Behavioral Interventions Using Consumer Information Technology as Tools to Advance Health Equity

The digital divide related to consumer information technologies (CITs) has diminished, thus increasing the potential to use CITs to overcome barriers of access to health interventions as well as to deliver interventions situated in the context of daily lives. However, the evidence base regarding the use and impact of CIT-enabled interventions in health disparity populations lags behind that for the general population.

Literature and case examples are summarized to demonstrate the use of mHealth, telehealth, and social media as behavioral intervention platforms in health disparity populations, identify challenges to achieving their use, describe strategies for overcoming the challenges, and recommend future directions. The evidence base is emerging. However, challenges in design, implementation, and evaluation must be addressed for the promise to be fulfilled.

Future directions include (1) improved design methods, (2) enhanced research reporting, (3) advancement of multilevel interventions, (4) rigorous evaluation, (5) efforts to address privacy concerns, and (6) inclusive design and implementation decisions. (*Am J Public Health*. 2019;109: S79–S85. doi:10.2105/AJPH.2018.304646)

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The digital divide related to consumer information technologies (CITs) has diminished. Cell phone ownership is higher among African Americans and Hispanics than among non-Hispanic Whites, and smartphone ownership is at least 75% for all three groups.[1] Rural residents continue to lag behind those who live in urban and suburban areas in technology ownership, but about two thirds now have desktop computers or laptops and smart phones.[2] This increases the potential to use CITs to overcome barriers of access to health interventions as well as to deliver interventions situated in the context of daily lives and is particularly relevant for interventions aimed at behavior change. However, the evidence base regarding the use and impact of CIT-enabled interventions in health disparity populations lags behind that for the general population. The National Institute on Minority Health and Health Disparities (NIMHD) defines a health disparity as a health difference that adversely affects disadvantaged populations, based on 1 or more health outcomes. The main health outcomes are

1. higher incidence or prevalence of disease,
2. earlier onset or faster progression of disease,
3. poorer daily functioning or quality of life,
4. premature or excessive mortality, and
5. greater global burden of disease.[3]

Health disparity populations include "racial/ethnic minorities, low socioeconomic status, rural, sexual and gender minorities, and/or others subject to discrimination who have poorer health outcomes often attributed to being socially disadvantaged, which results in being underserved in the full spectrum of health care."[3(pxxx)]

A substantial number of systematic reviews and meta-analyses have assessed the quality of intervention studies as well as synthesized the evidence across studies, particularly randomized controlled trials, to advance what is known about CIT-enabled interventions in general and for those with specific health conditions, such as heart failure, asthma, tobacco use, obesity, and inadequate physical activity, and reflect a growing evidence base about the efficacy of CIT-enabled behavioral interventions for chronic disease and lifestyle modification.[4–9]

In contrast, the reviews about CIT-enabled interventions in health disparity populations are more descriptive in nature.[10,11] For example, a 2012 review of 125 CIT studies focused on health and wellness in historically underserved populations characterized the types of technologies involved, types of users, health topics covered, and evaluation focus, including outcomes measured.[11] Although the authors did not synthesize the findings of the

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RECOMMENDATIONS FOR HARNESSING CONSUMER INFORMATION TECHNOLOGY–ENABLED BEHAVIORAL INTERVENTIONS AS TOOLS TO ADVANCE HEALTH EQUITY

1. mHealth, telehealth, and social media–enabled behavioral intervention design should
   a. Integrate methods that facilitate the alignment of intervention focus, CIT platform, and user characteristics such as cultural beliefs, preferences, and functional, digital, and health literacy as well as ecological context of use; and
   b. Incorporate mechanisms of action for behavior change and persuasive design principles to sustain user engagement with the CIT-enabled intervention.
2. Encourage rigorous reporting standards for individual studies and promote adherence to the 20 equity-based extensions to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline.
3. Advance multilevel interventions by linking mHealth and social media–enabled interventions with the health care delivery system through EHR-based approaches such as clinical decision support, tethered patient portals, and clinical dashboards.
4. Evaluate mHealth, telehealth, and social media–based interventions rigorously throughout the stages of developing and implementing the CIT-enabled intervention with the evaluation design matched to stage of development (i.e., conceptualization through effectiveness testing).
5. Address user privacy concerns at the individual study level, and through policy advocacy at institutional, state, and national levels.
6. Make design and implementation decisions that foster the inclusion and sustained engagement of health disparity populations in CIT-enabled intervention studies.

