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Review Article

Health Behavior Change for Obesity Management

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Abstract
Health behavior change is central in obesity management. Due to its complexity, there has been a growing body of research on: i) the factors that predict the adoption and maintenance of health behaviors, ii) the development and testing of theories that conceptualize relationships among these factors and with health behaviors, and iii) how these factors can be implemented in effective behavior change interventions, considering characteristics of the content (techniques) and delivery. This short review provides an overview of advances in behavior change science theories and methods, focusing on obesity management, and includes a discussion of the main challenges imposed by this research field.

Introduction

Successfully influencing individual health behaviors has never been as important as it is today, mainly because of the well-known effects of these behaviors in the prevention and management of various health conditions, and due to the increased importance placed on individual autonomy and capacity to self-regulate their own health. Reducing overweight and obesity are key public health challenges. The World Health Organization (WHO) [1] estimates that 39% of adults worldwide are overweight and 13% obese, leading to a range of health complications as well as increased health costs. A recent meta-analysis led by our research laboratory [2] examining the prevalence of weight control attempts worldwide (72 studies;

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n = 1,189,942) showed that 42% of adults from general population and 44% from ethnic-minority populations are trying to lose weight, and 23% reported trying to maintain their weight at some point. Behavioral interventions targeting changes in diet and physical activity are the cornerstone of interventions for weight management in overweight and obese populations [3] and seem to be effective in reducing weight and improving health at least in the short term (e.g. [4]).

The emergence and rapid growth of the health behavior change field is one response to the urgent need to understand the complexity behind individuals' decisions and engagement in behaviors that affect their health and well-being, including sustained weight management. Health behavior change interventions (HBCIs) have the potential to improve the health of populations if they can be scaled up and appropriately targeted, considering issues like difficulty and motivation for change [5]. Since interventions are meant for the real world, context sensitivity is paramount. In other words, an intervention is only as successful as its capacity to adequately respond to a problem in an environment for a certain target population and focused on certain behavioral outcome(s). Evidence-based practice health behavior change therefore depends on the adequate development and implementation of interventions [6], making use of standardized methods to report them [7].

In this short narrative review, we will present some of the most current topics of research in the field of health behavior change, with a focus on the management of obesity, including i) the use of formal theories and a correct consideration of their mechanisms of action, ii) the choice of the behavior change techniques (or 'active ingredients') included in HBCIs, and iii) the use of technology to promote sustained behavior change.

The Role of Theory and Mechanisms of Action

Theories ('systematic way of understanding events or situations, (…) a set of concepts, definitions, and propositions that explain or predict these events or situations by illustrating the relationships between variables' [8], p. 4) are useful to understand, explain, and predict behavior and behavior change, as they conceptualize a set of interrelated constructs operating as predictors or mechanisms of action underlying behavior change. There are various levels of constructs that influence health behavior; they are therefore conceptualized in health behavior change theories. These can be done at the environmental level whether it is physical, cultural, or social (e.g., advice from a healthcare practitioner, low accessibility, peer support) or at the individual level including biological factors (e.g., food reward mechanisms) but also emotions, motivation, and self-regulation skills. Individual factors are considered fundamental for health behavior change as they are mostly responsible for the process of self-regulation of health behaviors. For instance, a systematic review looking at psychological mediators of sustained beneficial effects in lifestyle obesity interventions [9] found that higher levels of autonomous motivation, self-efficacy/barriers, self-regulation skills, flexible eating restraint, and positive body image were mediators of medium-/long-term weight control. High autonomous motivation, self-efficacy, and use of self-regulation skills were significant mediators of physical activity while for dietary intake no consistent mediators were identified.

