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Health Behavior Theory to Enhance eHealth Intervention Research in HIV: Rationale and Review

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Abstract

Purpose of Review Optimal design and evaluation of eHealth interventions requires the specification of behavioral targets and hypothesized mechanisms of action—both of which can be enhanced with the use of established health behavior theories (HBTs). In this paper, we describe the major HBTs and examine their use in studies of eHealth interventions for HIV prevention and treatment and assess the contribution of HBT in developing and evaluating eHealth interventions.

Recent Findings Based on our review of the literature, we argue the field can benefit from more systematic selection, application, and reporting of HBT. We highlight theories specifically designed for eHealth and describe ways that HBT can be used by researchers and practitioners to improve the rigor and impact of eHealth interventions for individuals living with or at risk for HIV.

Summary This brief overview of HBTs and their application to eHealth intervention in HIV research has underscored the importance of a theoretically intentional approach. The theory should be used to inform the design of the eHealth intervention; the intervention should not determine the theory. A theory-driven iterative model of eHealth intervention development may not only improve our repertoire of effective strategies but also has the potential to expand our theoretical and empirical knowledge of health behavior change.

Keywords eHealth · mHealth · Behavior · Theory · HIV/AIDS

Introduction

eHealth is defined as the use of information and communication technology to support health and healthcare delivery and can include interventions such as mobile communication with patients, social media campaigns, and electronic medical data management [1, 2]. eHealth interventions generally aim to change an individual's health behavior in some way. For persons living with HIV, eHealth interventions might promote engagement and retention in care [3, 4] and self-management of the disease, including medication adherence [3–6]. eHealth prevention interventions for individuals at risk for acquiring HIV often focus on increasing regular testing [7] or reducing drug use [8] and sexual risk behaviors [9, 10].

Selecting the appropriate target behavior and hypothesizing likely mechanisms of effect are instrumental in the iterative development and testing of eHealth interventions. However, many interventions fail to articulate a conceptual framework, making it difficult to understand the behavioral mechanisms that might contribute to an intervention's efficacy.

In this paper, we join other researchers [11] in advocating for the use of behavioral theory to guide research on eHealth interventions. We briefly summarize and critique the theories commonly used in HIV research, examine the use of theory in eHealth studies, and describe theoretical frameworks developed specifically for eHealth. Finally, we suggest ways theory might be used in eHealth research, with specific application to texting interventions, to optimize the impact on HIV prevention and care.

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What Is Health Behavior Theory?

Theories provide a systematic way of understanding phenomena; they can generalize and simplify complex situations [12]. *Behavioral theories* describe interrelationships among a set of factors that explain or predict human behavior and behavior change. Within the category of behavioral theories, scholars sometimes draw a distinction between explanatory theories of behavior and theories of behavior change. *Explanatory theories of behavior* describe the underlying factors that determine or contribute to certain behaviors, helping us to understand and predict them. *Theories of behavior change* describe the process of behavior change over time. They delineate concepts that can be translated into strategies and messages in behavior change interventions, and they can form the basis for program evaluation. Most importantly, theories of behavior change can inform explicit assumptions about why or how a program might be efficacious. Of course, explanatory theories of behavior and theories of behavior change serve complementary roles. Attempting to change a behavior can require a thorough understanding of the factors that determine that behavior, and studying the psychological determinants of behavior can explain why interventions are successful in changing behavior and how to improve them. *Health behavior theories* (HBTs) are behavioral theories concerned with human health and health outcomes. Ideally, theories iteratively evolve in the context of empirical scrutiny. However, many theories are not highly specified or have not been rigorously tested. These are commonly referred to as theoretical or conceptual *models* or *frameworks* [13–15].

Why Employ Health Behavior Theories in eHealth Research?

As psychologist Kurt Lewin once famously contended, there is nothing so practical as a good theory [16]. Yet, some health researchers still question the utility of HBT, failing to recognize how it might improve their science. There are several reasons experts recommend using and clearly reporting HBT in the development and evaluation of eHealth interventions.