Note. CIT = consumer information technology; EHR = electronic health record.

studies reviewed, they made several recommendations about the use of CITs for health and wellness interventions. These included tailoring the CIT-enabled intervention to the intended population, contextually situating the CIT-enabled intervention to increase likelihood of behavior change, and increasing the use of mobile health (mHealth) and social media. They also called for explicit reporting of design processes to promote development of best practices and to standardize evaluation processes to create benchmarks for culturally informed use of CITs for health. Another descriptive review highlighted the promise of CITs for supporting health education and behavior change in underserved populations.[10]

Within the overall vision for the science of minority health and health disparities, the vision for CIT-enabled behavioral intervention research is to integrate the mechanisms of behavior change with appropriate CITs and persuasive design principles to rigorously design, implement, and evaluate CIT-enabled behavioral interventions for health disparity populations. The ultimate goal is to reduce health disparities by harnessing CITs to improve access to behavioral interventions, tailor intervention content to user characteristics and contexts, facilitate sustained engagement with the intervention, and support innovative evaluation strategies.

Motivated by this vision and goal, we critically analyzed and synthesized research on CIT-enabled behavioral interventions in general along with selected case examples from health disparity populations to (1) briefly summarize what is known about the use of 3 categories of CIT (mHealth, telehealth, and social media) as approaches for single and multilevel interventions aimed at improving health behaviors and outcomes of health disparity populations, (2) identify challenges to achieving their use and impact, (3) describe strategies for overcoming the challenges, and (4) recommend future directions (see the box on this page).

BEHAVIORAL INTERVENTION AND EVALUATION

The literature review and case example analysis conducted for this essay illustrate the promise or, in some instances, the impact, of mHealth, telehealth, and social media as CIT-enabled intervention strategies among health disparity populations and offer important lessons for future directions. The case examples, which we selected as exemplars of CIT-enabled behavioral interventions in health disparity populations based on our expertise and individual reviews of the literature, represent a broad range of target users, intervention foci, and study designs (Table A, available as a supplement to the online version of this article at http://www.ajph.org). For purposes of this essay, mHealth is defined as the use of mobile and wireless CIT for health purposes and social media is defined as CIT that facilitates the creation and sharing of content through an online community. Telehealth interventions are limited to CIT-enabled interventions that involve patient–provider communication and a patient behavioral component.

The critical analysis of the case examples (Table A) and narrative synthesis in the following paragraphs summarize the emerging evidence base for the acceptability, feasibility, and efficacy of single- and multicomponent CIT-enabled behavioral interventions in health disparity populations. The case examples also illustrate the role of CITs to support innovative intervention evaluation.

Mobile Health

Although the depth and breadth of evidence is less for health disparity populations than for the general population, mHealth shows potential for promoting self-management activities for healthy eating and weight loss,[12,13] medication adherence,[14] and reduction of chronic disease symptoms related to asthma,[14] HIV,[15] and depression.[16] Approaches such as text messaging,[13,14] mobile apps,[12] Web-based avatars,[15] and multimedia audiovisual

vignettes[16] support self-monitoring of diet and physical activity,[12,13,17] promote enhanced motivational learning,[14] and provide health education[14,15] and cognitive behavioral strategies[16] to mitigate symptoms.

