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More than a prescription: The need for behavioral theory to guide exercise interventions for osteoarthritis - A narrative review

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Abstract

Objective: Many clinical exercise trials show that participation in exercise, such as strength training and aerobic walking, reduce osteoarthritis (OA)-related pain and functional limitation. This has led to exercise being one of the most commonly prescribed treatments for OA. However, little attention is given to the complex *behavior* elements of exercise, that is exercise is an activity that adults need to choose to engage in regularly, which is necessary to ensure exercise can have long-term efficacy to address pain. The purpose of this review is to highlight the behavioral aspects of exercise.

Design: Narrative review

Results: Limitations of previous clinical exercise trials in OA and why and how behavioral theories should be used to guide exercise interventions are highlighted. Three behavioral theories commonly used for exercise and physical activity interventions in other populations are reviewed. An overview of choosing a behavioral theory, building a conceptual model, and linking behavior change techniques to theoretical constructs is provided. Finally, in order to make the results more generalizable and comparable across studies, a standardized approach to quantify exercise behaviors is recommended.

Conclusion: In conclusion, a shift to view exercise more as a behavior than a treatment is recommended. The use of behavioral theories is encouraged to guide interventions for clinical and research use to more effectively change exercise behaviors and reduce OA-related pain and functional limitations for the long-term.

Keywords

Behavior change; Exercise; Osteoarthritis

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Exercise as a central solution to address the burden of OA

Exercise is strongly recommended as a first-line strategy to alleviate osteoarthritis (OA)-related pain and functional limitations, such as difficulty getting up from a chair or climbing stairs [1]. Exercise is defined as a type of physical activity that is structured, planned ahead of time, and repetitive, and whose goal is to improve physical fitness [2]. There is a large body of evidence to support that exercise interventions reduce pain and functional limitations in adults with OA in the short-term [3] and continued adherence to exercise improves pain and physical function outcomes for the long-term [4]. However, intervention rarely leads to sustained participation in exercise, resulting in poor long-term outcomes for pain and functional limitation. Hence the saying, ‘use it or lose it’. In traditional exercise interventions, including those prescribed in clinical trials, patients are given exercise as a treatment, where the frequency, intensity, time, and type of each exercise are detailed. However, little attention is given to the fact that exercise is a *behavior*, that is an activity that adults need to choose in order to participate in regularly. Furthermore, few resources are provided to facilitate the integration of exercise into daily life. For example, current traditional rehab/exercise interventions are often performed in specialized clinical environments that are inaccessible after discharge, are costly, and consequently not sustainable. Thus, exercises are discontinued resulting in the return of pain and other OA-attributable consequences, which is highly problematic for adults with OA, where adults spend an average of 13 years until having a knee replacement [5].

The purpose of this narrative review is to argue that viewing exercise solely as a treatment rather than as a behavior limits its effectiveness. A shift in the approach of how exercise interventions are implemented in adults with OA is encouraged in order to facilitate long-term participation in exercise. This paper summarizes two influential exercise interventions that typify most prior OA exercise programs and notes key limitations, particularly their limited use of behavioral theory to support exercise adherence and long-term maintenance. Next, this paper focuses on encouraging a shift in the approach of changing exercise behaviors in OA and reviews key behavioral theories relevant for exercise in OA. Lastly, in order to better understand the relationship between exercise, physical activity, and pain, recommendations for the inclusion and measurement of pain and physical activity within OA clinical trials are provided.

Methods

A narrative review was chosen as a format for this manuscript because it allows for a meaningful discussion and a conceptual understanding of how behavioral science can and should enrich the use of exercise in treating OA. While a systematic review has many strengths, the narrow focus and strict rules prescribed preclude the ability to cover the range of issues surrounding how exercise is currently being prescribed and utilized as a mainstay treatment for OA [6]. A targeted search strategy used both Google Scholar and PubMed to identify peer-reviewed articles on exercise interventions for OA, behavioral science principles, and behavioral theories. Articles were selected in a non-systematic fashion based on their relevance and significance to the purpose of this narrative review.

