

Opportunities for Engaging Low-Income, Vulnerable Populations in Health Care: A Systematic Review of Homeless Persons' Access to and Use of Information Technologies

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We systematically reviewed the health and social science literature on access to and use of information technologies by homeless persons by searching 5 bibliographic databases. Articles were included if they were in English, represented original research, appeared in peer-reviewed publications, and addressed our research questions.

Sixteen articles met our inclusion criteria. We found that mobile phone ownership ranged from 44% to 62%; computer ownership, from 24% to 40%; computer access and use, from 47% to 55%; and Internet use, from 19% to 84%. Homeless persons used technologies for a range of purposes, some of which were health related.

Many homeless persons had access to information technologies, suggesting possible health benefits to developing programs that link homeless persons to health care through mobile phones and the Internet. (*Am J Public Health*. 2013; 103:e11–e24. doi:10.2105/AJPH.2013.301623)

THE HEALTH OF HOMELESS

persons is among the worst of any vulnerable group. Homeless persons experience high morbidity, and age-adjusted death rates are 2 to 4 times as high as those of the general US population.¹ Compared with the general population, emergency department use and hospitalization rates are higher and use of outpatient care is lower² among homeless persons, adding to inefficiencies in resource use.^{3–5} Those who are homeless are also less likely to report having a regular source of health care and are more likely to have forgone needed care.⁶ Despite their needs, access to and use of appropriate health care services by homeless persons is challenging. Previous studies have identified social and psychological barriers to care, including feeling suspicious of medical providers,^{7,8} feeling stigmatized or unwelcome,^{9,10} and having multiple competing needs such as shelter and food,⁶ as well as systemic barriers such as limited insurance coverage.¹¹ Moreover, lack of a permanent address and traditional communication infrastructure (e.g., landline phones) can impede the ability of homeless persons and health care providers to communicate consistently and reliably.

These challenges suggest a potential role for information technologies to facilitate access to health care and to improve disease self-management in the homeless population. Perhaps most notable, the rapid proliferation of mobile

phones in the United States presents opportunities for health care systems to improve communication with homeless persons and to increase both their retention in care and the continuity of care that they receive. According to the Pew Research Center, 85% of American adults own a mobile phone.¹² A number of studies have shown that mobile phone technologies improve communication between health care providers and traditionally vulnerable populations, such as persons of lower socioeconomic status and those with stigmatized health conditions.^{13–17} In light of these points, now may be an opportune time to develop and assess information technology–based outreach efforts for homeless populations in an effort to improve retention in, and continuity of, health care.

As a first step toward this goal, we conducted a systematic review of the existing health and social sciences literature. Our overarching objective was to synthesize what is known about access to and use of information technologies in homeless populations. Our review was guided by 3 research questions:

1. What is the prevalence of access to and use of information technologies (Internet, mobile phones, texting, etc.) by homeless populations?
2. What are homeless persons' purposes for using information technologies?

3. What are the barriers to and facilitators of access to and use of information technologies by homeless populations?

METHODS

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist for reporting of systematic reviews and meta-analyses,^{18,19} we began by conducting structured keyword searches of titles and abstracts across a variety of databases representing different academic disciplines. We included Medline via PubMed for its broad coverage of the health sciences literature and consulted MeSH term lists to identify terms relevant to our searches. Similarly, we included Sociological Abstracts and PsycInfo because of their expansive indexing of the social science and psychological literature. Last, because of their specific focus on the communication and information sciences, we also included Communication Abstracts and Library and Information Science Abstracts. We identified a small number of additional articles through consultation with experts in homelessness research at the time we began our database search.

Recognizing that research in this area is at an early stage, we defined information technologies quite broadly to encompass computers and the Internet as well as mobile phones, iPods, and applications (apps). The set of search

terms that we used is shown in Table 1. We also used an encompassing definition of what it means to be homeless, ranging from being literally homeless (i.e., living on the streets or in places unfit for human habitation) to staying in homeless shelters, transitional housing, or temporary accommodations with family, friends, or acquaintances (often referred to as being doubled up).^{20,21} The search terms that we used to represent the concept of homeless are listed in Table 1.

All searches were conducted between June 27 and July 12, 2012. We included sources in our review if they met the following inclusion criteria: (1) represented original research, (2) appeared in peer-reviewed publications, and (3) addressed at least 1 of our 3 research questions. We did not place any limitations on the age of study participants or on date of publication. We excluded articles that were not written in the English language; we also excluded dissertations and books as well as articles that focused exclusively on the use of information technologies among helping professionals, such as clinicians and social workers (Appendix 1, available as

a supplement to this article at <http://www.ajph.org>, provides our inclusion and exclusion criteria).

We obtained the full abstracts for the publications included in the search results from each bibliographic database, and 2 of us (D. K. M. and A. E. L.) applied the inclusion and exclusion criteria to identify a subsequent corpus of publications for which we gathered full-text content. The review was done sequentially (by A. E. L. and then by D. K. M.) without blinding. D. K. M. and A. E. L. discussed disagreements regarding whether abstracts should have full article review until they achieved consensus. We screened 871 article abstracts, 867 of which were found in our database searches and 4 of which were identified from consulting with experts in the field (Figure 1). Of the initial 871 abstracts, 847 were excluded after abstract review, resulting in a total of 24 publications. Two of us (D. K. M. and A. E. L.) then evaluated each article's full text to make a final determination of whether it fulfilled the inclusion and exclusion criteria. We found 16 articles that met the study criteria, and, as a final step, 2 of

us (T. P. H. and D. K. M.) examined each article's reference list for any articles that had not been retrieved in the database searches. Four titles appeared to be potentially relevant, but on review of each article's abstract we determined that none met the inclusion criteria. Thus, the final number of articles included in our review was 16. (The results of each of the 5 individual database searches are available in Appendix 2, available as a supplement to this article at <http://www.ajph.org>.)

