Digital health in a broadband land: The role of digital health literacy within rural environments

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Abstract:

The rapid rise and widespread integration of digital technologies (e.g., smartphones, personal computers) into the fabric of our society has birthed a modern means of delivering healthcare, known as digital health. Through leveraging the accessibility and ubiquity of digital technologies, digital health represents an unprecedented level of reach, impact, and scalability for healthcare interventions, known as digital behaviour change interventions (DBCIs). The potential benefits associated with employing DBCIs are of particular interest for populations that are disadvantaged to receiving traditional healthcare, such as rural populations. However, several factors should be considered before implementing a DBCI into a rural environment, notably, digital health literacy. Digital health literacy describes the skills necessary to successful navigate and utilize a digital health solution (e.g., DBCI). Given their limited access to high-speed internet, higher cost associated for similar services, and poorer development of information and communication technologies (ICTs), most rural populations likely report lower digital health literacy – specifically, computer literacy, the ability to utilize and leverage digital technologies to solve problems. Hence, DBCIs should address this 'digital divide' between urban and rural populations before implementation. Practical solutions could include evaluating rural communities' access to ICTs, needs assessments with rural community members, as well as integrating rural community stakeholders into the design of digital literacy education and interventions.

Consumer digital technology is a ubiquitous element of modern life. A recent report from Statistics Canada in 2018 estimates that 88% of Canadians own a smartphone and use the internet [1]. Healthcare services and providers looking to leverage digital technologies have given rise to the field of 'digital health,' which according to Lupton, "refers to a wide range of technologies directed at delivering healthcare, providing information to lay people and helping them share their experiences of health and illness, training and educating healthcare professionals, helping people with chronic illnesses to engage in self-care and encouraging others to engage in activities to promote their health and wellbeing and avoid illness" [2]. Digital health encompasses previously used concepts to describe the merge of technology with healthcare. For our purposes, digital health covers the concept of eHealth, which describes the application of information and communication technologies (ICTs) in the health sector [3] and the more specific concept of mobile health (mHealth) which refers to the use of wireless mobile devices, like smartphones, that have the computing power, built-in sensors, and internet connectivity to facilitate and monitor healthcare interventions [4]. Utilizing digital health as a tool for digital health interventions offers numerous advantages over traditional means of healthcare delivery and interventions [5-7].

The term digital health intervention describes a "discrete functionality of the digital technology to achieve health sector objectives" and can be aimed at clients/patients, health care providers, health system or resource managers, or data services [8]. Within the context of our commentary, we will be focusing on digital health interventions aimed at improving the health outcomes of clients/patients, also referred to as persuasive systems [9] or digital behaviour change interventions (DBCI), [10].

DBCIs symbolize an enormous potential for promoting health behaviours, such as healthy eating and physical activity [11], due to the widespread uptake of smartphones which allows for an unprecedented level of reach and scalability of high-quality healthcare. Ambient sensors (e.g., accelerometer, location tracking) and the ability to prompt notifications/reminders and evaluate collected data in response to real-time events (a.k.a., ecological momentary assessment) highlight the unique adaptive capabilities of DBCIs. For example, the Carrot Rewards app aims to improve physical activity through offering small monetary incentives (points)

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based upon smartphone sensor tracked step counts, as well as education and social competition elements [12]. Emerging work involving DBCIs report efficacy for a variety of health behaviours include physical activity [13], diet [14], and medication adherence [15].

In order to fully reap the benefits of DBCIs adequate digital health literacy should be considered. Norman and Skinner define digital health literacy as "the ability to seek, find, understand, and appraise health information from electronic (e.g. mobile and internet) sources and apply the knowledge gained to addressing or solving a health problem" [16]. In particular, digital health literacy consists of analytical skills (i.e., traditional literacy & numeracy, information literacy, media literacy) and context-specific skills (i.e., health literacy, computer literacy, science literacy), [16]. Current evidence describes an association between digital health literacy and healthy behaviours, such as exercise, healthy eating, and sleep behaviour [17]. Similarly, a lack of digital health literacy may lead to adverse outcomes, such as chronic illness, lower perceived self-management skills, and lower self-perceived understanding of health status, symptoms, and optional treatments [18]. Additionally, recent conceptual frameworks highlight the direct influence of computer literacy on engagement with DBCIs [19]. Thus, digital health literacy skills should be qualified as part of the DBCI research design process. Digital health literacy warrants particular attention among digitally underserved or disadvantaged populations, such as those residing in rural areas. Hence, the purpose of our commentary is to discuss the role of digital health literacy [1] in relation to the effectiveness of DBCIs, specifically for rural populations; [2] as an outcome of disparity among rural and urban areas; [3] and as the focal point for proposed strategies in rural areas.

Rural populations experience unique barriers related to their physical environment that impede the delivery of and access to traditional healthcare services. Canada's rural population, defined by Statistics Canada as those who live in outside settlements of <1,000 inhabitants with a population density of <400 inhabitants per square kilometre [20], are often subject to barriers to health care services and interventions including: geographic barriers (e.g., increased travel to receive healthcare services), limited availability of health care personnel and services, and cultural factors (e.g., unfamiliarity with the healthcare system), [21]. As a result, rural Canadians report poorer health outcomes and cite greater unmet health care needs, compared to their urban counterparts [22-23]. Given that 16.8% of Canada's total population, as of 2016, lives in a rural area [24], DBCIs, through the use of ICTs, represent a potentially transformative solution to addressing the distinct healthcare barriers of this population. Yet, at present, DBCIs have typically been run in urban centres, such as university settings [25], or recruit through convenience sampling in cities [5]; results obtained in these environments may not be replicated in rural areas, in large part due to a gap in digital health literacy.