Influential exercise and rehabilitation Interventions in OA

One of the most influential clinical exercise interventions for OA comes from Messier et al. [7,8] called the Intensive Diet and Exercise (IDEA) trial. The trial examined the effects of exercise only, diet induced weight loss, and diet plus exercise induced weight loss. The exercise component of the intervention included group exercise sessions in a facility led by a trained interventionist for one hour/day, 3 days/week for the first 6 months. The sessions included two aerobic walking phases and one strength training. During months 7–18, participants could choose whether or not to perform exercises at home, in the facility, or a combination of the two. The diet plus exercise induced weight loss group had less pain (Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC] Pain subscale range 0–20) than the exercise only (1.02; 95% CI, 0.33–1.71; $P=.004$) or diet only (1.13; 95% CI, 0.44–1.82; $P=.001$) groups at 18 months, though the clinical significance of this was uncertain. The diet plus exercise group had better function and walked further during the 6 min walk test than the exercise only group (21.2 m; 95% CI, –36.3 to –6.4; $P=.005$) and diet only group (41.5 m; 95% CI, –56.4 to –26.6; $P < .001$) [7].

Another more recent influential clinical exercise intervention for adults with knee OA is called the Physiotherapy Exercise and physical Activity for Knee osteoarthritis (PEAK) [9,10]. The PEAK study examined the effects of face-to-face physical therapist consultations with video consultations. For both conditions, five consultations over 3 months were provided. During these consultations, physical therapists provided an individualized prescription of 5–6 strength training exercises to be performed at home three times/week. Physical therapists also developed individualized physical activity plans and participants were provided with a wearable tracker to monitor daily steps. Education, and a self-monitoring log to track strengthening exercises were also provided. Hinman and colleagues found similar improvements in WOMAC pain subscale (range 0–20) (2.98 ± 2.23 for face-to-face and 3.14 ± 1.87 for video) and WOMAC physical function subscale (range 0–68) (10.20 ± 11.63 for face-to-face and 10.75 ± 9.62 for video) after 3 months with no differences between either delivery approach [10].

While there are many exercise interventions in OA, the two chosen are not only some of the most influential studies, but also include exercise interventions which are representative of the majority of exercise interventions conducted previously in OA. Both of these studies were successful and resulted in increases in exercise and reductions in pain over time. The IDEA study by Messier et al., follows the more traditional approach viewing exercise as a treatment versus a behavior. The PEAK study on the other hand, while more recent, is starting to highlight the shift to fully recognizing that exercise is a behavior and interventions require additional behavioral strategies to change behavior. Some of the limitations of previous trials are highlighted as a first step to encourage a shift in the approach of changing exercise behaviors in OA.

Exercise in supervised and specialized environmental settings

Most exercise interventions for adults with OA have most commonly used structured in-person supervised sessions within a healthcare clinic/center and include all necessary equipment. Additionally, these sessions take place under the supervision of an exercise

professional or interventionist, and often occur with other participants, creating a group environment. It is well established that adherence to exercise is better when sessions are supervised as compared to unsupervised or self-directed exercise [11]. Further, supervision, social support from a healthcare professional, and accountability are common facilitators to exercise [12,13] and self-management [14]. The controlled group environment with the healthcare professionals' support and supervision are likely important contextual factors that are primary contributors to the initial effectiveness of many previous exercise interventions in OA.

Exercise prescription as a treatment instead of a behavior

Both patients and study participants expect their doctor or physical therapist to know the best for them, much in the same way medication is prescribed. As such, the specific type of exercise(s) patients and study participants should perform is chosen for them. Once a health professional or research assistant prescribes the exercise, he/she will provide a brief demonstration and/or give instructions on how to perform the exercises, and provide detail about the frequency, intensity, and dose of that exercise. Often, an underlying expectation is that participants will continue with those exercises for the long-term after being told what to do. Participants are also typically asked to track their exercises; however, this tracking often is reported more as a method for clinicians and researchers to gauge adherence to each of the exercises, as compared to as a self-regulatory behavioral strategy that the participant uses to become aware of behaviors and then adjust or modify behaviors based on progress towards the goal.

Often missing from prescription is attention to the complex *behavior* elements of exercise and the realization that behavioral strategies are needed in addition to the exercise prescription, in order for individuals to adopt and maintain exercise behaviors long-term. Health professionals, including physicians and physical therapists, are given little to no formal training in the behavioral aspects of exercise, which has been a longstanding issue, first highlighted by the Institute of Medicine (IOM) in 2004 [15]. Subsequently, the behavioral aspects of exercise are largely ignored in both clinical settings and research studies, but are critical for any health behavior change.