One of us (A. E. L.) extracted data for each full-text article and entered them into an Excel spreadsheet (Microsoft, Redmond, WA) that included authors, publication date, journal, title, purpose, methods, sample description and size, definition of homelessness used, results, limitations, and funding source. Some articles addressed more than 1 of our research questions and thus appear in more than 1 of our results tables. Studies were heterogeneous in populations, measures (e.g., computer use in past 30 days vs computer use ever), sampling strategies, and methods (quantitative vs qualitative).

We performed critical appraisal of the quantitative studies following the methodology described by Young and Solomon²² for cross-sectional studies (all quantitative studies in this review were cross-sectional). They recommended 4 methodological considerations:

1. Is the study sample clearly defined?
2. How representative is the sample (e.g., is the response rate sufficiently high)?
3. Are relevant exposures and potential confounding factors and outcomes accurately measured?
4. Are patients with a wide range of disease severity included?

One of us (D. K. M.) conducted the appraisal, and 2 of us (T. P. H. and A. E. L.) examined the appraisal findings. All 3 subsequently discussed discrepancies and came to consensus on the final appraisal findings. Because of the paucity of research on homelessness and technology use, the purpose of the appraisal was not to exclude studies from the review but rather to inform our analysis, conclusions, and recommendations by understanding the limitations of the included studies. We did not formally appraise the qualitative studies because of a lack of consensus in the literature on the methods and value of such efforts.^{23,24} Institutional review board approval was not needed because we examined and synthesized published data only.

RESULTS

The 16 articles included in our study^{21,25-39} represent 12 different studies because in 4 instances 2 articles reported data from the same participants. The combined sample size of the 12 studies was

TABLE 1—Search Terms Used When Querying Databases

No.	Concept	Query Executed
1	Homeless	homeless* OR unstable housing OR unstably housed OR housing stability OR supportive housing
2	Computers	computer* OR computers (MeSH)
3	Technologies	technolog* OR communication technolog* OR technology (MeSH)
4	Mobile technologies	ipad OR handheld OR mobile computing OR smart phone* OR mobile phone* OR iphone OR android OR app OR sms OR text messag* OR mobile technolog* OR personal digital assistant* OR tablet computer*
5	Informatics	Informatics
6	Internet	Internet OR online
7	Mhealth	m-health OR mhealth
8	Technology disparities	digital divide
9		2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8
10	Total	1 AND 9

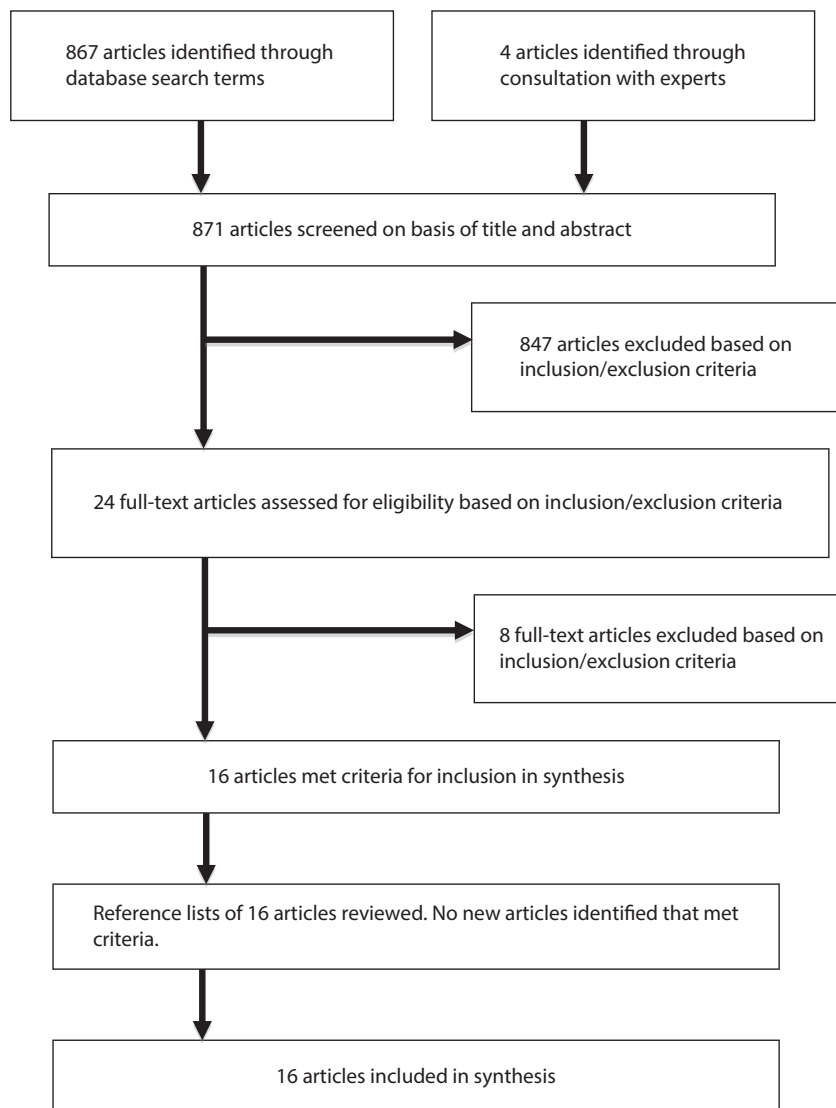


FIGURE 1—Flowchart representing the literature search strategy on homeless persons' access to and use of information technologies.

1082 homeless persons. The sample sizes for individual studies ranged from 7 to 265. Of the 12 studies, 7 used quantitative methods and 5 used qualitative methods. Our critical appraisal of the 7 quantitative survey research studies (representing 11 articles) indicated that none met all 4 criteria for high-quality cross-sectional studies as defined by Young and Solomon.²² All had clearly defined study samples (criterion 1)

in that they indicated who their target was, yet none, from our analysis, presented strong evidence that their samples were representative (criterion 2) of their target population (e.g., homeless adults, homeless adolescents), largely because of the use of convenience samples, typically recruited over a relatively brief time period, from a single social service agency caring for homeless persons. For example, some

researchers recruited homeless adolescents as they came to a drop-in social service agency for services,²⁵ and others used snowball sampling after identifying initial participants with the assistance of a homeless services organization.^{27,28} In addition, 2 studies^{21,35,37} did not demonstrate that they had measured important exposures and potential confounding variables (criterion 3) such as employment or education, and 2

studies^{21,33} did not present details on the range of severity of homelessness represented by their sample (criterion 4), as measured by duration, chronicity, or frequency of homelessness or by type of shelter (e.g., doubled up, emergency shelter, street).