Recently, a broad consensus emerged indicating that HBCIs can be optimized if they are informed by theory [10], as it facilitates the understanding of what works to change a certain behavior and how it works [11]. Theories of behavior change propose the mechanisms of action (under the broad categories of capacity, opportunity, and motivation) and the moderators of change through causal predictions. While there is an agreement in health behavior change that the use of theory is useful to promote long-lasting behavior change, there is still

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limited research on the effectiveness of theory-based (vs. non-theory-based) interventions. For instance, a recent meta-analysis by Gourlan and colleagues [12] investigated the effects of 82 theory-based randomized controlled trials targeting physical activity and showed beneficial but small effects of theory-based interventions in changing physical activity (d = 0.31). Similar results were found in a meta-analysis of digital-based interventions targeting various health behaviors (85 studies), in which the extensive use of theory (e.g., use theoretical constructs to develop intervention techniques) was associated with larger intervention effects [13]. Another meta-analysis examining the influence of theory use in physical activity and dietary interventions, did not find significant associations (e.g. [14]). There are several reasons that may explain these results: i) limited number of theories commonly tested (e.g., Social Cognitive Theory, Theory of Planned Behavior), ii) the fact that some theories may not provide a clear explanation on the process of behavior change maintenance, and iii) when interventions are explicitly based on theory, they often do not apply it extensively [12, 14]. Furthermore, research findings suggest that single-theory approaches may be more effective in influencing behaviors such as physical activity, comparing with those interventions applying multiple theories [12, 13]. This finding may be related to the fact that some interventions consist of a combination of two or more theories (or key constructs from these theories) lacking internal coherence and parsimony [15].

One of the problems faced when intending to use theory in HBCIs is the large number of theories that currently exist. Recently, a panel of experts has identified and compiled 83 formal theories of behavior and behavior change (including more than 1,700 theoretical constructs) in a comprehensive compendium [16]. Faced with so many theories from which to select from, researchers and practitioners need the skills to make decisions regarding the best candidate theory for a given behavior and context. This can be particularly difficult when targeting multiple behaviors (e.g., physical activity and diet), which is the case when considering weight management interventions. To guide this process, efforts have been made to make frameworks for the development of HBCIs informed by theory. This includes the Intervention Mapping Protocol [17] or the Theoretical Domains Framework [18]. In addition, tools such as the Theory Coding Scheme allow for an evaluation of the extension of use of theory in a HBCI [19]. The overarching COM-B model [6], which contains three broad theory-related dimensions of behavior change determinants – competence, motivation, and opportunity –, can also be used to make decisions on the design of HBCIs, especially when this is conducted without input by health psychologists or behavior change specialists.

While behavioral interventions seem to be effective in promoting weight loss, weight loss maintenance is a key challenge as most adults that successfully lose weight tend to regain part of it within 1 year [20]. Currently, there are very few comprehensive treatments available, and indeed most of the research has focused on the behavioral aspects associated with weight loss [21, 22]. A recent systematic review on theoretical explanations for behavior change maintenance [22] identified five interconnected theoretical explanations about how individuals maintain initial behavior changes over time: i) maintenance motives – tendency to maintain behavior when there are sustained motives (e.g. enjoyment) and congruence between behavior and identity/values (e.g. self-determination theory [23]); ii) self-regulation – includes self-monitoring and coping strategies (self-regulation theory [24]); iii) physical and psychological resources (e.g. self-control theory [25]), iv) habit – habitual behaviors supported by automatic responses to cues (e.g. habit theory [26]); and v) environmental and social cues – supportive environment, social support, behavior in line with social changes (e.g. normalization process theory [27]). At present, in long-term weight management there is some support for the effectiveness of HBCIs which are based on self-determination theory (e.g. [9, 28, 29]) and self-regulation theories (e.g. [9, 30, 31]).

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The Active Ingredients of Interventions: Behavior Change Techniques

A key aspect in the development, implementation and evaluation of HBCIs is the adequate characterization of its content – the 'active ingredients', i.e., the techniques used in interventions to help change another's or one's own behavior. These techniques represent the lowest-level, irreducible, fundamental elements of an intervention aimed to influence on behavior and are commonly designated behavior change techniques (BCTs) [32]. Some examples of BCTs are 'prompt self-monitoring', 'provide feedback on progress', or 'restructure the environment'. Naturally, complex HBCIs typically involve several of such techniques in various combinations, and detailed taxonomies of BCTs that can be used in HBCIs can be of use in both research and practice, as they promote a shared language between health behavior change researchers and practitioners. Interventions can be described in clearer and more consistent ways and more rigorously tested and compared in research studies, when techniques are reliably used. In turn, practitioners can more easily and consistently be trained in, and be evaluated based on, the use of standardized techniques.