Use of the ISLAGIATT principle to develop exercise interventions in OA

Martin Eccles, an Emeritus Professor at the University of Newcastle, proposed that many interventions are being developed using the ISLAGIATT principle, which stands for "It Seemed Like a Good Idea at the Time." [16] Most exercise interventions in OA do not provide details on how interventions are developed. While it is possible that some of these OA clinical trials are developed in a systematic way, key details, such as describing the theoretical underpinnings of specific intervention techniques are overlooked.

Very few exercise interventions in OA report the use of behavioral theories, or if they do, the details on how they are used and applied are unclear. For example, Messier et al. reported that interventionists were trained in behavioral techniques based on Social Cognitive Theory [7] and a Social Cognitive Theory framework was used in the intervention to enhance self-efficacy [17]. However, it is unclear how Social Cognitive Theory was

applied in the intervention as the theory was not mentioned in the design and rationale [18]. As well, self-efficacy, a core construct of Social Cognitive Theory, is behavior specific. While Mihalko et al., provide a comprehensive overview of strategies used to increase self-efficacy, the strategies do not target the efficacy being examined. The self-efficacy measured in that study was focused on confidence related to physical function, such as balance confidence during specific activities, confidence walking for different durations and gait efficacy [17]. However, the behavioral strategies described target self-efficacy to engage in exercise regularly, which is different from functional efficacy. While increasing control beliefs related to function are helpful, self-efficacy to engage in exercise is also necessary to maintain behavioral changes long-term.

Similarly, Hinman et al. also indicated that the physical therapist consultations were informed by the Behavior Change Wheel, which provides a systematic method to develop evidence-based intervention [19,20]. Hinman et al. provided a comprehensive list of the behavior change techniques (BCTs) used within the trial and specific examples of exactly how and when these BCTs were implemented. BCTs are the active components of an intervention that are designed to help change behaviors. Michie et al. developed a taxonomy of 93 unique BCTs to aid in specifying, evaluating, and implementing behavior change interventions [16]. Use of BCTs is associated with improved adherence to exercise interventions for OA [21]. Despite the comprehensive description provided in the manuscript, a key limitation is that the details regarding how the BCTs were chosen is not clear. In particular, the process of using the Behavior Change Wheel involves first identifying a specific behavior and next using the Capability Opportunity Motivation-Behavior (COM-B) Model to analyze that behavior and diagnose reasons why the behavior is not occurring [19,20]. This process was not described, so while BCTs are helpful, without guiding theory to inform which BCTs are used, it is hard to understand how and why interventions are working.

The need for behavioral theory to guide exercise interventions

Based on the literature, it is clear that simply providing exercise prescriptions and recommendations within controlled and supervised settings is not sufficient to create longstanding behavioral change for performing exercise consistently that may lead to reductions in pain in OA [22]. Both clinical investigators and health care professionals need to recognize that exercise behaviors are being influenced by a variety of factors, both internal and external to the individual with OA and across multiple domains (physical, psychosocial, and environmental). Examples of internal factors include mobility limitations, motivation, beliefs, and self-efficacy. External factors, by contrast, include social influences and the environment; such as choosing to exercise in a group to connect with others.

In order to produce sustained changes in exercise behaviors, behavioral theories should be used in the development, implementation, and evaluation of exercise interventions in OA to target the proposed influences of exercise behaviors. Theories can be used to help understand, explain, and predict exercise behaviors. Behavioral theories have been applied to exercise and physical activity behaviors since the 1980s [23]. Evidence suggests that interventions which are theory-guided have modest effect sizes to increase physical activity

immediately after intervention than interventions not developed based on theory in healthy adults [24] ($d = 0.31$, 95% CI[0.24, 0.37]) and adults with cancer (SMD = 0.34, 95% CI [0.24, 0.44]) [25].