First, theories can guide the design of eHealth intervention strategies so that they are based on our understanding of what drives behavior and behavior change [12, 13]. Consistent with calls for evidence-based approaches in the health fields, employing existing HBTs enables researchers to benefit from decades of collective thought rather than reinventing models, using intuition, or rehashing usual practices. Furthermore, incorporating HBT into intervention development can illuminate a wider range of possible intervention targets to influence the outcome of interest than might be identified without a guiding theory. Interventions can more completely address the full complement of behavioral targets and determinants

when prospectively guided by established HBT instead of models created de novo.

It is unclear whether behavioral interventions that are explicitly guided by HBT are more efficacious than atheoretical interventions. Some meta-analyses of non-eHealth behavioral interventions to reduce sexual risk behavior suggested higher efficacy in theory-based interventions compared to those not guided by theory [17–21]. A meta-analysis of short messaging service (SMS) interventions targeting a variety of non-HIV health behaviors [20] as well as a review of behavioral interventions for HIV prevention [12] and ART adherence [22] found no evidence of differing efficacy by HBT use.

The second argument for using HBT in eHealth research is which it provides constructs which can be operationalized and measured as potential mediators and moderators in analysis of an intervention's effect on primary health outcomes. This enables a more comprehensive understanding of the intervention's mechanism of action, which is valuable regardless of the intervention's impact on clinical outcomes. Indeed, theory is particularly important in the face of null findings to define next steps in modifying the intervention.

Finally, employing common HBTs across studies provides a shared language that facilitates rigorous comparison between studies, synthesis of findings, and generalizability to other contexts. It can also contribute to the further refinement of theory.

What Are the Major Health Behavior Theories?

The HBTs most widely used in HIV research are described in Table 1. The first three theories (i.e., Health Belief Model, Theory of Reasoned Action, and Theory of Planned Behavior) describe processes at the intrapersonal level, focusing mainly on cognitive-attitudinal or affective-motivational constructs within individuals [24]. Social cognitive theory (SCT) was later developed to better incorporate the important influence of the social context, although many interventions based on SCT neglect to include aspects of the broader social environment. While SCT recognized the influence of the interpersonal context, Social Norms Theory was the first theory to explicitly identify the influence of perceived social norms on behavior, followed by the Socio-Ecological Model [25, 26], a multi-level theory. The Transtheoretical Model (TTM) or Stages of Change Model distinguished itself by attempting to elucidate the decision-making process evolving over time as an individual contemplates changing health risk behaviors. The Information-Motivation-Behavioral Skills (IMB) model was one of the first models to specifically focus on HIV behaviors. It was later modified to incorporate the process of chronic care initiation and engagement with the health system.

The HBTs incorporate many similar constructs, which have led to attempts at unifying them [37–39]. Although these

Table 1 Major health behavior theories in HIV research

Theory	Origin	Key components
Health Belief Model (HBM) [27]	Developed in the 1950s to explain individuals' failure to adopt disease prevention and early detection strategies	Proposes that beliefs about health threats (perceived susceptibility and severity) and expectations (perceived benefits, barrier, costs) lead to risk reduction behaviors, given cues to action (e.g., bodily symptoms or media messages).
Theory of Reasoned Action (TRA) [28, 29]	Developed in 1967 from the theory of attitude	Assumes an individual considers the consequences prior to engaging in a behavior and that behaviors are under the individual's control. Thus, an individual's intention/attitude/motivation and subjective norms are important elements.
Theory of Planned Behavior (TPB) [28]	Derived from TRA in 1980 to incorporate an to individual's perceived behavioral control	Suggests that behaviors are influenced by an individuals' motivation or intention to perform the behavior and the amount of control the individual has over the behavior.
Transtheoretical Model and or Stages of Change Model [30, 31]	Developed to understand the experience of smokers trying to quit	Focuses on the decision-making of an individual making intentional change. TTM posits six phases of change: pre-contemplation, contemplation, preparation, action, maintenance, and termination.
Social Cognitive Theory (SCT) [32]	Derived from Social Learning Theory (SLT) [33], in 1986 to incorporate the social context	Posits that behavior change is influenced by dynamic and reciprocal interactions among personal, environmental, and behavioral elements. Suggests behavioral interventions focus on information provision, attitude change to enhance motivation, skill development, self-efficacy, social supports, and reinforcement.
Social Norms Theory (SNT) [25]	Developed to understand student substance use	Asserts that an individual's behavior is more influenced by perceived norms than to actual norms, suggesting the need to understand environmental and interpersonal influences on behavior change.
Information-Motivation-Behavioral Skills (IMB) Model [34, 35]	Developed to explain HIV-related behaviors [34], was later expanded to explain chronic care initiation and engagement [35]	Identifies information, motivation, and behavioral skills as individual determinants of behavior maintenance and change.
Socio-Ecological Model Describes [26, 36]	Developed in the 1980s to explain human development [26], later adapted for health promotion [36]	Explains behavior change through the dynamic interactions of personal and environmental factors. SEM describes several intersecting levels of influence, including individual, interpersonal, network, organizational, community, policy, and structural determinants.