Telehealth

Few studies have been conducted on the use of telehealth for behavioral interventions in health disparity populations[8,9]; most studies primarily focus on remote monitoring. However, the Informatics for Diabetes Education and Telemedicine project, a large 5-year randomized controlled trial in New York State, demonstrated the positive influence of a multilevel (patients and primary care providers) telehealth intervention on nutrition and exercise practices and clinical indicators of low-income, rural and urban, elderly, minority patients with diabetes.[18] A more recent smaller study in rural West Virginia supported the use of mI SMART (Mobile Improvement of Self-Management Ability through Rural Technology), a multicomponent intervention (video visits, health education, self-management, and blood pressure, glucose, and weight monitoring) in multiple chronic conditions.[19] Houlihan et al. integrated interactive voice response with patient education, cognitive behavioral interventions, screening and referrals, and alerts to a nurse coordinator in an randomized controlled trial targeting adults with physical disability and secondary chronic conditions. Results included a reduction in prevalence of pressure ulcers for women, decrease in depression severity, and increase in patient reports of health care availability.[20]

Social Media

Social media–based interventions have been implemented with a variety of online platforms, and a few studies have explicitly focused on health disparity populations. Bull et al. conducted a large cluster randomized controlled trial of a Facebook intervention focused on preventing sexually transmitted infections in a racially and ethnically diverse sample, and demonstrated positive effects at 2 months for condom use and proportion of sexual acts protected by condoms.[21] A recent qualitative study exploring Latino adult smokers' perceptions showed support for the use of social media–delivered interventions to support smoking cessation.[22]

Although some studies have focused on use of social media alone, several studies have integrated social media with other strategies for a multicomponent intervention. For example, Herring et al. assessed the feasibility and demonstrated positive effects of a technology-enabled behavioral intervention (Facebook, text messaging, telephone coaching) targeting weight loss among low-income Hispanic and non-Hispanic Black mothers 1 year postpartum.[23] Another weight loss study compared podcasts only with podcasts plus diet and physical activity monitoring through a mobile device plus interactions with study counselors and other research participants over Twitter.[24] The number of downloaded podcasts was significantly correlated with weight loss in both groups, but minorities were less likely than Whites to complete the intervention, thus limiting their potential to benefit from the intervention and suggesting the need for strategies to improve their engagement with the intervention.

Consumer IT for Evaluation

Traditional evaluation protocols can be problematic for health disparity populations, which often face challenges such as transportation to the research site, job hours, and elder or child care responsibilities. Several case examples illustrate innovative use of CITs for evaluation. Kolmodin MacDonell et al. evaluated the impact of tailored computer-based educational sessions and text messages on African American youths' adherence to asthma controllers using Ecological Momentary Assessment, a method in which data are collected daily.[14] Implementing Ecological Momentary Assessment via text messages improved evaluation data collection frequency, timing, and completeness and limited response burden. Another aspect of evaluation that can be supported by CITs is teasing out the ingredients of multicomponent interventions to examine relationships with outcomes of interest. For example, in a CIT-enabled breast cancer survivor self-management intervention comprising 104 intervention ingredients (e.g., texts, tasks, tests, videos), the researchers used log file analysis to assess the amount of self-tailoring by users and to categorize users on the basis of patterns of ingredient use (i.e., level of engagement with the self-management intervention components) for linkage with outcomes of interest.[25]

The Promise

In summary, these examples suggest that mHealth, telehealth, and social media–enabled behavioral interventions (particularly if the intervention is multicomponent[18,23,24]) show promise[12–15,17,23,24] and, in some instances, significant influence[18,21] on NIMHD-defined outcomes of interest for health disparity populations. Moreover, in the general population, substantial evidence shows an increase in effect size when the CIT-enabled intervention is enhanced with human or CIT-based support.[26] Such support is essential for overcoming barriers, such as technical problems attributable to a lack of familiarity with a specific CIT or concerns about loss of privacy or confidentiality. The latter may be of particular concern in health disparity populations that have experienced discrimination or stigma. In addition, mHealth, telehealth, and social media can facilitate innovative evaluation with limited response burden for research participants who may have difficulty fitting traditional evaluation protocols into their daily lives and responsibilities.

