

Original Paper

Combining Users' Needs With Health Behavior Models in Designing an Internet- and Mobile-Based Intervention for Physical Activity in Cardiac Rehabilitation

Konstantinos Antypas^{1,2*}, RN, MSc; Silje C Wangberg^{3,4*}, DPsych, PhD

¹Norwegian Center for Integrated Care and Telemedicine, University Hospital of North Norway, Tromsø, Norway

²Department of Clinical Medicine, Faculty of Health Sciences, UiT The Arctic University of Norway, Tromsø, Norway

³Narvik University College, Narvik, Norway

⁴Regional Center on Substance Use, University Hospital of North Norway, Narvik, Norway

* all authors contributed equally

Corresponding Author:

Konstantinos Antypas, RN, MSc

Norwegian Center for Integrated Care and Telemedicine

University Hospital of North Norway

PO Box 35

Tromsø, N-9038

Norway

Phone: 47 97613265

Fax: 47 77754099

Email: konstantinos.antypas@telemed.no

Abstract

Background: Internet-based physical activity interventions have great potential in supporting patients in cardiac rehabilitation. Health behavior change theories and user input are identified as important contributors in the effectiveness of the interventions, but they are rarely combined in a systematic way in the design of the interventions.

Objective: The aim of this study is to identify the appropriate theoretical framework, along with the needs of the users of a physical activity intervention for cardiac rehabilitation, and to combine them into an effective Internet- and mobile-based intervention.

Methods: We explain the theoretical framework of the intervention in a narrative overview of the existing health behavior change literature as it applies to physical activity. We also conducted a focus group with 11 participants of a cardiac rehabilitation program and used thematic analysis to identify and analyze patterns of meaning in the transcribed data.

Results: We chose stage-based approaches, specifically the transtheoretical model and the health action process approach as our main framework for tailoring, supplemented with other theoretical concepts such as regulatory focus within the appropriate stages. From the thematic analysis of the focus group data, we identified seven themes: (1) social, (2) motivation, (3) integration into everyday life, (4) information, (5) planning, (6) monitoring and feedback, and (7) concerns and potential problems. The final design of the intervention was based on both the theoretical review and the user input, and it is explained in detail.

Conclusions: We applied a combination of health behavioral theory and user input in designing our intervention. We think this is a promising design approach with the potential to combine the high efficacy of theory-based interventions with the higher perceived usefulness of interventions designed according to user input.

Trial Registration: Clinicaltrials.gov NCT01223170; <http://clinicaltrials.gov/show/NCT01223170> (Archived by WebCite at <http://www.webcitation.org/6M5FqT9Q2>).

(*JMIR Res Protoc* 2014;3(1):e4) doi: [10.2196/resprot.2725](https://doi.org/10.2196/resprot.2725)

KEYWORDS

focus group; design methodology; user involvement; user needs; health behavior models; tailoring; SMS; Internet; cardiac rehabilitation; smoking cessation; physical activity

Introduction

Burden of Cardiovascular Diseases

The contribution of noncommunicable diseases to the burden of disease has increased over the last decades, especially in Western Europe. Cardiovascular diseases clearly have an important impact in this, ranked at the top of the causes of death with an increasing share in the burden of disease from 1990 to 2010 [1].

Internet-Based Interventions to Support Physical Activity

In the same period the world experienced the explosive development of the Internet. Nowadays, use of the Internet is so widespread in many countries that it has become a popular means of delivering interventions to assist in diagnosis, treatment, prevention of illness, and the promotion of health. The number of health-related websites was estimated in the year 2000 to be more than 100,000, while today there are so many that it is not even possible to find an accurate estimate [2]. It would also be risky to estimate the general impact of Internet use on the burden of disease, but research shows that under certain conditions it can be a very useful tool in supporting self-management [3-9]. More specifically, there is the potential to influence physical activity that is very important for the prevention and the rehabilitation of cardiovascular diseases [7,10].

The effectiveness of Internet-based health interventions is connected with the adoption of the appropriate theoretical framework [11-14], while the viability of these interventions is associated with strong user involvement in their design [15]. For that reason, we are using a methodological approach that is combining the user-input and health behavioral theory to develop an Internet- and mobile-based physical activity intervention for cardiac rehabilitation.

Following our suggested process, we first review relevant models of health behavior and discuss our choice of the theoretical background for the intervention. We next present results from a user needs focus group, and finally, we describe the resulting design of the intervention.

Methods

Construction of Theoretical Framework

The choice of a theoretical framework is explained through a narrative overview and discussion of models of health behaviors in light of applicability to longitudinal tailoring. Then, theoretical concepts fitting well within different stages of behavioral change are reviewed.

User Needs Focus Group

The user needs focus group took place in February 2010 at the Skibotn Rehabilitation Center in Norway. There were 3 women with mean age 64.3 years and 8 men with mean age 59.4 years, all attending the center's cardiac rehabilitation program that month. The focus group was conducted at the center during the

fourth and last week of the program's duration and lasted one hour.

The discussion was based on an interview guide, but it was stressed that the goal would be an open discussion. The first part of the focus group was about needs, thoughts, and ideas of the users regarding support to increase physical activity and the corresponding role of technology. During this first part, the interviewers didn't present any of the ideas for the intervention. The second part started with a very short presentation of some of the researchers' ideas regarding the proposed intervention. The discussion that started in parallel with the presentation, and continued afterwards, focused on the opinions and reflections of the participants on the proposed concepts and intervention features. There were two interviewers that led the discussion.

The focus group discussion was audio recorded, verbatim transcribed, and analyzed with thematic analysis. Of the two researchers that analyzed the data, the first is a nurse with work experience in cardiovascular diseases. By the time of the focus group, the cardiovascular nurse had already developed some ideas regarding the intervention based on discussions with personnel at the rehabilitation center and on previous experiences with heart patients. The second researcher is a health psychologist with previous experience in developing Internet-based as well as tailored, health behavior change interventions, thus interpreting the data through glasses tinted by health behavior theories.