HBTs have been helpful in identifying possible targets for risk reduction interventions, there is mixed evidence for their validity [22, 40].

Critics cite the limited focus of these prominent HBTs on individuals, with calls for more comprehensive multi-level models [41]. Indeed, later models of health behavior have moved beyond an individual focus to holistically consider communities or populations, emphasizing community-driven approaches to addressing health [14]. These community-level models explore how social systems function and change and how to mobilize members within entire communities or settings such as schools or work sites [24]. These diverse theories, which are beyond the scope of this review, address social networks, social influence, social marketing, and social diffusion [11].

The cognitive emphasis of HBTs has been another common critique, especially when these theories are applied to adolescents [12]. The failure of HBTs to account for the powerfully motivating factors of sexual desire and pleasure, such as in the context of an ongoing relationship, has been an obstacle in their application to sexual risk reduction efforts [12, 24]. The lack of attention to the relationship context, especially for women who are often disempowered in their intimate partnerships with men, prompted the development of the Theory of Gender and Power [42]. Finally, some critics have cited the theories' limited relevance for ethnic/racial minorities and called for greater use of Critical Race Theory [43–45].

How Well Does eHealth Intervention Research Incorporate Health Behavior Theory?

There have been several reviews of eHealth interventions in the field of HIV prevention and treatment, many of which

assessed the incorporation of behavioral theory. These reviews indicated 23 to 74% of eHealth interventions in HIV were informed by HBT [3, 5, 12, 46]. One review reported that social cognitive theories accounted for half of all theories employed among eHealth interventions for adolescents [12]. Another review found that IMB was the most common theory employed in eHealth interventions targeting medication adherence [46]. The use of theory was less common among studies in low- and middle-income countries (19%) relative to high-income countries (48%) [3, 23]. The lack of theory-informed eHealth interventions is not unique to the field of HIV prevention and treatment. Reviews of eHealth interventions targeting other behavioral health outcomes such as smoking cessation, physical activity, and sexual health have also demonstrated an uneven application of theory [11, 47–50]. Riley et al. noted that the extent to which theory is employed varies by health behavior and seems to be influenced by the presence of clinical guidelines, simplicity of the intervention, and precedence [48]. Moreover, even when HBTs were employed in intervention design, the theoretical components hypothesized to be affected by the intervention were not always systematically explored. These findings highlight the need for greater integration of HBT at all steps of intervention development and evaluation [48].

What Are the New Theories Specific to eHealth?

