Review

Health and Wellness Technology Use by Historically Underserved Health Consumers: Systematic Review

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Abstract

Background: The implementation of health technology is a national priority in the United States and widely discussed in the literature. However, literature about the use of this technology by historically underserved populations is limited. Information on culturally informed health and wellness technology and the use of these technologies to reduce health disparities facing historically underserved populations in the United States is sparse in the literature.

Objective: To examine ways in which technology is being used by historically underserved populations to decrease health disparities through facilitating or improving health care access and health and wellness outcomes.

Methods: We conducted a systematic review in four library databases (PubMed, PsycINFO, Web of Science, and Engineering Village) to investigate the use of technology by historically underserved populations. Search strings consisted of three topics (eg, technology, historically underserved populations, and health).

Results: A total of 424 search phrases applied in the four databases returned 16,108 papers. After review, 125 papers met the selection criteria. Within the selected papers, 30 types of technology, 19 historically underserved groups, and 23 health issues were discussed. Further, almost half of the papers (62 papers) examined the use of technology to create effective and culturally informed interventions or educational tools. Finally, 12 evaluation techniques were used to assess the technology.

Conclusions: While the reviewed studies show how technology can be used to positively affect the health of historically underserved populations, the technology must be tailored toward the intended population, as personally relevant and contextually situated health technology is more likely than broader technology to create behavior changes. Social media, cell phones, and videotapes are types of technology that should be used more often in the future. Further, culturally informed health information technology should be used more for chronic diseases and disease management, as it is an innovative way to provide holistic care and reminders to otherwise underserved populations. Additionally, design processes should be stated regularly so that best practices can be created. Finally, the evaluation process should be standardized to create a benchmark for culturally informed health information technology.

(J Med Internet Res 2012;14(3):e78) doi:10.2196/jmir.2095

KEYWORDS

health care disparities; biomedical technology; health education; health knowledge, attitudes, and practice; health care quality, access, and evaluation; educational technology; cultural diversity

Introduction

While the visibility of health disparities has recently come to the forefront of the US health care agenda, the topic of health care disparities is not new. In 1984 the health of the nation was addressed in the "Health, United States, 1983" report conducted by the US Department of Health and Human Services. This report stated that African Americans and other racial and ethnic minorities were experiencing a higher burden of death and illness than the rest of the nation [1]. As a reaction to this report,

the Secretary of the Department of Health and Human Services created the first group solely designated to study minority health issues—the Task Force on Black and Minority Health. In 1985, this group published a comprehensive study on minority health problems, "Report of the Secretary's Task Force on Black and Minority Health." The report brought more awareness of health disparities in historically underserved populations and spurred research [1].

In the United States, historically underserved populations are growing in size, and hence health disparities are affecting a growing proportion of Americans. For instance, while 2000 census findings showed that 82% of the population was white, by 2015 this number is predicted to decrease to 79%. At that time, it is expected that these will be 5% Asian, 13% African American, and 15% Latino [2]. By 2050, ethnic populations will double in size in the United States and constitute 40% of the population [2]. Similar studies conducted outside of the census found similar results. Partida reported that one in eight Americans is foreign born, and 45% of children less than 5 years of age are not white [3]. Beyond ethnicity, the percentage of older Americans is also increasing, with the oldest (85+ years of age) and ethnic elderly populations growing at the fastest rates [4].

With historically underserved populations growing in the United States, it is important to study the potential and existing health disparities facing them. While there is no consensus regarding the specific definition of what constitutes a health disparity, the National Institutes of Health defined a health disparity as "differences in the incidence, prevalence, mortality, and burden of diseases and other adverse health conditions that exist among specific population groups in the United States" [5]. More specifically health disparities include inequalities and inequities in (1) environment, (2) access to, use of, and quality of care, (3) health status, or (4) a specific health outcome [5]. Examples of racial and ethnic health disparities include certain populations with exceedingly high rates of cardiovascular disease, diabetes, asthma, and cancer [6]. While factors including lower socioeconomic status, lack of insurance, lower levels of education, and living in communities with more environmental hazards have been cited as social determinants outside of the health care system, these do not fully account for health disparities [6]. A patient's culture may contribute to the disparities facing them by influencing health beliefs, values, preferences, and behaviors. For instance, a patient's ability to recognize symptoms and then effectively describe the symptoms to a provider will influence their interactions with their provider, which can in turn affect their health outcomes [6]. The United States made eliminating health disparities one of its main goals through Healthy People 2010, a federal interagency workgroup that provides 10-year national objectives for improving the general health of Americans [7]. Healthy People 2010 targeted disparities based on race and ethnicity, gender, education, income, geographic location, disability status, or sexual orientation [8].

As technology is being used to further the success of the health care system, there is interest in understanding how the increased use of technology affects the already unequal ability of minorities to access health care [9]. Health technology has been used since as early as the middle to late 19th century, when electrocardiograph data were transmitted over telephone wires [10]. Today, health information technology (IT) is used to benefit both the health care consumer and public health as a whole. Health care consumers benefit from health IT by receiving a higher quality of care, reduction in medical errors, fewer duplicate treatments and tests, decreases in paperwork, lower health care costs, access to health information, and access to affordable care [11]. The public health sector benefits from health IT, as it can facilitate earlier detection of infectious disease outbreaks, improve the tracking of chronic disease management, and gather de-identified data for research [11].

Technology can be used in a variety of ways to positively affect historically underserved health care consumers. For example, telemedicine has been suggested as a possible way to address health care disparities among historically underserved urban populations. Research shows that urban communities are often unable to access health care in a timely manner due to low physician-to-population ratios, limited specialty care, and overcrowded, inadequate, and inefficient organizational structures [12]. Telemedicine is an innovative way to decrease the health care gap through mitigating geographic barriers [12].

