M, Skinner H. Challenges of internet recruitment: a case study with disappointing results. J Med Internet Res 2005 Mar 19;7(1):e6 [FREE Full text] [Medline: 15829478] [doi: 10.2196/jmir.7.1.e6]

Abbreviations

AUDIT: Alcohol Use Disorders Identification Test
CYD: Check Your Drinking

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Original Paper

Health Information Literacy and Competencies of Information Age Students: Results From the Interactive Online Research Readiness Self-Assessment (RRSA)

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Abstract

Background: In an era of easy access to information, university students who will soon enter health professions need to develop their information competencies. The Research Readiness Self-Assessment (RRSA) is based on the Information Literacy Competency Standards for Higher Education, and it measures proficiency in obtaining health information, evaluating the quality of health information, and understanding plagiarism.

Objective: This study aimed to measure the proficiency of college-age health information consumers in finding and evaluating electronic health information; to assess their ability to discriminate between peer-reviewed scholarly resources and opinion pieces or sales pitches; and to examine the extent to which they are aware of their level of health information competency.

Methods: An interactive 56-item online assessment, the Research Readiness Self-Assessment (RRSA), was used to measure the health information competencies of university students. We invited 400 students to take part in the study, and 308 participated, giving a response rate of 77%. The RRSA included multiple-choice questions and problem-based exercises. Declarative and procedural knowledge were assessed in three domains: finding health information, evaluating health information, and understanding plagiarism. Actual performance was contrasted with self-reported skill level. Upon answering all questions, students received a results page that summarized their numerical results and displayed individually tailored feedback composed by an experienced librarian.

Results: Even though most students (89%) understood that a one-keyword search is likely to return too many documents, few students were able to narrow a search by using multiple search categories simultaneously or by employing Boolean operators. In addition, nearly half of the respondents had trouble discriminating between primary and secondary sources of information as well as between references to journal articles and other published documents. When presented with questionable websites on nonexistent nutritional supplements, only 50% of respondents were able to correctly identify the website with the most trustworthy features. Less than a quarter of study participants reached the correct conclusion that none of the websites made a good case for taking the nutritional supplements. Up to 45% of students were unsure if they needed to provide references for ideas expressed in paraphrased sentences or sentences whose structure they modified. Most respondents (84%) believed that their research skills were good, very good, or excellent. Students’ self-perceptions of skill tended to increase with increasing level of education. Self-reported skills were weakly correlated with actual skill level, operationalized as the overall RRSA score (Cronbach alpha = .78 for 56 RRSA items).

Conclusions: While the majority of students think that their research skills are good or excellent, many of them are unable to conduct advanced information searches, judge the trustworthiness of health-related websites and articles, and differentiate between various information sources. Students’ self-reports may not be an accurate predictor of their actual health information competencies.

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KEYWORDS

Health information; electronic health information; evaluation of electronic resources; electronics; telecommunications; consumer health information; patient education; educational status; computer network

Introduction

Background and Purpose of the Study

As society moves toward evidence-based medicine [1], health providers, health educators, and health care consumers must acquire not only basic health information literacy skills but also more advanced competencies [2]. These competencies include evaluation of the quality of health information resources, obtaining health information documents on narrow topics by conducting advanced searches, judging the trustworthiness of health information sources, and understanding the advantages and disadvantages of different media. The last point is of special concern because many individuals have come to rely on the Internet as a main source of health information. This research addresses the Healthy People 2010 Objective 11-2, currently worded as "to improve the health literacy of persons with inadequate or marginal literacy skills," but which may be expanded to the entire US population instead of only to those with marginal or inadequate literacy skills [3]. In addition, it aims at providing needs assessment information that may aid in accomplishing Objective 11-3, which is related to increasing the proportion of health communication activities that include research and evaluation, and Objective 11-4, set to increase the proportion of health-related websites that disclose information that can be used to assess the quality of the sites.

Recent reports suggest that over 55% of Americans with Internet access seek health information online [4]. One of the most common complaints about online health information searches is the amount of time required to process the documents that are found [5], but this observation is likely to be related to the general nature of the searches conducted—few information consumers use advanced search features, precisely specify their keywords, or limit their searches in some other way. While Internet search engines help identify a very large number of health-related documents, their use calls for advanced competencies that not all information consumers may possess. For example, the vast majority of documents found on the Internet have not passed a rigorous peer-review process. The ability to conduct one's own review is clearly an advanced skill. Arguably, health information consumers will be at a greater risk of making health decisions on the basis of noncredible information if they conduct a Google search as opposed to a search in a scholarly library database. This risk will be particularly high for individuals with poor health information competencies. Research comparing clinical evidence to Internet information reveals numerous examples of erroneous and potentially harmful information on such popular topics as cancer rates, smoking cessation methods, and fever management in children [6-8].

Internet users may tend to underestimate the effort and competence required for obtaining trustworthy health information. A decade ago, communication researchers who compared print and television media described this paradox:

> *[Individuals] have learned that print materials, so highly prized in school and elsewhere, are indeed more difficult to process, whereas TV can be processed for pleasure without much effort. However, this argument pertains only to the minimum effort needed for the satisfactory processing of materials; it says nothing about the amount of additional effort one could expend in processing televised material if one aimed at a deeper understanding of it[9].*

Although the Internet provides access to a vast number of documents on health-related topics, it is hard to build evidence-based knowledge about a health issue if one cannot determine the credibility of websites and the trustworthiness of the online documents. The *minimum* effort required for identifying millions of websites on a particular health topic is in sharp contrast with the *average* effort required to sift through the gigabytes of information in order to sort out the most credible documents, or at least those that appear as such.

Higher education institutions in the United States provide access to an unprecedented quantity of digital information via library archives, licensed online databases, and the public-access Internet. To differentiate between publicly accessible Web documents and password-protected scholarly databases, which can be accessed by paid members via the Web, we refer to the former as the "the public-access Internet."

Our study explores three basic questions: How proficient are university students at finding and evaluating health-related information? How well do they understand the difference between peer-reviewed scholarly resources and opinion pieces or sales pitches? How aware are they of their own level of health information competencies? The main goal of this project was to identify approaches to building Information Age competencies of young health consumers, specifically a cohort of 18- to 23-year-old students enrolled in higher education programs.

Literature Review: Health Information and the Internet

In accordance with the Healthy People 2010 health communication objective [3], public health professionals attempt to assist consumers seeking health information via the Internet, for instance, by reinforcing the need for quality standards and widespread criteria for evaluating health information [10-14]. Cline and Haynes [10] note that, while critics are fast to question the quality of online health information, limited empirical research on this topic does not allow any broad conclusions to be drawn. In a study published the same year, Eysenbach and colleagues [15] reported that Internet coverage of health information was often inconsistent, although the accuracy was generally good, and that search engines and simple search terms did not provide efficient access to health information. Crespo [16] reviewed several studies on online health information seekers and concluded that most users seemed to focus on finding information quickly rather than on evaluating the information found. Similarly, Eysenbach and Kohler [17] found that individuals explored only the first few links obtained from a search using a general search engine. Although some Internet users attempted to assess the credibility of sites by, for example, examining their source and professional designs, many people did not read the “about us” sections of websites, learn about the authors or owners of the sites, or review disclaimers and disclosure statements. Very few Internet users later remembered from which websites they retrieved information or who stood behind the sites [17].

Thus, abundance of health information does not always translate into informed choices. Hibbard and Peters [18] suggest that three factors should be considered in selecting information presentation strategies: (1) the complexity and amount of information; (2) the nature of the choice—degree to which there is a right or best option; and (3) the experience, motivation, and skills of users. The third point, deficient information skills, may prevent members of the public from recognizing that key information is missing, from understanding the difference between biased and unbiased information, from distinguishing evidence-based claims, and from interpreting the information intended for health professionals [10]. Researchers, having observed individuals who, on average, spent about one-half hour looking for health information, concluded that information consumers should have at least a tenth grade reading level to process Web materials. Many websites presented to the participants of this study contained material at a college level [15].

Online health care is having a growing cultural impact, affecting the practitioner-patient relationship and opening up the possibility of new roles for social workers and educators in the provision of health services [19]. The increasing use of the Internet draws scientists’ attention to modeling individual behavior, contributing to the development and refinement of individual health theories and models, such as the Theory of Planned Behavior, The Health Belief Model, and The Transtheoretical Model [20]. The theoretical framework for this study is largely based on the information processing theories and concepts discussed below.

Schneider and Shiffrin [21] distinguish two qualitatively different modes: (1) conscious, intentional processing of information that is capacity limited (*controlled processing*), and (2) quick and efficient *automatic processing* of information that has greater capacity, for example, when several tasks can be done at the same time. Automaticity requires less attentional resources than controlled processing, and it is developed through extensive practice under the condition of consistent stimuli and response requirements. When surfing the Internet, for example, health information consumers limit their exposure to inconsistent conditions—they tend to use the same search engines and the same searching methods, such as entering keywords into the nonadvanced search window. The assessment of health information competencies in this study incorporates tasks that call for automatic processing and tasks where stimuli and response requirements of the task are inconsistent with most health information consumers’ information search practices.

We also draw upon Anderson’s ACT theory [22,23], which explains skill acquisition. It incorporates research on automaticity and explains the development of cognitive skills important for processing digitized health information from a variety of electronic sources [24]. According to Anderson [22,23], skill development has three stages: (1) the declarative knowledge stage, when knowledge of facts is built, such as facts about reputable sources of health information and general procedures for obtaining information; (2) the knowledge compilation stage, which is characterized by proceduralization and composition; and (3) the procedural stage. To illustrate the second stage, consider a health information consumer who follows a set sequence of specific steps to search for a health-related terms (*proceduralization*) and reapplies this sequence until sufficient information on a health topic is found (*composition*). Once at the knowledge compilation stage, a consumer can perform an information search task at a higher speed and with fewer errors than at the declarative knowledge stage. High speed and low error rate are both important markers of skilled performance. However, a disadvantage of knowledge compilation is the rigidity of behavior, when individuals find it increasingly difficult to attend to intermediate feedback (e.g., step-related results) and engage in strategy modification (e.g., by adopting a search strategy that produces a greater number of trustworthy health information resources) [24]. Declarative and procedural knowledge are discussed in greater depth in the Methods section.

An Interdisciplinary Research Partnership

Our research originated from the collaboration of a psychologist, a health educator, and a librarian who set out to understand and improve health information competencies of the Information Age generation. The collaboration enhances our research in several ways. The psychologist contributes expertise in the area of psychometrics and test design, whereas the health educator contributes knowledge of health consumers’ behavior and intervention designs. The librarian contributes expertise in training and enhancing patrons’ health information–seeking skills [25], as well as knowledge about gateways to authoritative consumer health information, for example, Medline Plus [26,27]. Linnan and colleagues [28] believe that library/public health partnerships are capable of increasing information access, the quality of available health information, and the technological expertise of all community members. Neighborhood libraries often serve the online health information needs of consumers who may not have Internet access at home, such as the elderly, ethnic groups, and low-income and undereducated populations [29,30], whereas university libraries also serve as gateways to scholarly health materials that are not available on the public-access Internet. In addition to public-access health resources available online, this research focuses on scholarly health resources in academic libraries and their use by students who are training to become health professionals.

Methods

Participants

A sample of 400 college-age students was selected because this cohort is the first Information Age generation that has been exposed, for up to one-half of their lives, to the Internet. Students enrolled in three courses in the College of Health

Sciences at a Midwestern university were invited to participate in the study. The first class was a high-enrollment introductory course on the determinants of health. Although only undergraduate students (n = 354) participated in this course, they represented all levels of undergraduates—freshman (59%), sophomores (22%), juniors (9%), and seniors (10%). The second class was an advanced course in health administration in which both undergraduate (n = 19) and graduate students (n = 3) were enrolled. The third class was a mid-level health education course (n = 25) for undergraduate students. All students enrolled in the advanced health administration course and the mid-level health education course were majoring in health professions. About one third of the introductory course students with declared majors were majoring in a health-related discipline, and 31% of students had not made up their minds about a major field of study.

Introductory course students completed the assessment for extra credit, while others did it to learn more about their own skills. The instructors emphasized that the purpose of the assessment was to help students become competent consumers of health-related information.

Measures

Health Information Competencies

Ivanitskaya and Casey developed the Research Readiness Self-Assessment (RRSA) to measure basic research skills based on the Information Literacy Competency Standards for Higher Education developed by the Association of College and Research Libraries [2,31]. The RRSA designers' original intent was to measure information competencies, both general and discipline specific, of students attending colleges and universities. A health information version of the RRSA is discussed in this paper; it was created to specifically evaluate health information competencies. Competencies are knowledge/skills sets essential for accomplishing a goal, in this case, finding quality information on a specific health topic. The RRSA measures competencies linked to such college-age health information consumer behaviors as determining possible sources of health information, conducting health information searches, evaluating the quality of documents found, and using those documents appropriately. One of the relevant competencies is knowledge of plagiarism because it can be applied to properly recognize ideas contributed by others and to evaluate health-related documents. The RRSA designers aimed at measuring *foundational* competencies that are (1) transferable to other knowledge domains (e.g., social sciences in addition to health sciences); (2) applicable to a large number of health information consumers; (3) consistent with typical behaviors or experiences of health information consumers who seek information from electronic sources; and (4) that capture the nature and spirit of critical thinking, life-long learning, and advances in information technology. It is important to note that the RRSA instrument does not measure higher order skills that characterize experienced researchers, such as the design of clinical trials [31]. The word *research* in the assessment's title matches the language commonly used by the lay population, as in "going to Google to research a health topic," which is indicative of such behaviors as searching, judging, and making decisions.

The RRSA contains the following items: (1) multiple choice or true/false questions that measure declarative knowledge; (2) interactive, problem-based exercises that measure procedural knowledge; (3) demographic questions; and (4) a question that asks for a self-report about the level of the respondent's research skills [31].