Results

Narrative Overview of Background for Theoretical Framework

Tailoring and Models of Health Behavioral Change

In this section, we present the rationale behind the choice of the theoretical framework for the Internet- and mobile-based intervention for physical activity. At first we explain why we use tailoring, an effective element of persuasive technology [15]. Then we present the different models of health behaviors, and how we combined them to comprise the core of the tailoring algorithm.

Tailoring

Bibliographic evidence is pointing toward the effectiveness and usefulness of tailoring. For example, perceived program relevance and amount of the materials read are found to be mediators of the effect of an Internet-based smoking cessation program [16]. A tailored intervention is one that is adapted to the characteristics of the individual, typically based on responses to a questionnaire [17]. Tailoring relies on three main methods: (1) personalization, (2) adaptation, and (3) feedback [18]. Personalization involves referring to the recipient in the text on the basis of details such as first name, age, gender, or hometown. Adaptation concerns the content of the text itself, which can be tailored according to a variety of theories. Feedback is a widely used feature in which the recipient is informed about scores on a scale, and how to interpret the results. In newer, more complex tailoring, these features are often combined, and the components of the Internet-based intervention may also be tailored.

Tailored health messages are in general perceived as more interesting and personally relevant, liked better, read more thoroughly, discussed more, and remembered better compared to nontailored educational material [19-22]. Personalization shows the most consistent effects of being tailored to [23,24] and involves referring to the recipient in the text on the basis of details such as first name, age, gender, or hometown. This is consistent with self-referent encoding, that all information that we associate with ourselves, is more easily noticed, stored, and retrieved [25].

Models of Health Behavioral Change

Continuum Versus Stage-Based Models of Behavioral Change

Models for health behavior can be roughly divided into two categories: (1) continuum models, and (2) stage-based models [26]. Velicer and Prochaska [27] argue that Schwarzer’s [26] division between continuum versus stage-based models can be conceptualized as theories of behavior versus theories of behavior change. The continuum models, to a great extent, are based on correlational studies of predictors of an on-going behavior, whereas the latter, to a greater extent, have studied predictors of transitional processes into a greater readiness for change. For the purpose of clarifying different implications for tailoring, we will continue our discussion with Schwarzer’s dichotomy.

Continuum models describe antecedents of behavioral change with the implicit assumptions that the sum of these antecedents needs to be above a certain threshold for a behavior to occur. Models vary as to whether and which variables are necessary and sufficient for behavioral change to happen. For instance, several models agree that having an intention to perform a behavior is necessary (but not sufficient) for the actual behavior to occur. Stage-based models, on the other hand, assume that there are distinct stages characterized by specific cognitive processes and motivational needs that the individual should pass through in sequence to get to behavioral change.

The Intention-Behavior Gap

Researchers within both kinds of models agree that there is a “gap” between intention and behavior [28], but a discussion

with important implications for interventions is whether (for instance) intention is a static (indicator) or a dynamic (and changeable) variable [27]. Before and after forming an intention is a common chasm across several stage-based models [26], and is also seen as an important distinction demanding different strategies in nontheoretical methods such as motivational interviewing [29], which has been successful in supporting people in changing a host of health behaviors [30,31], including those relevant to cardiovascular disease risk [32-35]. Tailoring based on the continuum kind of models would imply that one determines which variables are “low” and then aims the intervention at increasing these, while tailoring based on stage-based models will identify the stages and deliver an intervention directed at the described processes within the particular stage.

Noar et al [36] found in their meta-analysis of tailored interventions that those based on the Transtheoretical model (TTM) [37] had the greatest effect. They further found that the number and type of theoretical concepts tailored on, including stage of change and processes of change, were associated with behavior change [36]. In general, physical activity interventions based on the TTM have not been very effective. Adams and White [38] point out potential reasons why this may be—that physical activity is complex, and that several of the reviewed interventions might not have optimally operationalized the TTM concepts. In other words, how we tailor to the relevant needs and processes within each stage is at least as important as the overarching framework (ie, the stages).

Starting From Stage of Change

As the first step in our tailoring, the participants’ stage of change is assessed using the University of Rhode Island Change Assessment - Exercise 2 (URICA-E2) [39]. In the next step, they follow different paths depending on the stage, starting with feedback on the current stage. As can be seen in Table 1, in addition to the variables described in the TTM [37], we have added some specific constructs from other theories according to what we see to be a good fit to the relevant processes in each stage. These are described in more detail below, along with our operationalization of these constructs in the tailoring of our physical activity intervention.

Table 1. The five TTM stages enriched with well fitting constructs from several theories.

	Stages from the TTM				
	Precontemplation	Contemplation	Preparation	Action	Maintenance
Relevant psychological constructs in different stages	Consciousness raising [37], Regulatory focus [40,41], Values [29], Environmental reevaluation [37], Outcome expectancies [42], and Supporting autonomy [29]	Decisional balance [37] and Self-reevaluation [37]	Action planning [26], Coping planning [26], Implementation intentions [43], and Self-efficacy for action [26]	Contingency monitoring [37], Counterconditioning [37], Stimulus control [37], Helping relationships (TTM) [37], Social support, Self-monitoring rewards, and Self-efficacy for maintenance [26]	Self-efficacy for recovery [26] and Relapse prevention

Regulatory Focus

A variable that we tailor on when we deliver health information to those who are concerned with the pros and cons of behavior

change (ie, those in the first two stages) is the individuals’ promotion- or prevention-goal orientation (regulatory focus). Regulatory focus theory [40,41] separates those who are primarily motivated by achievement and gaining rewards

(promotion) from those who are more concerned about avoiding loss and risk of such (prevention). This has implications for the kind of health information the individual is most affected by, and consequently, how we frame health information. Latimer et al showed that tailoring to regulatory focus (ie, matching it to the individuals' regulatory focus) could increase both physical activity [44] as well as fruit and vegetable intake [45]. Our participants are presented with a regulatory focus assessment (Regulatory Focus Questionnaire-RFQ)[41]. Depending on classification, the participants are sent either prevention- or promotion-framed SMS text messaging (short message service, SMS) messages concerning physical activity over the next two weeks.