Researchers in the field of eHealth and the sub-field of mobile health (mHealth) have argued for theories that expand beyond the traditional HBTs to account for the specific medium and the interactive, adaptive, and time-intensive behavioral processes that can be accessed when using mobile technology [11, 48]. Specifically, Riley et al. [48] contend that eHealth interventions require greater specification of the dynamic regulatory processes within the individual:

> Adoption of dynamical system models for mobile health behavior interventions does not require that our current health behavior theories and models be discarded, but the predominately static, linear nature of these theories appears to be a poor fit with the intra-individual dynamics of future mobile technology interventions. (p.66)

In addition, theories for eHealth interventions could address domains specific to digital technology, such as factors related to adoption [51], predictors and consequences of engagement [52], gamification, and retention, which lie beyond the scope of traditional HBTs.

Theories specific to eHealth interventions are in development. Two of the early theories focused narrowly on internet web pages. The eHealth Behavior Management Model [53]

combines the Transtheoretical Model, the behavioral intent aspect of the Theory of Planned Behavior, and persuasive communication principles to direct internet users to stage-specific information. Originally used in an HIV risk reduction intervention for South African women, the model's impact was limited by lack of attention to site-specific factors, including lack of internet access, literacy, and culturally appropriate web content. Ritterbrand et al. [54] developed an Internet intervention model drawing from social marketing strategies, web-based design/development techniques, and models of knowledge transfer as well as psychological models of behavior change. The model posits that Internet interventions can promote behavior change and symptom improvement through nine non-linear steps, and that web design, human coaches, characteristics of the user, and environmental factors influence website use. This model could be applicable to other technologies, though how technologic components are specifically mapped onto desired outcomes has not been elucidated [55].

Relevant to a wider range of technologies is Fogg's concept of a behavior change support system (BCSS), which can target "tiny habits" or well-circumscribed behaviors [56]. The model focuses on motivation, ability, and triggers, with the assumption that eHealth interventions should be responsive to individual's motivation and adapt behavior (through simplification) or the environment (through triggers) appropriately. Building on the BSCC, Oinas-Kukkonan described a Persuasive System Design addressed forming, altering, and maintaining behavior [57]. Its four design features involve reducing complex behaviors into simpler ones; positive reinforcement, reminders, and suggestions; conveying trustworthiness and expertise; and social support.

Mohr et al. developed the eHealth Behavioral Intervention Technology (BIT) Model, which encompasses both the conceptual and technological aspects of an intervention and is presented as a step toward formalizing how to design, develop, and deploy eHealth interventions [55]. It includes aims; behavior change strategies (e.g., education, monitoring, feedback, motivation enhancement); elements (i.e., logs, messaging); characteristics; and workflow.

Bull et al. offered an Integrated Theory of mHealth which incorporates classic theory, health communication theory, and social networking. They provided recommendations for facilitating access, designing messages, selecting HBT constructs, and engaging social networks [11].

Finally, Tomlinson et al. [58] suggested the field could benefit from moving away from specific theories for individual intervention strategies. They developed a Multiphase Optimization Strategy (MOST) [59], which is an iterative approach drawn from engineering. According to the MOST, the range of possible features for a particular eHealth strategy is identified and then a small number of factors are chosen for empirical testing in multi-factorial designs.

How Might HIV Researchers Employ Health Behavior Theory in eHealth Interventions?

Theory can be used in many aspects of eHealth intervention research. Typically, theory is used to inform the content or design of the intervention and for evaluation purposes, such as in constructing the assessment questionnaire. Michielsen et al. noted that of the 25 HIV prevention interventions they reviewed that used HBTs, theory was used in 13 to inform content only, in four for evaluation purposes only (e.g., designing the evaluation or questionnaire), and in seven for both. The analyses can only evaluate the theory if the theoretical constructs are assessed [12]. When the theoretical constructs are assessed, analyses can evaluate whether theoretically driven mediators actually account for the intervention effect and identify whether factors not accounted for by the theory were more influential. Note in Michielsen et al.'s review, only 3 of 25 articles provided this information.