Declarative knowledge, defined as knowledge of facts or verbal knowledge, is a precursor to higher-order learning, which is needed, for example, to complete a sequence of steps to critically analyze a website or to employ elegant information search strategies [32]. Declarative knowledge questions in the RRSA measure knowledge of plagiarism, health information sources, and research-related terminology. For example, the following item is used to measure knowledge of research-related terminology:

> *A journal article abstract is…*
>
> 1. *an annotated list of references used in the article*
> 2. *a summary of the article's content*
> 3. *a summary of other research on this topic*
> 4. *a note or paragraph about the authors of the article*
> 5. *a glossary of abstract concepts included in the researcher's model*

Compared to declarative knowledge, procedural knowledge is related to skills and problem solving. Essential for reproduction of learned behaviors, procedural knowledge is defined as knowledge of the process used to complete a task (e.g., how an information search process can be sequenced, organized, or controlled) [32]. In the RRSA, problem-based interactive exercises are used to measure procedural knowledge. Procedural knowledge questions include links to websites, library catalogs, and interactive search modules designed specifically for the RRSA. Students demonstrate their database navigation skills by setting up basic and advanced searches. For example, the following item is used to measure skill in conducting a search using Boolean operators (*and, or, not*):

> *You are interested in gathering information about work stress but are not interested in its medical side effects. Set up a document search in a separate window using the following keywords: stressmedical. Click here to begin your search [a hyperlink to an interactive online module similar to searches in health-related library databases, such as Medline, with text fields for entering key words and a choice of Boolean operators]. Report the number of documents you found: a) 255; b) 555; c) 700; d) 1164; e) 55164.*

In addition, students evaluate the quality of research publications, make judgments about website trustworthiness, and detect plagiarism. For example, the following item is used to measure evaluation of the trustworthiness of websites:

> *You are looking for information on various nutritional supplements. You found three websites. Click on the links below to examine each site and to evaluate its*

> *content. Which of these websites is the most trustworthy? a) cognitogenic aids [a hyperlink]; b) dormitogenic aids [a hyperlink]; c) vescorogenic (gustatogenic) aids [a hyperlink].*

Instrument Piloting and Validation

To pilot test an earlier version of the RRSA instrument and to gather initial evidence about its validity and reliability, we administered a 60-item assessment to undergraduates (n = 100) and doctoral students (n = 45), as well as professional librarians (n = 5) and health professionals (n = 3). The feedback from librarians and health professionals offered preliminary evidence in support of the instrument's face validity and content validity. Specifically, the librarians confirmed that the items included in the RRSA assessment conformed to the Information Literacy Competency Standards and addressed knowledge and skills important to health information consumers. The wording of several items, both stems and response options, was revised based on librarians' recommendations. In addition, the librarians completed the assessment themselves. Their scores were then compared to the scores of students at two academic levels, undergraduate and doctoral. The results indicated that individuals with greater training and experience in managing digital health information performed better than individuals with less experience. Undergraduate students' overall scores were the lowest (about 66% correct responses), followed by doctoral students' scores (73%) and librarians' scores (95%). These results offer preliminary evidence of the assessment's criterion-related validity. The pilot test indicated an acceptable internal consistency value (Cronbach alpha > .70), although it could be improved (approach .80) if four items were removed. Therefore, four RRSA items that reduced the overall internal consistency were deleted.

The revised assessment contains 56 items, including 16 multiple-choice questions and 40 true/false questions grouped under 7 stems (Multimedia Appendix 1). For example, knowledge of information sources is measured by a stem that states, "Which of these citations are to journal articles?" The participants then check all that apply from the list of 6 true/false items (3 references to journal articles, 1 book reference, and 1 book chapter reference). Items are scored as +1 if the answer is a correct positive or a correct negative and +0 if the answer is a false positive or a false negative. Further description of the development of the stimulus materials used in website evaluation appears in the Results section, under Proficiency in Evaluating Health Information.

The RRSA assessment was designed to be useable by more than one institution. Its content can be adapted to the needs of various educational programs. Specifically, instructions to participants, the text of individual questions, detailed feedback, links to additional resources, and disclaimers (e.g., about participants' rights and how the information they provide will be used) can be revised, without help from programmers, using the password-protected online control panel. This has been done by three US universities and one Canadian university that adopted the RRSA for use in their academic programs. For example, all four institutions revised search questions to enable their students to search for documents in their own university's library catalog. The original RRSA designers provide coaching and training in order to ensure that the changes made to the RRSA do not have a negative impact on its reliability and validity. Ongoing validation studies provide a quality control mechanism and allow the testing of new or revised questions suggested by the partner institutions. The administration of the RRSA to partner institutions is supported through grants, partner donations, and volunteer efforts by the RRSA design team members.

Other Measures

We asked the study participants to share information about their age, gender, and education. Self-reported level of research skills was measured with a single item, "How do you rate your research skills?" with six response options ranging from 1 (nonexistent) to 6 (excellent).

Procedures

The RRSA instrument was administered online. Each student was issued a unique pass to access RRSA questions. The students had the option of submitting an incomplete survey and then returning to it at a later time to finish the remaining questions. This feature promoted better information processing and relieved the students from the need to rush and finish the entire assessment on their first attempt. The average estimated RRSA completion time was 26 minutes. Upon answering all questions, the students received an individualized results page that summarized their performance in different areas by providing a score, a maximum possible score, and percent attained. In addition to the numerical RRSA results, the Web page displayed individually tailored feedback composed by an experienced librarian. The Web page was programmed to compare, within each performance category, each individual student's performance to the performance of a norm group. In accordance with the student's competency level, the feedback provided suggestions for skill improvement and an explanation of factors that may have contributed to low, average, or high performance in each area. Finally, students who completed the RRSA were given the option to request additional materials for remedial learning, such as an explanation of the difference between scholarly and nonscholarly resources. The links to these additional materials were delivered to students via email.

Data Analyses

Descriptive statistics were used to examine respondents' performance in four areas—searching for health-related information, understanding plagiarism, evaluating health information, and self-reported skill level. To examine the relationship between self-reported skill level and actual performance, we computed composite scores. A composite overall score, which is indicative of the health information competency level, was created by adding points for 56 items, which were either true/false or multiple choice. Composite score calculations were preceded by an internal consistency reliability analysis that determined the appropriateness of combining responses from multiple items. We used a Spearman correlation to assess the relationship between the actual skill level (overall score) and self-reported skill level. A multiple regression analysis was used to examine the relationship between actual performance and perceived skill while holding the amount of education (number of credit hours earned) constant.

Results

Our research questions were the following: How proficient are university students at searching for and evaluating health-related information? How well do they understand the difference between peer-reviewed scholarly resources and opinion pieces or sales pitches? How aware are they of their own level of health information competencies? The results for each question are presented below, preceded by a sample description.

Respondent Characteristics

The participation rate was 77%. Nonrespondents (n = 92) differed from respondents (n = 308) in terms of their academic level (t_{400} = 2.29, *P* = .02). Freshmen were slightly more likely not to participate in the RRSA than seniors; the participant group included 7% less freshmen and 10% more seniors than the nonparticipant group. Most respondents were female (77%) and between 18 and 23 years of age (95%). The vast majority of respondents (98%) did not have a bachelor's degree, and the remaining students were working toward their master's degrees. Because we administered the RRSA to students in health professions courses, over one third of respondents were majoring in health sciences. Common majors were athletic training and sports medicine, health administration, physical education, pre-physical therapy, and public health promotion. On average, the undergraduates who participated in the study had completed 40 or fewer semester credit hours of university coursework. A quarter of respondents reported earning over 71 credit hours.

Proficiency in Searching for Health Information

Table 1 summarizes performance in searching for health information. The data indicate that most students recognize common health journal titles and can perform a basic search in a library catalog, for example, by entering an exact book title into the title search. Few students, however, can perform an advanced search for a book when they know the book's author (with a very common last name), general topic, and publication date. We call this search advanced because imprecise book specifications make it hard to find the book without performing a search that takes into account all or nearly all of the available information.

The data also show that two thirds of study participants are unable to understand or apply Boolean operators, such as *and*, *or*, and *not*. Boolean operators are used in most search engines, including those used for navigating the Internet (Google or Yahoo), library databases with scholarly journal articles, and library catalogs. Even though most students (89%) understand that a one-keyword search is likely to return too many documents, few are able to narrow a search by using multiple search categories simultaneously or by employing the Boolean operators. In addition, nearly half of the respondents have trouble discriminating between primary and secondary sources of information, as well as between references to journal articles or other published documents, such as books or book chapters.

Proficiency in Evaluating Health Information

One of the most important markers of a competent health information consumer—critical judgment of information—is assessed in two ways: (1) the first set of questions calls for a review of three full-text articles from journals, and (2) the second set of questions calls for a comparison of three health-related websites.

The three journal articles are on the topic of job satisfaction, a topic relevant to any profession, and come from a full-text library research database. They include a rigorous empirical study, a case study, and an opinion article. Only the empirical study has a bibliography and an explicit statement about the author's affiliation. The opinion article, clearly the least authoritative source, makes no mention of the author's affiliation. As shown in Table 1, most respondents can determine the article publication date; it appears at the top of a full-text article. Many respondents can also identify an opinion article. Fewer respondents know how to determine if an article includes a research review and are able to check for the author's affiliation.

The three Web pages about nutritional supplements are realistic looking interactive screens that appear to be live websites. The content of these mock websites, developed specifically for the RRSA, includes graphics, hyperlinks, and text about nonexistent classes of nutritional supplements—cognitogenics, dormitogenics, and gustatogenics. Each website is dedicated to one class of supplement and explains its purpose (e.g., cognitogenics help people with learning disabilities), prevalence (e.g., "gustatogenic aids have been available in Germany and Canada for over five years"), and safety. Even though the descriptions of nutritional supplements were fictitious, all three websites accurately stated that the US Food and Drug Administration did not evaluate the safety or benefits of these nutritional supplements.

Table 1. Searching and evaluating health information: performance on select measures (n = 308)

	Respondents With Correct Answers	
	n	**%**
Searching for Health Information		
Knowledge of a scholarly source, *Journal of American Medical Association* (7)	293	95
Demonstration of a skill in locating a book in a university library catalogue based on its exact title (16)	286	93
Understanding that a one-keyword generic search may return too many documents—an overwhelmingly large number of resources on a variety of topics (4)	275	89
Use of a proper research strategy—thinking about a broad topic to identify a sub-area of interest (2)	268	87
Ability to detect a journal citation that is incomplete—lacks a year of publication (17)	241	78
Understanding of a term “article abstract”—a summary of the article’s content (8)	234	76
Knowledge that a journal is a source of scholarly (analytical) information on a narrowly specialized topic (6)	214	70
Understanding of a term “bibliography”—a list of references or citations (9)	213	69
Identification of a primary source of health information: medical record (14)	195	63
Identification of references to journal articles from a list of references that includes both book references and article references (11)	187	61
Knowledge of a peer-reviewed journal article as an authoritative source of specialized health information (12)	185	60
Identification of a primary source of health information: hospital annual report (14)	173	56
Demonstration of a skill in locating a book in a university library catalogue based on a non-unique authors’ name and a general topic (15)	111	36
Knowledge of Boolean operators (*and, not, or*) (3)	105	34
Demonstration of a skill in setting up and performing a search with Boolean operators (*and, not, or*) (13)	98	32
Evaluation of Information: Full-Text Journal Articles		
Evaluation of journal articles: Identification of an article published prior to year 2000 (22)	248	80
Evaluation of journal articles: Identification of an article based on opinion rather than well-supported evidence (19)	242	79
Evaluation of journal articles: Identification of an article based on a review of existing research (20)	166	54
Evaluation of journal articles: Identification of an article written by an author whose affiliation is unknown (21)	148	48
Evaluation of Information: Websites on Nutritional Supplements		
Evidence-based decision-making: Disagree that “all three websites make a good case for taking nutritional supplements” (25)	187	61
Evaluation of health-related websites: Identification of the most trustworthy website (23)	154	50
Evaluation of health-related websites: Ability to identify the purpose of a website—to sell services (24)	42*	46
Evidence-based decision-making: Agree that “none of the websites makes a good case for taking nutritional supplements” (25)	67	22

*This question was added later, and, therefore, it had a smaller number of respondents (n = 92).

Note: RRSA question numbers are shown in parentheses; see Multimedia Appendix 1 for exact question wording.

To facilitate comparison of the three websites, we built in standard features that provided clues about high or low credibility. The standard features are URLs (two websites were .org and one was .com), links to the authors’ biographies, dates of publication, references, disclaimers, and links to organizations with which the authors are affiliated. These features act as contextual clues that maximize or minimize the trustworthiness of the websites. A review of such features is part of many website evaluation recommendations (for example, in their 1999 publication, Kotecki and Chamness [11] draw evaluators’ attention to a website’s features rather than its text), yet it is unclear if health information consumers are able to compare these features across multiple websites.

These standard features, rather than the text content, are intended to differentiate the websites in terms of their credibility. Because all respondents are equally uninformed about the nutritional supplements described in the text, they must attend to other features when making quality-related judgments. This purposeful design was motivated by the desire to avoid the confounding influence of pre-existing knowledge about the subject matter described in the document that is being judged. A good measure of one’s ability to critically evaluate Web pages is being able to disentangle the judgment of a website’s features from the judgment of its content. Study participants may have had preconceived notions about the quality of nutritional supplements depending on their purpose (e.g., cognitogenics are for sleeping disorders and gustatogenics are for appetite suppression). To avoid a possible interaction between the untrustworthy features of a website and the believable description of the nutritional supplement, we asked a group of students (n = 52) to judge the trustworthiness of the supplements' descriptions presented as Microsoft Word documents rather than as websites. Although the level of trustworthiness was about the same for all nutritional supplement descriptions, the least trusted nutritional supplements were placed on the website with the highest number of untrustworthy features.

When five subject matter experts independently reviewed the three websites and rated their trustworthiness using the Kotecki and Chamness [11] website evaluation tool, they reached 100% agreement regarding the most trustworthy site. In comparison, undergraduates' performance was much poorer: only 50% of respondents were able to identify the most trustworthy website (see Table 1).

Understanding the Difference Between Scholarly Resources and Sales Pitches

Less than half of respondents determined the purpose of the least trustworthy website, which was to sell products and services. The visitors to this .com website are charged for reprints of the content, offered discounted products, and provided with multiple prompts (e.g., a running line) to book a consulting appointment with a private nutritionist who has few relevant qualifications. Customer testimonials posted on this site describe fantastic outcomes achieved within an unrealistically short time frame.

Less than a quarter of study participants reached the correct conclusion that none of the websites made a good case for taking the nutritional supplements, whereas 39% of respondents thought that all three websites made a good case for taking the supplements.

Understanding Plagiarism

Health care professionals are expected to share health information with others, for example, by summarizing information from a variety of sources and distributing it to patients and clients. Higher education programs prepare students to apply standard rules for acknowledging contributions by others and referencing idea sources. Because this skill set is expected to become an integral part of their professional ethics, we built the RRSA to include measures of students' knowledge of plagiarism, their ability to recognize it, and their awareness of its penalties. Our results indicate that the vast majority of students (92%) know that their university may impose a severe penalty for plagiarism, up to and including expulsion. Table 2 and Table 3 display responses to sample questions that measure declarative knowledge of plagiarism. They show that many students are aware that common knowledge can be reproduced without references, whereas words written by others should be enclosed in quotation marks and accompanied by a complete reference. But when presented with more ambiguous examples of plagiarism, some study participants demonstrated misconceptions about what constitutes plagiarism. A surprisingly large number of respondents believed that it is appropriate to present another person's ideas as their own without citing a specific source, especially if this person is a relative or if the original words have been slightly modified.

Table 2. Understanding plagiarism: when references are needed (n = 308)

Which of the following can be reproduced without proper reference? Check all that apply:	**Respondents With Correct Positive or Negative Answers**	
	n	**%**
Common knowledge[*]	294	96
Hospital board member's point of view	264	86
My classmate's ideas	232	75
Unpublished works	223	73
Spoken word	209	68
My dad's political opinions	156	51

[*] Common knowledge can be reproduced without proper reference.

Note: Items are scored as +1 if the answer is a correct positive or a correct negative and +0 if the answer is a false positive or a false negative.