CHALLENGES AND RECOMMENDATIONS

The following sections describe challenges to using CIT-enabled behavioral interventions with health disparity populations and strategies for overcoming the challenges. These challenges can be grouped according to the major phases of intervention research—design, implementation, and evaluation. Other challenges fall into the cross-cutting category of bioethics. Recommendations for future directions are integrated into each section.

Intervention Design Challenges

There are multiple challenges to CIT-enabled behavioral intervention design. The failure to match behavioral intervention

mechanisms and CIT features and functions with user characteristics, including ecological context of use, results in suboptimal intervention design. For example, existing off-the-shelf mHealth apps are often insufficient to meet the needs of health disparity populations because of a mismatch between user needs and system features and functions.[27] Beyond the CIT itself, user characteristics, such as cultural beliefs, preferences, and functional, digital, and health literacy, affect capacity and willingness to use and sustain engagement with technology-enabled interventions.[16,24] For instance, cultural beliefs, such as personalism and familism, among Latinos may suggest a preference for tailored content and social media–based interventions. In terms of capacity, the digital divide has shifted from simple CIT access to having sufficient functional, digital, and health literacy to benefit from a CIT-enabled intervention. Moreover, social determinants of health and other factors affect the ecological context in which research participants engage with CIT-enabled interventions. For example, income level may limit the size of the data plan or number of text messages a participant may be able to accommodate.

User-centered design, participatory design, and community-based participatory research share a common goal of incorporating the perspectives and needs of target users into CIT-enabled intervention design to ensure that the intervention meets user needs.[28] These approaches were applied in several case examples.[15,19] Although each approach involves engaging target users, they differ in the extent to which target users are integrated into the research process.[28] Community-based participatory research, a frequently used approach for research with health disparity populations, has the highest level of user engagement because target users and other stakeholders are involved from design through dissemination. This approach is exemplified in the HIV/STD Outreach, Prevention, and Education (HOPE) project, which included an online intervention related to sexual health for African American youths.[28]

Regardless of the specific approach, CIT-enabled interventions take place in diverse ecological contexts that are influenced by social determinants of health and other factors. As a consequence, consideration of the context of user engagement with the CIT-enabled intervention is an essential aspect of ensuring that the intervention is well-matched to the health disparity population of interest. Participatory approaches also are relevant when transforming an evidence-based human-delivered intervention into a technology-enabled intervention. For example, an ongoing NIMHD-funded study is incorporating user-centered design to transform the MyPEEPS HIV prevention intervention for young men who have sex with men[29] into an mHealth intervention.

Another strategy to address the issue of mismatch among behavioral mechanisms and targets, CIT features and functions, and user characteristics in CIT-enabled intervention design is to incorporate evidence-based mechanisms for behavior change and persuasive design principles that optimize user interactions with CIT into the intervention design process. Michie et al. have delineated a taxonomy of evidence-based behavioral mechanisms derived from multiple behavioral theories and related literature (Table B, available as a supplement to the online version of this article at http://www.ajph.org).[30] By providing a tool to tease out the active ingredients of the behavioral intervention, the taxonomy provides an important foundation for building the knowledge base on evidence-based behavior change mechanisms for all populations and to facilitate comparisons across populations to determine whether efficacy differs. In addition, there is some evidence to support the relationship between 4 categories of persuasive design principles that enable and support user engagement with the CIT-enabled intervention (Table C, available as a supplement to the online version of this article at http://www.ajph.org) and intervention adherence and effectiveness.[31–33] Primary task support facilitates ease of use of the CIT and dialogue support motivates the user to stay involved with the CIT-enabled intervention to reach the intended behavior.

In addition, although credibility support is essential, health disparity populations may have different perceptions of what makes a system credible. As a consequence, new approaches for credibility support that build upon meaningful definitions of trustworthiness for the health disparity population are warranted. The persuasive design principle of social support leverages social influence to motivate behavior change and may be particularly important to health disparity populations that value social connectedness.