Not surprisingly, the broader technology search terms, including “computer,” “technology,” and “Internet,” yielded the most articles when combined with our homeless search terms (Appendix 2). Our results highlight that more recent advances in information technology have thus far been infrequently studied with homeless populations; for example, Medline included only 8 articles related to homeless persons and mobile technologies. Some studies covered several technologies at once, for example, mobile phone and Internet use among homeless persons, and most were limited to a single city, typically in the United States, although we found 1 study conducted in Canada³² and 1 conducted in Scotland.²⁶ Reflecting our encompassing definition of homelessness and corresponding search terms, the studies that we found included general homeless populations as well as more targeted populations, including unsheltered (“street”) homeless adults, homeless adult drug users, and homeless adolescents.

Research Question 1: Access and Use

Our first research question was “What is the prevalence of access to and use of information technologies (Internet, mobile phones, texting, etc.) by homeless populations?” Nine articles, representing 6 studies conducted between 2006 and 2012, presented data on access to and use of technologies by homeless persons (Table 2).^{21,25,27,28,33,36-39} All relied

TABLE 2—Access, Use, and Factors Associated With Use of Information Technologies by Homeless Persons

Reference	Sample Size	Respondents and Setting	Methods (Response Rate) ^a	Prevalence of Technology Ownership and Usage	Factors Associated with Technology Use and Ownership
Eyrich-Garg ^{27,b}	100	Unsheltered men and women in Philadelphia, PA	Survey (98%)	44% of the sample had access to a mobile phone. Of these, 80% owned it, 18% borrowed long term, and 2% rented. 100% used the phone for calling, and 61% also used texting.	Possessing a mobile phone was positively associated with having a high school diploma ($P = .005$) and with fewer total years of lifetime homelessness ($P = .002$). Texting was positively associated with having experienced more than 1 episode of homelessness ($P = .008$).
Rice et al. ^{36,c}	169	Homeless adolescents in Los Angeles, CA	Survey (NA)	62% of the sample owned a mobile phone (40% owned a working phone, 15% owned a phone with no minutes, 7% shared a phone with a friend). 62% of the sample reported using a mobile phone at least once a day.	Characteristics associated with mobile phone ownership were older age ($P = .02$), not sleeping on streets ($P = .02$), and not being heterosexual ($P = .01$).
Stennett et al. ²¹	39	Homeless adults (location not reported)	Survey (75%)	54% of the sample owned a mobile phone, and 39% had e-mail accounts that they checked at least once per week.	Not reported
Redpath et al. ³³	265	Homeless and indigent drug users in Long Beach, CA	Survey (NA)	55% of participants had used a computer in their lifetime; 24% had owned a computer at some point in their lifetime; 19% had accessed the Internet in the past 30 d.	Lifetime use of computer was positively associated with education (having completed high school; $P < .001$) and with amphetamine use in the past 30 d ($P < .01$). It was negatively associated with older age ($P < .01$) and with days of marijuana use ($P < .05$). Stratified analysis by race found that for Whites, only the education relationship remained significantly associated with lifetime computer use. For Blacks, education, marijuana use, and age relationships remained significant.
Eyrich-Garg ^{28,b}	100	Unsheltered men and women in Philadelphia, PA	Survey (98%)	47% of the sample had used a computer in the past 30 d. Among the computer users, median numbers of days of computer use (in the past 30) was 30. Median number of hours of computer use in the past 30 d was 17.7.	Characteristics associated with computer use in the past 30 d were younger age ($P = .022$); having a high school diploma ($P = .005$); not having slept exclusively on streets for prior 14 nights ($P = .016$); not considering oneself homeless ($P = .008$); having fewer years of lifetime homelessness ($P = .038$); and having lower Addiction Severity Index composite scores ($P = .016$)
Rice et al. ^{38,d}	201	Homeless adolescents in Los Angeles, CA	Survey (NA)	84% of the sample reported using the Internet once a week or more.	Not reported
Young and Rice ^{39,d}	201	Homeless adolescents in Los Angeles, CA	Survey (NA)	79% of the sample used online social networks almost every week, particularly MySpace and Facebook.	Not reported

Continued

TABLE 2—Continued

Barman-Adhikari and Rice ^{25,c}	169	Homeless adolescents in Los Angeles, CA	Survey (NA)	54% of the sample were daily Internet users and relied on public Internet access.	Not reported
Rice et al. ³⁷	136	Homeless adolescents in Los Angeles, CA	Survey (91%)	Nearly 75% of the sample used social networking technology (i.e., mobile phone, e-mail, texting) to maintain ties with home-based social connections.	Not reported

Note. NA = not available.

^aWe calculated response rates on the basis of information provided in the articles. None provided enough detail to ensure that the rates are comparable or that they meet the standards of the American Association for Public Opinion Research.

^bThese 2 articles reported data from the same participants but are described in separate rows because each emphasizes a different technology.

^cThese 2 articles reported data from the same participants but are described in separate rows because each emphasizes a different technology.

^dThese 2 articles reported data from the same participants but are described in separate rows because each emphasizes a different technology.

on structured surveys to gauge participants' perceptions and use of technologies. Sample sizes ranged from 39 to 265 individuals, and all of the studies were limited to a single city.

Although steps were taken to identify participants who met predefined inclusion criteria (e.g., adolescents, substance users, street homeless persons), the samples were nonetheless convenience samples. For these reasons, the question of whether the findings reported here are representative of the general homeless population should be approached cautiously.