To promote widespread adoption of health IT, the US Department of Health and Human Services established the Office of the National Coordinator for Health Information Technology [13]. Health IT refers to "a variety of electronic methods used to manage information about people's health and health care, on both an individual and a group level" [14]. Research has shown that health IT can enhance quality, communication [15], and cost-effective care [16], and can facilitate culturally competent outreach and education [17].

The purpose of this review was to examine ways in which technology is being used by historically underserved populations in order to decrease the health disparity through facilitating or improving health care access and health and wellness outcomes. While several studies have investigated how historically underserved populations use technology when addressing their health, these studies focused on a single historically underserved group or a single health issue. We used a methods-description approach method to synthesize published research from reference databases to draw a larger conclusion from the current literature [18]. We explored four main questions from the reviewed papers. (1) Which types of technologies are used to address potential disparities? (2) Which health issues are addressed in the reviewed papers? (3) Which historically underserved groups are targeted for technology-based interventions? (4) How are the health benefits and technologies evaluated? The systematic review was conducted in four reference databases (PubMed, PsycINFO, Web of Science, and Engineering Village) with search strings consisting of three topics: technology, historically underserved groups, and health. Findings are divided into five sections, each answering one of the five main questions. Outcomes include recommendations for increased use of certain technology, along with recommendations to use culturally informed technology in regard to distinct types of health conditions.

Methods

Definitions

The term minority has been used often in health research. However, the term is problematic, as it can create a sense of inferiority for the population in question [19]. Eysenbach suggested that eHealth is a broad topic encompassing 10 main concepts, one of which is equity [20]. He noted that certain patient populations are disadvantaged based on their lack of money, skills, and access to computers. However, the use of the term minority only further perpetrates these inequities. For this reason, we will not use the term minority in this paper. Instead, we will use the term historically underserved to refer to populations that are disadvantaged based on their race, ethnicity, age, gender, socioeconomic status, health status, or geographic location.

Larson stated that simplistic definitions of health should be avoided, as they lead to simplistic measures of health, health outcomes, and quality of care [21]. Therefore, it is important to use a more holistic definition of health that includes wellness; for instance, the World Health Organization defined health as "a state of complete physical, mental and social well-being, not just absence of disease" [21]. Pervasive health care takes this concept a step further and can be defined as "healthcare to anyone, anytime, and anywhere by removing locational, time and other restraints while increasing both the coverage and the quality of healthcare" [22].

The *Health Technology Assessment Handbook* defined health technology as "a collective term for procedures and methods for examination, treatment, care and rehabilitation of patients, including instruments, drugs, and preventive procedures" [23]. Health IT, which differs slightly from health technology, refers to the implementation of information processing that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge to facilitate both decision making and communication [24]. Health IT used directly by consumers is called consumer health IT. Or and Karsh defined consumer health IT as "computer-based systems that are designed to facilitate information access and exchange, enhance decision making, provide social and emotional support, and help behavior changes that promote health and well-being" [25].

eHealth refers to the use of electronic communication and information technology within the health sector. Tools often referred to in connection with eHealth include personal digital assistants, compact discs and DVDs, and interactive games [26]. Telemedicine, which is a part of eHealth, allows providers and patients in different geographic locations to communicate through computers, information, and telecommunication [12]. Telehealth, which is often used synonymously with telemedicine, is defined by the World Health Organization as telemedicine used by others beyond the physician [10] such as nurses and pharmacists. For this review, the author of the original paper differentiated between these 2 terms. For instance, if the author of the paper under review used the term telemedicine, we used it for this review; if the author of the reviewed paper used telehealth, we used it for this review as well.

Electronic health records (EHRs) are an electronic form of the traditional patient health record (patient's health profile, and environmental and behavioral information). EHRs include a time dimension and allow multiple providers to contribute information to the record [27]. EHRs have been shown to have a positive influence on quality of care, patient safety, and system delivery [17]. Electronic medical records are similar to EHRs except they are created solely for care delivery organizations—that is, hospitals and physician's offices [28]. EHRs have the ability to increase access to health care, reduce medication errors, and improve administrative efficiency and quality of care [16]. In contrast to the EHR, personal health records are an optional tool that allows people to manage their own health records [29]. The personal health record is a lifelong resource of health information that is managed by the individual in an electronic, universally available form [29].

For this review, we used a broad definition of technology that includes technology designed for both health and wellness. In this review, health-specific technology designed specifically for the clinical setting includes health IT, EHRs, and telemedicine. We also included wellness informatics, defined as "a human-centered computing science focused on the design, deployment, and evaluation of human-facing technological solutions to promote and manage wellness acts such as the prevention of disease and the management of health" [30], in this review. Wellness informatics encompasses technology that may have little or no interaction with the health care system and is used primarily by the consumer [30]. For this review, wellness informatics tools included media technology created for other domains, such as television, radio, and computers.

Search Strategy

From July to October 2011, we searched the online reference databases PubMed, Web of Knowledge, PsycINFO, and Engineering Village. For each database, we chose keywords to match the specific database's thesaurus and used them to create search phrases. Each search phrase consisted of three key components: a word or phrase considering historically underserved populations, a word or phrase considering technology, and a phrase considering health, health access, or wellness (Table 1). Keywords about historically underserved populations included cultural diversity, ethnic groups, minority groups, cultural competency, ethnocentric, cross-cultural difference, racial and ethnic attitudes, racial and ethnic differences, and racial and ethnic discrimination. Keywords pertaining to health or health access included health education, patient acceptance of health care, attitudes to health, access to information, electronic health care, health, health system, and patient care. Finally, words considering technology included telemedicine, technology, medical technology, educational technology, medical information systems, eHealth, and health technology. When combined into the longer 3-part phrases, a total of 424 search phrases were used.

Table 1. Search terms by topic.