Recommendation 1. mHealth, telehealth, and social media–enabled behavioral intervention design should

- integrate methods that facilitate the alignment of intervention focus, CIT platform, and user characteristics, such as cultural beliefs, preferences, and functional, digital, and health literacy as well as ecological context of use; and
- incorporate mechanisms of action for behavior change and persuasive design principles to sustain user engagement with the CIT-enabled intervention.

Implementation Challenges

The major challenge related to intervention implementation is the limited evidence base about what works for whom in a particular context. The development of best practices for intervention implementation for both single-level and multilevel interventions aimed at health disparity populations is hampered by the lack of process-level detail included in the published literature. For example, papers often lack detail about the composition of the study sample from the perspective of equity-based extensions to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline,[34] the components of the intervention in terms of the behavioral target and mechanisms, whether persuasive design principles were included in CIT-enabled intervention design, if intervention components were delivered as intended, the levels of user engagement with the intervention, and the barriers and enablers of the intervention implementation at the individual and organizational level.

A second aspect of the limited evidence base is the dearth of multilevel behavior intervention

studies specific to health disparity populations that integrate CIT and health care delivery technology. An exception is the Informatics for Diabetes Education and Telemedicine project, which targeted Hispanic, Black, and non-Hispanic White urban and rural patients with diabetes as well as their primary care providers.[18] Implementation of multilevel interventions that integrate mHealth or social media with health care delivery is rare, but electronic health records (EHRs) offer some opportunities to do so. In the Beacon Communities Collaborative funded by the Office of the National Coordinator for Health Information Technology, 3 of 17 communities combined EHR-based clinical decision support with mHealth as a patient engagement strategy.[35] Although the focus was not explicitly on health disparities, the Louisiana and South Michigan Beacon Communities included large numbers of people who experience these disparities. In addition to clinical decision support, other EHR-based strategies with potential for multilevel intervention targets that integrate CITs are tethered patient portals[36] and clinical dashboards.[37] Tethered patient portals support patient data entry and tracking, viewing of clinical data, secure patient–provider communication, and linkage to information resources. Clinical dashboards offer integrated displays of data from a variety of sources including those that are patient-generated.

Recommendation 2. Encourage rigorous reporting standards for individual studies and promote adherence to the 20 equity-based extensions to the PRISMA guideline.

Recommendation 3. Advance multilevel interventions by linking mHealth and social media–enabled interventions with the health care delivery system through EHR-based approaches such as clinical decision support, tethered patient portals, and clinical dashboards.

Intervention Evaluation Challenges

Evaluations of CIT-enabled behavioral interventions frequently suffer from challenges or limitations that make it difficult to establish conclusions about feasibility, mechanism of action, and effect on outcomes. These include sample size and composition, outcome assessment, and scalability and translatability.

In terms of sample, CIT-enabled behavioral intervention studies often involve small samples of fewer than a hundred participants and lack a reference group. As a consequence, although such studies speak to intervention efficacy in the target population, they do not specifically address reducing health disparities between the target population and reference groups, although the feasibility of doing such comparative studies has been demonstrated.[16,18]

There are multiple challenges associated with outcome assessment. For example, the authors of a review of 16 randomized controlled trials that assessed the outcomes of CIT-enabled interventions for asthma control in minority populations noted that the time required for thorough evaluation sometimes renders the CIT component of the intervention obsolete by the time of reporting, thereby limiting its relevance and replicability.[38] Challenges to outcome assessment also exist with smaller feasibility and pilot studies, which often focus on important CIT-related variables such as attitudes toward technology or perceived ease of use, but may not gather clinical or behavioral outcome data needed to estimate an effect size for a fully powered randomized controlled trial.

Another challenge is that few studies evaluate the interventions' scalability and translatability to other settings. Frameworks such as the Reach, Efficacy/Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) model[39] provide approaches relevant to CIT-enabled interventions that could be applied to address scalability and translatability. For example, the RE-AIM Reach dimension explicitly considers the characteristics of the study sample and the potential of the intervention to reach health disparity populations.