Table 3. Defining plagiarism (n = 308)

Which of the following are plagiarism examples? Check all that apply:	**Respondents With Correct Positive or Negative Answers**	
	n	**%**
Submitting a free research paper that was downloaded off the Internet.*	290	95
Reproducing a sentence that you found quoted in a book without referring to the original source.*	276	90
Enclosing the word-for-word sentence in quotation marks, accompanied by a citation.	271	88
Copying from the source verbatim without any quotation marks but adding a citation.*	215	70
Putting someone's idea in my own words without citing a specific source.*	201	65
Using similar sentence structure to express another person's ideas without referring to the original source.*	169	55

*These items are examples of plagiarism..

Note: Items are scored as +1 if the answer is a correct positive or a correct negative and +0 if the answer is a false positive or a false negative.

To measure procedural knowledge of plagiarism, we ask respondents to compare a sentence from a *Health Affairs* article by Lapetina and Armstrong [33] to two other sentences that may have been plagiarized (question 20). Over two thirds of respondents (82%, n = 253) detected plagiarism in a sentence that closely follows the original but provides no reference to the original source. The percent of respondents who correctly identified a sentence without plagiarism (89%, n = 275) was comparable to the percent of respondents who knew that they should enclose the word-for-word sentence in quotation marks and cite the source (88%, n = 271, as shown in Table 3).

Awareness of Personal Health Information Competencies

When asked "How do you rate your research skills overall?" most respondents (84%) believed that their skills were good, very good, or excellent. To compare self-reported and actual skill levels, we computed an overall health information competency score for each participant. An acceptable level of internal consistency reliability (Cronbach alpha = .78) for 56 right/wrong items indicates that it is appropriate to calculate the overall score as the sum of points of these 56 items. The overall scores ranged from 20 to 54 with a mean of 37 (SD = 6.35) and did not significantly depart from a normal distribution.

Actual performance was examined by self-reported skill level. The group differences were mostly in the expected direction (see Table 4), but there was a large amount of variation in the overall score *within* each self-reported skill level. This indicates that the overall health information competency score was high for some students and low for other students, despite the fact that their self-reported competency was the same.

Table 4. Means for health information competency overall score by self-reported skill level

How do you rate your research skills?	**n**	**Mean Overall Score**	**SD**
Nonexistent	0	-	0
Poor	3	36.33	4.04
Fair	47	34.89	5.52
Good	162	36.89	6.29
Very good	83	37.64	6.89
Excellent	13	36.77	6.10
Total	308	36.78	6.35

Health information competencies may vary as a function of education; therefore, we regressed undergraduates' overall scores on the amount of credit hours earned toward the bachelor's degree (Step 1) and self-reported skill level (Step 2). The level of education was operationalized as the number of credit hours earned (0-9, 10-24, 25-40, 41-70, and more than 71). The analysis was conducted for 302 undergraduate students (six graduate students were removed from this analysis). Age could not be used as a control variable because most students (95%) fell into the same category of 18 to 23 years of age. The variables entered on Steps 1 and 2 account for 8% of variance in the overall score (R^2 = .08). The amount of education significantly predicted the overall score (β = .28, P < .001). When credit hours earned were held constant, self-reports of skill fail to explain a significant amount of variance in the overall score (β = .08, P = .23). Overall, the results suggest that although students' self-ratings of research skills tend to increase with the increasing level of education, these self-reports may not be an accurate predictor of students' actual health information competencies.

Discussion

Interpretation of Findings

The present study represents a systematic effort to measure health information competencies using a standardized and reliable measurement tool, the Research Readiness Self-Assessment (RRSA). The data were obtained from a diverse sample of 308 respondents (77% response rate). Nonrespondents (n = 92) differed from respondents (n = 308) in terms of their academic level: freshmen were slightly more likely not to participate in the RRSA than higher-level students. The most likely explanation for nonparticipation is a lack of interest in extra credit rather than the computer-assisted administration of the RRSA. It is possible, of course, that students with particularly poor computer skills found the online administration a barrier. However, a semester after we collected the data reported in this paper, there was a 100% participation rate by 180 undergraduates in two introductory courses where the instructors required RRSA completion. The two course instructors reported no student complaints about not being able to follow emailed instructions on how to complete the assessment.

The data indicate that many students lack important competencies that may limit their ability to make informed health choices. We observed deficiencies in the areas of conducting advanced searches, discriminating among different types of information sources, referencing other people's ideas, and evaluating information from Web pages and journal articles. Our data suggest that undergraduate students are inaccurate judges of their own competencies and hold a very positive view of their ability to do research. This finding may reveal an important barrier to building health information competencies of college-age students.

We found that there is a large competency gap between the average and the best information consumer. An average undergraduate in our sample is able to solve only 68% of problems that are solved by the best performing study participant (an average score of 37 versus a maximum score of 54). Health information competencies are applied to transform health-related information into knowledge that is consistent with the most current medical practice. High competence variability is a proxy indicator of students' varying ability to make evidence-based decisions. In the past, limited access to information may have prevented health information consumers from acquiring knowledge and making informed choices. The new generation of health information consumers has, for the most part, easy access to information; yet it may not be able to take full advantage of this convenient access.

Our study shows that individuals with limited health information competencies may fail to locate the best available information due to employing poor search strategies. Searches that do not take into account all of the important criteria often produce low-relevancy documents or documents from commercial websites that promote products or services. These sites often present one-sided evidence, which can be detrimental to making a good decision about one's health. Overall, many students are rather unsophisticated information consumers who rely on basic searchers and the easiest ways of retrieving information.

We found that many individuals know little about information sources—primary versus secondary, articles versus books, commercial versus noncommercial websites, and opinion pieces versus empirical studies. Information consumers who do not understand these distinctions are likely to engage in information processing that is shallow and superficial. They may, for example, follow a search path that produces the highest number of documents, rather than a path that produces documents of the highest quality. When the number of documents criterion is applied, Google and Yahoo significantly outperform all scholarly databases available through libraries. For instance, a Google search for the keyword *health* produces, in less than a second, over 8 million results ordered by popularity (as of June 2005, 25% of these results had .com URLs and 16% had .org or .gov URLs), where a similar search in Medline Plus produces 665 results, organized by health topic. With heavy reliance on public-access Internet search engines, an Information Age generation student may have an inaccurate conception that the Internet is the only place where society stores its best knowledge.

Once the plethora of documents is obtained, they need to be critically evaluated. Although health consumers are warned to critically examine websites to determine the document's purpose, author's affiliation, date of publication, and other features [11-14], these website evaluation criteria are only useful to those who know how to apply them. Many students in our sample appear not to possess these skills, and this finding is consistent with other observational studies (e.g., [17]). Our website evaluation exercise reveals both poor judgment and readiness to follow the lead, even when the authors of the online documents do not explicitly ask for purchase of their products. Although we measured a behavioral intent, rather than an actual behavior, there is still a significant potential for harm, ranging from financial losses to negative health effects, if only a few individuals execute their intent to take nutritional supplements that can be best described as "fake" or "bogus." As we designed the most trustworthy website for the RRSA, it was alarming to witness the ease of misrepresenting or even falsifying health information. In designing the trustworthy site, we tried to meet as many website evaluation criteria as possible, and it became very apparent that these criteria do not guarantee information accuracy. Even completely false information about nonexistent food supplements can be made to appear trustworthy, as though it comes from an authoritative source.

Indeed, there is no substitute for good judgment when it comes to navigating information. Because this good judgment is a product of both critical thinking and extensive knowledge of the subject matter being researched, we believe that higher education programs are uniquely positioned to develop health information competencies. However, initial work on developing Information Age competencies needs to be done at the K-12 level when children are beginning to be exposed to various sources of information, including the Internet.

In this study, we reviewed three broad categories of information competencies—obtaining information, evaluating information, and using information. Using information includes such behaviors as reaching evidence-based conclusions and sharing information with others, a behavior guided by one's understanding of plagiarism. One study of plagiarism revealed that cyberplagiarism, or inappropriate use of phrases and ideas published on the Internet, is prevalent even among scholars [34]. Our findings suggest that, in college students, the plagiarism behavior may originate not only from motivation to cut corners (e.g., to cut-and-paste text without citations) but also from the lack of nuanced knowledge about plagiarism. The information revolution has rapidly intensified the exchange of ideas, but the distinction between plagiarism and proper acknowledgment of others' ideas continues to be poorly understood. Many students, for example, think that they do not need to provide references for paraphrased sentences or for sentences whose structure they modified. Perhaps these students view plagiarism as a violation of ownership of *exact words* rather than a violation of ownership of *ideas*. Similarly, some respondents believe that it is appropriate not to give credit for original ideas that are expressed orally (rather than in writing) or by people whom they know well. If carried into one's professional life, this misconception can make it difficult to follow ethical norms for recognizing others' knowledge contributions. Such ethical norms are strong in health professions, and their violation may lead to negative consequences.

Perhaps the most interesting finding is the fact that participants are so unaware of their own skill deficiencies. It is possible that students make global judgments about their research skills based primarily on their ability to access information. That is, one's ability to access information may be confused with one's ability to generate knowledge from the information accessed. But obtaining information is merely the first step of knowledge acquisition. All of our study participants can access the Internet, as demonstrated by completing the RRSA online, but not all may be able to make good use of the information they access. Extending the argument by Solomon and Leigh [9] from television to Internet search engines, we conclude that the effort an individual expends to locate millions of documents in Google is a poor indicator of the true effort needed to process the obtained material "if one aimed at a deeper understanding of it" [9]. The Information Age generation of college students may benefit from this point.

Implications for Health Promotion Practice

The findings of our study have several implications for individuals who practice health promotion for health information consumers. Health educators, librarians, and other professionals who play an active part in promoting health information literacy need to assist health information consumers in becoming more aware of their skill limitations. These professionals should develop their own proficiency in managing modern media and be able to find, evaluate, interpret, and present health-related information to other information consumers. Research on health information competencies of practicing health professionals remains limited, and we do not yet have a complete picture of their preparedness for evidence-based practice. But in one survey study of 1097 registered nurses, it was found that many respondents "had no exposure to the research process in their educational programs, do not appreciate the importance of research to practice, and have great difficulty understanding research articles" [35]. In this study, most registered nurses did not search databases such as Medline or felt skilled to do so. This preliminary evidence suggests that health professionals need to build their health information competencies.

The RRSA instrument offers an operational definition of information literacy, which remains an ill-defined concept. Upon examination of 97 Medline articles on the topic of information literacy for health care professionals, Saranto and Hovenga [36] found that the concept of information literacy has not yet been established. It is sometimes used interchangeably with *computer literacy* and *informatics awareness* or with the ambiguous term *computer experience*. The RRSA assessment used in the present study adds to the literature on health literacy by defining basic knowledge and skills needed for managing electronic health information resources.

Among the limitations of the present study is the narrowly focused sample, which limits our ability to generalize the study's findings to the broader population of health information consumers. The students from a Midwestern university may not be completely representative of the entire population of US Information Age students, due to, for example, the relatively homogeneous ethnic composition and possible overrepresentation of individuals raised in rural communities. In our future studies, we intend to broaden the pool of RRSA participants by including multiple educational institutions as well as urban and rural communities located in different geographic regions.

In contrast with many health information literacy studies, this research presents the results obtained via direct measure of skills and knowledge rather than via self-reports by health information consumers. While the reliability of the RRSA assessment reaches acceptable levels, it is necessary to further assess its unidimensionality, content validity, and criterion-related validity. A comprehensive validation study of the RRSA instrument is currently under way.

Conclusions

Today, health consumers are actively seeking information and using it to make health decisions. The ease of accessing information may influence their perceptions of their ability to make informed health decisions. Our study shows that to become savvy information consumers, young people may need assistance in understanding the various health media, building awareness of their own skill sets, and improving their ability to make evidence-based decisions. Individuals with less education and exposure to information-related activities are expected to have even lower health information competencies than our study participants [37]. Health educators must continue to partner with a variety of groups that play an important role in promoting health information literacy, such as librarians and educators.

The assessment tool used in the present study is a self-administered instrument that provides a reliable account of health information competencies related to managing electronic health information. Data acquired through this research can be used to suggest curriculum improvements and estimates of the higher end level of skill held by health information consumers. It can also be used to educate health information consumers about their levels of skill necessary for managing health information from electronic sources. RRSA findings suggest that health information competencies of undergraduate students, many of whom will soon enter a variety of health professions, are limited. Health literacy educators can utilize RRSA findings to design educational interventions that impact information consumers' skills and prepare them for the challenges of living and working in the Information Age.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

RRSA questions.

[WinWord (.doc) file, 52 KB - jmir_v8i2e6_app1.doc]

Multimedia Appendix 2

Video of the online-administered RRSA instrument.

[EXE file (Windows executable), 1.9 MB - jmir_v8i2e6_app2a.exe]

[SWF Macromedia Flash, 1.2 MB - jmir_v8i2e6_app2b.html]

Multimedia Appendix 3

Powerpoint slides about the RRSA study.

[PowerPoint (.ppt) file, 76 KB - jmir_v8i2e6_app3.ppt]

References

1. Bradley P, Herrin J. Development and validation of an instrument to measure knowledge of evidence-based practice and searching skills. Med Educ Online 2004;9(15) [FREE Full text]
2. ; Association of College & Research Libraries. Information literacy competency standards for higher education. Chicago, IL: Association of College & Research Libraries; 2000. URL: http://www.ala.org/ala/acrl/acrlstandards/informationliteracycompetency.htm [accessed 2006 Apr 8] [WebCite Cache ID 95237]
3. ; Office of Disease Prevention and Health Promotion. Communicating Health: Priorities and Strategies for Progress. Action Plans to Achieve the Health Communication Objectives in Healthy People 2010. 2003 Jul. URL: http://odphp.osophs.dhhs.gov/projects/HealthComm/ [accessed 2006 Apr 13] [WebCite Cache ID 1144960777105140]
4. Walther JB, Wang Z, Loh T. The effect of top-level domains and advertisements on health web-site credibility. J Med Internet Res 2004 Sep 3;6(3):e24. [Medline: 15471750] [doi: 10.2196/jmir.6.3.e24]
5. Hogan TP, Palmer CL. Information preferences and practices among people living with HIV/AIDS: results from a nationwide survey. J Med Libr Assoc 2005 Oct;93(4):431-439. [Medline: 16239938] [PMC: 16239938]
6. Biermann JS, Golladay GJ, Greenfield ML, Baker LH. Evaluation of cancer information on the Internet. Cancer 1999 Aug 1;86(3):381-390. [Medline: 99357313]
7. Cheh JA, Ribisl KM, Wildemuth BM. An assessment of the quality and usability of smoking cessation information on the Internet. Health Promot Pract 2003 Jul;4(3):278-287. [Medline: 22973147] [doi: 10.1177/1524839903004003012]
8. Impicciatore P, Pandolfini C, Casella N, Bonati M. Reliability of health information for the public on the World Wide Web: systematic survey of advice on managing fever in children at home. BMJ 1997 Jun 28;314(7098):1875-1879. [Medline: 97367429]
9. Solomon G, Leigh T. Predispositions about learning from print and television. J Commun 1984;34(4):129-130. [doi: 10.1111/j.1460-2466.1984.tb02207.x]