Mobile phone ownership and usage. Three studies addressed mobile phone use and ownership, reporting rates of mobile phone ownership ranging from 44% to 62%.^{21,27,36} One study by Eyrych-Garg²⁷ found a 44% rate of mobile phone ownership (including direct ownership, long-term borrowing, and renting) among a convenience sample of 100 unsheltered street homeless persons in Philadelphia, Pennsylvania. The sample was 73% male and 78% African American, with a mean age of 45 years. Additionally, 61% of the mobile phone owners had texted at least once, and 20% had accessed the Internet at least once on their mobile phones. Factors associated with mobile phone ownership were having obtained a high school or general equivalency diploma ($P = .005$) and fewer lifetime years of homelessness ($P = .002$). Use of texting was associated with having experienced more than 1 episode of homelessness ($P = .008$).

Rice et al.³⁶ reported a somewhat higher percentage (62%) of mobile phone ownership among 169 homeless adolescents in Los Angeles, California. The sample was 66% male, 32% African American, 27% White, 13%

Latino, and 28% mixed race or other. Mean age was 20.9 years ($SD = 2.1$). In this sample, 40% owned a working phone and used it every day, 15% owned a phone but had no minutes at the time of the interview, 7% shared a phone with a friend, and 15% did not own a mobile phone but were able to borrow one from a friend or associate. Additionally, 62% of surveyed adolescents reported using a mobile phone at least once per day. Mobile phone ownership was associated with not being heterosexual ($P = .01$), older age ($P = .02$), and living in a shelter or in temporary housing versus living on the street ($P = .02$). In a study of 39 homeless and unstably housed adults interviewed at free meals programs, Stennett et al.²¹ found that 54% owned a mobile phone.

Computer ownership and usage. Two studies addressed computer use and ownership.^{28,33} One found that 47% of the homeless persons in the sample had used a computer in the past 30 days, and the other reported that 55% of its homeless sample had ever used a computer.

Redpath et al.³³ found a 24% lifetime rate of computer ownership in their study of 265 homeless drug users from Long Beach, California. Computer use was considerably higher; however, with 55% reporting they had used a computer at some point in their lives. Predictors of lifetime computer use were having completed high school ($P < .001$) and use of amphetamines in the past 30 days ($P < .01$), and factors negatively associated with lifetime computer use were older age ($P < .01$) and use of marijuana in the past 30 days ($P < .05$).

Eyrych-Garg²⁸ found that 47% of 100 unsheltered homeless adults in Philadelphia had used

a computer in the past 30 days. In that study, the most common location used to access a computer was a public library (87.2%), followed by social service agencies (27.7%), university libraries (14.9%), coffee shops (6.4%), churches (4.2%), friends' homes (2.1%), work (2.1%), and hotel lobbies (2.1%). Furthermore, 19.1% reported using a mobile phone to access the Internet. Factors associated with computer use were younger age ($P=.022$), having a high school diploma or general equivalency diploma ($P=.005$), not having slept exclusively on the streets for the past 14 nights ($P=.016$), not considering oneself homeless ($P=.008$), having fewer years of lifetime homelessness ($P=.038$), and having lower Addiction Severity Index drug composite scores ($P=.016$).

Internet use. Six studies addressed Internet use among homeless persons,^{21,25,33,37-39} indicating prevalence of Internet use ranging from 19% to 84% of the sample. Studies used different measures of Internet use, ranging from Internet use over a 7-day period to over a 30-day period.

In a study of 265 homeless drug users from Long Beach, Redpath et al.³³ found that 19% of the sample reported accessing the Internet in the prior 30 days. Rice et al.³⁸ found that among 201 homeless adolescents from Hollywood, California, 84% used the Internet once a week or more, including 24% who used it more than 1 hour a day and 27% who used it almost every day. Of the sample, 4% reported never using the Internet. Additionally, the most popular location for accessing the Internet among respondents was a public library (50%), followed by a youth service agency (31%), home or where the respondent was staying (23%), an

Internet café (22%), and a friend or associate's home (22%). Other locations were through a mobile phone (18%), at school (12%), and at work (5%).

Studies of homeless adolescents also found high rates of Internet use. Young and Rice³⁹ found that 79% of their sample accessed social networking Web sites at least once per week, 22% used them several times a day, 22% used them once a day, 19% used them once every few days, 15% used them once a week, 12% used them less than once a week, and 9% never used them. The study did not report whether the homeless adolescents who reported never using social networking Web sites accessed the Internet in general for other purposes. Barman-Adhikari and Rice²⁵ found that 54% of their sample used the Internet daily, and they also reported that 32% of their sample had personal Internet access where they were staying or through their mobile phone.

After interviewing 39 homeless adults, Stennett et al.²¹ found that 39% reported checking e-mail accounts on a weekly basis. The study did not report rates of general Internet use among the sample for purposes other than checking or sending e-mail.

Research Question 2: Purposes for Using Technologies

The second research question was "What are homeless persons' purposes for using information technologies?" Twelve articles published between 2005 and 2011 reported on homeless persons' purposes for using such technologies (Table 3). Three of the studies used qualitative methods; including 2 employing in-depth, semi-structured interviews,^{31,32} and

1 using photo-elicitation interviews,³⁰ which combined in-depth qualitative interviews with participants' taking pictures to share with researchers as a kind of visual diary.⁴⁰ The other 9 articles involved structured surveys.^{25,27,28,34-39}

Study sample sizes ranged from 7 to 201 individuals. Among the most common reasons for using technologies, whether mobile phone or Internet, was the desire to stay connected to family members and friends. Searching for employment, keeping in touch with potential or current employers, and seeking housing were other common reasons. Less prevalent, but still reported, was using technologies to keep in touch with helping professionals, such as caseworkers or physicians.