Historically underserved populations	Technology	Health and health access
Cultural diversity[a]	Telemedicine[a,b,c]	Health education[a]
Ethnic groups[a,d]	Technolog*[a,b,c]	Patient acceptance of healthcare/ethnology[a]
Medically underserved areas[a]	Medical technolog*[a,d]	Acceptance of healthcare[a]
Minority group[a]	Educational technology[a]	Attitudes to health[a]
Cross-sectional studies[a]	Electronic healthcare[d]	Access to information[a]
Cultural competenc*[a,d]	E-health[d]	Health knowledge, attitudes, practice[a]
Health status disparities[a]	Health technololog*[d]	Evaluation[d]
Disparit*[d]	Healthcare technolog*[d]	Health access[d]
Social factors[d]	Medical information systems[b]	Technolog* acceptance[d]
Ethnocentric[d]	Medical computing[b]	Healthcare professionals[d]
Reference group culture[d]	Information technology[b,c,d]	Health system[d]
Cultur* bias[d]		Health[d]
Minorit*[d]		Healthcare[b]
Cultural aspects[b]		Patient care[b]
Culture bound syndromes[c]		Health disparities[c]
Ethnology[c]		Health attitudes[c]
Cross cultural differences[c]		Health knowledge[c]
Racial and ethnic attitudes[c]		Health impairments[c]
Racial and ethnic differences[c]		Health complaints[c]
Racial and ethnic groups[c]		
Race and ethnic discrimination[c]		

[a] PubMed.
[b] Engineering Village.
[c] PsycINFO.
[d] Web of Science.

Inclusion and Exclusion Criteria

The scope of the review was focused by establishing inclusion and exclusion criteria. The selection criteria were that the paper (1) focused on a specific priority population(s), (2) discussed how the populations' identity affected their experience within the health care system, and (3) discussed how technology use affected the experience.

We excluded studies if they (1) were published over 15 years ago (prior to 1996), (2) were not in English, (3) were conducted outside of the United States, (4) did not deal with health or wellness, (5) discussed mental health, end-of-life care, or dental care, or examined cost as the main variable, and (6) discussed the historically underserved population as a current or future employee of the health system instead of as a patient.

Analysis

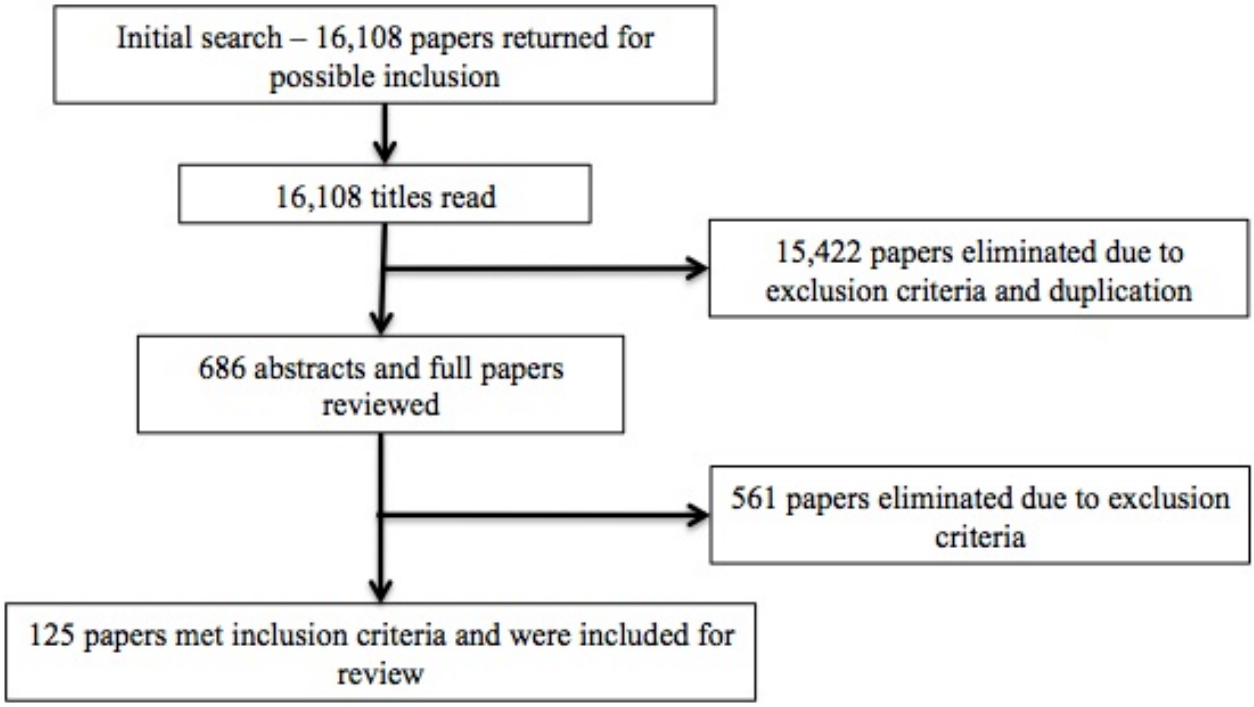
We used a methods-description approach to analyze papers that met the inclusion criteria. This method documented the objective characteristics (as they were described by the primary author) of each study's methods [18]. In compliance with the methods-description approach and to ensure standardized data extraction of the reviewed papers, we created a data table [18] with the following sections: title, author, purpose, and key findings. After completing the table, we defined recurrent topics through coding. Coding is defined as the "analytical process through which concepts are identified and dimensions are discovered in data" [31]. Through use of coding, the following ideas were explored: the targeted historically underserved group, the health issue examined, how technology was used, evaluation techniques, and barriers to access or adoption (Multimedia Appendix 1 [4,9,12,13,15-17,32-149]).

Results

The 424 search phrases returned 16,108 papers. We excluded 15,422 papers as duplications or via the exclusion criteria through reading the titles. After reviewing the abstracts and full papers, we eliminated another 561papers as not meeting the inclusion criteria. A total of 125 papers met the inclusion criteria and were included in this review (Figure 1). An overview of the 125 papers can be found in Multimedia Appendix 1.