10. Cline RJ, Haynes KM. Consumer health information seeking on the Internet: the state of the art. Health Educ Res 2001 Dec;16(6):671-692. [Medline: 21639062] [doi: 10.1093/her/16.6.671]
11. Kotecki JE, Chamness BE. A valid tool for evaluating health-related WWW sites. J Health Educ 1999;30(1):56-59.
12. ; National Cancer Institute. How to evaluate health information on the Internet: questions and answers. URL: http://www.cancer.gov/cancertopics/factsheet/Information/internet [accessed 2006 Apr 8] [WebCite Cache ID 95271]
13. ; US Food and Drug Administration. Health information on-line. FDA Consumer. 1996 Jun. (5) URL: http://www.fda.gov/fdac/features/596_info.html#site [accessed 2006 Apr 8] [WebCite Cache ID 95274]
14. ; World Health Organization. Medical products and the Internet: a guide to finding reliable information. Geneva, Switzerland: WHO; 1999.
15. Eysenbach G, Powell J, Kuss O, Sa ER. Empirical studies assessing the quality of health information for consumers on the world wide web: a systematic review. JAMA 2002;287(20):2691-2700 [FREE Full text] [Medline: 22016241] [doi: 10.1001/jama.287.20.2691]
16. Crespo J. Training the health information seeker: quality issues in health information web sites. Libr Trends 2004;53(2):360-374.
17. Eysenbach G, Köhler C. How do consumers search for and appraise health information on the world wide web? Qualitative study using focus groups, usability tests, and in-depth interviews. BMJ 2002 Mar 9;324(7337):573-577 [FREE Full text] [PMC: 11884321] [Medline: 21881326]
18. Hibbard JH, Peters E. Supporting informed consumer health care decisions: data presentation approaches that facilitate the use of information in choice. Annu Rev Public Health 2003;24(1):413-433. [doi: 10.1146/annurev.publhealth.24.100901.141005] [Medline: 22553934]
19. Oravec JA. On the "proper use" of the Internet: self-help medical information and on-line health care. J Health Soc Policy 2001;14(1):37-60. [Medline: 21268684] [doi: 10.1300/J045v14n01_03]
20. Bensley RJ, Mercer N, Brusk JJ, Underhile R, Rivas J, Anderson J, et al. The e Health Behavior Management Model: a stage-based approach to behavior change and management. Prev Chronic Dis. 2004 Oct. (4) URL: http://www.cdc.gov/pcd/issues/2004/oct/04_0070.htm [WebCite Cache ID 95277]
21. Schneider W, Schiffrin RM. Controlled and automatic human information processing: I. Detection, search, and attention. Psychol Rev 1977;84:1-66.
22. Anderson JR. Acquisition of cognitive skill. Psychol Rev 1982;89(4):369-406. [doi: 10.1037/0033-295X.89.4.369]
23. Anderson JR. Skill acquisition: compilation of weak-method problem solutions. Psychol Rev 1987;94(2):192-210. [doi: 10.1037/0033-295X.94.2.192]
24. Weiss HM. Learning theory and industrial and organizational psychology. In: M. Dunnette, LM Hough, editors. Handbook of industrial and organizational psychology. 2nd ed. Vol. 2. Palo Alto, CA: Consulting Psychological Press; 1990:171-221.
25. Kovacs JK. Why develop web-based health information workshops for consumers? Libr Trends 2004;53(2):348-359.
26. ; US National Library of Medicine, National Institutes of Health. Medline Plus: Trusted Health Information for You. URL: http://medlineplus.gov/ [accessed 2006 Apr 8] [WebCite Cache ID 1142436740039770]
27. Miller N, Tyler RJ, Backus JEB. Medline Plus: The National Library of Medicine brings quality information to health consumers. Libr Trends 2004;53(2):375-388.
28. Linnan LA, Wildemuth BM, Gollop C, Hull P, Silbajoris C, Monnig R. Public librarians as a resource for promoting health: results from the Health for Everyone in Libraries Project (HELP) librarian survey. Health Promot Pract 2004 Apr;5(2):182-190. [Medline: 15090172] [doi: 10.1177/1524839903258018]
29. Connell E. Designing for diversity. Colorado Libraries 2004;30(1):39-40.
30. Detlefsen EG. Where am I to go? Use of the Internet for consumer health information by two vulnerable communities. Libr Trends 2004;53(2):283-300.
31. Ivanitskaya L, Laus R, Casey AM. Research Readiness Self-Assessment (RRSA): assessing students' research skills and attitudes. J Libr Adm 2004;41(1/2):167-183. [doi: 10.1300/J111v41n01_13]
32. Kraiger K, Ford JK, Salas E. Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. J Appl Psychol Monogr 1993;78(2):311-328. [doi: 10.1037/0021-9010.78.2.311]
33. Lapetina EM, Armstrong EM. Preventing errors in the outpatient setting: a tale of three states. Health Aff (Millwood) 2002;21(4):26-39 [FREE Full text] [Medline: 22111577] [doi: 10.1377/hlthaff.21.4.26]
34. Eysenbach G. Report of a case of cyberplagiarism--and reflections on detecting and preventing academic misconduct using the Internet. J Med Internet Res 2000 Mar 31;2(1):E4 [FREE Full text] [Medline: 21577988] [doi: 10.2196/jmir.2.1.e4]
35. Pravikoff DS, Pierce ST, Tanner A. Evidence-based practice readiness study supported by academy nursing informatics expert panel. Nurs Outlook 2005;53(1):49-50. [Medline: 15761401] [doi: 10.1016/j.outlook.2004.11.002]
36. Saranto K, Hovenga EJS. Information literacy-what it is about? Literature review of the concept and the context. Int J Med Inform 2004 Jun 30;73(6):503-513. [Medline: 15171979] [doi: 10.1016/j.ijmedinf.2004.03.002]
37. Birru MS, Monaco VM, Charles L, Drew H, Njie V, Bierria T, et al. Internet usage by low-literacy adults seeking health information: an observational analysis. J Med Internet Res 2004 Sep 3;6(3):e25 [FREE Full text] [Medline: 15471751] [doi: 10.2196/jmir.6.3.e25]

Abbreviations

RRSA: Research Readiness Self-Assessment

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Letter

Health Care Interventions Delivered Over the Internet: How Systematic was the Review?

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Related Articles:

Comment on: Griffiths F, Lindenmeyer A, Powell J, Lowe P, Thorogood M. Why Are Health Care Interventions Delivered Over the Internet? A Systematic Review of the Published Literature. J Med Internet Res. 2006 Jun 23;7(2) p. e10 http://www.jmir.org/2006/2/e10/

Comment in: Griffiths F. Health Care Interventions Delivered Over the Internet: How Systematic was the Review? - Author's Reply. J Med Internet Res. 2006 Jun 30;8(2) p. e12 http://www.jmir.org/2006/2/e12/

(J Med Internet Res 2006;8(2):e11) doi:10.2196/jmir.8.2.e11

I found the title and description of the recent review by Griffiths et al. [1] misleading. The authors describe their paper as "a systematic review". However, the article fails to cite several published (and indexed) trials of internet-delivered therapy (e.g. [2]). The search strategy and inclusion criteria were neither transparent nor replicable. The authors note that they did not "set out to identify every published eHealth intervention paper" yet give no reason to believe that the sample obtained is representative of the population of studies being reviewed.

References

1. Griffiths F, Lindenmeyer A, Powell J, Lowe P, Thorogood M. Why Are Health Care Interventions Delivered Over the Internet? A Systematic Review of the Published Literature. J Med Internet Res 2006 Jun 23;7(2):e10 [FREE Full text] [doi: 10.2196/jmir.8.2.e10]
2. Klein B, Richards JC. A Brief Internet-based Treatment for Panic Disorder. Behav Cog Psychother 2001 Mar 06;29(1):113-117. [doi: 10.1017/S1352465801001138]

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Letter

Health Care Interventions Delivered Over the Internet: How Systematic was the Review? - Author's Reply

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Related Articles:

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Author's Response

We thank Evan Mayo-Wilson for raising the issue on how systematic and exhaustive our search for our recent qualitative analysis [1] was. This was not a systematic review as in a common usage of the term for example by the Cochrane Collaboration. We used systematic methods to undertake a qualitative review of the literature on health care interventions delivered over the Internet. To identify common themes it was important to identify a broad range of published studies but we did not feel that it was necessary to be exhaustive. In our paper we describe in some detail how we identified the literature including the use of three existing systematic reviews, a hand search of JMIR and our own previously published literature review. Through the triangulation of these search approaches we aimed to identify the main body of relevant literature. We realise we may not have identified every published paper of relevance.

Thank you for drawing our attention to the paper by Klein and Richards [2]. This paper would be excluded from our review. As mentioned in our paper the focus of our review was interventions where the networking provided by the Internet is a component of the intervention. One of our exclusion criteria was “no networked features, such as computer-based decision support systems delivered from a CD or interventions where there was no use of the Internet beyond delivery (ie, they could have been delivered by a CD)”. From the description of the intervention in the Klein and Richards paper it appears to have no networked features.

References

1. Griffiths F, Lindenmeyer A, Powell J, Lowe P, Thorogood M. Why Are Health Care Interventions Delivered Over the Internet? A Systematic Review of the Published Literature. J Med Internet Res 2006 Jun 23;8(2):e10 [FREE Full text] [doi: 10.2196/jmir.8.2.e10]
2. Klein B, Richards JC. A Brief Internet-based Treatment for Panic Disorder. Behav Cog Psychother 2001 Mar 06;29(1):113-117. [doi: 10.1017/S1352465801001138]

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Original Paper

Who's Using PDAs? Estimates of PDA Use by Health Care Providers: A Systematic Review of Surveys

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Abstract

Background: Personal digital assistants (PDAs) find many uses in health care. Knowing rates of collective PDA use among health care providers is an important guiding step to further understanding those health care contexts that are most suited to PDA use and whether PDAs provide improved health outcomes.

Objectives: The objectives of this study were to estimate current and future PDA use among health care providers and to discuss possible implications of that use on choice of technology in clinical practice and research.

Methods: This study was a systematic review of PDA usage surveys. Surveys were identified as part of an ongoing systematic review on the use of handheld devices. Reports from eight databases covering both biomedical sciences and engineering (1993-2006) were screened against distinct eligibility criteria. Data from included surveys were extracted and verified in a standardized way and were assessed descriptively.

Results: We identified 23 relevant surveys, 15 of which were derived from peer-reviewed journals. This cohort of surveys was published between 2000 and 2005. Overall, since 1999, there is clear evidence of an increasing trend in PDA use. The current overall adoption rate for individual professional use ranges between 45% and 85%, indicating high but somewhat variable adoption, primarily among physicians.

Conclusions: Younger physicians and residents and those working in large and hospital-based practices are more likely to use a PDA. The adoption rate is now at its highest rate of increase according to a commonly accepted diffusion of innovations model. A common problem with the evaluation of information technology is that use frequently precedes research. This is the case here, in which PDA adoption rates are already high and projections are for rapid growth in the short term. In general, it appears that professional PDA use in health care settings involves more administrative and organizational tasks than those related to patient care, perhaps signaling where the growth in adoption is most likely to occur. We conclude that physicians are likely accustomed to using a PDA, and, therefore, technology expertise will probably not be a barrier to implementing PDA applications. However, there is an urgent need to evaluate the effectiveness and efficiency of specific tasks using handheld technology to inform those developing and those using PDA applications.

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KEYWORDS

Personal digital assistant; systematic review; survey; health care; health technology adoption

Introduction

A handheld computing device, also commonly known as a personal digital assistant (PDA), is a mobile computer about the size of the palm of the hand. More modern devices can access external networks or the Internet through a wireless connection. Since 1993, when Apple launched the first PDA (Newton MessagePad), use of PDAs has increased worldwide, with global PDA sales projected to surpass 17 million in 2008. This represents a compounded annual growth rate of 17.8% between 2002 and 2008 [1].

Health care has not been immune to this technological advance in handheld computing. In fact, PDAs find many applications in health care. Family physicians and specialists have been using PDAs for general medical reference, such as drug interactions, pharmacopeias, and cardiac risk [2-4]. Other important applications of PDAs are those involving data collection and management, as in patient tracking, electronic Case Report Forms in clinical trials, patient diaries, and infection surveillance [4-9]. However, the suitability of PDAs across all health care contexts and whether they benefit health outcomes remain open questions.

Many of us would agree that it is necessary to evaluate a technology before its adoption to allow health care providers to make informed decisions. However, given that technology is a moving target, a common problem with evaluation is that practice frequently precedes research. By the time researchers have obtained funding, completed a study, and published it, the technology is either in widespread use or has been abandoned [10]. As well, the appropriate type of evaluation is not independent of the stage of adoption of the technology. For example, if 90% of the target users have already adopted a technology, then studies evaluating its general utility will no longer inform the adoption decision. In this case, research should focus on optimization of the technology in use. This is a familiar scenario in information technology research, and it underscores the importance of understanding the rates of adoption in helping direct approaches to research [10].

In a general overview article, Fischer et al (2003) summarized the current literature covering the use of handheld devices in medicine, primarily related to PDA functionality [4]. While implementation issues were discussed, rates of adoption were not addressed. Further, a recent review of PDA use in health care by Baumgart (2005) examined operating systems, basic functionality, security and safety, and limitations of PDA use [11]. It is a thorough overview of studies published since 2000 that addresses applications of handheld computers for health care professionals, but it touches only briefly on the prevalence of handheld use. Therefore, to our knowledge, there has not been any structured review conducted to date that specifically addresses the extent of use of handheld devices and estimated adoption rates. As such, this paper aims to systematically summarize all available survey data on health care providers' use of PDAs with the view of presenting the best available estimates of current PDA use. This paper also aims to project expected future adoption based on established technology diffusion models. From this information we draw implications for research and practice.

Methods

For the purposes of this systematic review of surveys, the term PDA is used synonymously to refer to any handheld device. Some examples include the following: Blackberry; Palm operating system devices, which include Palm Tungstens, Handspring Visor, and Sony Clie; and Pocket PC devices, which include the Compaq iPAQ and HP Jordana.

Data Sources

Surveys were identified as a subset selected from a broader systematic review examining all studies related to handheld devices in health care settings. Thus, initial search strategies and retrieved articles reflected this more extensive focus. This comprehensive literature search was conducted in consultation with an information specialist. The searched bibliographic databases covered both medical and engineering disciplines, including the following eight databases: Medline, Current Contents, Inspec, BA/RRM, Biotechnology, Biological Abstracts, EI Compendex, and EMBASE. The search was restricted to English-language literature published January 1993 (corresponding to the development of the first palm device) to February 2005. An updated search of Medline (PubMed) and EI Compendex (EI Village 2) was run near the project's completion (January 30, 2006).

Furthermore, the reference lists from included studies were examined in an effort to identify additional surveys not captured in the reference databases. In addition, surveys identified from Google searches and those known to the authors to have been conducted by private market research firms as well as physician groups were nominated for inclusion in our screening.

Electronic Search Strategy

The intent of searching the biomedical databases was to retrieve *all* studies related to handheld devices in health care. It is for this reason that the word *survey* was not included as a specific term in the original search strategy. The search did include the sample search terms detailed in Appendix 1. The search strategy for engineering databases limited retrievals to those articles relating to both handheld computing and health. All bibliographic databases were searched using subject headings tailored to each database and free-text terms in the titles and abstracts.