Decisional Balance

The balance between the pros and cons of behavior change has been shown to predict readiness to change across a host of health behaviors [46]. Our contemplators are presented with a decisional balance questionnaire [47]. The participant is then presented with immediate feedback according to whether they perceive more pros or cons with regard to regular physical activity. Next, the participant is presented with a list of potential reasons for becoming more physically active, and asked to tick off the relevant ones, before being asked to add some more in free text. This list is displayed on "My Page." "My Page" is the profile page of the intervention where the most important information, the activities and the interaction of the user, and of their friends, are presented as a feed. A more detailed description of the functionality, as developed in combination with the user input, can be found in the section "Functionality" of the website.

Planning

In the planning phase of another stage-based model, the Health Action Process Approach (HAPA) [26,48], one separates action planning from coping planning [49,50]. Action planning refers to the planning of where, when, and how to perform the target behavior, and is thus similar to Gollwitzer's concept implementation intentions [43]. Coping planning, on the other hand, concerns strategies for dealing with anticipated barriers, and is thus strongly connected to self-efficacy. From the preparation stage and onwards, the participant is asked to plan their physical activity in the "Exercise Agenda." There, they can add several entries by planning what kind of activity, when, and where for each entry, thus forming an implementation intention. After completing planning, they are assessed for self-efficacy for this action plan. If it is very low, the user is asked to revise the action plan to make it more realistic.

Self-Efficacy

The concept self-efficacy refers to the degree to which an individual perceives that he or she can perform a particular behavior. The concept of self-efficacy stems from the social cognitive theory [42], but since self-efficacy is so closely related

to behavior change, several researchers have assimilated it into other theories [26,29,51,52]. In the context of the two-stage HAPA [26], self-efficacy is important throughout behavior initiation, action, and maintenance, but HAPA distinguishes three kinds of self-efficacies: (1) action self-efficacy, you can perform the target behavior; (2) maintenance self-efficacy, you can maintain the target behavior despite barriers; and (3) recovery self-efficacy, you believe that you can succeed after a setback. While action self-efficacy in the HAPA model is directly related to intention, it is only indirectly related to behavior mediated via intention. Maintenance and recovery self-efficacy are on the other hand not related to intention, but directly related to behavior [26]. All these self-efficacies are assessed in the preceding stage. If the self-efficacy is low or moderate, the participant receives SMS messages concerning self-efficacy for the relevant stage over the next two weeks and also is asked to identify potential barriers (selecting from a list and in free text), and to generate strategies to address them. Strategies are then listed on "My Page."

Social Support

Social support is important both directly for health status and via its influence on health behaviors [53]. In the TTM, social support is referred to as helping relationships and is seen as relevant to the action stage [37]. Social support is also found to increase throughout the stages [54]. We assess and give immediate feedback on social support in the preparation stage.

Relapse Prevention

Relapse prevention is trying to identify, prevent, or prepare to deal with high-risk situations. The most important goal is to make a plan for getting back to the plan; to prepare for continuing with the new health behavior in the event of a lapse, rather than giving in, perceiving the situation as all gains are lost, and all effort wasted, thus turning the lapse into a full-blown relapse [55]. Relapse prevention is mostly considered in relation to giving up substance use (eg, smoking cessation) [56], but we consider it relevant for other health behaviors too, and send SMS messages about relapse prevention to those of our participants in the maintenance stage that have indicated low to moderate self-efficacy for maintenance.

The Focus Group

The Seven Themes

There are seven main themes that were identified in the focus group: (1) *social*, (2) *motivation*, (3) *integration to everyday life*, (4) *information*, (5) *planning*, (6) *monitoring and feedback*, and (7) *concerns/potential problems*. The themes are presented in the thematic map (Figure 1 shows these themes, also see Multimedia Appendix 1 for these themes). The results and the thematic map presented in this paper are a slightly more revised version than the one used for the development of the intervention, in the direction of improved synthesis of the data.

Figure 1. Thematic map of the focus group themes.

Social

The largest pattern of meaning that appeared in the focus group was the *social* theme. In addition to its high level of frequency, this theme is the one that included the most subthemes and codes. Under this theme we have included ideas, thoughts, and needs, expressed by the users referring to companionship, belonging to a group, or communication with others.

One of the dimensions of this theme repeatedly expressed by the participants was the importance of not being alone in the behavior change endeavour. This was an important factor that helped them during their stay in the rehabilitation center, and it was something that they wished to maintain after they were discharged. In some cases, they were referring to the importance of staying connected with the very same people with whom they shared the rehabilitation program.

I am like this, that I need a bit of this motivation from the others also, to try alone, this is... This is the problem...so...this here with the local team, this can be a reasonable angle of this also, or approach eeh...attach yourself to the local team, also continue this you have started with them now...for example. [Male]

The importance and the benefits of belonging to a group were further explained. Peer support is the main benefit the participants seemed to enjoy at the rehabilitation center, and is one of the mechanisms through which they can help each other.

A forum of course is also something to talk about, a brilliant thing...talk with each other in a forum and ask things...put out eeh... [Male 1]

you should have a forum only between... peers... [Male 2]

As expected, the peer support appears to be connected with the functionality of the forum. In the next extract, we also see the concept of the social obligation that the participants recognize as a possible mechanism to maintain or increase physical activity. The participants feel the obligation to do something that their peers are doing or ask them to do.