All selected papers discussed the health disparity facing the historically underserved group in question and the importance of closing the gap or reducing the disparity. One-quarter of the papers (32) focused only on the health disparity without analyzing a potential solution. The remaining 93 papers briefly mentioned the disparity but focused on accessing a possible solution to lessen the disparity. For instance, 1 report discussed the health disparities facing the Hispanic community in the background of the paper. However, the main purpose of the paper was to determine the effectiveness of *La Clinica del Pueblo*, a health education collaboration that uses radio to increase medical knowledge and have a positive affect on health behaviors [44]. The design and development of the technology was discussed in detail in only 13 of the reviewed papers. More often, the authors simply stated that technology was used in an attempt to lessen the disparity. Additionally, 5 papers were review papers; of the 5 review papers, 2 discussed diabetes [36,62], 2 discussed general health and health IT [9,15], and 1 discussed health literacy for people whose second language is English [65].

Figure 1. Flow diagram of the study selection process.



Which Types of Technologies are Used to Address Negative Health Outcomes for Historically Underserved Populations?

We identified 30 types of technology in the selected papers (Table 2). The technology included both health informatics tools (personal digital assistant, radio, Internet, telephone, mobile computer, mobile phone, videotape, computer, kiosk, MP3, television, compact disc, multimedia tool, instant messaging, and fax machine) and more traditional health technology (general health IT, medical technology, telemedicine, telehealth, telemanagement, electronic medical records, personal health records, EHR, eHealth, assisted reproductive technology, high technology hospitals, rapid human immunodeficiency virus (HIV) testing, implantable cardioverter defibrillator, cochlear implants, and assistive technology). The technology was used in a variety of ways, including as educational tools, as pieces of interventions, or as collaboration tools between physicians and patients.

Table 2. Paper breakdown by technology.

Technology	Number of papers
Video	34
Internet (email, social networking sites)	23
Telemedicine	10
Computer (computers in clinics)	9
Television (advertisements and shows)	8
General health information technology	6
Electronic health record	6
Radio	5
Telephone	5
Mobile phone (text messaging)	5
Assisted reproductive technology	5
Multimedia tool	4
Assistive technology	4
Telehealth	3
Compact disc	2
Kiosk	2
Telemanagement	2
eHealth	2
Medical technology	1
Electronic medical record	1
Personal health record	1
Personal digital assistant	1
Mobile computer	1
High-technology hospitals	1
MP3	1
Rapid HIV[a] testing	1
Implantable cardioverter defibrillator	1
Cochlear implants	1
Instant messaging (on a computer)	1
Fax machine	1

[a] Human immunodeficiency virus.

At Which Disease, Health Problem, or Potential Problem is the Technology Aimed?

The reviewed papers discussed 23 health issues (Table 3). Roughly one-quarter of the papers (33) did not focus on a single health topic, but instead discussed the general health of a population. Other papers examined health issues such as disease management (eg, diabetes, asthma, and obesity); health behaviors (eg, nutrition and smoking); and short-term issues (eg, breast-feeding, issues facing pregnant mothers, and child development).

Nearly half of the papers (62) examined the use of technology to create effective and culturally informed interventions (16 papers) or educational tools (46 papers). The reviewed papers pointed to many interventions and educational tools that were successfully designed for a historically underserved group. A study found that having famous athletes, musicians, and other celebrities from the African American community record commercials for adolescents' MP3 players resulted in better health knowledge about asthma [95]. Another study created a telenovela for Latinas to discuss breast cancer in the dramatic and narrative format of a typical telenovela. Relating to the women on a cultural level, such as through the telenovela, resulted in higher breast cancer knowledge for the participants [144].

Table 3. Paper breakdown by health issue.

Health issue	Number of papers
General health	33
Cancer	17
Diabetes	14
HIV/AIDS[a]	14
Nutrition, physical activity	8
Sexually transmitted infections	7
Reproduction	5
Obesity	4
Cardiovascular disease, heart problems	4
Breast-feeding	3
Smoking	3
Asthma	3
Persons with disabilities	3
Pregnancy issues	2
Pharmacy	2
Sensorineural hearing loss	1
Organ donation	1
Hepatitis C	1
Health literacy	1
High blood pressure	1
Poison control	1
Hypertension	1
Child development	1

[a] Human immunodeficiency virus/acquired immunodeficiency syndrome.

Which Historically Underserved Groups are Technology-Based Interventions Designed for in the Literature?

The papers identified 19 different historically underserved populations (Table 4). Of the reviewed papers, 18 discussed multiple groups (eg, elderly African Americans or Hispanic women) and therefore appear in 2 categories in the table. In 8 the group in question self-identified as “racial and ethnic minorities.” We copied this term in this review paper only when the original author did not provide sufficient details to determine which racial or ethnic minorities were being examined. In addition to racial and ethnic minorities, the reviewed papers also included historically underserved groups that were characterized by their age, gender, location, and socioeconomic status.

Table 4. Paper breakdown by historically underserved group.

Historically underserved group	Number of papers
African American	64
Hispanic	51
Women (mothers)	26
Low socioeconomic status	11
Elderly	11
Adolescents, teens, and children	8
Racial and ethnic minorities	8
English as a second language	5
Native American and Alaskan	4
Men	4
Rural	4
Underresourced setting, underserved community	3
Community health center: underserved, low socioeconomic status, racial and ethnic groups	2
People getting tested for HIV[a]	2
Asian American	1
Immigrant	1
Homeless	1
People with AIDS[b]	1
People living with HIV	1

[a] Human immunodeficiency virus.

[b] Acquired immunodeficiency syndrome.

How Are the Health Benefits and Technologies Evaluated?

