

# Digital technology for health promotion: opportunities to address excess mortality in persons living with severe mental disorders

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## ABSTRACT

Persons with severe mental disorders (SMDs) experience dramatically reduced life expectancy compared with the general population. We consider the role of digital technologies for addressing this serious public health concern. In this clinical review, we apply the *multilevel risk model* recently introduced by the WHO to conceptualise how digital technology can support efforts to reduce excess mortality risk at the individual, health system and social determinants of health levels. In particular, digital technologies show promise for targeting preventable physical health conditions in persons with SMDs. However, evidence on the use of these technologies for addressing early mortality risk factors is lacking. At the individual level, digital interventions show promise for managing mental health symptoms, promoting healthy lifestyle behaviours and targeting substance use concerns. At the health system level, digital interventions can support care coordination, clinician training, screening and monitoring health indices and shared decision-making. At the social determinants of health level, digital interventions can facilitate opportunities to engage peers for illness self-management and health promotion and for delivering and/or augmenting supported employment programmes. The time is ripe to capitalise on early evidence to support future development, testing and delivery of effective digital efforts targeting risk factors that contribute to shorter life expectancy in persons with SMDs. Key challenges and opportunities for future research include increasing user engagement, involving users during development and testing of digital interventions, carefully considering risks/harms and rigorously evaluating effectiveness and costs to support the scalability and sustainability of promising digital approaches.

## INTRODUCTION

Individuals living with severe mental disorders (SMDs), including schizophrenia, schizoaffective disorder, major depressive disorder or bipolar disorder, experience dramatically reduced life expectancy compared with the general population.<sup>1</sup> Meta-analyses and epidemiological studies have estimated that this excess mortality disparity ranges from 10 to 30 years earlier than the general population.<sup>2–4</sup> Despite growing awareness about this alarming public health concern,<sup>1</sup> the response has been limited and progress to date has been lacklustre as reflected by recent studies suggesting that this mortality gap may actually be worsening over time.<sup>5 6</sup>

With considerable evidence documenting the extent of the mortality gap,<sup>1</sup> it is essential that research funding and clinical resources support the development, implementation and sustained delivery of evidence-based interventions targeting a range of modifiable risk factors that account for reduced life expectancy among individuals with SMDs. Excess mortality is largely due to preventable physical health conditions, equating to roughly 70% of deaths in this at-risk group.<sup>2</sup> These primarily include cardiovascular and respiratory diseases as well as infectious diseases, diabetes and cancers.<sup>1</sup> Unnatural causes of death account for approximately 18% of deaths among individuals with SMDs,<sup>2</sup> with rates of suicide, homicide and accidental death all substantially higher when compared with the general population.<sup>1</sup>

To illustrate the multiple contributors to early mortality among persons with SMDs, Liu and colleagues (2017) from the WHO proposed a *multi-level risk model*.<sup>1</sup> In their model, risks are classified across three levels: (1) individual; (2) health system; and (3) social determinants of health. This model accounts for individual level characteristics such as diagnosis, symptom severity, health behaviours and motivation as well as health system factors including service delivery, knowledge and attitudes of healthcare providers and appropriate use of anti-psychotic medications. The social determinants of health level of the model recognises the impact of numerous social and environmental factors that negatively affect mortality risk, including individuals' socioeconomic position, employment status, social relationships, access to supportive community resources, experiences of stigma and discrimination and effects of public policies. These various factors across each level of the model interact with one another and combine to negatively impact life expectancy. No single factor is responsible for early mortality, and this multilevel model underscores key opportunities to intervene.<sup>1</sup>

In this clinical review, we apply the WHO multi-level intervention framework to conceptualise how digital technologies could support efforts for health promotion and reducing excess mortality risk due to natural causes among individuals with SMDs. This includes using digital technologies as stand-alone interventions, as tools to complement in person programmes and as approaches for enhancing existing evidence-based practices and clinical services. Digital technologies, ranging from smartphones, mobile applications and web-enabled platforms have emerged as a collection of promising strategies for



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reaching and supporting intervention delivery, contributing to improved illness management and promoting the adoption of positive health behaviours among persons with SMDs.<sup>7</sup> While digital technologies also hold potential for addressing unnatural causes of excess mortality, such as suicide, in this clinical review, we focus on opportunities to address natural causes of excess mortality since they account for the greatest proportion of early deaths in people with SMDs.