The work led by Michie and colleagues [33, 34] is perhaps the most comprehensive and resulted in BCT taxonomies for a range of behaviors, including physical activity, diet, and smoking. More recently, these were collapsed into one overarching list – the BCT Taxonomy v1 – including 93 techniques, organized into 16 higher-level domains [35]. Since the publication of the first BCT taxonomy [36], several meta-analyses of randomized controlled trials have examined the use of BCTs i) looking at the association between the number of BCTs used and the magnitude of the effects, ii) determining which BCTs effectively target certain theoretical constructs, and iii) investigating if certain clusters of theoretically driven BCTs are associated with better results in several health behaviors (e.g. [37]) and health conditions (e.g. [30, 38]). One of the main reasons for conducting these analyses is that there are typically considerable levels of heterogeneity in the effects of HBCIs. By examining the techniques used in these interventions (as well as the theoretical frameworks that support them), we can select BCTs or clusters of BCTs that can have a higher impact on a certain target behavior under certain conditions, and exclude others in order to develop more effective HBCIs.

Results from reviews suggest that combined use of BCTs can be associated with greater effectiveness. Michie and colleagues [37] found that interventions combining self-monitoring with other BCTs derived from self-regulation theories (e.g. [25]), such as goal setting, provision of feedback, planning and goal revisiting, were more effective in promoting changes in physical activity and healthy eating in the general population than other interventions not using these techniques. Similar effects were found in other meta-analyses, including weight loss and maintenance interventions in overweight/obese subjects (e.g. [30]). In the context of digital-based interventions for weight management, Hutchesson et al. [39] point to the potential beneficial effects of self-monitoring and personalized feedback, and Sherrington and colleagues [40] found that internet-delivered weight loss interventions providing personalized feedback resulted in greater weight loss but only in the short term.

While the BCTT V1 was developed without the consideration of the role of theory in informing the selection and use of BCTs, another common framework for the development of health behavior change interventions – intervention mapping –, clearly states that the selection of techniques should take into consideration the theoretical parameters for its effectiveness [17]. In this respect, taxonomies can be sought for specific theories, where techniques that target the most important constructs of that framework are described. As an example, Teixeira and colleagues [41] are currently developing a comprehensive list of techniques used to influence key self-determination theory constructs.

A better linkage between BCTs and health behavior change theories is a potential benefit since psychological constructs presented in theories are presumably well-targeted by some

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techniques but not (or less so) by others. Techniques are useful in HBCIs to the extent that they impact on the putative mechanisms of action (e.g. goal setting) to change a given behavior (e.g. physical activity). Currently, there are efforts begin made in linking clusters of BCTs to specific mechanisms of action and overarching behavioral theories [42].

Delivery of Health Behavior Change Interventions: Digital Progress

Another important dimension on the development of effective HBCIs is the delivery of the intervention, which can have an impact on the effectiveness of interventions (e.g. face to face vs. printed material; delivered by psychologist vs. nurse) as well as on the operationalization of certain theories [43]. While there has been a significant progress in specifying BCTs and the mechanisms of action and theoretical frameworks involved in health behavior change, less attention has been given to the elements of delivery. Dombrowski and colleagues [43] propose that 'form of delivery' includes 'all features through which behavior change intervention content is conveyed including: the provider, format, materials, setting, intensity, tailoring and style'. Any HBCI can use a combination of forms and modes of delivery (MoDs). Carey and colleagues [44], define MoD as the way in which BCTs are delivered. They are currently developing a hierarchical classification system in order to specify the MoDs applied in HBCIs, using a similar approach to the development of the BCTT V1. For example, the MoD 'informational' includes human, printed material, digital and environmental change; and 'digital' includes technology for delivery (e.g. mobile device) and digital content type (e.g email).