Other than the 3 review papers, the papers all used formative technology evaluation. They used two forms of evaluation: (1) evaluation of health changes related to use of the technology and (2) evaluation of the technology itself; few papers (23) used both types of evaluation. A total of 76 of the papers evaluated health changes due to use of the technology (eg, changes in health knowledge, health behavior changes, biometric changes, or changes in health-related quality of life). Of the 107 papers that evaluated technology, 57 evaluated acceptance of the technology (satisfaction or acceptance, usefulness, and willingness to use), 14 evaluated usability (ease of use), 35 evaluated the user's ability to access the technology (access or usage rates and number of websites or television advertisements with the desired information), and 1 measured improvements in technology literacy. In addition, 64 papers relied on the participants' self-report to evaluate the technology, 14 measured ease of use, 22 measured usefulness of the technology, and 28 evaluated satisfaction with the technology. When an intervention or educational tool was evaluated, some of the authors (25 papers) measured improvement in participant health knowledge, while others measured behavior change (22 self-reported behavior changes and 18 observed behavior changes). Furthermore, 10 papers measured biometric changes in the observed health condition, 31 examined access and usage rates of the technology, and 7 recorded whether patients were interested in using the technology in the future. Finally, 4 papers measured the number of websites or television advertisements viewed by the population being studied. Table 5 lists the evaluation methods.

Table 5. Evaluation metrics.

Evaluation metric	Number of papers
Evaluation of health changes related to use of the technology	
Health knowledge	25
Behavior change (self-reported)	22
Behavior change (observed)	18
Biometric change	10
Health-related quality of life	1
Evaluation of the technology itself	
Access and usage rates	31
Self-reported satisfaction and acceptance	28
Usefulness (self-reported)	22
Ease of use (self-reported)	14
Willingness to use	7
Number of websites or television advertisements with desired information	4
Technology literacy improvement	1

Discussion

The purpose of this study was to examine ways in which technology is being designed for historically underserved populations to facilitate or improve health care access and health outcomes. The reviewed studies focused on either (1) a defined historically underserved population, such as African Americans or people with a lower socioeconomic status, or (2) a historically underserved population, such as racial and ethnic minorities, as a group.

The results are organized into the four main questions. (1) Which types of technologies are used to address negative health outcomes for historically underserved populations? (2) At which disease, health problem, or potential problem is the technology aimed? (3) Which historically underserved groups are technology-based interventions designed for in the literature? (4) How are the health benefits and technologies evaluated?

Which Types of Technologies are Used to Address Negative Health Outcomes for Historically Underserved Populations?

The papers discussed 30 different types of technology; half (15) are typically used within a clinical setting, while the remaining 15 types are often used outside of a medical setting. Technologies that are often used outside of a clinical setting were mentioned in the majority of papers (102 papers) and included technologies such as videotapes, Internet, computer, and radio. While not originally created for the health care system, these types of technology were readily adapted to aid health consumers. If a historically underserved population is already familiar with and has access to this type of technology, the technology might be an appropriate platform choice. For instance, 34 papers used videos to relay health messages. Videos are readily understood and easily accessed by the majority of the US population and therefore likely a good choice for health education or interventions aimed at historically underserved populations.

A total of 45 papers used technology typically used within a health care setting (eg, telemedicine, EHRs, or assisted reproductive technology). However, seven of these technologies (medical technology, electronic medical records, personal health records, high-technology hospitals, rapid HIV testing, implantable cardioverter defibrillator, and cochlear implants) were mentioned in only 1 paper [69,77,85,88,121,124,126]. Furthermore, telemedicine was the only type of health-specific technology mentioned in 10 or more papers.

Additionally, 16 papers discussed more than one type of technology, and the majority of these papers (14) mentioned two types of technology typically used outside of the medical office. The remaining 2 papers mentioned one type of each: one type of technology typically used at a clinic, and one type typically used outside of a clinic (telemedicine and videotapes [142], assistive technology and Internet [72]). None of the papers mentioned using more than one type of technology that is typically used inside a medical office.

Among the reviewed papers, videotapes were widely discussed as a method for interventions and educational tools (24 papers). Using videotapes instead of written materials to educate patients increased comprehension among breast cancer patients with low literacy skills [41]. Culturally tailored videotapes that employed characters of the same ethnic background as the patient influenced African American and Hispanic women on both a cognitive and emotional level [41]. Additionally, multiple studies showed increased trust among the patients when the narrator or main character of the educational videotape was the same ethnicity or race as the audience [47,144,150]. In addition, 2 studies demonstrated how storytelling can be used in videotapes to effectively communicate and educate patients about a specific health condition [78,122]. Videotapes were often complemented by other technology such as informational

brochures [63], the radio [125], the computer [45,47], self-efficacy and skill-building exercises [53], multimedia tools [102,136], and telemedicine [142].

The Internet is highly used by health care professionals for interventions and education. One study showed the increased benefit of the Internet to individuals with lower incomes and education levels despite their lower use of the Internet to access health information [151]. Women, minorities, and poverty-stricken individuals (who are also part of the population with the fastest-growing rate of HIV/acquired immunodeficiency syndrome [AIDS]) are those most likely to not have access to the Internet [59]. While many historically underserved populations have lower access to the Internet on a computer, they have higher usage rates of mobile Internet access on handheld devices [151]. Almost two-thirds of African American (64%) and Hispanic people (63%) have wireless access to the Internet. In fact, more African American and Hispanic people own cell phones (87%) than their white counterparts (80%) and, further, these historically underserved populations use their phone data functions more than their white counterparts do [9]. Gibbons suggested that, due to the high usage rates, these tools could improve patient engagement and be an effective mode for interventions [9]. Crilly and colleagues suggested wireless handheld devices as a viable alternative for patients who face barriers due to geography [151]. Eyrich-Garg conducted a study on homeless individuals who faced barriers due to geography. Of the participants in his study, nearly half (44%) owned a mobile phone [59]. Of this 44%, one-fifth had accessed the Internet via their mobile phone in the past 30 days. For this reason, Eyrich-Garg suggested that health care providers could disseminate health information to the homeless through use of mobile phones [59].