Reasons for mobile phone use. Three articles described reasons why homeless persons used mobile phones.^{27,30,36} Respondents used mobile phones to stay in touch with family and friends, to provide an identity that avoided the stigma of homelessness, and to provide a sense of safety. Eyrich-Garg²⁷ found that mobile phone users felt reassured that they could get help in a medical emergency or when threatened by robbery or violence. Other respondents in this same study reported that their mobile phone helped them stay clean from drugs by keeping them connected to supportive individuals and groups. Le Dantec and Edwards,³⁰ through interviews with 13 homeless adults, found that some used their mobile phones as an identity management tool to mitigate the social stigma of homelessness, conceal their homeless status, and project the image of a stable lifestyle. Rice et al.³⁶ reported that among the 169 homeless adolescents they surveyed, the people the

adolescents most often talked to on their mobile phones were friends or associates from home (51%); siblings, cousins, or other nonparent family members (43%); parents (41%); friends or associates from the streets (38%); potential employers (24%); friends or associates met online (23%); caseworkers, social workers, or youth agency staff (17%); and current employers (12%).

Reasons for computer, Internet, and e-mail use. Five articles described some combination of computer, Internet, and e-mail use by homeless persons.^{25,28,31,32,38} These studies indicated that homeless persons used these technologies for a wide range of purposes, including word processing, finding health-related information, connecting with friends and peers, and finding sex partners. Moser³² interviewed 13 homeless adults who reported that they used the Internet to communicate with family and friends, pass time during the day, mitigate the social stigma of being homeless, look for jobs, develop personal businesses, and obtain education. Eyrich-Garg²⁸ found that among unsheltered homeless adults who used the Internet, 94% used it for what she termed "business purposes," such as searching for information on employment, housing, and medical conditions. These purposes were followed by leisure activities, including surfing the Internet, playing games, listening to music, and watching videos (77%); communicating with friends and family (45%); accessing social networking Web sites (15%); word processing (15%); and e-mailing for leisure purposes (11%).

In a study of 201 homeless adolescents, Rice et al.³⁸ described patterns of e-mailing and use of

TABLE 3—Purposes for Which Information Technologies Were Used by Homeless Persons

Type of Technology and Reference	Sample Size	Respondents and Setting	Methods (Response Rate)	Purposes for Which Respondents Were Using Technology (%)
Mobile phone Eyrich-Garg ^{27, a,b}	100	Unsheltered men and women in Philadelphia, PA	Survey (98%)	Connect with family (70%) Connect with friends (34%) Sense of safety (for health and crime-related emergencies, etc.; 32%) Employment (seeking, checking on hours, receive call from boss, etc.; 23%) Connect with helping professionals (case worker, physician, etc.; 16%) Other: seek stable housing, to help stay clean of drugs (percentage not provided) (Percentages are based on the 44 mobile phone users.)
Le Dantec and Edwards ³⁰	13	Homeless adults from outreach centers (location not reported)	Qualitative interviews including photoelicitation techniques ⁴⁰	Keep in touch with friends and family Identity management tool (i.e., a sign of social status) (No percentages reported.)
Rice et al. ^{36,c}	169	Homeless adolescents in Los Angeles, CA	Survey (NA)	Talk to friends or associates from home (50.9%) Talk to siblings, cousins, or other family members (42.6%) Talk to parents (41.4%) Talk to friends or associates from the streets (37.9%) Talk to potential employers (24.3%) Talk to friends or associates met online (23.1%) Talk to case workers, social workers, or staff at youth agencies (17.2%) Talk to current employers (11.8%)
Computer, Internet, and e-mail Eyrich-Garg ^{28,b}	100	Unsheltered men and women in Philadelphia, PA	Survey (NA)	Business purposes (searching information on employment, affordable housing, medical conditions, etc.; 94%) Leisure (surfing the Internet, playing games, listening to music, watching videos, etc.; 77%) E-mail friends and family (45%) Use social networking Web sites (15%) Word processing (15%) E-mail for leisure purposes (11%) (Percentages are based on the 47 respondents who had used a computer in the past 30 d)

Continued

TABLE 3—Continued

Miller et al. ³¹	7	Homeless men who just completed a shelter work readiness program in Philadelphia, PA	Qualitative interviews	Build life skills (i.e., managing stress and time, doing Internet research, organizing personal documents, writing résumés) Leisure gaming E-mail Develop a business Personal budgeting (No percentages reported.) Use e-mail to communicate with friends or associates from home (44.8%), friends or associates from the streets (36.8%), nonparental family members (36.3%), friends or associates met online (34.8%), and parents (30.9%) Use social networking Web sites to communicate with friends or associates from home (59.7%), friends or associates met online (42.8%), nonparental family members (42.3%); friends or associates from the streets (40.8%); and parents (18.9%) Seek sex partner online ^e (25.4%) (Percentages are based on the 194 Internet users) Receive forwarded health information (75.4%) Connect with home-based peers (66.4%) Look online for general health information (61.0%) Connect with street-based peers (52.7%) Connect with online peers (47.9%) Look online for information on HIV and sexually transmitted infection (47.3%) Look online for sex-related information (40.7%) Connect with parents (34.1%) Talk about sex in online social networks (27.5%) Look online for HIV testing information (23.3%) Pass time during the day E-mail to keep in touch with friends and family Mitigate the social stigma of being homeless Surf the Internet Listen to music Look for jobs Develop a personal business Obtain education Word processing (No percentages reported.)
Rice et al. ^{36,d}	201	Homeless adolescents in Los Angeles, CA	Survey (NA)	
Barman-Adhikari and Rice ^{25,c}	169	Homeless adolescents in Los Angeles, CA	Survey (NA)	
Moser ²²	13 ^f	Homeless and nonhomeless users of computers installed in homeless shelters in Calgary, Alberta	Qualitative interviews	