The earlier stages of developing CIT-enabled interventions are often best served by participatory design methods that can elucidate user needs and ensure that the design matches user needs. Moreover, as described in several case studies, formative research is useful in determining potential barriers and facilitators of use that need to be considered in the implementation process. Although efficacy and effectiveness studies frequently implement a traditional randomized controlled trial design, Multiphase Optimization Strategy and Sequential Multiple Assignment Randomized Trial designs for developing adaptive interventions have significant advantages given their ability to add or change intervention components at predefined critical decision points. This ability may be relevant to increasing the efficiency of the study, enhancing or sustaining engagement of health disparity populations, or refining a multicomponent intervention to meet the needs of such populations.

Recommendation 4. Rigorous evaluation of mHealth, telehealth, and social media–based interventions should occur throughout the stages of developing and implementing the CIT-enabled intervention with the evaluation design matched to stage of development (i.e., conceptualization through effectiveness testing).

Cross-Cutting Bioethical Challenges

The bioethical principles of autonomy (i.e., respect for persons), beneficence, and justice face major challenges when mHealth, telehealth, and social media are used as behavioral intervention platforms for health disparity populations. First, in terms of autonomy, which is typically protected by informed consent, use of social media and global positioning system–enabled mHealth apps as intervention components adds complexity to questions of data ownership and maintenance of privacy. For example, control over personal information may be unclear and participants may have concerns about potential discrimination based on personal data.[40] Transparency about individual control of personal data, including who has access to the data and for what purposes, is of paramount importance for CIT-enabled interventions. Engaging intended users throughout the design and implementation processes may overcome concerns about privacy as a barrier to intervention participation.

Second, beneficence is facilitated by methodological rigor to ensure that scarce resources are used wisely and decisions are not made on the basis of unsound

findings. Strategies for designing and implementing CIT-enabled behavioral interventions that support beneficence include cultural appropriateness, intervention tailoring, and participatory design to address challenges such as language issues, low health literacy, social determinants of health, and connectivity issues, and to define the value of the interventions and outcomes. Racial and ethnic concordance also is an important consideration to enhance beneficence. For example, a design that incorporates telehealth providers who share similar, racial, ethnic, and demographic characteristics with research participants has the potential to advance knowledge about active engagement of health disparity populations in managing their own health.

Third, a challenge for justice is the fact that populations who experience health disparities are underrepresented in CIT-enabled behavioral intervention studies. As a consequence, these populations will not have equal opportunity to benefit from the research unless researchers carefully consider strategies that support inclusion in CIT-enabled interventions such as designing for a CIT that is broadly used by the health disparity populations of interest or providing support for loaner devices or data plans that make it feasible for individuals with low socioeconomic status to participate.

Recommendation 5. Address user privacy concerns at the individual study level and through policy advocacy at institutional, state, and national levels.

Recommendation 6. Make design and implementation decisions that foster the inclusion and sustained engagement of health disparity populations in CIT-enabled intervention studies.

CONCLUSIONS

The emerging evidence base for CIT-enabled behavioral interventions supports the promise of such interventions and is beginning to describe their influence on relevant health disparity outcomes. Some challenges to fulfilling the promise are unique to health disparity populations because of factors such as user characteristics and the ecological context of the use of the CIT-enabled intervention. Other challenges limit optimal design, implementation, and evaluation of CIT-enabled interventions for all populations, but are particularly pertinent to health disparity populations, which bear a greater chronic disease burden and have lower health-related quality of life. These populations are likely to benefit from increased access to behavioral interventions that address important health disparity targets (e.g., nutrition, physical activity, medication adherence, chronic disease symptom management, and prevention of sexually transmitted infections) that can be delivered through CITs that they are already using in their daily lives, are tailored to their characteristics and ecological context of use, and facilitate sustained engagement with the intervention. As a consequence, the recommendations for future directions outlined here address both types of challenges and are aimed at the overarching goal of harnessing CIT-enabled behavioral interventions as tools to reduce health disparities and to advance health equity. AJPH

CONTRIBUTORS

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

HUMAN PARTICIPANT PROTECTION

This research did not involve human participants.

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