I am saying that if we have it fixed, one time per week, that we send a message to each other and then, then you feel committed to say yes, for as long as you like...Yes, then you must have something else that really, you have something else that you have to do, or else...you just do it. [Female]

In another instance, the social obligation is connected with a request for a training diary combined with the forum.

Training diary on the Internet...And also have a group where someone can subscribe to a forum, or have a...to brag...yesterday I walked for an hour and today

I have been to the training...and tomorrow I have thought, yes...So, it is like this that someone gets to, a bit, a bit like a competition, internally between each of us. We will train, as much as possible we will commit to ourselves a bit more also. [Male]

Commitment is also related to a healthy competition with each other. Through the forum, the participants suggested that they would succeed simply to encourage each other, an important mechanism related to the *social* theme.

Yes, yes I think that for many...if you take as basis the situation we are in now and you want to prolong it as long as possible, all of us want to stay here four weeks more, isn't it? And four weeks after that, life is great here...But to stay in touch with the "gang," so, so I think that the most of us would think that, yes, the Internet, the approach that is best, I don't have any faith in SMS, but eeh, Internet, a forum yes. To keep up, keep the spirit of the team up, the mood, the good flow. [Male]

The participants also had specific suggestions regarding the functionality of the forum. For example, they were positive about having two levels of access, one reserved only for the members of the same monthly group. In this level, they would like to share photos with the other members, maintaining their bonds after the rehabilitation stay. The social dimension of the forum was not only mentioned in relation to the other participants, but also included the personnel of the center. The participants mentioned that they would like to know that at the forum there are health professionals they can trust to answer their questions.

Yes, there should be someone that can answer, that has a clue and that can answer. [Male]

There should be professionals too...yes. [Female]

The fact that Facebook is the largest and most popular social network, and one of the most popular websites in Norway, can explain that users were often inspired by Facebook functionality, and sometimes even explained a desired functionality as "like Facebook." In the same context, the concept of a training buddy was also popular. That is a person that would be paired with that participant, and they would support each other possibly with their physical presence, but mainly through the interaction the Internet tool would provide.

Almost like Facebook that...A forum is a living thing, like you come here and just are...new things pop up all the time and...between users...it's alive. (...) Do you want to be my workout friend? (Laughter from the rest of the group) [Male]

Regarding the choice of technology that would support the social functions of the intervention, participants mentioned the Internet and SMS in both parts of the focus group (in the general

discussion and the discussion after the initial ideas were presented). One participant was sceptical to the usefulness of the SMS, but this didn't reflect the opinion of the rest of the group.

Motivation

The theme *motivation* includes ideas and methods believed to influence or capable of influencing the participants' behavior. The theme includes the strong belief that the responsibility for change of behavior is personal. The participants mentioned it mainly in relation to what is going to happen after they leave the rehabilitation center.

I believe actually, I believe that someone gets used to it, if we make a system, habits. That it doesn't get too much, that we know that...we go online...and we get our own responsibility of our own training. [Male 1]

It is not, it is not that anyone says that you have to cycle. Also, it is made that each does what himself/herself feels. [Male 2]

So, so, it requires self-discipline. [Male 3]

Making a decision to prioritize themselves and the behavioral change was also very central. Prioritization was discussed in several instances as a method to maintain physical activity and generally continue the changes in behavior after the discharge.

That we chose to prioritize the demands others have of us. [Female]

Down-prioritize ourselves all the time. [Male 1]

Got to be better at saying—"No thanks, today I can't." But on Tuesday it doesn't work either, for I'm exercising" [Male 2]

Integration to Everyday Life

Another theme that emerged from the focus group was *integration to everyday life*. The participants often referred to thoughts and things to do that are helping them to integrate a desirable behavior into their everyday life. In the same way, the participants wanted technology that would assist them in maintaining the desired behavior in a way that also integrates it into their everyday life. Special emphasis was placed on simple changes in the activities of their everyday life that can increase physical activity.

I think that someone should not have high expectations of himself, that would make him strive to get there. I believe that you get tired of it, I think you should have only simple changes in your life. [Male]

The participants also discussed that creating new habits is helpful in changing behavior by integrating the desired behavior into everyday life, mainly by replacing old bad habits. The reverse order also seemed to be possible. By integrating an activity or even a technology into everyday life, an old habit could be replaced with a new good one that would assist in changing behavior.

I believe in small simple things like in everyday life, that if someone manages to walk to the store or walk

to work maybe...things like that can also be important, instead of taking the elevator, if you are working in a building that you can take the stairs instead of the elevator, if you do it often, it is not bad either...instead of sit in the car and drive a few meters, to walk to the shop instead, so can someone ride a bicycle when it becomes summer, or go with the chair-sledge...that someone can do things like that, it gets possible. Someone becomes so lazy that doesn't bother, sits in the car, the old habit, instead of just walking. [Male]

A technology that would help to integrate the desired behavior into everyday life should also be integrated into everyday life. Ubiquitous technology can support behavior change in the challenging situations of everyday life, or remind users of their own commitments.

If you could get a message every day, there and then? [Male 1]

Have you been good today? No, now you have to go out, time for exercise. [Male 2]

Get out you lazy bastard! [Male 1]

And it should come on a specific time you have decided to walk today, or go out... [Male 2]

Or even better, a couple of hours before...so you won't change your mind. [Male 1]

Information

Despite being in a rehabilitation program where they could have access to all the information they needed, or maybe because they were there and were experiencing good access to information, the participants of the focus group expressed their need for tools that would help them access the right information for a long time after their discharge. They referred repeatedly to the need to find the right answers, either through a forum or a kind of knowledge bank. They also wanted the health professionals to take an active part in the forum, and specifically for physical activity, provide suggestions for training plans.