Continued

TABLE 3—Continued

Author(s)	Sample Size	Study Location	Method	Key Findings
Rice et al. ^{37,h}	136	Homeless adolescents in Los Angeles, CA	Survey (91%)	Keep in touch with homeless peers (100%), home-based peers (74%), parents (50%), and case workers (44%)
Young and Rice ^{39,d}	201	Homeless adolescents in Los Angeles, CA	Survey (NA)	Used social networking Web sites (percentages based on n = 175 respondents): MySpace (78.1%), Facebook (29.9%), and Twitter (10.0%) Communicate with friends online about (percentages based on 175 respondents): love and relationships (45.8%); videos (30.9%); drinking, drugs, or partying (30.4%); sex (27.9%); school (27.9%); being homeless (20.9%); and safe sex (6.0%). Use social network sites to find sex partners (22.8%; percentages based on 136 respondents)
Rice et al. ^{35,h}	136	Homeless adolescents in Hollywood, CA	Survey (91%)	Connect via social networking technologies to home-based peers (mean = 1.54; SD = 2.21), home-based friends (mean = 0.59; SD = 1.22), street-based peers (mean = 0.57; SD = 1.15), and street-based friends (mean = 0.38; SD = 0.89) ⁱ
Rice ³⁴	103	Sexually active homeless adolescents in Los Angeles, CA	Survey (NA)	Use of social networking technologies (Internet, texting, phone) to interact with home-based peers reported by "slightly more than half" of the sample.

Note. NA = not available.

^aIn this study, mobile phone use included calling and texting.

^bThese 2 articles reported data from the same participants but are described in separate rows because each emphasizes a different technology.

^cThese 2 articles reported data from the same participants but are described in separate rows because each emphasizes a different technology.

^dThese 2 articles reported data from the same participants but are described in separate rows because each emphasizes a different technology.

^eThis was based on a question that did not differentiate between e-mail and social network sites; it read, "Have you ever used the Internet to find someone to have sex with?"

^fComplete study sample was 42 but only 13 of these were homeless persons. The remainder were staff and other key informants.

^gSocial networking technologies refers to Internet, mobile phones, and texting.

^hThese 2 articles reported data from the same participants but are described in separate rows because each emphasizes a different technology.

ⁱThe means refer to the number of contacts of a given type in the electronic social network.

social networking Web sites. Among the 194 participants who had access to the Internet, the most common use of e-mail was to communicate with friends or associates from home (45%), friends or associates from the streets (37%), nonparental family members (36%), friends or associates met online (35%), and parents (31%). Separate questions asked about use of social networking Web sites. The purposes for using such sites were similar to those for using e-mail and in roughly the same proportions; they included communicating with friends or associates from home (60%), friends or associates met online (43%), nonparental family members (42%), friends or associates from the streets (41%), and parents (19%). Using an item that asked about seeking sex online (and that did not differentiate between e-mail and social networking sites), the authors found that 25% had ever used the Internet to find a sex partner.

Barman-Adhikari and Rice²⁵ described how 169 runaway and homeless adolescents used the Internet for social contact. These youths connected with home-based peers (66%), street-based peers (53%), online peers (48%), and parents (34%). Additionally, 75% of the sample reported receiving health information forwarded from others through the Internet, and 28% discussed sex through online social networks. They sought health-related information online regarding general health (61%), HIV and sexually transmitted infections (47%), sex (41%), and HIV testing (23%).

Reasons for online social networking. Four studies focused on how homeless persons used online social networking.^{34,35,37,39} These studies were limited to adolescent

youths living in California. Rice et al.³⁷ found that homeless adolescents used their online social networks to maintain ties with homeless peers (100%), home-based peers (74%), parents (50%), and case workers (44%). In their study of 201 homeless adolescents from Los Angeles, Young and Rice³⁹ reported the relative popularity of social networking sites. Most popular was MySpace, used by 78%; Facebook, used by 30%; and Twitter, used by 10%. Respondents discussed a wide variety of topics with their friends on these sites, such as love and relationships (46%); videos (31%); drinking, drugs, or partying (30%); sex (28%); school (28%); being homeless (21%); and safe sex (6%). Additionally, 23% of the sample reported using the Internet to find sex partners. Rice et al.³⁵ reported on the number of

online ties that homeless adolescents had, which ranged from a mean of 1.54 home-based peers (SD=2.21) to a mean of 0.38 street-based friends (SD=0.89).

Research Question 3: Barriers and Facilitators

Our third research question was “What are the barriers to and facilitators of access to and use of information technologies by homeless populations?” Four studies identified barriers to or facilitators of information technology use. All used qualitative research methods (Table 4).^{26,29–31} All 4 articles described barriers, and only 2 reported facilitators. Sample sizes ranged from 7 to 25 participants.

Barriers to technology use. Two studies noted that respondents reported lack of skills in using

a computer or the Internet as a barrier to use.^{29,31} One study suggested that lack of confidence in skills, described as “fear of failure” by the authors, was another barrier for some study participants.³¹ Other barriers to computer use were lack of time to use computers, being asked to leave public computers, and forgetting e-mail account passwords. Two studies identified barriers to mobile phone use, which included loss and theft of phones, costs of maintaining a working phone, difficulty accessing free electrical outlets to recharge phones, and needing to sell one’s phone for cash.^{26,30}

Facilitators of technology use. Of the 2 studies that identified facilitators to information technology use among the homeless, 1 focused on computer use and 1

focused on mobile phone use. Miller et al.³¹ found, in a sample of 7 residents of a long-term shelter for homeless persons, that provision of computer training as part of a work readiness program⁴¹ gave participants confidence in using computers. Le Dantec and Edwards³⁰ found that pay-as-you-go mobile phone plans, rather than monthly plans, facilitated the use of mobile phones among homeless persons.