We propose that the uptake and effectiveness of

DBCIs in rural areas would likely be limited or hindered based, in part, on a poorer digital health literacy of these communities, specifically computer literacy [16]. Computer literacy is the ability to utilize and leverage digital technologies to solve problems [16]. In the context of digital health, computer literacy describes the ease and aptitude for individuals to navigate and engage with health care services and interventions through modern digital technologies such as computers, smartphones, mobile applications, and peripheral technology (e.g., Fitbit, smart assistant). For example, computer literacy impacts if, how, and the extent to which an individual may be able to: navigate a digital health application and its features on their specific device, self-monitor their daily step count through an application on their smartphone, manage their personal data through privacy settings, and engage in the participative and social features of the web, including social media platforms.

Although strengthening individuals' computer literacy is foundational for successful DBCI implementation, rural communities likely struggle with achieving equity in computer literacy for a number of reasons. Rural communities lack access to the same high-speed internet services as their urban counterparts. This dearth of options is attributed mainly to the limited and rudimentary internet infrastructure within these areas. While 96% of urban Canadians in 2016 had access to broadband internet speeds of 50 megabits per second (Mbps) of download speed and 10 Mbps of upload speed, only 39% of rural and remote Canadians had access to the same services [26]. Lack of broadband development, compared to urban areas, further hinders access to similar ICTs in rural regions [27]. Even if rural Canadians have access to ICTs, they are often cost-prohibitive. Not only do rural Canadians have fewer choices of Internet Service Providers (ISP) nation-wide, compared the price for similar speeds of internet offered in urban centres, rural areas are often much more expensive, with fewer affordable options [28]. Lower-income rural households are therefore further disadvantaged, with lower household income being associated with both lower use of ICTs and lower digital literacy [29]. This disparity in access and affordability to ICTs, or "digital divide" [26] creates fewer opportunities for Canadians living in remote or rural areas to explore and familiarize themselves with digital health solutions. A recent survey in the US reported nearly a quarter of rural adults do not access the internet on a daily basis, and 15% report never going online (compared to 9% of urban respondents), [30]. Taken together, lack of access, development, and affordability of ICTs in rural areas act as barriers to the acquisition of digital health literacy skills, and consequentially reinforce the divide of computer literacy and health knowledge [31].

Taken as a whole, successful DBCI implementation must account for the potential computer literacy inequity among rural and urban populations. To this end, we propose several practical strategies that should be considered prior to implementing a DBCI in a rural/remote community.

Foremost, the access to ICTs of a population must be determined, since the principle of DBCIs hinges upon

the use of these digital devices. This could be done through questionnaires via mailed letters, calling, and/or snowball recruitment. If a population has access to the appropriate ICTs, then the subsequent step should be to evaluate the digital health literacy of the population. This can be achieved through a community needs assessment [32] which aims to identify local challenges of a target population and implement recommended solutions. A multitiered, targeted community needs assessment model uses quantitative (e.g., Digital Health Literacy Instrument) [34] and qualitative methods [e.g., focus groups with rural residents] to collect data from multiple sources (e.g., rural residents, community leaders, healthcare practitioners, ISPs) in order to highlight various health needs. This needs assessment process could be guided by rural health research-specific guides [34] with questions informed by conceptual models, such as the model for mHealth readiness [35], which assesses the readiness of a community towards mHealth initiatives.

Finally, consideration should be taken when designing digital health literacy material for rural populations. Formative work has recommended that digital health literacy content be made relevant to remote and rural communities "in order to foster their inclusion" [29]. Hence, the creation of digital health literacy educative materials should involve collaboration between knowledge users (i.e., rural community members) and experts (e.g., clinicians, health behaviorists, researchers). This integrative process aligns with the principles of integrated knowledge translation, allowing for "deeper understanding of contextual circumstances which, in turn, enhances the usefulness of the research findings" [36]. Embedding rural community stakeholders in the research and development process, by way of town hall meetings and community representatives within research teams, for instance, will help in tailoring and modifying digital health literacy education to address the unique barriers among rural areas.

There are, of course, limitations to how well these solutions can be implemented. The lower adoption and usage of ICTs among rural Canadians presents the biggest barrier to improving digital health literacy, since access to digital devices predicates improving digital literacy [37] in much the same way that access to reading material is necessary for improving literacy. This digital divide is shrinking, however, as Canadian policies specifically targeting broadening ICT infrastructure to rural areas are enacted, such as the Connecting Canadians program [38]. Yet, even with access to ICTs, the sheer heterogeneity in digital technologies (e.g., brand, operating systems, features, user interface) may make it difficult to standardize educational materials or resources aimed at improving digital health literacy. For example, a separate walkthrough for how to download, navigate, and/or utilize features of smartphones may be required for iOS devices vs. Android devices. Recruitment of rural community members also poses a barrier as it is more difficult when compared to urban communities – even when dealing with digital health. Assessing outcomes such as access to ICTs means recruitment methods must reflect participants potential lack of access to ICT, necessitating analog

means of advertisement, recruitment, and study communications [e.g., face-to-face, mailed letters, posters], which can be slow in remote or rural areas [39]. Finally, given the relative nascency of DBCIs, little work has been done examining the impact of digital health literacy within a rural-focused DBCI.

In sum, digital health represents a potentially transformative and modernized means of healthcare. The ability to adapt traditional health care interventions to DBCIs has potential for an unprecedented level of reach, impact, and accessibility. However, applying DBCIs to a rural environment requires consideration for the digital divide and resultant inequality in computer literacy. Evaluating the digital health literacy landscape through needs assessments and embedding stakeholders in digital health literacy development are practical steps to bridging the divide.

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