**METHODS**

Our literature search was informed by recent systematic reviews describing use of digital technology for persons living with SMDs. These include five reviews: *Batra et al (2018)*;<sup>8</sup> *Biagianti et al (2017)*;<sup>9</sup> *Berry et al (2016)*;<sup>10</sup> *Naslund et al (2015)*<sup>7</sup> and *Alvarez-Jimenez et al (2014)*.<sup>11</sup> Initially, we searched lists of included studies from each of these reviews. Then, we searched MEDLINE/PubMed and Google Scholar to determine if there were any additional recent studies published since the searches conducted in these reviews. We specifically searched for studies involving use of digital technology, defined as mobile devices such as cellphones or smartphones, mobile applications, wearable devices and sensors and online platforms, for targeting risk factors for early mortality among individuals with SMDs, including schizophrenia, schizoaffective disorder, major depressive disorder or bipolar disorder. We summarised these studies emphasising how digital technology

could support efforts to address early mortality according to the WHO multilevel framework spanning the individual, health system and social determinants of health.

**DIGITAL INTERVENTIONS AND THE MULTILEVEL INTERVENTION FRAMEWORK**

Numerous studies have highlighted the promise of digital technologies for targeting the health needs of individuals with SMDs. This includes digital interventions for supporting illness self-management and relapse prevention among people with schizophrenia<sup>11</sup> and for promoting treatment adherence and retention in care among individuals receiving community mental health services.<sup>7</sup> Several studies show that access to and use of smartphones and other digital technologies among people with SMDs is comparable to the general population.<sup>12 13</sup> Additionally, digital technologies may make it possible to reach those without access to formal healthcare services or who may be reluctant to seek care and for targeting individuals in their own homes or outside formal clinical settings.<sup>14</sup> However, use of digital technology for specifically addressing risk of early mortality in this group has received little attention.

In [table 1](#), we have highlighted specific instances where digital interventions may afford opportunities for targeting multiple risk factors for early mortality guided by Liu and colleagues’ (2017)

**Table 1** Multiple levels of risk factors for early mortality and the potential for digital interventions for individuals living with severe mental disorders\*