DISCUSSION

Our systematic literature review identified a paucity of research on the use of information technologies by homeless persons. Although our search encompassed 5 databases spanning the health and social sciences, we identified only 16 articles relevant to our

TABLE 4—Barriers and Facilitators to Homeless Persons’ Use of Information Technologies

Type of Technology and Reference	Sample Size	Respondents and Setting	Methods	Identified Barriers	Identified Facilitators
Computers and Internet					
Hersberger ²⁹	25	Sheltered homeless adults in Seattle, WA, Indianapolis, IN, and Greensboro, NC	Qualitative interviews and participant observation	Lack of computer skills	Not reported
Miller et al. ³¹	7	Homeless men (location not reported)	Qualitative interviews	Lack of Internet skills Fear of failure prevented use of public computers	Computer training program
Bure ²⁶	11 ^a	Homeless and formerly homeless adults in Edinburgh and Glasgow, Scotland	Qualitative interviews	Forgetting e-mail passwords Feeling unwelcome at public libraries (for computer use) Lack of computer or Internet skills	Not reported
Mobile phones					
Bure ²⁶	11 ^a	Homeless and formerly homeless adults in Edinburgh and Glasgow, Scotland	Qualitative interviews	Loss of phone Selling phones	Not reported
Le Dantec and Edwards ³⁰	13	Homeless adults from outreach centers (location not reported)	Qualitative interviews, including photo elicitation techniques	Cost of device and ongoing fees for use Keeping battery charged Theft of device	Pay-as-you-go plans instead of monthly contracts for mobile phones

^aComplete study sample was 16, but only 11 of these were homeless or formerly homeless persons. The remainder were staff and other key informants.

3 research questions. Moreover, none of those 16 articles featured randomized controlled trials or controlled observational studies. Surveys of homeless persons were more common, but most had small, unrepresentative samples. Our critical appraisal revealed that a stronger evidence base is still needed to understand the extent of technology use among homeless persons and the factors contributing to variation in its use. However, the current level of evidence is not surprising; this area of research is new and the population of interest presents a variety of methodological and ethical challenges for researchers. By definition, homeless persons are hard to enumerate, which makes representative sampling very difficult to achieve. The studies we reviewed used a variety of techniques—from snowball sampling to recruitment at drop-in centers and food pantries—that are prone to sampling bias. For all of these reasons, the use of information technologies by homeless persons remains an area that merits further investigation.

Despite prevailing assumptions that homeless persons are cut off from many communication channels, our literature review indicated that substantial numbers of homeless persons may have access to and use the Internet and mobile technologies. Although research in this area is in the early phases, we found, in answer to our first research question, that mobile phone ownership ranged from 44% to 62%. Computer ownership ranged from 24% to 40%, computer access and use ranged from 47% to 55%, and Internet use ranged from 19% to 84%. Although these rates are lower than those in the general US population, they seem surprisingly high in light of the limited

resources available to the populations of focus in this review. By comparison, according to recent Pew Research Center and US Census Bureau reports about the general US population, 77% of households have a computer,⁴² 74% of adults use the Internet,⁴³ and 85% of adults own a mobile phone.¹²

For research question 2, we found that information technologies were used for a wide range of purposes, not unlike those of the general population, particularly connecting with family.^{27,28} Other reasons for technology use may reflect the realities of being homeless; for example, 32% indicated that having a mobile phone gave them a sense of personal safety and security, knowing they could quickly reach police or medical help.²⁷ Others reported that these technologies helped mitigate the stigma of homelessness because e-mail addresses and phone numbers often connote a sense of stability and normalcy^{30,32} even when a person's life may be in considerable turmoil.

Although our research questions did not specifically address health-related uses of technology, we nevertheless were attuned to such uses. Several of the studies reported health-related uses of these technologies by homeless persons. Homeless persons used mobile phones to connect with helping professionals, including clinicians.²⁷ They used the Internet to obtain information about medical conditions and other health-related issues.^{25,28} Some reported that mobile phones helped them stay sober and clean because they could reach out to a support network to help them fight drug cravings and prevent relapses.²⁷ These uses suggest that information technologies could

provide opportunities to improve the health of homeless persons.

Two studies reported on the use of the Internet by homeless adolescents related to sexuality.^{25,38,39} Some used the Internet to seek out sex-related information, and others used the Internet and social networking sites as a means to find sex partners. Neither of these is a new phenomenon,^{44,45} but the relatively high prevalence of HIV^{46,47} and sexually transmitted infections^{48,49} among homeless persons suggests that making public health information and counseling more readily available online, tailored to the needs of homeless and unstably housed adolescents, may be valuable.

Only 4 studies addressed research question 3 regarding barriers to and facilitators of technology use. Those studies indicated that common barriers to information technology among homeless persons include the limited availability of public computers²⁶; the cost of owning and maintaining technologies, especially mobile phone fees³⁰; difficulty finding places to recharge mobile phones; theft of phones³⁰; and lack of computer skills.²⁹ Only 2 facilitators were identified: computer training programs and, for mobile phones, pay-as-you-go plans that were more attractive than contract plans.³⁰

Although adoption rates for Internet and mobile phones have been rising in the general US population,⁵⁰ we were not able to judge from the reviewed studies—because of the relatively narrow time frame in which the studies were conducted and the substantial variation in populations examined (e.g., youths, street homeless persons, substance users)—whether a similar trend is occurring among homeless populations.

However, variation in use of technology by age was apparent. The Internet was used by 84% of adolescents weekly or more often, as reported by Rice et al.,³⁸ compared with 47% of adults who had used a computer in the past 30 days, as reported by Eyrich-Garg.²⁸ Similarly, 62% of adolescents in 1 study had a mobile phone³⁶ compared with 44% of adults in another study.²⁷

The relatively high prevalence of information technology use apparent across the studies that we reviewed probably reflects broad societal and economic trends in which Internet and mobile phones have become, in economic terms, necessities rather than luxuries. Homeless persons' access to these technologies has been facilitated by at least 3 factors. First, the price of information technologies, including mobile phones and computers, has dropped rapidly over the past decade, making them affordable even to people with incomes of a few hundred dollars a month.⁵¹ In addition, a variety of programs distribute free mobile phones to low-income persons.⁵² Second, as our review indicated, libraries, community centers, veteran centers, and homeless shelters often provide free computer and Internet access and were viewed as important access points by homeless persons. Third, these technologies, especially mobile phones but also smaller tablet computers, are well suited to the living situations of homeless and unstably housed persons, who often carry their valuable possessions on their person at all times.