It should be a forum where you have the opportunity to get...eeh...get the right answers, [...] access to a resource, this is what I believe it becomes. It has an effect. [Male 1]

What is good with a forum is that everything that is asked and discussed and answered...it stays there, you don't even have to ask, if...if it [the forum] is used a lot, you can just with a simple search find what you need...The hope is that it will become a kind of knowledge bank. And the problems you have experienced like pain and things that you can go in and have a look and talks to others about them. [Male 2]

Planning

This theme covers a very effective part of the behavior change process. The participants expressed the necessity to plan in advance their physical activity in order to actually do it. First of all, the plans have to be realistic in order to make it possible to achieve them.

[...] if we were sportsmen, we would have to climb extremely high. As you say, leave the car, to walk a bit, we have made a lot. [Male]

Maybe it is a bit of [your] responsibility, a time schedule with realistic goals. [Female]

The technical dimension of this theme was expressed with a clear request for a training diary that would help the users plan activity, preferably on a weekly basis so they would avoid being drawn to their old way of behaving, where physical activity was constantly neglected.

[...] I believe that what is important with the schedule is that you set it off, you prioritize a bit, you see that okay, that and that day it passes better maybe. So you say at those two days or three days a week, they are mine, then I should train. If you don't make it to a system, it gets difficult, easy to neglect, if you don't put aside time for it, because then it is so many other things that comes in front all the time. Then it becomes neglected, this is anyway my experience. But if you, like what I did before Christmas, before I came here, then I decided that in the evenings I should be going on walking tours. When the children go to lie down, I am going for a tour. And I did it. [...] It should come first...or we die, this is how I am thinking... [Male]

Monitoring and Feedback

The theme of *monitoring and feedback* appears in the second part of the focus group, during the discussion and after the presentation of some specific ideas for the intervention. It refers to the necessity and the requirements related to keeping a record of the physical activity of the users, and how to present it in a meaningful way to them. The discussion was dominated by the previous experiences of some of the participants with monitoring sensors, feedback statistics, and graphs, mainly from commercial products and services. The rest of the group was also interested even if they had no personal experience with the sensors, and generally were positive to the idea.

After what I have seen, there is a whole program, and shows graphically also how the climb has been, also the mountains, everything is there. There is also the pulse there. I have been many times in on the Internet and seen how the whole training of the day has been. [...] And there you can see them, there is graphic representation, how it has been, up the hill, down the hill and... [Male]

Concerns and Potential Problems

Despite the positive reception to the idea of an intervention, several concerns and fears for potential problems were expressed during the focus group. Regarding the process of changing behavior, the participants of the focus group were concerned about the obstacles they have to overcome in their effort to maintain or increase physical activity. Lack of training facilities, lack of time, or just going back to their everyday life are possible obstacles that make them question their ability to maintain the desired behavior.

We have developed some habits while here. This, this I believe we cannot manage outside. And then we maybe cannot maintain, keep enough habits. We haven't...[...] I live far from people and fatherland, to say it like this. [...] Yes, my place is far [from a city]...we have no swimming pool or any big activities. We should just organize our own activities...when we live far, far in a village. [Male 1]

For example, 52 weeks that I can use them as I want, but I should try to use them right. [Me] and someone else that has to go to work, we cannot do it equally. [Male 2]

Along with the concerns about the obstacles in changing behavior were the concerns about relapsing from the desired behavior. For various reasons individuals might stop being physically active for short or long periods of time, and for that case, the participants expressed a need for support to get them back on track.

And when you come home and you get back pain, you don't manage to keep up, so you become disappointed and sad, and you feel that, no, I am a loser. [Male]

The major concerns though, were expressed for the technology. When it came to the usability of the website, the participants suggested that we should consider e-literacy issues and offer training to the users. They also recommended that the website be maintained in such a way that it is constantly updated, with the content remaining politically and religiously neutral and independent. A few participants were sceptical of the SMS technology, believing it was not answering the needs for behavior change. This view was balanced by the request of many other participants to send them reminders and motivational messages to trigger behavior change. The potential risk of high dropout rate from the forum was also discussed.

As in many Internet-based interventions, participants shared another important concern—privacy. They asked to have the choice on what to share with whom.

You can choose, if you want it...to make it public...Make it accessible for the others, so...it should be a keystroke or a choice you do [...] In periods it might be like that, that you don't want to show it... [Male]

A female participant also expressed a concern regarding the ability of an intervention to cover the needs of women too. This shows the need for a gender-sensitive approach, mainly by offering additional training where it is needed. Finally, tailoring, a concept very central to the suggested intervention caused scepticism in a few participants. They questioned the ability of technology to provide a satisfying degree of personalization.

But it is not possible that you [have] many different [categories], because someone is not so individual that cannot fit in maybe four different...I am thinking like this...I want to believe that to make conclusions from the questionnaire there, that has maybe four different categories...do you know what I mean?...I answer in this way, I belong to category four, Ola

answered that, he belongs in category three, in this way, a bit slack it is, ...If it is tailored to 12 different [categories], then it becomes, it becomes very ambitious, I think... [Male]

The Design of the Intervention

The researchers translated the combination of the theoretical framework and the user input into the technical requirements documentation that was later used by an external collaborator to develop the actual intervention. In [Table 2](#), we list the

contribution of the theoretical constructs and the relevant focus group themes in each functionality element of the intervention. The intervention is based on the popular open source content management framework Drupal. The main phase development that produced a functional prototype lasted one year. It was followed by a second phase of six months that included bug fixing by the external collaborator, the implementation of the tailoring algorithm into Drupal, testing, and content development by personnel of the Norwegian Center of Integrated Care and Telemedicine and the Skibotn Rehabilitation Center.

Table 2. Contribution of theory and user input in the functionality included in each element of the intervention.