Multiple levels of risk	Risk factors for early mortality	Relevant examples of digital technology interventions from the literature†
Level 1: <i>Individual factors</i>	<ul style="list-style-type: none"> <li>▶ Illness severity</li> <li>▶ Symptoms</li> <li>▶ Age of onset</li> <li>▶ Family history</li> <li>▶ Time since diagnosis</li> <li>▶ Lifestyle behaviours</li> <li>▶ Chronic medical conditions</li> <li>▶ Substance use</li> <li>▶ Motivation</li> </ul>	<ul style="list-style-type: none"> <li>▶ Smartphone applications for management of mental health symptoms (eg, FOCUS, Actassist, PRIME)<sup>29 31 32</sup></li> <li>▶ Telehealth programmes for psychiatric and medical instability<sup>22 23</sup></li> <li>▶ Telephone-based wellness coaching for weight reduction and wellness promotion<sup>24</sup></li> <li>▶ Wearable activity tracking devices for supporting behavioural weight loss interventions<sup>25</sup></li> <li>▶ Web-based smoking cessation programme<sup>26</sup></li> <li>▶ Smartphone-based smoking cessation apps<sup>27 28</sup></li> </ul>
Level 2: <i>Health system factors</i>	<ul style="list-style-type: none"> <li>▶ Lack of leadership</li> <li>▶ Inadequate financing</li> <li>▶ Poor quality and fragmented service delivery</li> <li>▶ Lack of care coordination</li> <li>▶ Limited workforce and staff capacity</li> <li>▶ Negative attitudes among health providers</li> <li>▶ Limited knowledge, skills or proficiency among providers</li> <li>▶ Effects of antipsychotic medications and other treatments</li> </ul>	<ul style="list-style-type: none"> <li>▶ Health Technology Program to support delivery of evidence based mental health treatments, relapse prevention after a hospitalisation for psychosis and technology coach for care coordination<sup>38</sup></li> <li>▶ Web-based platform for training clinicians in delivery of evidence-based treatments in community mental health settings<sup>36</sup></li> <li>▶ Electronic screening tool for recording and monitoring metabolic syndrome indices including anthropometric measures such as weight, body mass index, blood pressure and waist circumference<sup>33</sup></li> <li>▶ Electronic personal health record to allow patients with serious mental illness and comorbid medical conditions to access their own health information in community mental health centres<sup>35</sup></li> <li>▶ CommonGround web application to support the clinical encounter in community mental health settings by facilitating goal setting and shared decision-making<sup>34</sup></li> </ul>
Level 3: <i>Social determinants of health</i>	<ul style="list-style-type: none"> <li>▶ Discriminatory policies</li> <li>▶ Low socioeconomic position</li> <li>▶ Poverty</li> <li>▶ Homelessness</li> <li>▶ Low health literacy</li> <li>▶ Societal stigma</li> <li>▶ Negative attitudes and discrimination</li> <li>▶ Poor environment</li> <li>▶ Impoverished or unsafe neighbourhoods</li> <li>▶ Limited access to social support</li> <li>▶ Few community resources</li> </ul>	<ul style="list-style-type: none"> <li>▶ Peer-delivered and mobile technology supported integrated medical and psychiatric self-management intervention called PeerTECH for older adults with serious mental illness and medical comorbidity<sup>39</sup></li> <li>▶ Mobile technology and popular social media combined with peer support as part of a lifestyle intervention for promoting weight loss and improved fitness by creating community of wellness to facilitate interactions and support among participants towards achieving lifestyle goals<sup>40 41</sup></li> <li>▶ WorkingWell mobile app aimed at supporting employment and providing coping strategies for improving success in the work environment by focusing on key factors such as relationships, mental illness challenges, encouraging motivation and managing lifestyle and wellness concerns outside of work, such as sleeping and eating well<sup>45 46</sup></li> </ul>

\*This table is adapted from the ‘Multilevel model of risk for excess mortality in persons with severe mental disorders’ described by Liu and colleagues (2017).<sup>1</sup>

†Recent relevant examples from the literature using digital technologies for addressing risk factors for early mortality among individuals living with severe mental disorders.

multilevel intervention framework.<sup>1</sup> It is important to consider that the multilevel framework offers a roadmap by illustrating key targets for digital interventions, and that at times the interventions identified in this clinical review may not align perfectly with the framework, highlighting areas for further investigation. There may be novel ways to leverage how individuals with SMDs use these technologies to scale efforts targeting treatment and management of psychiatric symptoms, promoting physical health and well-being and addressing multiple modifiable risk factors that contribute to substantially reduced life expectancy, including smoking, obesity, substance use and chronic medical conditions. Digital interventions could target co-occurring mental and physical health concerns, which together are major contributors to early mortality. For instance, a common scenario may require ongoing management of symptoms of schizophrenia while simultaneously managing diabetes, chronic respiratory disease and needing to overcome symptoms of depression to engage in healthy eating and regular exercise. While research supports the use of digital interventions for general patient populations,<sup>15–17</sup> these programmes are often not suitable for persons with SMDs. For instance, digital interventions for general patient populations typically lack key design features, such as simplified layout, content at lower reading level and easy to navigate interface, necessary to enhance usability for individuals with SMDs who may experience cognitive deficits, low literacy and persistent symptoms.<sup>18–21</sup> Therefore, promising digital interventions for individuals with SMDs must be tailored to meet their needs. In the sections that follow, we draw from published scientific literature demonstrating how digital approaches designed for persons with SMDs can potentially support health promotion and target risk factors for early mortality in this group.