Limitations

The studies included in this systematic review had numerous limitations. Most had small sample sizes, with the largest being 265

participants. All were observational studies using convenience samples, and, except for 2 studies, they were restricted to a single neighborhood or city. None described homeless persons living in rural areas.

Our systematic review also had limitations. It was restricted to peer-reviewed articles published in English. Additionally, although our search strategy was extensive, we did not try to identify potentially relevant publications from government offices, community agencies, or other such entities (i.e., gray literature). As is the case with many systematic reviews, the variety of populations (e.g., adolescents vs adults), methods, and measures precluded a meta-analysis. A total of only 12 studies (16 articles) met our criteria and were thus included in the review. This number is small when compared with some systematic reviews, and yet, because the topic concerns the poorest and most disenfranchised members of society and their use of technologies, it is encouraging that research has at least begun in this area.

Future Research

On the basis of our findings and the pressing health-related needs of homeless populations, we propose additional research focused on information technologies and homeless populations. Our optimism about this line of research comes from the dramatic increase in research related to technology use in a variety of populations. A steady increase has occurred in research about the use of mobile phones in the general population to improve access to and engagement in health care, including the use of texting to increase clinic attendance,⁵³ improve disease self-management, effect behavior change,⁵⁴ and prevent diseases.⁵⁵

A number of these studies have included low-income populations in developing countries,^{56,57} suggesting that homeless populations in the United States may also be potential beneficiaries of interventions using these relatively low-cost technologies. Special challenges will have to be addressed, however, for the US homeless population, in which the prevalence of mental health disorders is relatively high.^{58,59}

A priority issue that needs to be addressed before, or in concert with, the pursuit of a research agenda for enhancing homeless persons' health through information technologies is increasing homeless persons' access to technology, because at least 38% do not have a mobile phone and at least 45% do not have access to a computer. Without efforts in this area, substantial economic and health disparities will persist. Some US government programs provide free mobile phones and an allotment of free monthly minutes to indigent persons.⁶⁰ These programs should continue, and they should consider shifting from providing feature phones to smartphones because of the latter's enhanced functionality, such as mobile apps that could be developed to quickly link the user to social services and even to brief health-related interventions. Another promising area is the provision of basic training to homeless persons to improve computer, Internet, and mobile phone texting skills. Studies of hands-on technology training for computer-inexperienced vulnerable groups have shown that both self-efficacy and technology use increase as a result.^{61,62} Even if trainees do not own a computer, the increase in their technology skills and confidence is likely to lead to greater motivation to seek out free

computer use at libraries and other public locations.

We describe 3 promising domains of research stemming from our findings on the availability and use of information technology, particularly mobile devices, among homeless persons. Across these 3 domains, work should focus on developing and testing interventions that use mobile devices to engage and support homeless persons in the health care process.

Engagement and appropriate utilization of services. Interventions are needed that use mobile phone technologies to increase homeless persons' engagement with health care providers and systems. Such interventions might include appointment reminders, notifications that laboratory results are available, and caring outreach messages^{63,64} to let homeless persons know that health professionals are thinking of them and are genuinely interested in their welfare. These interventions could entail simple outreach—via text message or automated voice message—to homeless patients who have not been in contact with their providers for a long time or who are deemed at risk because of physical or mental conditions. The messages could express concern for the patient and ask whether the person would like an appointment (“John, we haven’t seen you in a while. Would you like to call or text us to make an appointment? We’re here for you at xxx-xxx-xxxx”). This type of proactive outreach has been successful via postcards and letters sent through the postal service.^{63,64}

For homeless persons with smartphones, apps can be developed that provide information about accessing homelessness-related community resources, such as locations and hours of

health care providers, urgent care clinics, emergency shelter contact information, meals and food pantries, and mental health and social work hotlines.

Adherence to treatment. In low-resource countries, numerous promising instances have occurred of information technologies contributing to improved medication adherence among low-income patients.^{56,65} Text messages have been used to remind patients of daily doses or to provide weekly reminders about the importance of regularly taking medications. Providing reminders that it is time to refill medications is another means of improving medication adherence that could easily be achieved through mobile technologies.

Behavior changes. The prevalence among homeless persons of risky behaviors, including tobacco use, alcohol and substance use, and unsafe sex, is high. Brief interventions and motivational interviewing have been adapted to new information technologies, including mobile apps, to address issues such as nutrition, weight loss, and smoking cessation.^{66–68} Homeless persons may especially benefit from this form of delivery because of the difficulty they have getting to health centers where such interventions have traditionally been delivered.

Conclusions

We found surprisingly high access to information technologies among homeless populations, including 44% to 62% who had a mobile phone, 47% to 55% who had access to computers, and 19% to 84% who used the Internet regularly. Homeless persons used these technologies for reasons that are similar to those of the general population but also for reasons that may be associated with their

homeless status. Barriers to technology use were numerous.

The current research base is quite limited. Studies had relatively small sample sizes, used convenience sampling, and relied on cross-sectional surveys or qualitative interviews for data collection. We found no randomized trials of the efficacy or effectiveness of information technologies to provide health or other welfare benefits to homeless persons. Further studies should move toward experimental or quasi-experimental designs to determine whether uses of information technologies by homeless persons can lead to improved outcomes.

Given the evidence currently available and our limited understanding of potential influencing factors, focusing early research on process-oriented outcomes, particularly within the 3 domains of research that we have articulated, may be most fruitful. Having a deeper understanding of how use of information technologies by some of the most vulnerable members of society changes engagement with services, treatment adherence, and health behaviors could in turn provide a foundation for future work that examines outcomes further along the causal pathway, including improved health and decreased mortality. ■

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Contributors

D. K. McInnes conceived of the study and was responsible for the study design conducted literature searches, analyzed and interpreted data, participated in drafting the article, and made final revisions. A. E. Li conducted literature searches; entered, analyzed, and interpreted data; and drafted the article and contributed to its revision. T. P. Hogan contributed to the search strategies, conducted literature searches, interpreted data, and contributed to the writing and revising of the article.

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