Elements of the intervention	Relevant theoretical constructs	Relevant focus group themes
Levels of access	-	<i>Social and concerns/potential problems</i>
Microblog functionality of “My Page”	Social support, Consciousness raising, and Helping relationships (TTM)	<i>Social and motivation</i>
Activity calendar	Preparation (TTM), Action planning, Contingency monitoring, and Self-monitoring	<i>Planning, monitoring and feedback, social, information, motivation, and integration to everyday life</i>
Discussion forum	Social support and Helping relationships (TTM)	<i>Social and information</i>
General information	Consciousness raising and Self-efficacy for action	<i>Information</i>
Contact with physiotherapist and technical support	Social support	<i>Social, information, and concerns/potential problems</i>
Weekly activity goal on “My Page”	Outcome expectancies, Self-efficacy for action, Action planning, Implementation intentions, and Supporting autonomy	<i>Motivation, planning, and monitoring and feedback</i>
Simple feedback graph on “My Page”	Outcome expectancies, Self-reevaluation, and Consciousness raising	<i>Monitoring and feedback, information, and planning</i>
My reasons for physical activity, my strategies to increase physical activity, and overcome barriers on “My Page”	Self-efficacy for maintenance and recovery, Values, Coping planning, Relapse prevention, and Decisional balance	<i>Motivation, integration to everyday life, information, and concerns/potential problems</i>
Tailoring algorithm	Mainly based on theoretical constructs (see detailed explanation under Theoretical framework and Table 1)	<i>Motivation, planning, social, information, integration to everyday life, and concerns/potential problems</i>

Functionality of the Website

The Graphic Design

The graphical design of the website was based on the graphic profile of the patient organization that owns the collaborating rehabilitation center. Since the offer of the intervention is an extension of the services offered by the face-to-face rehabilitation, it is important to use the visual elements and a palette familiar to the users and identical to the website of the rehabilitation center, to the website of the patient organization that owns the center, and to all the printed materials that are used by the organization and all its services. Since the patient organization is one of the biggest and most active in Norway, we expect that the level of trust toward our intervention will be positively affected. The main colors of the website are blue and light blue, which, according to the graphic profile of the organization, have been chosen because they symbolize clean air and breath. For the typography, modern, but simple fonts have been selected to make the information easy to read.

Three Levels of Access

There are three levels of access for most of the components of the website. The first one is information accessible by all the registered users of the website. The second level is accessible only by a specific group of users that are called friends. Friends are by default the participants of the same rehabilitation monthly group, for example, participants that have been to the rehabilitation center in January 2012. A user can add or delete friends from her profile page. A third level of access is reserved for the user and the information that is private. Users with administrative roles can have access to information of all levels.