Despite the effectiveness of theory-guided interventions of changing exercise behaviors, the majority of clinical exercise trials in rheumatology conditions do not use behavioral theories to inform the development of their exercise interventions. Among the influential exercise trials in OA discussed earlier, theory was not used to guide these interventions to the best of our knowledge. This finding is also found in rheumatoid arthritis (RA), where a systematic review examining the use of theory in exercise interventions reported that the use of theory is low, not fully used in the development of exercise interventions, and has not increased in published RA exercise trials despite the fact that behavioral theories have been around for the past 40 years and used in other patient populations [26]. It is unclear why behavioral theories have yet to be fully adopted for exercise for OA. Theory-guided interventions have been tested for years and shown to increase exercise and physical activity in various populations including adults with diabetes [27], obesity [28], and cancer [29].

There are many different behavioral theories and models that can be applied to exercise interventions. A brief overview of three common or new and promising behavioral theories are provided that could be used to help guide more effective exercise interventions in OA: The Social Cognitive Theory, Self-Determination Theory, and the Dual Process Theory.

The social cognitive theory

The Social Cognitive Theory (SCT) is one of the most common behavioral theories used across numerous health behaviors, including exercise and physical activity. The SCT suggests that human behaviors are influenced by human cognition and external stimuli. SCT posits that personal and environmental factors influence human behaviors, and that these behaviors, personal factors, and environmental factors influence each other, known as reciprocal determinism [30]. One of the most influential theoretical constructs from the SCT on exercise behaviors is self-efficacy, or one's confidence in their ability to perform a behavior. Self-efficacy is one of the primary determinants of physical activity and exercise behaviors and the general population [31] and for adults with osteoarthritis [32]. In a review by Ghazi et. al., interventions for musculoskeletal rehabilitation including OA that used the SCT demonstrated modest to large effect sizes in increasing self-efficacy [33].

The self-determination theory

The Self-Determination Theory (SDT) [34] is a theory that behavior is driven by motivation that can come from controlled (external) to autonomous (internal) sources, and the more autonomous forms of motivation are consistently related to greater physical activity than controlled forms [35]. Importantly, three psychological needs lead to more autonomous forms of regulation: *autonomy*, freedom for choice and types of exercise; *competence*, feeling capable to perform exercise; and *relatedness*, the need to feel connected with others. When these three needs are satisfied, they help to develop intrinsic motivation for exercise. Although the SDT is a relatively newer theory, the use in exercise and physical activity interventions has continued to increase over the years. More importantly, SDT-based

interventions in non-OA populations have been effective at increasing physical activity behaviors [36], highlighting the potential of this theory for helping develop more effective interventions in OA.

Dual process theories

Dual Process Theories are the most recent of the theories discussed and were initially developed recognizing that certain behaviors, such as physical activity, were not fully driven by intentions [23]. Higher physical activity behaviors are associated with greater habit strength, suggesting that habits may be contributing to exercise behaviors more than initially thought. Dual Process Theories [23,37] posit that human behavior is influenced by reflective processes and automatic processes. Reflective processes are those that are deliberate and intentional, whereas reflective processes are more automatic and often nonconscious. While the research examining the effectiveness of interventions guided by Dual Process Theories is only just emerging, there is evidence of the strong role of both intention and habits in predicting physical activity and exercise behaviors [38].

Applying behavioral theory to exercise interventions

The use of theories can be overwhelming. Theories are abstract and no theory is all inclusive, which makes them challenging to understand and apply. Many theories are complex, and it is not necessary to use every aspect of a theory. Likewise, interventions do not have to be guided by a single theory. Many times, it may be necessary to draw on multiple theories to guide an exercise intervention, particularly given the number of determinants influencing exercise behaviors. There are many resources available which provide a comprehensive overview of behavioral theories and how they can be used within research or practice [39,40]. Further, given the hesitation and uncertainties of theories, Demmelmaier and Iversen [26] recommend that clinicians receive more training in behavioral theories or collaborate with behavioral scientists with experience in developing and implementing theory-based exercise interventions.