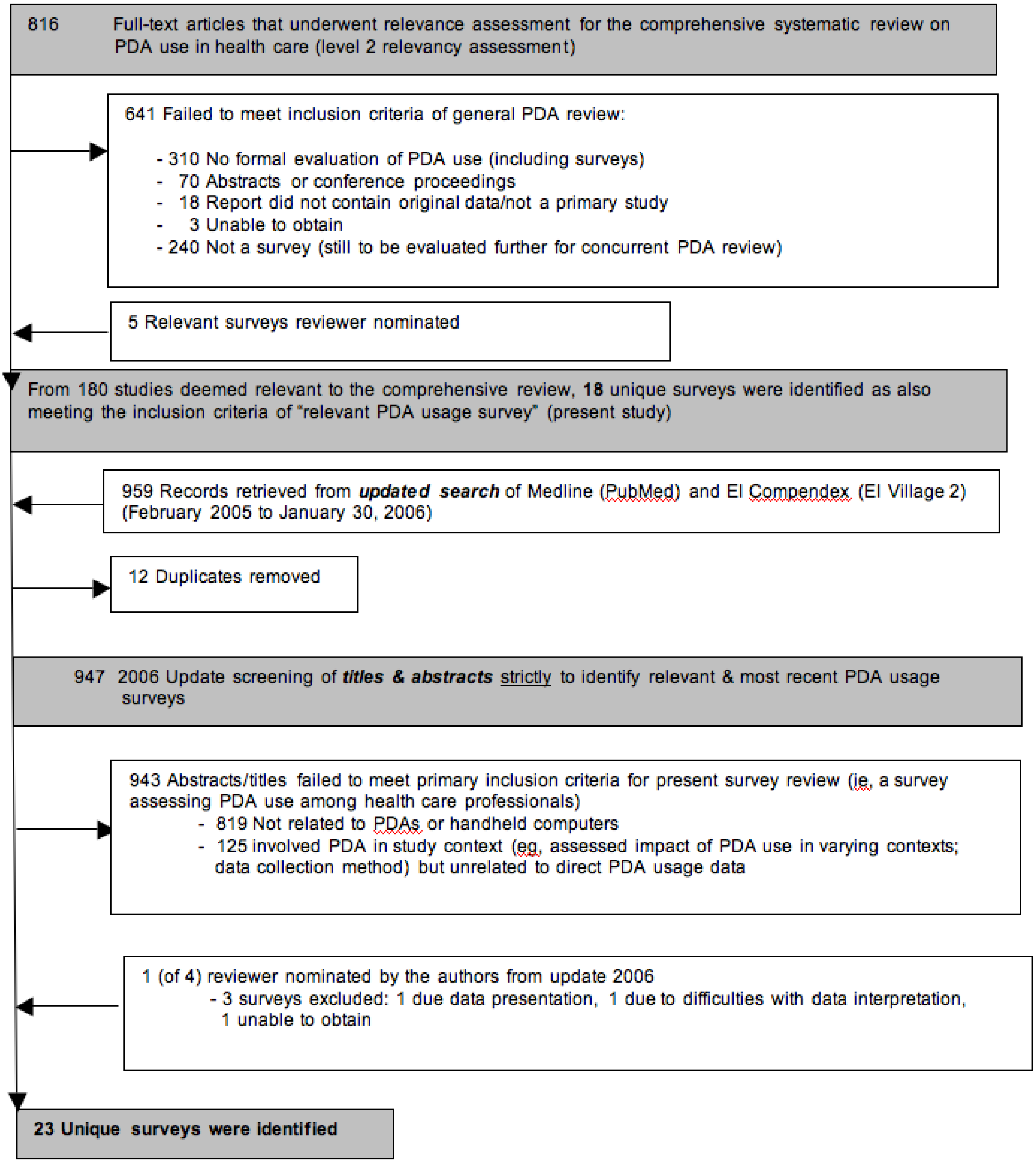
Eligibility Criteria

Surveys were included for this present review if they met the following initial criteria: related to an application in human health care and involved the use of a PDA device; contained original data; written in English (not including abstract or conference proceedings); published after 1993; and specifically reported handheld usage rates (prevalence of PDA use as a metric) in populations of health care professionals who were surveyed about the extent of their PDA use. Although conference proceedings were excluded, if deemed potentially relevant, a cross-check was conducted to see if there was an ensuing journal publication. A survey was not included if the handheld device being evaluated had undergone extensive custom modifications. A final set of unique references was identified and posted to the proprietary Web-based screening system SRS (Systematic Review Software).

Selection Process

The selection process for this present survey review consisted of two phases. First, it began with a screen of full-text articles that had already been retained because their title, abstract, or keywords suggested they contained relevant information on PDA use in health care settings. Therefore, for assessment of relevance, surveys were included if they appeared to contain pertinent study information and if there was no unequivocal reason for exclusion. Second, upon updating the searches, authors returned to the screening of the title, abstract, and keywords for each citation strictly to identify potentially relevant and most recent PDA usage surveys. Eligibility criteria were applied to the full-text surveys, which were reviewed independently by two reviewers (CG and KE). Disagreements were resolved by consensus. Figure 1 provides a modified QUOROM flow chart outlining the process for selecting identified PDA usage surveys.

Figure 1. Modified QUOROM Flow Chart for Identified PDA Usage Surveys



Data Abstraction

The contents of each included survey were abstracted by one reviewer (CG), with an additional research assistant providing verification (TR).

Analysis

The data from all included surveys were extracted in a predefined, standardized fashion with abstraction verified by a second person and assessed descriptively (Appendix 2). Quality assessment methods for descriptive study designs such as surveys have not been established. Although some assessment frameworks exist for assessing survey research [12,13], none of them have been validated or empirically shown to include criteria that are associated with the reduction of bias in empirical surveys. Therefore, survey quality was not formally assessed.

Table 1. Included surveys

	Year of Survey/Publication	Author	Prevalence of PDA Use	Health Care Professional Group
1	1999/2000	Hucko [18]	15% (use in clinical work)	Physicians
2	NS/2001	ACP-ASIM [19]	47% (use in clinical work)	Specialists (Internists)
3	2001/2001	Versel* [20]	60% (use in practice)	Physician Executives (organizational survey)
4	2001/2001	Martin [21]	19.3% (use in clinical practice)	Physicians & Specialists
5	2001/2001	Taylor [22]	26% (use in practice)	Physicians
6	2001-2002/2002	AAP [23]	38% (NS)	Specialists (Pediatricians)
7	2000-2001/2002	Criswell* [24]	67% (use in practice)	Residents (Family Medicine) (organizational survey)
8	2001/2004	Miller [25]	26.2% (office-based use)	Physicians
9	2001/2004	Balen [26]	33% (use at work or home)	Pharmacists
10	2001-2002/2004	Barrett [27]	75% (use in practice)	Medical Residents
11	2002/2002	Martin [2]	27.9% (use in clinical practice)	Physicians & Specialists
12	2002/2002	Versel* [28]	33% (use in physician offices)	Physician Executives (organizational survey)
13	2002/2003	McCleod [29]	46% (use at medical institutions)	Specialists, Medical Residents, & Fellows (Internists)
14	2002/2004	Carroll [30]	35% (use at work)	Specialists (Pediatricians)
15	2002/2004	DeGroote [31]	61% (use on an academic health science campus)	Health Sciences Faculty & Medical Residents
16	2003/2003	Martin [32]	32.9% (use in clinical practice)	Physicians & Specialists
17	NS/2003	Vincent [33]	36% (use alone or in conjunction with log-card procedure in documenting)	Medical Residents (Family Practice)
18	2003/2003	Versel* [34]	75% (carry & use PDAs)	Physician Excutives (organizational survey)
19	2004/2005	AMA/Forrester [14]	57% (use regularly in a work week)	Physicians, Specialists (Surgeons), & Medical Residents
20	2004/2005	Wilden [35]	91% own; 85% use on daily basis; 9% weekly; 215% monthly	Specialists (Anestheologists)
21	2001/2005	Stromski* [36]	64% of programs report “most or all” residents use for clinical purposes	Medical Resident Programs (Emergency Medicine) (organizational survey)
22	NS/2005	Stroud [37]	67% (NS)	Nurse Practitioners & Students
23	NS/2005	Boonn [38]	45.1% (own or use daily)	Specialists (Radiologists)
	NS/2004	Joy† [17]	Difficult to interpret the prevalence numbers among the resident respondents	Medical Residents (Obstetrics & Gynecology)
	2004/2005	National Physician Survey (Canada)† [15]	Unable to establish overall prevalence due to way data have been presented; 48.6% of medical students have a PDA (although unable to infer use)	Physicians, Specialists (various), & Medical Students

Note: An excerpt from the “Taking the Pulse” study published in October 2004 by Manhattan Research [16] reports that 40% of all US physicians currently use a PDA, increasing from 35% in 2003. However, for this present review, the authors were unable to obtain a full copy of the report in spite of having contacted Manhattan Research on two separate occasions (February 2006).

NS = not specified

*Survey conducted at organizational level (vs individual level responses)

†Survey of PDA use but prevalence data could not be established (referred to descriptively only)

Results

From a total of 816 full-text articles that underwent relevance assessment for a systematic review of the literature examining broad-ranging PDA use in health care, a subset of 18 surveys reporting PDA prevalence rates were identified (see Figure 1). Additionally, upon updating the search, an additional 959 records were retrieved and screened, from which 5 additional unique surveys were included. Furthermore, a total of 8 surveys were reviewer nominated, 3 of which were identified upon updating. Unfortunately, the authors were not able to obtain access to one Internet market research report. Prevalence numbers from 2 surveys were found too difficult to interpret, and, therefore, these data could not be utilized further in our results; however, we refer to both studies descriptively.

It is from this pool of literature that a total of 23 unique surveys were identified (Table 1):15 were published articles in scientific journals, and 8 were nonacademic, reviewer-nominated citations that were either reports available for purchase, press releases, or trade magazine articles and thus not subject to formal peer review. Of these 8 surveys, 5 were conducted by Internet market research firms, 2 were conducted by physician groups, and 1 was conducted by a market research firm in conjunction with a physician group (American Medical Association).

Survey Characteristics

The included surveys were published between 2000 and 2005, with survey data collected between 1999 and 2004. One survey had a four-year lag between data collection and publication, three surveys had a lag of three years, and three surveys had a lag of two years. We were unable to determine publication lag in four surveys as no data collection dates were provided. Surveys were from the United States (16), Canada (4), Australia (1), both the United States and Puerto Rico (1), and both the United States and Canada (1). Survey methodology reflected the following: self-administered questionnaires distributed solely by mail (11); telephone interviews (2); Web-based online surveys (4); and combined distribution by electronic or postal mail as determined by the recipient (4). Two studies did not report the methodology used. Response rates ranged from 5.7% to 92.6% across 13 of the included surveys; 10 surveys did not report such rates.

PDA Use

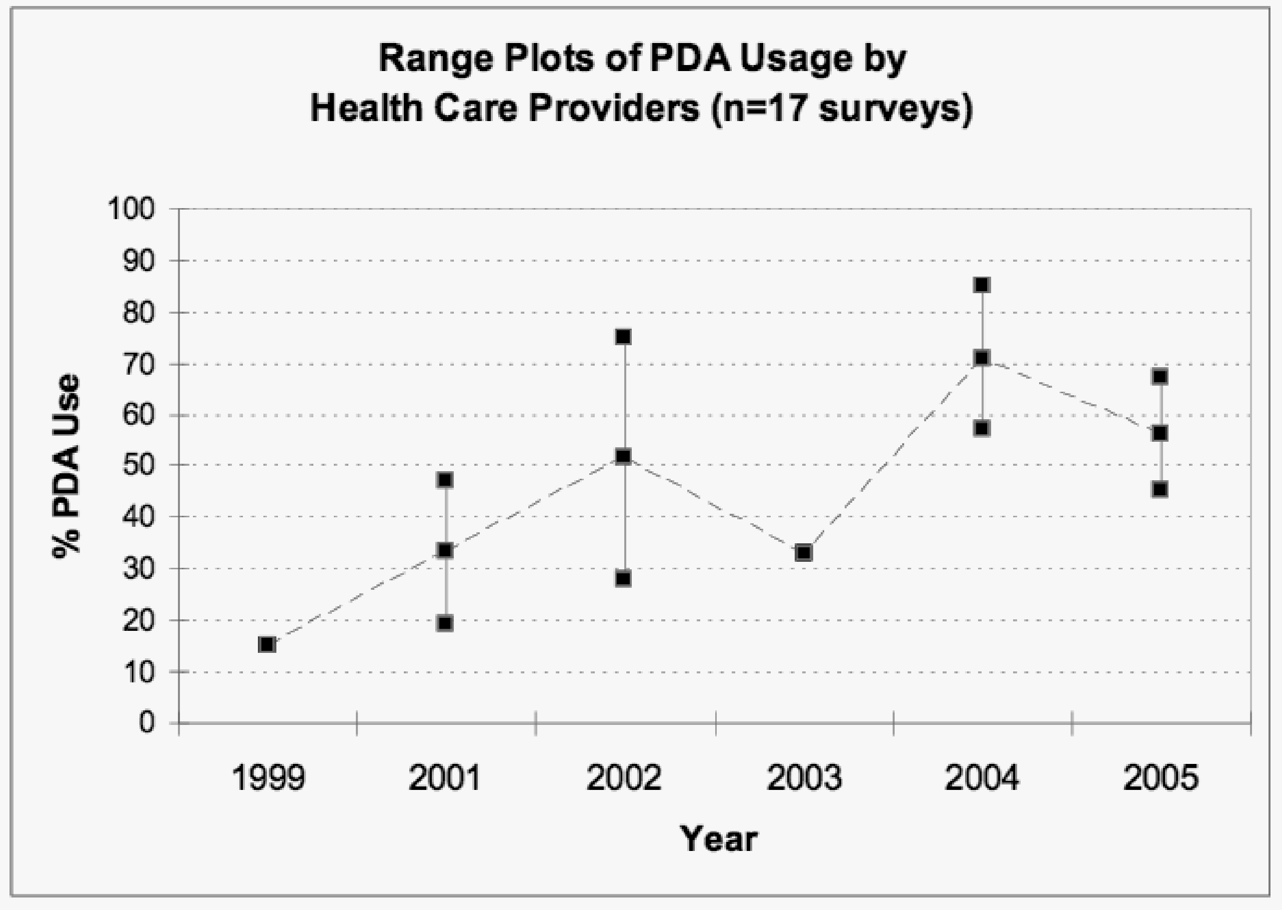
In presenting the results, we group the PDA users by type of health care provider and personal characteristics (eg, age).

In terms of PDA use, physician specialists were surveyed exclusively in five surveys. Three surveys examined practicing physicians, three included physicians and specialists combined, two included medical residents exclusively, while two surveyed an amalgam of physicians, specialists, medical residents, and/or students. Three surveys targeted physician executives and organizational practice leaders. One survey was directed at directors of family practice residency programs, while a further survey targeting individual PDA use in emergency medicine resident programs was completed at the organizational level.

In addition to physicians as users of technology, one survey targeted practicing hospital pharmacists and another targeted a national sample of nurse practitioner students and faculty. One survey included faculty and residents across several health science disciplines, including medicine, dentistry, nursing, public health, pharmacy, and applied health science.