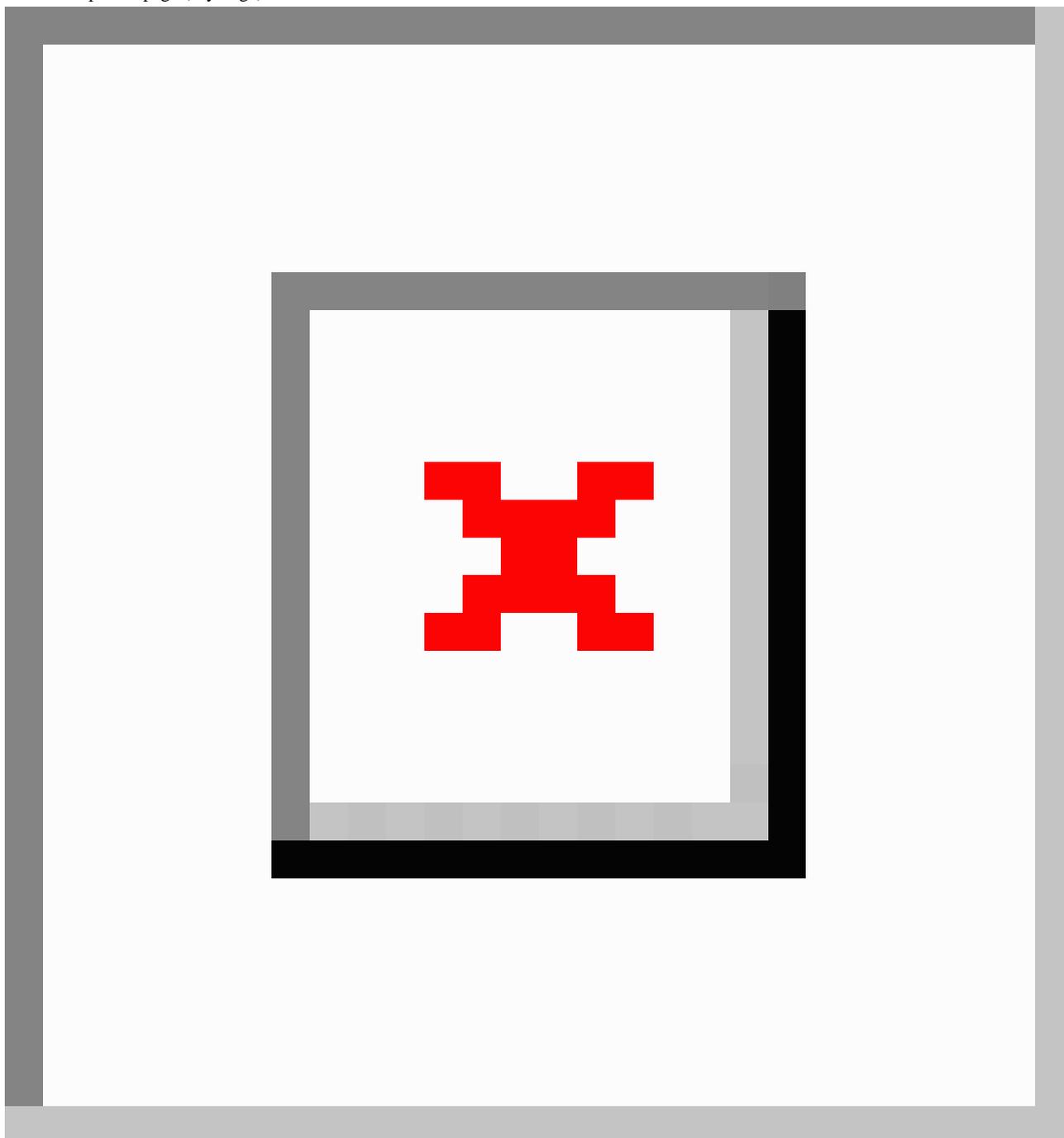
My Page

For the user, the starting point is the profile page, called “My Page” ([Figure 2](#) shows this page). The profile page includes a wall functionality that could also be described as a microblog functionality, where the planned and completed activities from the calendar appear. The user can write how they feel in general or about the activities they have planned, and can see other users’ posts. To avoid lengthy posts, a limit of 340 characters

is applied. For each post on the profile, there is the possibility for the friends of the user or the center's personnel to comment. From the profile page, the user can access the friends' list and the personal information page. The most recently planned

physical activities appear also on the side of the profile page. There is also a link to the group page. The group page is similar to the profile page, but only shows the latest activities of the members of the monthly group to which the user belongs.

Figure 2. The profile page (My Page).



Activity Calendar

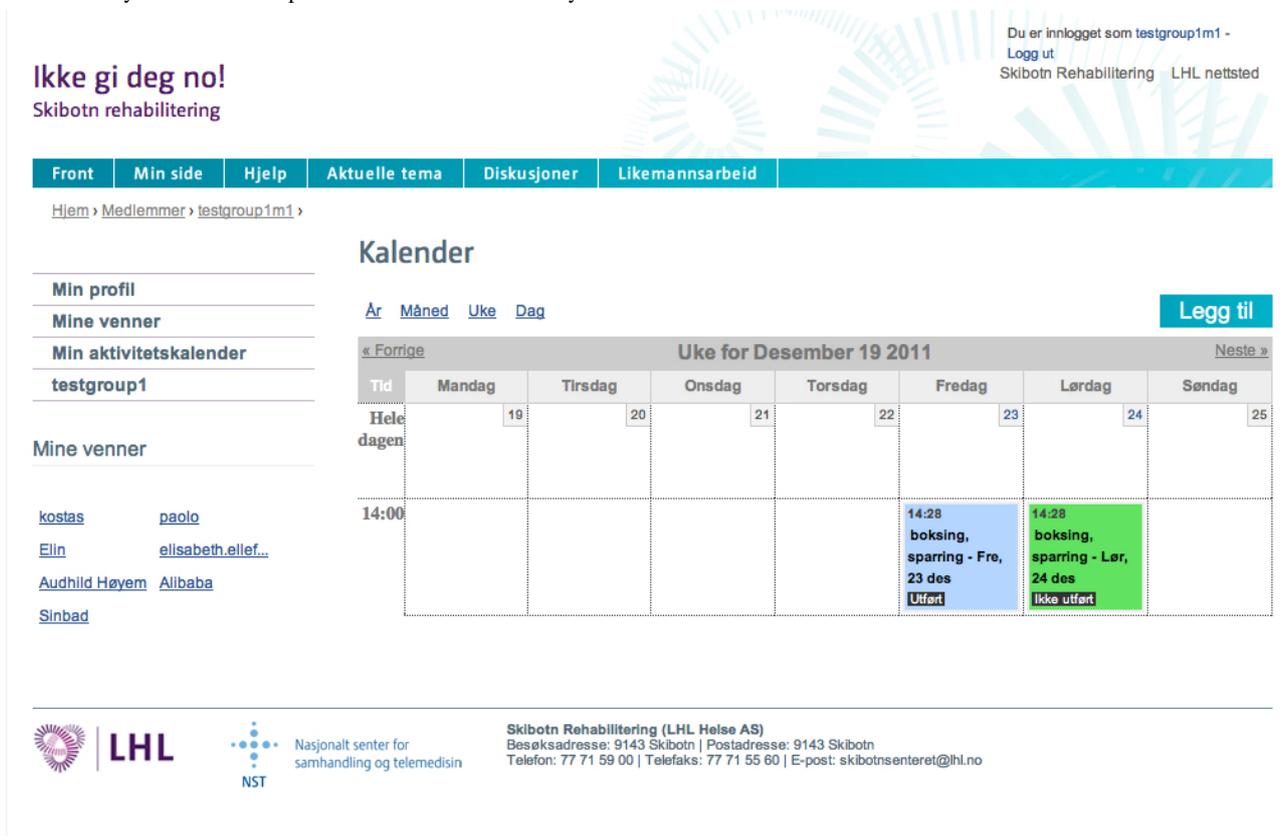
The activity calendar is a planning and reminder tool. The main view is the weekly calendar (Figure 3 shows this weekly view), since the users are encouraged to plan activities on a weekly basis, but daily, monthly, and yearly views are also available. The completed activities appear on the calendar with a different color, and the user can edit both the completed and planned activities. To plan an activity, the user can choose from a preselected list with common activities (Figure 4 shows this

page). The user has to set the start date and time, duration in hours and minutes, and planned intensity according to Borg's scale [57]. In addition, the user can choose to make the activity public or private, to write the place of the activity, and to provide an additional description. An important functionality is that there is the possibility to challenge some or all of their friends to take part in the activity by inviting them through the same page. The invited friends will see an invitation on their profile page and will also get an email and an SMS invitation. For each planned activity, the user will receive an SMS reminder 15

minutes before the planned beginning of the activity, and an SMS at the planned end asking about the completion of the activity (Figure 5 shows this reminder). The last SMS contains a URL link that users with smartphones can use to confirm their activity as completed and state the actual duration of the activity, the actual intensity, and write a comment if they want (Figure

6 show this page). Users without a smartphone can update the information the next time they log in on the website. The information about the completed activity is published on the profile of the user and can also be seen by their friends on their page.