Once the theory or theories that will be used to guide the intervention are determined, researchers and health care professionals can develop a conceptual framework for the exercise intervention being implemented. This conceptual framework is specific to each intervention and can visualize and explain the relationships between the key theoretical constructs, behaviors, and outcomes that are expected. See Fig. 1 for an example of a conceptual model for a weight loss program designed for adults after knee replacement that was guided by constructs from both the Self-Determination Theory and Social Cognitive Theory [41]. Once the theoretical constructs (e.g., self-efficacy, autonomy) to be targeted are determined within the conceptual framework, the theoretical constructs should be tied with BCTs. Michie et al. developed a taxonomy of 93 unique BCTs to aid in specifying, evaluating, and implementing behavior change interventions [16]. For example, self-efficacy can be targeted by setting attainable behavioral goals or providing verbal persuasion about capability. Linking appropriate BCTs to theoretical constructs will help to test the mechanism of action that is expected based on the conceptual framework.

Within OA and rheumatic conditions, the effectiveness of specific BCTs on changing physical activity and exercise behaviors has been mixed. Some reviews suggest that the effectiveness of BCTs cannot be determined and highlight the low use of BCTs (37.7% of trials used only one BCT) within exercise interventions [42]. Among exercise interventions in those with persistent musculoskeletal pain, the BCTs that were the most effective at promoting exercise adherence included social support, goal setting, instruction of behavior, demonstration of behavior, and practice/rehearsal [43]. Among those with lower limb OA, the most effective BCTs were the use of behavioral contracts, rewards, goal setting behavior, self-monitoring of behavior, and social support [21]. Few interventions have been informed by theory [43], likely contributing to the inconsistent results on which BCTs are most effective in OA. The BCTs chosen are not linked to a theoretical framework or conceptual model, limiting our understanding of the mechanism of change that is driving behavior change in the effective interventions.

Developing future exercise interventions using a systematic approach guided by behavioral theory is recommended. Choosing your guiding theory or theories should be guided by targeting the determinants of exercise behavior of your population. Barriers and facilitators to your specific exercise behavior need to be determined for your population. For instance, adults with knee OA often report knee pain as a barrier to exercise [44]; however, it is likely that many other factors are influencing their participation in exercise. It is critical to determine the full scope of determinants of behavior. Once determined, you can choose a behavioral theory which best fits the population, as well as the specific intervention goals (e.g., initiation, maintenance). After a theory and conceptual model are developed, choose appropriate BCTs to target the proposed theoretical constructs influencing exercise behaviors. Equally important to guiding your intervention on theory, is to evaluate the effect of your intervention on your targeted theoretical constructs. For example, if your conceptual model is proposing that your intervention will target self-efficacy to exercise, it is critical to measure exercise self-efficacy to see if in fact your intervention actually changes self-efficacy. This will lead to a better understanding of why and how behaviors may or may not be changing, and continuing to build more and more effective exercise interventions.

Focus on exercise behaviors rather than adherence to exercise prescriptions (goal attainment)

Consistent with the recommendation to view exercise as a behavior instead of a treatment, using a standardized approach and shifting to focus on measuring exercise behaviors instead of general adherence to an intervention is encouraged. Currently, there is no standardized way to quantify and compare adherence or goal attainment to exercise prescriptions across studies [45]. OA clinical trials use different exercise prescriptions and varying methods to assess adherence. For example, Hinman et al., assessed adherence to prescribed exercises using a 0 (strongly disagree) to 10 scale (strongly agree) [10], whereas Messier et al., examined the percentage of the sessions completed over the number scheduled [7]. While helpful to see how close participants are to reaching study specific goals, the varying definitions and methods used to report adherence to an exercise prescription make it difficult to interpret and compare results across studies.

If adherence is to be measured, adherence to the behavioral exercise intervention (e.g., how many sessions were attended) and recommended behavioral strategies (e.g., how many days of action planning and self-monitoring were completed) should be assessed. Measuring the adherence to the intervention and recommended behavioral strategies is necessary to understand if, how, and what dose of the intervention is necessary for behavior change and subsequent improvements in pain and OA-related symptoms.

Conclusion

Exercise is a core intervention applied to address pain and functional limitations associated with OA. Historically, exercise has been prescribed as a medication with a specific dosage with little to no consideration of its inherent behavioral aspects. It is recommended that the OA community shifts to start incorporating the behavioral aspects of exercise in the conceptualization and design of interventions for clinical and research use. This shift is critical to increase the adoption and consequent efficacy of exercise to address pain and functional limitations. Central to this shift is the need to use behavioral theories as an underpinning to change techniques to facilitate the adoption of exercise. Finally, in order to make the results more generalizable and comparable across studies, a standardized approach and a focus on quantifying exercise behaviors rather than focusing on goal attainment to an exercise prescription is recommended. Because exercise works only when performed, behavioral strategies will help adults with OA more consistently use exercise to manage daily pain and functional limitations.