To more accurately reflect handheld use across time, reported surveys were examined, when possible, from the timepoint when survey data were collected versus when published. When not possible, the publication date was the reported timepoint used. Collectively, the included surveys do indicate that PDA use is high, albeit somewhat variable, across studies. The reported prevalence rates of PDA use lend themselves well to an estimation of trend over time (Figure 2), and, as such, since 1999, there is evidence of an increase in PDA usage. Results do not include surveys completed at the organizational level. Surveys are presented according to data collection dates, with the exception of the American College of Physicians study (2001) [19], Stroud (2005) [37], and Boonn (1995) [38], which report publication dates only. The noted drop in 2003 is due to the paucity of surveys conducted in that year. Based on the most recent survey statistics (2004/2005), the current overall adoption rate varies between 45% and 85%, as derived from individual level survey data. In addition, of the five surveys completed at the organization level (eg, physician executives or medical program directors speaking on behalf of their individual members), the PDA use of their group members was estimated to be 60% (2001) [20], 67% (2001) [24], 64% (2001) [36], 33% (2002) [28], and 75% (2003) [34].

Figure 2. Range plots of PDA usage by health care providers (n = 17); middle points represent range medians



To elaborate on the percentage of overall adoptions rates, a US survey of 769 practicing physicians conducted in 1999 found that only 15% of physicians use a PDA in practice [18]. In a 2000/2001 survey of directors of family practice residency programs in the United States and Puerto Rico, use of handheld computers by either an individual or group was reported in 67% of the residency programs [24]. In 2001, 47% of 489 US-based internists surveyed were using a PDA [19]. A subsequent 2001 survey of 834 practicing physicians found that the proportion using PDAs had increased to 26% [22]. If we only look at professional use, then the increase is from 10% in 1999 to 18% in 2001 [22]. Among a national sample of practicing physicians surveyed in 2001, 26% reported using PDAs for office-based work [25]. In 2001/2002, 38% of 696 office-based physicians indicated that they used a PDA in their practice [23]. Of practicing hospital pharmacists surveyed in 2001, 33% reported using a PDA at work or home, with 28% using one on a daily basis [26]. These numbers reflect both types of use: personal and professional (ie, as an integral part of everyday practice). In 2001, 75% of residents in a teaching hospital reported using their PDA on a daily basis [27]. In 2002, 35% of US pediatricians were using a PDA at work, and 40% had one for personal use [30], and 46% of internal medicine physicians and residents were reporting PDA use [29].

In Canada, similar PDA use data have been collected since 2001 as part of the annual Physician Resource Questionnaire conducted by the Canadian Medical Association. PDA use among physicians increased from 19% in 2001 [21] to 28% in 2002 [2] and to a third in 2003 [32]. These data conclude that, in 2003, a third of Canadian physicians were using PDAs, which marked a 73% increase from 2001. Further, more than 50% of Canadian medical doctors under 35 years of age reported that they were using a PDA or wireless device in clinical practice [32]. The data did not differentiate type of professional use.

In a PriceWaterhouseCoopers survey in 2001, 60% of the physician executives who responded indicated that their organization had at least one physician with a PDA [20]. Reportedly, this represented an upward trend from 26% in a similar 2000 survey. Further, in 2003, the trend continued, and 75% of respondents reported that their organization's physicians were using PDAs. This increase in PDA use came after a steep decline to 33% in 2002 [28,34]. A sample of health science faculty and medical residents was surveyed in 2002 about their PDA use. Combined results from the various faculties and residents indicated that 61% used a PDA [31].

In 2004, 57% of a sample of US physicians indicated that they regularly used a handheld computer in a typical work week [14]. Results obtained in 2004 from a survey of members of the Austalian Society of Anaesthetists indicated that 91% of respondents owned a PDA; 85% reported using it on a daily basis, and 66% were reportedly "dependent" upon the handheld device, although the term *dependent* was not defined [35]. In 2005, when physician members of the Radiologicial Society of North America were surveyed, 45.1% reported owning or using a PDA on a daily basis [38]. However, the survey authors suggested use among this group of specialists appeared to be lower than for other physicians because a radiologist often works in front of a full workstation in clinic and therefore relies less on a mobile device. Further, PDAs are not yet well equipped to handle the tasks radiologists need to perform. In 2005, Stroud et al became the first group of researchers to address the use of PDAs in the field of nursing. Survey results concluded that the majority (67%) of participants used this technology [37].

While PDA use has clearly increased since 1999, it appears as though only a handful of studies have examined the prevalence and usage patterns of such technology outside of physician groups. Furthermore, when comparing the included surveys in depth, distribution of use is not uniform across selected characteristics of surveyed health care professionals. Therefore, further subgroup analyses from the included surveys are provided below. Patterns of handheld use are also briefly examined.

Patterns of PDA Usage

Age

Based on a survey of 250 family physicians, as far back as 1995, younger physicians (less then 40 years of age) were more likely to consider carrying a handheld computer than older physicians (94% vs 84.5%) [39]. More recent data from this present review also suggest an age differential in usage patterns. A 2001 survey of 834 US practicing physicians found that use of handheld devices was higher among doctors under age 45 (33%) than among older doctors (21%) [22]. Another study found that pediatricians graduating from medical school in the last five years were more likely to use a PDA in practice than those who graduated more than five years ago [30]. According to a survey conducted by the American Academy of Pediatricians in 2001, PDA use was highest among those members under 30 years of age, with a reported usage rate of 75% [23]. Another study found that 60% of US internists below 40 years of age used a PDA, while only 34% older than 51 years did [19]. McLeod et al (2003) also found that PDA usage captured in 2002 among a sample of internal medicine physicians and residents under 30 years was much higher (68%) versus those over 40 years of age (37%) [29]. In Canada, 2003 usage was highest among younger physicians, with more than half of those under the age of 35 years (53%) using a PDA, compared with 15% of physicians aged 65 or older [32]. According to the American Medical Association/Forrester Research 2005 Physician and Technology Study, more doctors under the age of 40 years were reportedly using PDAs (55%) than those over 40 years (45%) [14]. In 2005, the mean age of nurse practitioners and students who reported using a PDA was 42 years [37].

Students and Medical Residents

Residents tend to be younger, therefore it follows that they are more likely to use PDAs. This is also substantiated by direct evidence. A survey of directors of family practice in the United States and Puerto Rico conducted in November 2000 (306 responses) found that use of handhelds in residency programs, either by an individual or group, was 67% [24]. A 2001 survey of residents in a teaching hospital reported that more than 75% used their PDA on a daily basis [27]. Stromski et al (2005) surveyed emergency medicine residency programs in 2001 to identify the methods of procedure documentation to examine the number of programs transitioning to more advanced information technology systems (eg, PDA use). Their results indicated that 13% of the residency programs required the use of PDAs, 15% of programs purchased PDAs for their residents, and a similar proportion reported that PDAs were used by “most or all” of their residents to document procedures. Further, 64% of programs reported that “most or all” of their residents utilized PDAs for clinical purposes. DeGroote et al found that, in 2002, 71% of medical residents reported using PDAs versus 56% of faculty members [31]. In a 2002 survey, McLeod et al noted that the percent of frequent PDA users among internal medicine residents and fellows in training exceeded 70%, compared to only 50% of attending physicians [29]. From a survey of the experiences of family resident graduates in obtaining hospital privileges and in documenting procedures and deliveries, Vincent et al (2003) concluded that 36% of the respondents used a PDA alone or in conjunction with a log-card, paper-based system. Unfortunately, this study did not present any other prevalence data on PDA use [33]. However, from survey data captured in 2004, the handheld technology gap between residents and physicians began to close: a US study concluded that 73% of residents regularly used a handheld computer in a typical work week, followed closely by 71% of family/general practitioners [14]. In a survey of PDA use by nurse practitioner students and faculty, Stroud et al found that of the total respondents who reported PDA use, 73% were nursing students [37].

One survey by Joy et al (2004) met our initial criteria but could not be incorporated into the results analysis. Although this study did examine PDA use in obstetrics and gynecology residency programs, it was difficult to interpret the prevalence numbers among the resident respondents. Likewise, the National Physician Survey (2004) did not present overall PDA prevalence rates but did ask Canadian medical students if they had a PDA or wireless device [15]. Of the 2721 respondents, 24% in first year, 40.6% in second year, 70.6% in third year, and 71.6% in fourth year reported having a PDA, representing an overall average of 48.6% among students [15]. Unfortunately, these 2004 figures provide no information on how medical students were using this technology and in what contexts.

Gender

PDA usage among men and women was equal in a 2001 survey of internists [19]. Similarly, McLeod et al (2002) found no significant gender difference in PDA users among a 2002 sample of internal medicine physicians and residents [29]. However, pediatrician PDA users were most likely male, as reported in 2002 [30]. As well, the 2003 Physician Resource Questionnaire analysis concluded that male physicians were somewhat more likely to use a PDA in their practice than were females (35% vs 30%) [32]. More recent data from a 2004 survey of PDA use among US physicians, specialists, and medical residents suggested that male clinicians were slightly more likely than their female counterparts to regularly use handhelds (53% vs 47%) [14]. On the other hand, nurse practitioner data from 2005 show that men (82%) were notably more likely than women (64%) to use a PDA ($P < 0.05$) [37]. However, the authors cautioned that they were unable to determine the significance of this finding given that the actual survey sample of men (n = 38) as opposed to women (n = 188) was small. The authors suggested that if ease with PDA technology is less common in women, then the nursing profession, dominated by females, may need elevated momentum to adopt PDA technology across nursing practice [37].

Family Physicians versus Specialists

The most recent Physician Resource Questionnaire (2003) analysis concluded that Canadian family physicians were just as likely to use a PDA (33%) when compared to medical (34%) and surgical (32%) specialists [32]. This was the third consecutive year these figures rose consistently across all physician groups in Canada [2,21,32]. However, according to a US survey of physicians published in 2005, the biggest adopters of PDAs in professional practice were family and general practitioners (71%) when compared to surgical specialists (54%) [14]. The above mentioned studies are the only survey data available directly comparing general physician use to that of specialists.

Large and Hospital-Based Practices

A US survey of practicing physicians found that use was higher among those who were wholly or partly hospital-based (33% and 29%, respectively) than among those who were office-based (23%) [22]. Usage was also higher among physicians in large practices (33%) than in solo practice (16%) [22]. Carroll et al (2004) also found that PDA users tended to not be in private practice [30]. Additional survey data from 2004 indicated that of US physicians practicing in primary practice offices with fewer than 10 physicians, 49% reported regular use of a handheld computer [14]. Miller et al (2004), reporting on a national sample of practicing physicians, found that in a group practice consisting of an average of nine physicians, handheld use was approximately 56% [25].

Urban versus Rural Physicians

From a random sample of US pediatricians in 2002, PDA users were most likely from urban communities [30]. Similarly, results from Canada’s Physician Resource Questionnaire in 2001 indicated PDA use to be higher among physicians practicing in urban centers (19.9%) than in rural centres (13.4%) [21]. However, by 2002, rural use (29.6%) surpassed urban use (27.7%) among physicians [2]. In Canada, this trend continued in 2003, with 36.9% of rural respondents indicating PDA use versus 32.5% of urban respondents [32].

Professional Use

Five surveys considered PDA use in both a professional and personal context; 17 studies exclusively captured professional use. One study reported general prevalence rates for PDA use among pediatricians; however, it did not specify if use was in clinical practice or outside of work.

In order to discern professional use more closely, we explored administrative PDA uses versus direct use in clinical patient care. We found that of the surveys that concern PDA use within a health care setting, 17 of 23 studies (74%) reported use pertaining to administrative or organizational tasks, while 14 of 23 studies (61%) addressed PDA use in patient care. Billing and coding were the most frequently performed administrative PDA functions in 50% of the surveys reporting administrative uses. This was followed by 44% reporting calendar scheduling, 31% reporting Web and email access, 25% reporting address book use, and 25% stating use in charting patient details into an electronic health record. Other reported administrative tasks included the following: word processing, calculator, charge capture, procedure documentation, outpatient tracking, resident hours, telephone message tracking, general time management/personal organizer, patient referrals, procurement of supplies, patient census, order entry, dictation, and passwords and pins.

In terms of patient care, access to drug information was reported in 93% of the surveys reporting clinical PDA use, while 50% reported prescribing, 43% stated accessing patient records, 43% described medical calculator use, and 36% indicated use in reference to laboratory values. Other reported clinical PDA uses included access to medical references, patient tracking and patient reminders, clinical decision pathways and managed care applications, telemedicine, and diagnostic imaging or radiology applications.

Only one survey reported PDA use for patient education, and one referred to PDA use for research purposes.

Discussion

This paper summarizes the results from surveys examining adoption of PDA use. These survey data are in reasonably good agreement and suggest a sizable proportion of physicians use handheld devices. However, most of the sources of survey data did not distinguish well between types of applications being used most often and whether the PDAs were being used professionally for administrative purposes or for direct clinical work. It is encouraging to note that our findings are similar to those of an analysis of online registrations and downloads of a PDA drug reference guide, which concluded that approximately one fifth of US physicians (150000) and half of medical students in the United States (33000) were PDA users [40].

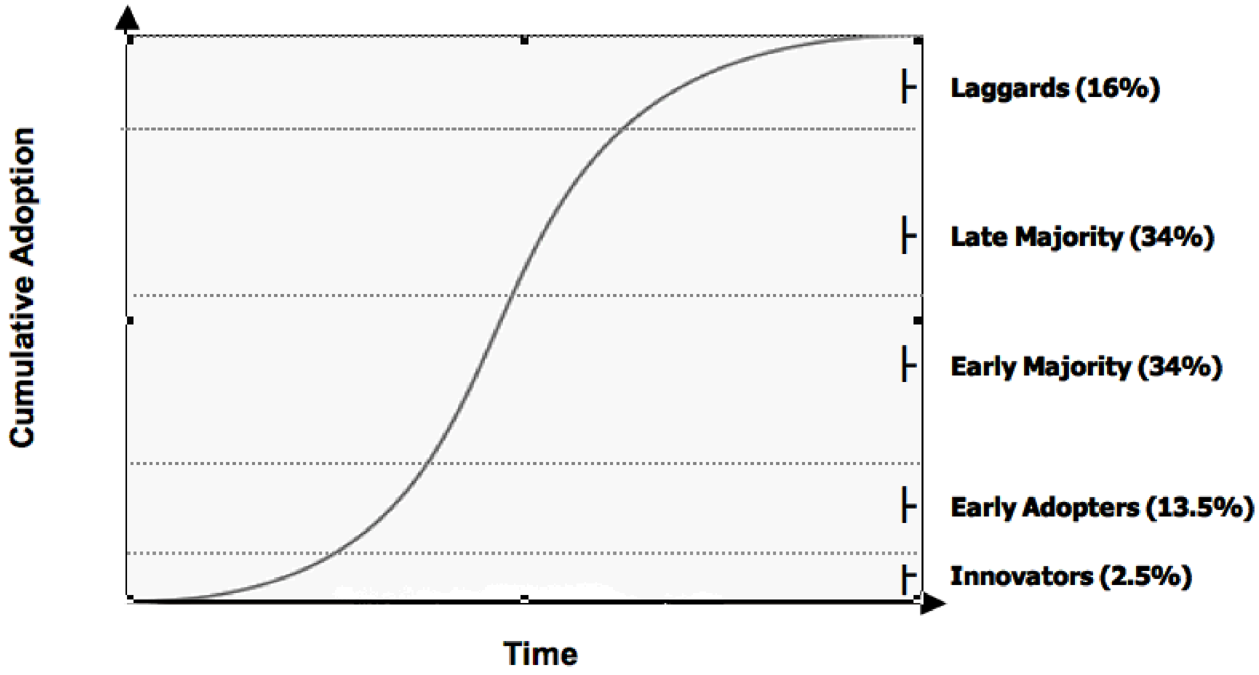
Our grouped survey data suggest that there is little information on the PDA usage rates among nonphysician health care providers. However, collectively, these data suggest that use of handheld devices has become a subject that health care professionals need to know about. By systematically gathering this usage information, it is difficult to deny the prevalence of PDAs in health care. With this basic understanding of current handheld usage patterns, we need to consider the impact of this development of mobile handheld technology on both practice and research.