### Digital interventions at the individual level

As behavioural health concerns among people with SMDs often involve co-occurring mental and physical health conditions,<sup>1</sup> digital technologies such as telehealth devices can be effective for managing co-occurring mental health and chronic medical conditions in this group.<sup>22,23</sup> Technology can also support health promotion programming, including telephone-delivered lifestyle coaching for weight reduction associated with antipsychotic medications,<sup>24</sup> and wearable activity tracking devices for enhancing community-based lifestyle interventions.<sup>25</sup> Digital interventions also show promise for addressing health behaviours such as tobacco use, as demonstrated in a pilot study of the ‘*Let’s Talk About Smoking*’ interactive, web-based motivational intervention.<sup>26</sup> This online programme from the USA contributed to greater smoking abstinence compared with a control condition among young adults with SMDs.<sup>26</sup> Recent formative work to develop a smartphone application for smoking cessation emphasised the importance of tailoring the content, design and layout of the digital intervention according to the needs of users with SMDs.<sup>27,28</sup>

Overall, most digital intervention studies at the individual level have focused on monitoring or managing mental health symptoms for persons with SMDs,<sup>7</sup> with well-documented feasibility and acceptability of these interventions.<sup>7,29</sup> Therefore, there may be opportunities to extend the impact of existing digital interventions by combining these programmes with evidence-based techniques for self-managing chronic medical conditions or promoting lifestyle behaviours towards addressing individual-level risk factors for early mortality. For example, FOCUS is a smartphone application developed in the USA supplemented by a digital clinician dashboard and mHealth support

specialist.<sup>29</sup> In a randomised controlled trial, this programme contributed to comparable improvements in clinical outcomes as standard care and resulted in significantly greater likelihood of commencing and engaging in clinical services.<sup>30</sup> Similarly, the Actissist smartphone application developed in the UK for early psychosis supports self-management and shared decision making by monitoring symptoms and providing real-time active management strategies.<sup>31</sup> In a pilot study, Actissist was associated with superior treatment effects compared with a control condition.<sup>31</sup> Another mobile application called PRIME from the USA was designed for young individuals with recent onset schizophrenia to improve motivation and functioning through goal setting and promoting better quality of life.<sup>32</sup> In each of these examples, there may be opportunities to incorporate strategies for managing chronic medical conditions, promoting health and wellness and addressing lifestyle behaviours.

### Digital interventions at the health system level

At the health system level, digital technology holds promise for supporting detection and monitoring of at-risk patients with SMDs. For example, an electronic screening tool for recording and monitoring metabolic syndrome indices in patients with SMDs was successful at changing clinician practice to screen, monitor and document risk factors such as weight, body mass index, blood pressure and waist circumference.<sup>33</sup> In another study, the CommonGround web application implemented in community mental health settings in the USA supports clinical encounters by allowing people with SMDs to participate in shared decision making, to identify their personal treatment goals and to communicate these goals to psychiatric care providers ahead of treatment visits.<sup>34</sup> In this approach, individuals emphasised the importance of lifestyle factors, highlighting the potential for CommonGround to support shared decision making related to addressing risk factors for early mortality.<sup>34</sup> Further, implementation of an electronic personal health record within community mental health centres allowed patients with SMDs and comorbid medical conditions to access their own health information and showed success in supporting goal setting, monitoring health indicators, accessing preventive services and contributing to greater engagement in care.<sup>35</sup>

Another study demonstrated that a web-based platform was effective for supporting clinician training in cognitive behavioural therapy for persons in recovery within community mental health settings.<sup>36</sup> This approach also showed potential for overcoming challenges such as high staff turnover, difficulties scheduling in-person training sessions and reliance on costly experts to lead in-person trainings.<sup>36</sup> Using digital technology for clinician education could be an important strategy for building capacity among community mental health clinicians and primary care clinicians for recognising and addressing risk factors for early mortality among persons with SMDs.