Using mobile phones as a means to send information via text messaging is mentioned in the literature as a viable option for racial groups. Similar to their usage of mobile phones, African Americans use text messaging more than their white counterparts do [55]. Samal et al found that text messaging was an acceptable mode of information and communication technology for African American women in an urban sexually transmitted infection clinic [105]. Another study tested the feasibility of text messages as an HIV prevention method for young African American men. The results were positive and suggested that humor be used to initially engage the patient before providing an HIV fact later in the text [148]. While the research is new and applied to only a few select historically underserved populations, text messages are being used as a modality to disseminate health information to these populations.

To access the desired and undesired effects of technology and to search for relevant literature about a technology, a clear definition and delineation of technology is necessary [23]. When the technology is a surgical instrument or a piece of equipment, the definition is seldom a problem; however, other technologies are more complex and unformed, and require more thought to define (eg, wound care, fast-track surgery, or electronic medication). When a definition is created, the technology should be described from its material nature, its purpose, the degree of dissemination, and its maturity [23]. Kristensen and Sigmund suggested that the technology can be defined through a series of questions about how the technology is used for the disease or illness, or the technology [23]. To define the technologies in this review, we asked the following questions [23]. (1) Are there any special professional or technical requirements for operating the technology? (2) Are there factors that affect the application of the technology? (3) What is the purpose and application area of the technology? (4) At which disease, health problem, or potential problem is the technology aimed?

Questions 1 and 2 point to the need to effectively design technology that can overcome cultural differences that are exaggerated by the digital divide, health literacy, and language differences between historically underserved groups and the larger population. Every user needs to be able to operate and understand the technology to effectively access and use it to improve his or her health [23]. With regard to question 3, 23 identified 16 types of technology applications (Table 6). Question 4 is discussed in detail below.

Table 6. Types of technology

Application of technology	Number of papers
Intervention or education tool	62
Health management tool	19
Tool for communication with provider	6
Health record	5
Reproduction	5
Assistive technology	4
Information-gathering tool	3
Interpretation tool	2
Information and communication technology	1
Health information tool	1
Cardioverter defibrillation—medical technology	1
Cochlear implant—medical technology	1
Pharmacy tool	1
Drug advertisements	1
Knowledge acquisition	1
Health literacy assessment	1

At Which Disease, Health Problem, or Potential Problem is the Technology Aimed?

Although 23 health issues were discussed in the reviewed papers, general health was discussed in one-quarter of the papers (33). The next five most mentioned health issues (cancer, diabetes, HIV/AIDS, nutrition and physical activity, and sexually transmitted infections) were mentioned in a disproportionate number of papers (60), while the remaining 17 health issues were mentioned in only 37 papers. Furthermore, eight of the health issues (sensorineural hearing loss, organ donation, hepatitis C, health literacy, high blood pressure, poison control, hypertension, and child development) were mentioned a only single paper each.

Which Historically Underserved Groups are Technology-Based Interventions Designed for in the Literature?

The reviewed papers discussed 19 historically underserved groups. African American and Hispanic populations were mentioned at least twice as often (64 and 51 papers, respectively) as the second-largest target group (ie, women were mentioned in 26 papers). While African American and Hispanic populations were mentioned often, other racial and ethnic groups were rarely mentioned. Native Americans and Alaskan natives were mentioned in 4 papers and Asian Americans were mentioned in only 1 paper. The studies involving Native Americans and Alaskan natives provided an overview of the Indian Health Service [114] and evaluated the positive implementation of EHRs [115], a telehealth network [56], and library access through the Internet [146]. The studies demonstrated the importance of involving and empowering the community to successfully implement health IT [56,146]. More research is needed on this population to better understand the intricacies of implementing health IT in the Indian Health Service. Only 1 paper mentioned Asian Americans [126]; however, this paper was not singularly about Asian Americans. The paper showed that white and Asian American children were more likely to receive cochlear implants than their Hispanic and African American counterparts [126].

While the majority of the papers did not mention gender, when gender was mentioned, women were discussed in 26 papers, while men were specifically discussed in only 4 papers. Of the 26 papers focused on women, 16 described health issues specific to women (7 papers on reproduction, 7 on breast cancer, and 2 on breast-feeding). The remaining 10 papers discussed health conditions that are not gender specific and that could affect males (3 papers on HIV, 2 on obesity, and 1 on the remaining health issues: general health, cardiovascular disease, sexually transmitted infections, nutrition, and cancer). Of the 4 papers dedicated to men, 1 discussed prostate cancer, which is specific only to men; however, the remaining 3 papers discussed HIV and sexually transmitted infections, which can also affect women. While it is understandable that papers discussing gender-specific health issues such as breast cancer or prostate cancer would focus on a single gender, 10 papers targeted only women and 3 papers targeted only men while addressing a non-gender-specific health issue.

It is important to note that attitudes toward technological interventions vary between historically underserved populations, not just between majority populations and historically underserved populations. A single intervention will not necessarily work for two separate racial or ethnic groups; interventions should be tailored to each population to be most effective. For instance, 1 study found that African American and Hispanic populations have different concerns regarding telemedicine [12]. While African American participants were

concerned by the physical absence of the health care professional and the ability to monitor their qualifications, Hispanic participants were concerned with whether telemedicine would be available to uninsured or undocumented individuals.

How are the Health Benefits and Technologies Evaluated?

The review papers used 12 types of evaluation. While we expected that most of the papers would use quantitative evaluation techniques, only half of the papers used these techniques. Objective evaluations were used in 90 papers (31 papers measured access or usage rates, 25 measured changes in health knowledge, 18 measured behavior changes, 10 measured biometric changes, 4 counted the number of websites or television advertisements with the desired information, 1 measured improvements in technology literacy, and 1 measured health-related quality of life). Self-reported measures were used in 93 papers (28 papers measured self-reported satisfaction or acceptance, 22 measured self-reported behavior changes, 22 measured self-reported usefulness, 14 measured self-reported ease of use, and 7 measure willingness to use the technology). Though 10 of the papers measured biometric changes, most of the papers did not evaluate the effects of the technology on health outcomes. Instead, the papers evaluated intermediate measures such as behavior changes or access rates of the technology.