In recent years, there has been a marked increase in the use of digital MoDs in lifestyle interventions for weight management. These are a viable option as they have the potential for wide reach at low cost, which is especially relevant if considered in a large scale and if intended to influence behaviors in the long term (which the case of weight management). Other advantages of using a digital approach are the potential to adapt content to individual needs (personalization), the delivery of information in an engaging and interactive form, and higher degree of fidelity to intervention content [45, 46].

While digitally based HBCIs are promising, research on their effects is still in an early stage. In the context of weight management in overweight/obese populations, previous reviews have reported positive albeit often small effects with considerable between-study variability [13, 39, 47]. There is therefore the need to identify which intervention components contribute to the effectiveness of digital-based interventions in promoting sustained weight management [13, 39, 40]. In a meta-analysis of internet-based interventions for health behavior change looking at the characteristics of most effective interventions, theory-based interventions incorporating a larger number of BCTs (vs. interventions with fewer BCTs) and using a variety of MoDs (e.g. internet, SMS) had larger effects on health-related behaviors [13]. The only published meta-analysis looking at the interactions between BCTs and MoDs in digital interventions did not find significant effects [48]. Research focusing on the development of strategies for sustained engagement alongside with health behavior change theory is also a priority for digital interventions [49].

Research on the effectiveness of using digital MoDs in promoting weight loss maintenance is very limited. There are currently two ongoing projects aiming to fill this gap. The first is the 'NoHoW – Evidence-Based ICT Tools for Weight Maintenance' (*www.nohow.eu*), a European Commission-funded project (Horizon 2020). Following available guidance for the development of complex interventions (e.g. [46, 50]), we developed a toolkit, using evidence-based intervention techniques derived from promising theoretical frameworks in weight loss maintenance, such as self-determination theory, self-regulation theory, and emotion regu-

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lation approaches. The toolkit is currently being tested in the context of a full-factorial randomized controlled trial. It will help us understand if digital-based interventions are an effective way to apply theory and techniques aiming at promoting weight loss maintenance, and which content is more effective for each behavior, for whom, under which circumstances and for which outcomes (Trial Registration: ISRCTN88405328).

The other is the NULevel trial [21], a self-regulatory intervention using automated remote weight-monitoring and feedback system using participants' mobile phones as the main MoD of theory-based BCTs (e.g., self-monitoring, goal setting, coping plans, and increase motivation), and an initial face-to-face behavioral component. NULevel evaluation is currently ongoing.

Conclusion

There is a scientifically rigorous body of research aiming to identify and improve our understanding of how to effectively develop, implement and evaluate HBCIs, namely in the field of weight management. Researchers have considered effective ways of 'speaking the same language' and to make knowledge accessible for interventionist by developing various taxonomies and frameworks. While considerable progress is evident in this area, there are still many questions to be answered and challenges ahead, as shown for example by the variability of the effects of HBCIs and limited results from meta-analyses examining interactions between intervention features. The Human Behavior-Change Project led by Michie and colleagues (*humanbehaviorchange.org*) is an example of the most recent efforts in the field of Health behavior change science to promote evidence-based practice [51]. The project consists of a multidisciplinary team of behavioral scientists, computer scientists, and system architects, aiming to build an ontology of behavior change interventions that will classify and organize HBCI features (e.g. BCTs, mechanisms of action, delivery, context) and develop a 'knowledge system' that, through artificial intelligence and machine learning, will automatically extract, synthetize, and interpret information from HBCI research reports, therefore contributing to the design of effective evidence-based interventions [51]. Another landmark project is the US Science of Behavior Change project (*scienceofbehaviorchange.org*), which also seeks to standardize and synthetize assessment methods and research protocols in the area of human behavior change. It should be noted that classification systems of features of health (and other) behaviors are still a work in progress, and there is ongoing debate on its limitations to capture the complexity of health behavior change [52].

Disclosure Statement

The authors have no conflicts of interest to declare.

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