Importantly, digital interventions have been identified as a possible strategy to strengthen health systems by supporting clinicians in coordinating care for patients with mental disorders.<sup>37</sup> One promising initiative launched in the USA is the Healthy Technology Program, which targets relapse prevention after hospitalisation using a technology coach who oversees and coordinates different technology components.<sup>38</sup> This model of coordinated technology-delivered treatment has demonstrated high acceptance by integrating various digital tools into care processes aimed at improving outcomes and reducing costs for persons with schizophrenia.<sup>38</sup> This multicomponent approach could also leverage technology to coordinate with primary care

services and allow opportunities to target chronic medical conditions, lifestyle behaviours and other early mortality risk factors.

### Digital interventions at the social determinants of health level

Few studies have examined whether digital interventions can specifically target social determinants of early mortality among persons with SMDs, though digital technology affords unique opportunities to leverage an individual's social networks and personal relationships and facilitate peer-to-peer communication, which can improve participant retention and engagement.<sup>9</sup> For instance, recent pilot studies have demonstrated the acceptability of using digital technology including smartphone applications to facilitate peer support for integrated medical and psychiatric self-management<sup>39</sup> and text-messaging and social media for facilitating peer-based lifestyle intervention targeting weight loss and improved fitness.<sup>40–43</sup> While still targeting individual level risk factors, such as exercise, diet or illness self-management, these initial efforts demonstrate the feasibility of technology for engaging peers and social relationships to support positive health behaviour change. These approaches may be especially appealing for persons with SMDs, as online communities can serve as sources of naturally occurring peer support<sup>44</sup> and given increasing interest in using social media to access lifestyle programmes and mental health services.<sup>14</sup>

Few digital interventions have specifically targeted poverty or homelessness, which are important contributors to shortened life expectancy in persons with SMDs. In one project in the USA, the feasibility and acceptability of the WorkingWell mobile application aimed at supporting employment and providing coping strategies for improving success in the work environment among persons with SMDs is currently being evaluated.<sup>45</sup> WorkingWell focuses on key factors such as relationships, mental health concerns, encouraging motivation and managing lifestyle and wellness outside of work, such as sleeping and eating well,<sup>46</sup> which are relevant for addressing risk of early mortality. Future research is necessary to determine whether digital technologies can enhance efforts targeting key social determinants of early mortality among individuals with SMDs.

### DISCUSSION

In this clinical review, we considered how Liu and colleagues' *multilevel risk model* can provide a roadmap for guiding use of digital technology interventions for targeting risk of excess mortality in persons with SMDs.<sup>1</sup> Few studies used technology to specifically address early mortality risk factors, yet several recent pilot studies of digital interventions showed promise for targeting lifestyle behaviours, managing co-occurring chronic medical conditions, and facilitating peer support for persons with SMDs. Digital interventions hold promise for strengthening health systems by bridging gaps in coordination between primary care and mental health services, improving information sharing among clinicians and supporting the delivery of integrated care for mental and co-occurring chronic health conditions. Further, digital training programmes could expand the role and competencies of clinicians in primary care or community mental health settings by equipping them with necessary skills and knowledge for recognising and treating risk factors for early mortality among their patients with SMDs and supporting referral to specialists when necessary.