Of the 67 papers that tested a culturally informed technology, 66 found the technology successful in at least one of the evaluated metrics; this points to the fact that health technology is an effective method to improve the health of historically underserved populations. The one study that did not have success aimed to improve HIV risk and sexual behaviors through a culturally appropriate educational video for 15- to 19-year-old black males [51]. Instead, the researchers suggested that an African American health educator conduct face-to-face interventions in order to have a greater impact.

Conclusion

This review illustrates how technology is being used by historically underserved populations to facilitate or improve their health care access and health and wellness outcomes. Synthesis of the literature points to the benefit of accounting for the end user's culture when designing health technology. A person's culture shapes how health information is received, what a health consumer considers a health problem, how symptoms are expressed, who should provide treatment, and what treatment should be provided [152]. The review conveys that culturally informed technology affects the health outcomes of the historically underserved populations facing health disparities in the United States.

Which Types of Technologies are Used to Address Negative Health Outcomes for Historically Underserved Populations?

The reviewed papers discussed 30 different types of technology, both those typically used inside a medical setting and those typically used outside of a medical setting. Health IT can lessen barriers facing historically underserved populations [11]. However, administrators and physicians should carefully analyze the type of technology they choose to implement, as different types of technology are better than others at overcoming certain barriers. Since different historically underserved populations face distinct barriers, choosing a technology type should be an informed decision. For instance, people living in rural and underresourced areas face extra barriers related to provider availability and transportation [153]. The use of telemedicine, where the providers can be located in a different region, can overcome these barriers and aid historically underserved populations in accessing patient-centered care [4,37]. However, of the reviewed papers, only 4 discussed using telemedicine to aid underresourced or rural populations [4,12,37,35]. In another example, using culturally tailored technology that places little financial burden on the consumer and is easy to use, such as videotapes, television advertisements, and compact discs, can help mitigate health disparities facing individuals with low socioeconomic status [154]. This review provides evidence that these technologies have been implemented to help historically underserved populations (34 video papers, 8 television papers, 2 compact disc papers). Additionally, the type of technology with the greatest potential to aid individuals facing multiple chronic conditions is EHRs [155]. However, none of the 32 chronic disease papers (diabetes, HIV/AIDS, asthma, and hypertension) used EHRs.

Choosing an appropriate type of technology is not enough; the technology should be tailored toward the intended population, as personally relevant health technology is more likely than more broad technology to change behavior [1].

At Which Disease, Health Problem, or Potential Problem is the Technology Aimed?

The reviewed papers discussed 23 health issues, with 33 of the papers discussing general health concerns. Since the US federal government requires recipients of federal funds to provide language assistance services, including bilingual staff and interpreters, at no cost to the patient [152], it is surprising that health literacy was not mentioned in more papers. Technology can easily translate difficult health terms and issues into more easily understood concepts for laypeople. Recent reports by the Institute of Medicine and Agency for Healthcare Research and Quality (AHRQ) recommended that future research examine culture and cultural differences when measuring health literacy [156]. Specifically, the 2004 AHRQ report recommended that covariates such as socioeconomic status or education level should be further explored [157]. In addition, it is surprising that chronic diseases were not mentioned in more papers, as chronic diseases are the leading cause of health disparities [36]. Technology can help health consumers manage their overall health behaviors and medicine intake, and thus we expected that more papers would have discussed chronic diseases.

Nearly half of the papers discussed how the technology was used to create culturally informed interventions or educational tools. Obtaining access to culturally appropriate and accessible health education is a necessary piece of receiving high-quality, patient-centered care [154]. Similarly, the reviewed papers support Barrera et al's findings that culturally appropriate health interventions are more effective than usual care. However, there are important limitations to previous research [158]. Since

culturally adapted interventions are seldom directly compared with nonculturally informed interventions, it is difficult to state with certainty that the cultural aspect of the intervention was an important piece of the success of the intervention.

Which Historically Underserved Groups are Technology-Based Interventions Designed for in the Literature?

The papers included in this review highlight a relatively limited number of historically underserved groups (19). However, the review papers did discuss seven priority populations defined by the AHRQ. The AHRQ focused on seven priority populations as specified by Congress in the Healthcare Research and Quality Act of 1999: racial and ethnic minorities, low-income groups, women, children, older adults, residents of rural areas, and individuals with special health care needs, such as individuals with disabilities and individuals who need chronic care or end-of-life care [153]. According to AHRQ, racial minority groups are white people, black people, Asians, Native Hawaiian or other Pacific Islanders, American Indian and Alaska natives, and people who belong to more than one race; ethnic minority groups are Hispanic or Latino [153]. Within the reviewed papers, chronic care and disabilities were not discussed as characterizing historically underserved groups but were mentioned as health issues facing the different populations. In addition to the AHRQ priority populations, the reviewed papers discussed an additional four historically underserved groups: people who speak English as a second language, men, immigrants, and homeless people.

Of the 19 historically underserved groups discussed in the reviewed papers, 11 of these groups were discussed in fewer than 5 papers. Further, five groups (Asian Americans, immigrants, the homeless, people with AIDS, and people living with HIV) were discussed in a single paper. The discrepancy in the number of papers reviewed per historically underserved population is potentially problematic, as it can result in gaps in information regarding the less-studied populations [153]. Furthermore, understudied populations are left out of relevant discourse and in turn rendered invisible and powerless [159]. It is important to study all historically underserved groups to avoid this invisibility and bring awareness to the populations.

The reviewed papers tended to examine one identity that an individual might hold. In addition to studying historically underserved groups separately, researchers should examine populations from an intersectional theoretical perspective. Intersectionality refers to particular forms of intersecting oppressions [160] such as being both Hispanic and an older individual. The combination of these two identities creates different barriers for the patient than either single identity would create on its own. While the papers discussed 18 combinations of cultural groups, they did not adequately theorize the issue of intersectionality and therefore cannot fully understand the barriers and problems facing individuals within the group.