According to a commonly accepted descriptive model of the diffusion of innovations developed by Rogers, when the cumulative rate of users of a new invention is plotted versus time, the result is an S-shaped curve [41]. Interestingly, this appears to be true of most technological innovations, irrespective of the technology. For example, Hall and Khan (2003) reviewed the S-shape adoption patterns of a variety of 20th century consumer products (eg, washing machines, video cassette recorders) [42], while Teng et al (2002) developed historical diffusion curves for information technologies (eg, personal computers, email) [43]. Variations in diffusion slopes do exist given that some technologies will diffuse more rapidly than others.

Health care information technologies have also been examined within this diffusion framework. England et al (2000) studied organizational and technological factors determining the rate at which innovations diffuse in the health industry [44]. In 2005, RAND Health completed a report characterizing the diffusion of electronic health records along an S-shaped adoption curve [45].

Technologies typically go through multiple phases during their adoption life cycle, which may last for many years [41,46]. The characteristics of the adopters change over time and so does the nature of suitable evidence to inform their adoption decisions. For example, innovators (the first 2.5% who adopt a new technology) do not need evidence to make an adoption decision. Early adopters (the next 13.5%) are satisfied with case studies and examples of successful adoption and benefits [41]. Examining the typical technology adoption curve for handheld devices (Figure 3) based on the adoption percentage of PDAs thus far from the most recent available data (2004/2005), it can be concluded that we are now at the steepest stage in the adoption S-curve, with a transition from the early majority to the late majority.

Figure 3. The S-shaped diffusion of technology curve [41]



The increase in PDA adoption means a potential reduction in hardware and training costs when using handheld devices in the provision of care and in research. Because of the high probability that target health care professionals may already have a handheld device and will already know how to use one, the overall hardware purchase costs could be reduced, and the end user will not necessarily have to be trained from scratch.

To date, use of PDAs in health care appears to have preceded extensive evaluative research. PDA adoption rates, already high, continue to be a moving mark with projections for rapid growth in the short term. By comparing handheld device diffusion to other health information innovations, and by placing PDA use within existing diffusion models, we are able to better predict the future of handheld growth in health care and therefore develop more timely and appropriate evaluative research to accompany such growth.

Unfortunately, we were unable to include information from two national physician surveys. The first report entitled “Taking the Pulse” was published in October 2004 by Manhattan Research [16]. Information gleaned from a report excerpt stated that 40% of all US physicians surveyed in 2004 were using a PDA, marking an increase from 35% in 2003. Reported top activities performed on a PDA by all US physicians (in order) were personal scheduling, professional scheduling, accessing a drug reference database, accessing online information, writing/entering clinical notes, and mobile email access [47]. These report findings are similar to our overall findings in this present review.

The second national physician survey not incorporated into our analysis was the Canadian National Physician Survey (NPS) (2004), which provides valuable insight into what information technology, including PDAs, physicians and specialists have in their main patient care settings [15]. However, overall prevalence rates could not be determined from the data provided given the manner in which they were presented. Nonetheless, in reviewing the national data, we can descriptively draw some conclusions. First, it appears as though male physician PDA use is higher than that of females. This appears to be consistent across all tasks involving PDA use although differences do appear to be small. This is consistent with our general findings in which males are only marginally more likely to use a PDA than are females. Interestingly, when examining age-related data from the NPS, it appears as though the age factor may in fact be PDA task-specific. For example, electronic health record usage appears to decrease as the age of physician users decreases. However, PDA use for drug interaction information increases when the age of the physician user decreases. This appears contrary to most other surveys that show younger age is associated with higher general PDA use. Perhaps what this information tells us is that handheld use may be more complex when broken into task-specific strata.

It is worthy to note that, with the exception of one survey focusing on nurse practitioner students, little mention was made in the surveys of PDA use by students across health care disciplines, including medicine. Several universities in Canada and the United States now mandate use of PDAs for medical undergraduate students and residency programs; therefore, it is assumed this could potentially affect prevalence rates. However, because none of the included surveys examined mandated use, we are unable to infer if this is responsible for recent increases. However, this raises an important issue to be considered in future studies related to students and rates of handheld adoption.

To better understand the prevalence rates among the included surveys, it became important to categorize the drivers for PDA use as either professional or personal. We therefore attempted to discern what specific PDA tasks the respective health care professionals were performing. This was done by classifying, whenever possible, the use as administrative versus care. On the surface, it would appear that administrative and organizational tasks on a PDA exceed those related to patient care, perhaps signaling where the growth in adoption is most likely to occur.

In this present review, we can only speak broadly to rates of adoption and patterns of use. Drawing inferences from the survey data was often limited by lack of, or differences in, operational definitions in aspects of handheld use being measured. For example, the term *use* was often not defined by frequency (eg, specific units of time—day, week, month). Taking these issues into consideration would be a useful exercise for future surveys as well as information technology prevalence studies in health care.

In conclusion, physicians are increasingly accustomed to using a PDA, and, therefore, technology expertise will not likely be a barrier to deploying handheld applications. There is an urgent need to evaluate the effectiveness and efficiency of specific tasks using PDA technology (eg, implementation, searching, reference, data entry, reporting) to inform those persons developing and those using handheld applications. Furthermore, it is not clear why there is a paucity of evidence on the extent of adoption of PDAs by other health care providers: is it that they lag in the use of this technology or is it simply that they have yet to be studied?

Limitations

This review has a number of limitations. Issues around response bias and inability to draw causal inferences weaken survey methodology. It may be the case that those surveyed feel a stronger affinity to the survey sponsor, who has a greater interest in the questions asked, or are in complete disagreement with the topic at hand. This can skew results in difficult-to-measure ways. Quite possibly, the nonrespondents are the least committed (ie, nonusers of PDAs). As a result, the critical objective of drawing a true random sample of the populations that are the focus of the survey is compromised and the findings somewhat impure.

The reported methodologies across these surveys appear to be heterogeneous, which limits their comparability. As noted, the quality of the included surveys could not be determined given the absence of validated quality assessment instruments, and, therefore, there was no adequate way to assess the influence of bias. A related issue is that some of the included surveys did not go through a rigorous peer-review process. These combined issues made judging the strength of the evidence not possible. One would assume surveys identified from scientific journals would be a source of less biased information. However, in defense of the nonacademic surveys, there is a consistency in results between those peer-reviewed versus those that were not. This may suggest that our main conclusions regarding adoption rates are fairly robust and not disconnected even with the inclusion of non–peer-reviewed evidence.

Conclusions

The objective of this study was to determine the adoption rates of PDAs in health care settings, and to project expected adoption in the future based on established technology diffusion models. Our findings from a systematic review indicate the current overall adoption rate for professional use of PDAs among health care providers, namely physicians, is 45% to 85%. Younger physicians, residents, and those working in large and hospital-based practices are more likely to use a PDA. Professional use in health care settings appears to be more focused on administrative tasks when compared to those related to patient care, although this requires further study. The adoption rate is now at its highest rate of increase according to a commonly accepted diffusion of innovations model. Additionally, the impact of PDA use on practice appears to be immediate in terms of costs and training. Familiarity will not likely be a barrier to deploying handheld applications in health care. However, there is a critical need to evaluate the effectiveness and efficiency of specific tasks using handheld technology within the health care system and across health care provider PDA user groups.

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Conflicts of Interest

Khaled El Emam is a co-founder of and has financial interests in TrialStat Corporation, a software company that develops electronic data collection tools for mobile devices.

Appendix 1

Medline Search Strategy

Medline Search History (Silver Platter)

- #19 (#17 and (la=english)) or ((#12 and (la=english)) or (#10 and (la=English)))
- #18 #17 and (la=english)
- #17 (palm or palms) and (microcomputer or computer or software)(157 records)
- #16 palm or palms
- #15 microcomputer or computer or software
- #14 (#12 and (la=english)) or (#10 and (la=English))
- #13 #12 and (la=english)
- #12 hand held computer
- #11 #10 and (la=English)
- #10 (handspring or apple newton or jornada) or (windows ce or pocket pc or clie) or (pda or personal digital assistant or personal digital assistants) or (handheld computer) or (palm pilot or palm os) or (blackberry or ipaq)
- #9 palm pilot or palm os
- #8 (la=english) and #7
- #7 (handspring or apple newton or jornada) or (windows ce or pocket pc or clie) or (pda or personal digital assistant or personal digital assistants) or (palm pilot or palm or palms or palm os) or (handheld computer) or (blackberry or ipaq)
- #6 blackberry or ipaq
- #5 handspring or apple newton or jornada
- #4 windows ce or pocket pc or clie
- #3 pda or personal digital assistant or personal digital assistants
- #2 palm pilot or palm or palms or palm os
- #1 handheld computer

Additional database search histories are available upon request from the authors.

Appendix 2

Table 2. Characteristics and Results of Surveys of PDA Use by Health Care Providers

First Author, Publication Year, Country of Origin	Year Data Collected	Survey Methodology	Description of Health Care Professionals	Sample Size & Response Rate (RR)	PDA Usage Rates	PDA Use by Age (%)	PDA Use by Gender (%)	PDA Use by Setting
Hucko, 2000, US [18]	1999	Mail survey	Practicing Physicians	769 respondents; RR NR	**15%** use handheld devices in practice	NR	NR	NR
ACP-ASIM, 2001, US [19]	NS	NR	Physicians (Internists)	489 respondents; RR NR	**47%**	< 40 years = 60% 41-50 years = 42% ≥ 51 years = 34%	NR (Stated usage among males & females equal)	NR
Versel, 2001, US [20]	2001	Mail survey	Physician Executives	432 respondents; RR NR	**60%** physicians in their practices	NR	NR	NR
Martin, 2001, Canada [21]	2001	Mail survey	Physicians (General Practitioners/ Family Physicians; Medical Specialists; Surgical Specialists)	For general survey RR = 42%; for PDA question 3246 respondents (992 female/2254 male); RR NR	**Overall use = 19.30%** GP/FP = 15.7% Med spec = 22.9% Surg spec = 22.4%	< 35 years = 26.8% 35-44 years = 20.8% 45-54 years = 19.6% 55-64 years = 17.5% ≥ 65 years = 10.8%	Female = 15.4% Male = 21%	NR
Taylor, 2001, US [22]	2001 (Jan-Feb)	Interviews (type NR)	Practicing Physicians	Nationwide sample 834; RR NR	**26%** (18% main use in practice; 8% mainly personal use)	< 45 years = 33% ≥ 45 years = 21%	NR	Group size: solo practice = 16% 2-9 = 28% 10-24 = 37% ≥ 25 = 33% mostly office-based = 23% mostly hospital-based = 33% exclusively hospital-based = 29%
AAP: Periodic Survey of Fellows #51, 2002, US [23]	2001 (Oct)-2002 (Feb)	Self-administered mail survey	Pediatricians (members of AAP)	1616 surveyed; 54.6% (882)	**38%** of reporting physicians (n = 696) use PDAs Use included: keeping a daily schedule (77%), accessing pharmacology references (76%), and medical calculations (75%)	Use highest among PDA users < 30 years (72%)	NR	100% office-based practice

First Author, Publication Year, Country of Origin	Year Data Collected	Survey Methodology	Description of Health Care Professionals	Sample Size & Response Rate (RR)	PDA Usage Rates	PDA Use by Age (%)	PDA Use by Gender (%)	PDA Use by Setting
Criswell, 2002, US & Puerto Rico [24]	2000 (Nov)	Mail survey	Directors of Family Practice Residency Programs	610 directors (493 listed in AAFP; 117 ACOFP); 306 respondents (257 AAFP; 49 ACOFP) = RR of 50%	Use of handheld computers either by an individual or group reported **67%** (204/306 programs); 30% of programs require applications used uniformly by all users	NR	NR	NR
Miller, 2004, US [25]	2001 (Oct-Nov)	Interviews (telephone)	Practicing Physicians	National stratified random sample of 1200; RR = 5.7%	**26.2%** used PDAs for work	Specific use by age NR (but mean age 48 years according to Physician IT User Type classification)	Specific use by gender NR (but % male = 81.8% according to Physician IT User Type Classification provided)	Specific use by setting NR (but mean practice size MDs = 8.8; group practice % = 55.8% according to Physician IT User Type Classification)
Balen, 2004, Canada [26]	2001 (May)	Mail survey	Practicing Hospital Pharmacists	106 sampled; 58 completed; RR = 55%	**33%** reported using PDAs at work or home; 28% used device daily	NR	NR	NR
Barrett, 2004, US [27]	2001 (Oct)-2002 (Apr)	Email invitation & online Web-based survey	Medical Residents from 7 residency programs (primary care & specialty programs)	Contacted 223 residents enrolled in six week residency programs; 88 completed survey RR = 40%	**75%** stated daily use of PDA	NR	NR	NR
Martin, 2002, Canada [2]	2002	Mail survey	Physicians (General Practitioners/ Family Physicians; Medical Specialists; Surgical Specialists)	For general survey RR = 37%; PDA question 2882 respondents (912 female/1970 male); RR NR	**Overall use = 27.9%** GP/FP = 25.1% Med spec = 31.1% Surg spec = 30%	< 35 years =43.7% 35-44 years = 31% 45-54 years =28.3% 55-64 years = 22.5% ≥ 65 years = 11.9%	Female = 23.8% Male = 29.7%	NR
Versel, 2002, US [28]	2002	Mail survey	Physician Executives	444 respondents; RR NR	**33%** of physician groups (not individual members)	R	R	NR