As digital technologies such as smartphones, wearable devices or social media become an increasingly important fixture in the daily lives of individuals living with SMDs, it may be possible to

monitor their use of these technologies for detecting risk factors for early mortality and supporting real-time delivery of targeted interventions. Studying patterns of individual technology use as a means to characterise health behaviours and illness symptoms is an emerging research area referred to as 'digital phenotyping'.<sup>47–48</sup> To date, examining patterns of social media use has generated insights about tobacco use, mental health symptoms and suicide among social media users with schizophrenia,<sup>49–51</sup> while careful monitoring of smartphone use over time can detect changes in mobility and social behaviour as risk factors for relapse among patients with schizophrenia.<sup>52–53</sup> Capturing data from various digital sources could inform a more fine-grained understanding of how mental health and physical health symptoms interact with environmental and social factors to contribute to poorer health and reduced life expectancy among individuals with SMDs. While most of the studies that we summarised in this clinical review focused primarily on persons with schizophrenia spectrum or psychotic disorders, it will be important for digital interventions aimed at addressing early mortality risk factors to be flexible in accommodating the needs of diagnostically heterogeneous groups in order to reflect the typical patient populations served in community mental health organisations. However, digital interventions could also incorporate multiple design features tailored to the unique needs of different mental health diagnoses, while potentially allowing interventions to adapt in response to real-time data to meet an individual's changing health needs.<sup>54</sup>

### Challenges and limitations

As digital interventions ranging from mobile phones, wearable devices or web-based platforms yield increasingly important opportunities to target early mortality risk factors in persons with SMDs, ensuring security and privacy of these efforts will be critical. Emphasis should be placed on informed consent, data privacy, confidentiality and support for individual autonomy and treatment goals. For example, concerns about privacy and lack of trust may contribute to low rates of engagement in smartphone applications among users with mental illness.<sup>55</sup> The immense data collection capacity of digital devices, the potential to extend the reach of services outside traditional clinical settings and new opportunities to engage peers and online networks in intervention delivery can result in unintended consequences and infringe on privacy and confidentiality.<sup>56</sup> To guide the development and evaluation of digital interventions for early mortality risk reduction, researchers and clinicians will need to carefully weigh benefits and risks, while fully disclosing any known or plausible risks to patients.<sup>57</sup> It will also be important to inform individuals with SMDs about potential risks associated with direct-to-consumer products, such as mobile applications or digital devices for promoting fitness and healthy lifestyle, as these may involve business models that place users at risk through data collection and sharing with third parties.<sup>57</sup> There remain considerable gaps in clinical knowledge surrounding the risks of digital interventions for persons with SMDs as well as limited awareness among researchers, clinicians and patients about the potential risks associated with using these devices,<sup>56–57</sup> highlighting an important area for further investigation especially in the context of addressing excess mortality in this patient group.

Efforts will also be needed to ensure adequate engagement in digital interventions at each level of the framework. Low engagement is a common challenge for many digital interventions for persons with SMDs<sup>55</sup> and may be attributed in part to the failure to integrate the perspectives, goals, interests and

needs of the target user group during the design of these digital programmes.<sup>58,59</sup> Furthermore, it is important to recognise that barriers to accessing digital technology remain a challenge for those in impoverished settings or rural areas. Development and evaluation of digital interventions typically favours a highly selective group of individuals interested and willing to participate,<sup>58</sup> who likely represent a small subset of the greater population of individuals served by mental health systems. To improve engagement and generalisability of digital interventions, it will be necessary to actively involve users throughout the development, evaluation and implementation process. Last, and importantly, across each level of the risk model, we found few effectiveness studies. This highlights the need for rigorous research to evaluate effectiveness and cost-effectiveness of promising digital interventions to fully determine the impact on reducing risk of early mortality. Emphasis is needed on assessing long-term outcomes, the costs of intervention development and delivery to ensure scalability and whether technology-based approaches contribute to greater impact in the form of reduced mortality risk compared with existing services.

## CONCLUSION

The time is ripe to capitalise on this early evidence to support the development, testing and delivery of effective digital efforts targeting risk factors that contribute to shortened life expectancy in persons with SMDs. Digital technologies such as social media may even offer compelling avenues for advocating for access to quality healthcare for persons with SMDs and demanding that this early mortality disparity be recognised as a major public health priority. We must strive to reverse course and look to emerging digital innovations to advance our efforts.

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