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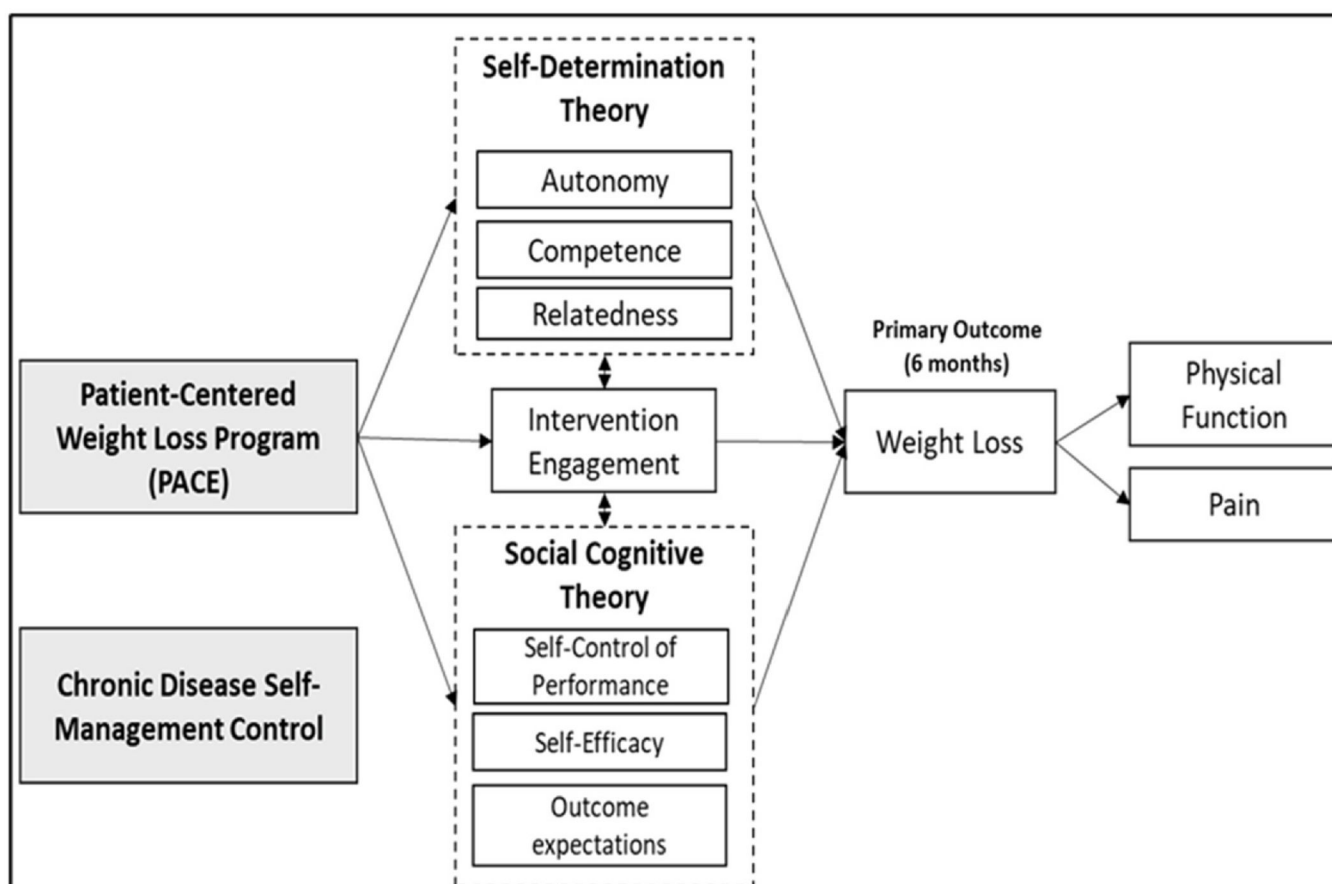


Fig. 1.
Example conceptual model of a weight loss program guided by both the self-determination theory and social cognitive theory.