First Author, Publication Year, Country of Origin	**Year Data Collected**	**Survey Methodology**	**Description of Health Care Professionals**	**Sample Size & Response Rate (RR)**	**PDA Usage Rates**	**PDA Use by Age (%)**	**PDA Use by Gender (%)**	**PDA Use by Setting**
McLeod, 2003, US [29]	2002 (May)	Mail survey	Internal Medicine Physicians & Residents	Mailed to 867 (473 returned & completed); RR=55%	Proportion of respondents who reported current PDA use = **46%** (218/473)	< 30 years = 68% 30-39 years = 51% ≥ 40 years = 37%	Female = 38% Male = 48%	Dept. of Internal Medicine at a multi-specialty, tertiary care academic medical center in the US Midwest
Carroll, 2004, US [30]	2002	Mail survey	Pediatricians (including residents)	Random sample of 2130 pediatricians; 1185 responded; RR = 62.3%	**35%** currently use PDA at work; **40%** currently use PDA for personal use	NR	NR Stated users most likely male (AOR = 2.29%, 95% CI 1.64-3.19)	Users most likely in urban community (AOR = 1.81, 95% CI 1.30-2.55) NOT in private practice (AOR = 1.47, 95% CI 1.03-2.11)
De Groote, 2004, US [31]	2002 (Nov)	Email invitation & online Web-based survey	Tenure, tenure-track & faculty and residents (including medical residents; dental, nursing, applied health sciences, public health science, pharmacy, and medical faculty)	1538 sampled; 352 responders; RR = 24%	**61%** used a PDA; 69% stated they owned a PDA	NR	NR	NA
Martin, 2003, Canada [32]	2003	Mail survey or email	Physicians (General Practitioners/ Family Physicians; medical Specialists; Surgical Specialists)	For general survey RR = 28.4%; PDA question 2251 respondents (756 female/1486 male); RR NR	**Overall use = 32.9%** GP/FP = 32.5% Med Spec = 33.8% Surg Spec = 32.2%	< 35 years = 52.6% 35-44 years = 38.7% 45-54 years = 31.1% 55-64 years = 27.8% ≥ 65 years = 14.7%	Female = 29% Male = 34.9%	NR
Vincent, 2003, US [33]	NS	Mail survey	Residents	RR = 62%	**Overall use = NR** Use alone or in conjunction with log-card procedure in documenting = 36%	NR	NR	NR

First Author, Publication Year, Country of Origin	Year Data Collected	Survey Methodology	Description of Health Care Professionals	Sample Size & Response Rate (RR)	PDA Usage Rates	PDA Use by Age (%)	PDA Use by Gender (%)	PDA Use by Setting
Versel, 2003, US [34]	2003 (Jul-Aug)	Online Web-based Survey	Physician Executives	436 survey respondents; RR NR	**18%** (78 respondents) indicated **75%** of physicians in their organizations using PDAs; 75**%** report that their organizations have at least 1 physician with PDA	NR	NR	NR
AMA/Forrester, 2005, US [14]	2004 (Aug-Dec)	Mail and online Web-based survey	Physicians (General Practitioners/ Family Physicians; Specialists; Residents/ Students as chosen randomly from AMA's database)	NR	**57%** used regularly in typical work week (average among all physicians) Use in typical work week: Residents = 73% Family/GPs = 71% Surgeons = 54%	< 40 years = 55% use PDA in typical work week	Female = 47% Male = 53%	Use in typical work week in primary practice (office-based with 10 or fewer physicians) = 49%
Wilden, 2005, Australia [35]	2004	Email request for Web-based survey	Anesthetists (members of ASA)	1870 sampled; 215 responders; RR = 11% (= 24% of ASA members actively using email)	**85%** use their PDA on a daily basis; 9% weekly; 5% monthly 91**%** own PDA 66% consider themselves "dependent" on PDA	NR (age, gender, and type of practice demographics presented but not in relation to PDA users)		
Stromski, 2005, US [36]	2001	Telephone survey	Emergency Medicine Residency Programs	113/122 programs; RR = 92.6%	**Overall use = NR** 64% of programs report "most or all" residents used a PDA for clinical purposes	NR	NR	R N
Stroud, 2005, US [37]	NS	Questionnaire sent via email or postal mail	Nurse Practitioner Students and Faculty	855 questionnaires distributed; 222 responded; RR = 27%	**Overall use = 67%**	NR (report indicated positive correlation between age and frequency (r = .21, *P* < .05) but stated this explained only 4% of variance)	Females = 64% Males = 82%	R N
Boonn, 2005, US & Canada [38]	NS	Recipients mailed surveys with option to complete by mail or via the Internet	Members of RSNA	1628 surveys sent; RR = 32.4%	**45.1%** reported owning or using a PDA on a daily basis	NR	NR (gender and type of practice demographics presented but not in relation to PDA users)	

First Author, Publication Year, Country of Origin	Year Data Collected	Survey Methodology	Description of Health Care Professionals	Sample Size & Response Rate (RR)	PDA Usage Rates	PDA Use by Age (%)	PDA Use by Gender (%)	PDA Use by Setting

PDA = personal digital assistant; NS = not specified; NR = not reported; RR = response rate; NA = not applicable; AAFP = American Academy of Family Physicians; AAP = American Association of Pediatricians; ACOFP = American College of Osteopathic Family Physicians; ACP = American College of Physicians; AMA = American Medical Association; ASIM = American Society of Internal Medicine; ASA = Australian Society of Anaesthetists; RSNA = Radiological Society of North America

References

1. Worldwide PDA & Smartphone Forecasts Report: 1998-2008. eTForecasts 2003. URL: http://www.etforecasts.com/ [WebCite Cache ID 1136949592194669]
2. Martin S. MD's computer, PDA use on the upswing. CMAJ 2002 Oct 1;167(7):794 [FREE Full text] [Medline: 22277181]
3. Adatia F, Bedard PL. "Palm reading": 2. Handheld software for physicians. CMAJ 2003 Mar 18;168(6):727-734 [FREE Full text] [Medline: 22528698]
4. Fischer S, Stewart TE, Mehta S, Wax R, Lapinsky SE. Handheld computing in medicine. J Am Med Inform Assoc 2003;10(2):139-149. [Medline: 12595403] [PMC: 12595403] [doi: 10.1197/jamia.M1180]
5. Koop A, Mösges R. The use of handheld computers in clinical trials. Control Clin Trials 2002 Oct;23(5):469-480. [Medline: 22280758] [doi: 10.1016/S0197-2456(02)00224-6]
6. Johannes CB, Crawford SL, Woods J, Goldstein RB, Tran D, Mehrotra S, et al. An electronic menstrual cycle calendar: comparison of data quality with a paper version. Menopause 2000;7(3):200-208. [Medline: 20269103]
7. Lapinsky SE, Weshler J, Mehta S, Varkul M, Hallett D, Stewart TE. Handheld computers in critical care. Crit Care 2001 Aug;5(4):227-231 [FREE Full text] [PMC: 11511337] [Medline: 21402487]
8. Lapinsky S, Weshler J, Varkul M, Mehta S, Stewart T. Evaluation of handheld computers in critical care. In: Bruch HP, Kockerling F, Bouchard R, Schug-Pab C, editors. New Aspects of High Technology in Medicine. Bologna, Italy: Monduzzi Editore; 2000:279-284.
9. Mclaws ML, Caelli M. Pilot testing standardized surveillance: Hospital Infection Standardised Surveillance (HISS). On behalf of the HISS Reference Group. Am J Infect Control 2000 Dec;28(6):401-405. [Medline: 20566383] [doi: 10.1067/mic.2000.111373]
10. Benbasat I, Zmud RW. Empirical research in information systems: the practice of relevance. MIS Quarterly 1999;23(1):3-16. [doi: 10.2307/249403]
11. Baumgart DC. Personal digital assistants in health care: experienced clinicians in the palm of your hand? Lancet 2005 Oct 1;366(9492):1210-1222. [Medline: 16198770] [doi: 10.1016/S0140-6736(05)67484-3]
12. Gautheir B. Assessing survey research: a principled approach (work-in-progress report). In: Proceedings of the Professional Marketing Research Society Annual Conference. Ottawa, Ontario, Canada; Apr 2001:1-28.
13. ; Council of American Survey Research Organizations. CASRO guidelines for survey research quality. 1998. URL: http://www.casro.org/guidelines.cfm [accessed 2006 May 9] [WebCite Cache ID 5FktyneTg]
14. Bishop L, Brown EG. 2005 Physicians and Technology Study. Usability holds back MD handheld usage. Forrester Research. 2005 Mar 15. URL: http://www.forrester.com/Research/Document/Excerpt/0,7211,36530,00.html [accessed 2006 May 9]
15. ; College of Family Physicians of Canada, Canadian Medical Association, Royal College of Physicians and Surgeons of Canada. 2004 National Physician Survey (NPS). 2005. URL: http://www.cfpc.ca/nps/English/home.asp [WebCite Cache ID 1144182003318267]
16. ; Manhattan Research. Taking the pulse. 2004 Oct. URL: http://www.manhattanresearch.com/products/Strategic_Advisory/ttp/ [accessed 2006 May 9] [WebCite Cache ID 5FnxfNZtY]
17. Joy S, Benrubi G. Personal digital assistant use in Florida obstetrics and gynecology residency programs. South Med J 2004 May;97(5):430-433. [Medline: 23352775] [doi: 10.1097/00007611-200405000-00002]
18. Hucko D, Cohen P. Computing in the physician's practice. Harris Interactive 2000.
19. ; American College of Physicians, American Society of Internal Medicine. ACP-ASIM survey finds nearly half of US members use handheld computers. ACP-ASIM Press Release. 2001 Oct. URL: http://www.acponline.org/college/pressroom/handheld_survey.htm [WebCite Cache ID 1136949366758807]
20. Versel N. 4th annual Modern Physician/PriceWaterhouseCoopers survey of executive opinions on key information systems issues: ready to roll. Modern Physician 2001 Nov;5(14):12-20.
21. Martin S. Computer use by Canada's physicians approaches 90% mark. CMAJ 2001;165:632.
22. Taylor H, Leitman R. Physicians' use of handheld personal computing devices increases from 15% in 1999 to 26% in 2001. Harris Interactive 2001 Aug 15;1(25):1-4.
23. ; American Academy of Pediatrics. AAP Periodic Survey #51: Use of computers and other technologies. Aug. URL: http://www.aap.org/research/periodicsurvey/ps51.htm [WebCite Cache ID 1136949724356232]

24. Criswell DF, Parchman ML. Handheld computer use in U.S. family practice residency programs. J Am Med Inform Assoc 2002;9(1):80-86. [PMC: 11751806] [Medline: 21623453] [doi: 10.1197/jamia.M1234]
25. Miller RH, Hillman JM, Given RS. Physician use of IT: results from the Deloitte Research Survey. J Healthc Inf Manag 2004;18(1):72-80. [Medline: 23145146]
26. Balen RM, Jewesson PJ. Pharmacist computer skills and needs assessment survey. J Med Internet Res 2004 Mar 29;6(1):e11 [FREE Full text] [Medline: 15111277] [doi: 10.2196/jmir.6.1.e11]
27. Barrett JR, Strayer SM, Schubart JR. Assessing medical residents' usage and perceived needs for personal digital assistants. Int J Med Inform 2004 Feb;73(1):25-34. [Medline: 15036076] [doi: 10.1016/j.ijmedinf.2003.12.005]
28. Versel N. 5th annual Modern Physician/PriceWaterhouseCoopers survey of executive opinions on key information systems issues: wave of the (not-so-distant) future. Modern Physician. 2002 Nov. p. 13 URL: http://healthcare.pwc.com/cgi-local/hcregister.cgi?link=pdf/itspending.pdf [accessed 2006 May 9] [WebCite Cache ID 5FnyfAmDW]
29. Mcleod TG, Ebbert JO, Lymp JF. Survey assessment of personal digital assistant use among trainees and attending physicians. J Am Med Inform Assoc 2003;10(6):605-607. [PMC: 12925551] [doi: 10.1197/jamia.M1313] [Medline: 22978900]
30. Carroll AE, Christakis DA. Pediatricians' use of and attitudes about personal digital assistants. Pediatrics 2004 Feb;113(2):238-242. [Medline: 14754932] [doi: 10.1542/peds.113.2.238]
31. De Groote SL, Doranski M. The use of personal digital assistants in the health sciences: results of a survey. J Med Libr Assoc 2004 Jul;92(3):341-348. [Medline: 15243640] [PMC: 15243640]
32. Martin S. More than half of MDs under age 35 now using PDAs. CMAJ 2003 Oct 28;169(9):952. [Medline: 22942114]
33. Vincent C, Kim S, Schneeweiss R, Stevens N. Documenting procedures and deliveries during family practice residency: a survey of graduates' experiences, preferences, and recommendations. Fam Med 2003 Apr;35(4):264-268. [Medline: 22614518]
34. Versel N. 6th annual Modern Physician/PriceWaterhouseCoopers survey of executive opinions on key information systems issues: faith-based spending. Modern Physician. 2003 Nov. p. 20-25 URL: http://www.modernphysician.com/docs/2003techsurvey.pdf [accessed 2006 May 9] [WebCite Cache ID 5Fnz4bmmc]
35. Wilden J, Riley RH. Personal digital assistant (PDA) use amongst anaesthetists: an Australian survey. Anaesth Intensive Care 2005 Apr;33(2):256-260. [Medline: 102299058]
36. Stromski CJ, Jeffers T, Bean E. Procedure documentation in emergency medicine residencies: a time of change. Acad Emerg Med 2005 Apr;12(4):375-376. [Medline: 15805332] [doi: 10.1197/j.aem.2004.07.021]
37. Stroud SD, Erkel EA, Smith CA. The use of personal digital assistants by nurse practitioner students and faculty. J Am Acad Nurse Pract 2005 Feb;17(2):67-75. [Medline: 15715901] [doi: 10.111/j.1041-2972.2005.0013.x]
38. Boonn WW, Flanders AE. Informatics in radiology (infoRAD): survey of personal digital assistant use in radiology. Radiographics 2005;25(2):537-541. [Medline: 15798069]
39. Ebell MH, Gaspar DL, Khurana S. Family physicians' preferences for computerized decision-support hardware and software. J Fam Pract 1997 Aug;45(2):137-141. [Medline: 97412729]
40. Rothschild JM, Lee TH, Bae T, Bates DW. Clinician use of a palmtop drug reference guide. J Am Med Inform Assoc 2002;9(3):223-229. [PMC: 11971883] [Medline: 21968650] [doi: 10.1197/jamia.M1001]
41. Rogers EM. Diffusion of innovations. 5th edition. New York: The Free Press; 2003.
42. Hall B, Khan B. Adoption of new technology. UC Berkeley Working Papers No. E03-330. Berkeley, CA: University of California Berkeley, Department of Economics; 2003:1-20.
43. Teng J, Grover G. Information technology innovations: general diffusion patterns and its relationship to innovation characteristics. IEEE Transactions on Engineering Management 2002;49(1):13-27. [doi: 10.1109/17.985744]
44. England I, Stewart D, Walker S. Information technology adoption in health care: when organisations and technology collide. Aust Health Rev 2000;23(3):176-185. [Medline: 20554476]
45. Bower A. The diffusion and value of healthcare information technology. Santa Monica, CA: RAND Corporation; 2005:1-101.
46. Moore GA. Crossing the chasm. New York: HarperBusiness; 1991.
47. Mort D. Portable devices: mobile data could help medicine. Research Information. 2005 Feb 14. URL: http://www.researchinformation.info/rijanfeb05mort.html [accessed 2006 May 9] [WebCite Cache ID 5FnzY2zlh]

Abbreviations

NPS: National Physician Survey
PDA: Personal Digital Assistant

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