How are the Health Benefits and Technologies Evaluated?

We identified 2 main forms of evaluation in the reviewed papers: evaluation of health changes related to use of the technology and evaluation of the technology itself. A fraction of the papers (23) used both types of evaluation. A wide range of evaluation metrics were used; about half of the papers (64) used self-reported measures as part of their evaluation, while 10 papers measured biometric changes. Even though previous research found self-reports to not be an accurate predictor of health information competencies [161], 32 papers used only self-reported metrics.

The reviewed papers did not include a validated method to evaluate the specific cultural aspect of the health technology. Design processes should be reported in the research so that best practices can be created for culturally relevant design methods. Only 13 of the reviewed papers provided detail on the design process of the interventions and educational tools. Future research should evaluate metrics for culturally informed health technology. These metrics will need to be adapted and changed for different cultural groups, as diverse cultural groups expect different criteria from their health technology.

Study Limitations

We followed systematic review methodology; however, this method has several limitations. Systematic reviews can only assess published work and report on the findings in those articles. Other potential limitations include the use of a single reviewer and the exclusion of studies regarding mental health, end-of-life care, and dental care.

Future Recommendations

More research about culturally informed technology for health is needed. In conjunction with this research, it is imperative for researchers to continue collecting data on cultural populations [162]. Gaps in knowledge about the access to and use of health services by historically underserved populations exist in terms of learning practices, methods to navigate services, and help-seeking behaviors [163]. Further research is necessary to understand the limitations of the data and avoid overgeneralizations [162]. Future recommendations include the following:

- Theoretical models and perspectives are needed to design culturally informed technologies.
- Methodologically, more research should be conducted to create a culturally informed approach to the design of health technology geared toward historically underserved populations. While methods should vary based on the technology, cultural population, and health issue, a broad methodology should be recommended for the future design of culturally informed health technology. This methodology might include formative research, which can aid researchers in overcoming their own implicit biases by using participatory methods to help them understand the population, create programs specific to the population's needs, and ensure the programs are acceptable to the population through pilot testing [164]. Formative research includes qualitative research methods such as focus groups, interviews with key informants, surveys, and field notes. When using formative research to develop culturally informed health IT, key informants might include cultural theorists.

- Financial incentives should be provided to organizations that adopt technology for historically underserved populations. The financial burden of purchasing, implementing, and maintaining health IT serves as a barrier to the adoption among underresourced providers who frequently serve lower socioeconomic patients [14].

Recommendations related to the type of technology chosen are as follows:

- When designing or implementing health technology for historically underserved populations, the type of technology should be carefully considered. Barriers to access and use of health IT differ between populations; different types of technology can be used to overcome distinct barriers. Therefore, the choice of technology type is important. Future research should create a comprehensive list of which types of technology would be most beneficial for each group. For instance, telemedicine is a useful tool to reach rural populations, and mobile telephones are a useful tool to reach African American populations.
- Trust and lack of cultural relevance have been found to be a barrier, as lack of trust in the technology, technical problems, or confusing instructions have a negative impact on adoption and usage rates among historically underserved populations [9]. More research is necessary to determine whether patients' culture changes their level of trust in culturally informed health IT.
- Future studies should examine how to best diffuse technology into a population [165]. When implementing an intervention, researchers should evaluate the readiness of the intended population.
- As new technology is invented and as the cost of current technology decreases, culturally informed health technology should be adapted. For instance, social media, which have rapidly grown in the 21st century [166], should be further examined as a possible method to reach historically underserved populations. Social media have already started to enter the health care system through online patient communities such as PatientsLikeMe, QuitNet, and CureTogether. These networks create spaces for patients to discuss specific conditions and share their experiences. If access does not serve as a barrier, research shows that these social networks can be useful for historically underserved populations [9]. Social media may prove to be a cheaper way to access geographically isolated populations.

Recommendations related to the disease, health problem, or potential problem are the following:

- Future studies should use culturally informed health IT for chronic disease management. The emphasis on self-management support programs has shifted from pedagogical education with education content defined by health care professionals to an individualized approach that addresses the specific needs of a patient's situation [167]. Future research should examine how to best use technology to aid in the disease management of historically underserved populations with chronic diseases.

The recommendation related to the evaluation of the technology is the following:

- The evaluation process should be standardized to create a benchmark for culturally informed health IT. Participatory approaches should be used when possible to evaluate technologies, but metrics related to culturally informed design are needed. While research should dictate these metrics, possible metrics might include issues surrounding access, usability, perceived usefulness, and cultural appropriateness.

Acknowledgments

This publication is supported by grant 1UL1RR025011 from National Institutes of Health and the University of Wisconsin-Madison Systems Engineering Initiative for Patient Safety (http://cqpi.engr.wisc.edu). The Agency for Healthcare Research and Quality's training grant provided support for this project (http://www.ahrq.gov/fund/training/rsrchtng.htm).

Conflicts of Interest

None declared.

Multimedia Appendix 1

Overview of reviewed papers.

[PDF File (Adobe PDF File), 161KB - jmir_v14i3e78_app1.pdf]

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Abbreviations

AHRQ: Agency for Healthcare Research and Quality
AIDS: acquired immunodeficiency syndrome
EHR: electronic health record
HIV: human immunodeficiency virus
IT: information technology

Edited by G Eysenbach; submitted 26.02.12; peer-reviewed by L Kvasny; comments to author 19.03.12; revised version received 28.03.12; accepted 25.04.12; published 31.05.12

Please cite as:
Montague E, Perchonok J
Health and Wellness Technology Use by Historically Underserved Health Consumers: Systematic Review
J Med Internet Res 2012;14(3):e78
URL: http://www.jmir.org/2012/3/e78/
doi:10.2196/jmir.2095
PMID:22652979