The strategy of employing SMS or text-based eHealth interventions, commonly used in HIV research, can illustrate the benefit of theory [47]. Texts are often used as simple reminders (for appointments, medication dosing times, etc.), but this does not obviate the need for a theoretical understanding of how they modify behaviors. Text messages, as Riley explains, appear conceptually transparent and are consistent with the "cue to action" component of many HBTs. However, the literature provides numerous examples of how behavior change is more complicated than it appears and that innovative modes of delivery alone are often ineffectual [48]. Indeed, some studies of SMS interventions to support adherence to ART as well as other chronic medications have suggested that the reminder function of the messages is less important in improving ART adherence than other mechanisms, such as social and informational support derived from connection with a healthcare worker. For example, comparison of messaging frequencies found that daily messaging was less efficacious than weekly messaging despite daily dosing of ART [60], and two-way interactive messaging was more efficacious than one-way messaging [61].

The thorough consideration of the target behavior and its predictors as well as the choice of an appropriate theory will determine whether texts are conceptualized, for example, as providing specific information, conveying a message of social support, enhancing motivation, serving as reinforcement, or countering forgetfulness. The theoretical conceptualization may then determine other aspects of the intervention, such as timing and frequency. For example, messages can be programmed for delivery at critical decision points (such as at approximate medication dosing times or times of likely triggers for risk behavior). Consistent with the TPB, delivering such timely messages reduces the interval between the behavioral intention and the decision to perform the behavior, which increases the likelihood of performing the desired behavior [20].

Theory also can be helpful in devising the content of text messaging. In a text messaging risk reduction intervention for methamphetamine-using MSM, Reback et al. demonstrated how message content could vary in accordance with the choice between social support theory, HBM, or SCT [62]. For example, a message for informational social support might be "Mix Viagra & Poppers? U may come and then go." For the HBM construct of health threat, a sample message is "His STD is not as cute as he is." A number of formative publications evaluating community desires regarding eHealth interventions have combined end-user input and behavioral theory to compose messaging. For example, HBM has been used as the basis of SMS messaging to promote retention in prevention of mother-to-child transmission services [63, 64] and HIV testing [65]. These interventions emphasized communication of perceived susceptibility HIV, perceived benefits of care or testing, and self-efficacy.

Finally, theory can be used to strengthen evaluation of a text messaging intervention, by directly measuring whether the hypothesized elements of the chosen HBT were modified by the intervention. Few studies leverage theory in this way [48]. One example where this was done is in a trial of SMS messaging to improve ART adherence in youth [66]. The intervention was based on SCT, and the investigators included in their evaluation a mediation analysis measuring SCT constructs of self-efficacy, outcome expectancy, and motivation.

In sum, text messaging should not be construed as an atheoretical, stand-alone behavior change strategy; instead, both the process and the content of messages can operate as a tool by which behavior change methods can be administered. As Cole-Lewis et al. exhorted, we must envision the mechanisms of change in order to evaluate them and, thereby, improve our interventions [47]. Ultimately, text message interventions are informed by relevant theories and supported by prior research may prove to be more efficacious.

Conclusion

This brief overview of HBTs and their application to eHealth intervention in HIV research has underscored the importance of a theoretically intentional approach. Researchers should study the desired behavioral outcome and context of the end-user and then select a theory that fits with that outcome and context, suggesting relevant mechanisms of action. As noted, cultural variables and age, gender, and race/ethnicity may influence the appropriateness of a particular HBT. Such a systematic selection of likely mechanisms may lead to more effective eHealth interventions and a more systematic program of research. Indeed, as Tomlinson warned, "implementing untested mHealth interventions at scale without a theory of behaviour change is likely to result in many failed scale-up projects and significant levels of wasted resources" [58].

Researchers across academic disciplines, with no need for a behavioral science degree, can investigate potential HBTs and adopt one early in the research process. The theory should be used to inform the design of the eHealth intervention; the intervention should not determine the theory. Key components of the chosen theory should be assessed and analyzed to determine the likely mechanisms of the effect of the intervention as well as to evaluate the appropriateness of the theory. A theory-driven iterative model of eHealth intervention development may not only improve our repertoire of effective strategies but also has the potential to expand our theoretical and empirical knowledge of health behavior [48].

Compliance with Ethical Standards

Conflict of Interest The authors declare no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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