Figure 3. Weekly overview of the planned activities of the activity calendar.



Ikke gi deg no!
Skibotn rehabilitering

Du er innlogget som testgroup1m1 -
Logg ut
Skibotn Rehabilitering LHL nettsted

Front Min side Hjelp Aktuelle tema Diskusjoner Likemannsarbeid

Hjem > Medlemmer > testgroup1m1 >

Kalender

Ar Måned Uke Dag Legg til

« Forrige **Uke for Desember 19 2011** Neste »

Tid	Mandag	Tirsdag	Onsdag	Torsdag	Fredag	Lørdag	Søndag
Hele dagen	19	20	21	22	23	24	25
14:00					14:28 boksing, sparring - Fre, 23 des Utført	14:28 boksing, sparring - Lør, 24 des Ikke utført	

LHL Nasjonalt senter for samhandling og telemedisin
NST

Skibotn Rehabilitering (LHL Helse AS)
Besøksadresse: 9143 Skibotn | Postadresse: 9143 Skibotn
Telefon: 77 71 59 00 | Telefaks: 77 71 55 60 | E-post: skibotnsenteret@lhl.no

Figure 4. Planning of an activity in the activity calendar.

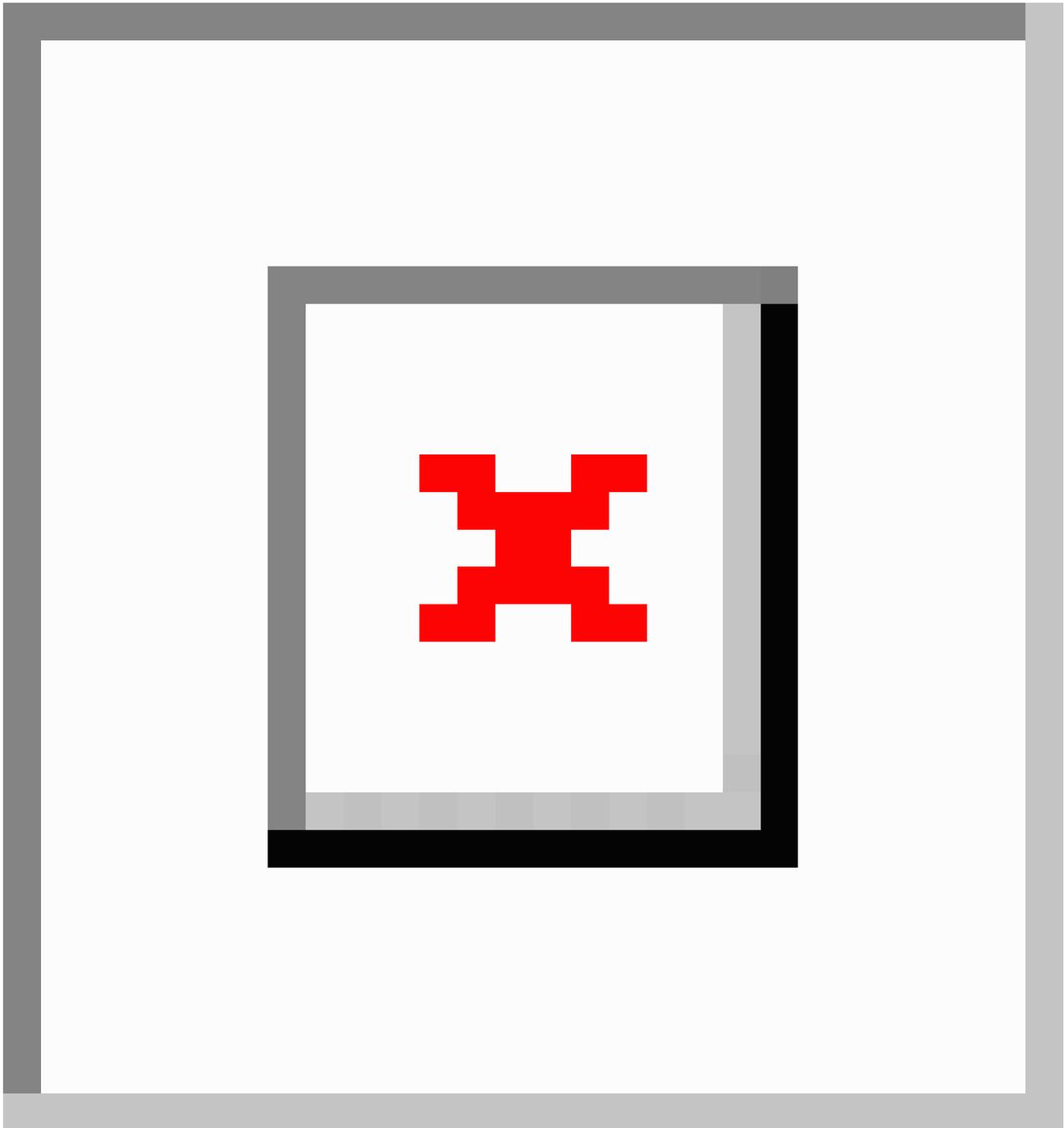


Figure 5. SMS before and after planned activity: "Remember Ball game, football/handball at 17:50 (second SMS from below)," "Did you do the activity Ball game, football/handball?" "If so, you can confirm it by following the link [unique URL]" (first SMS from below).



Figure 6. Mobile page for confirming the completed activity. Questions about the intensity of the activity, actual duration of the activity, and free text comment field (left image). The intensity of the activity according to Borg's scale (right image).

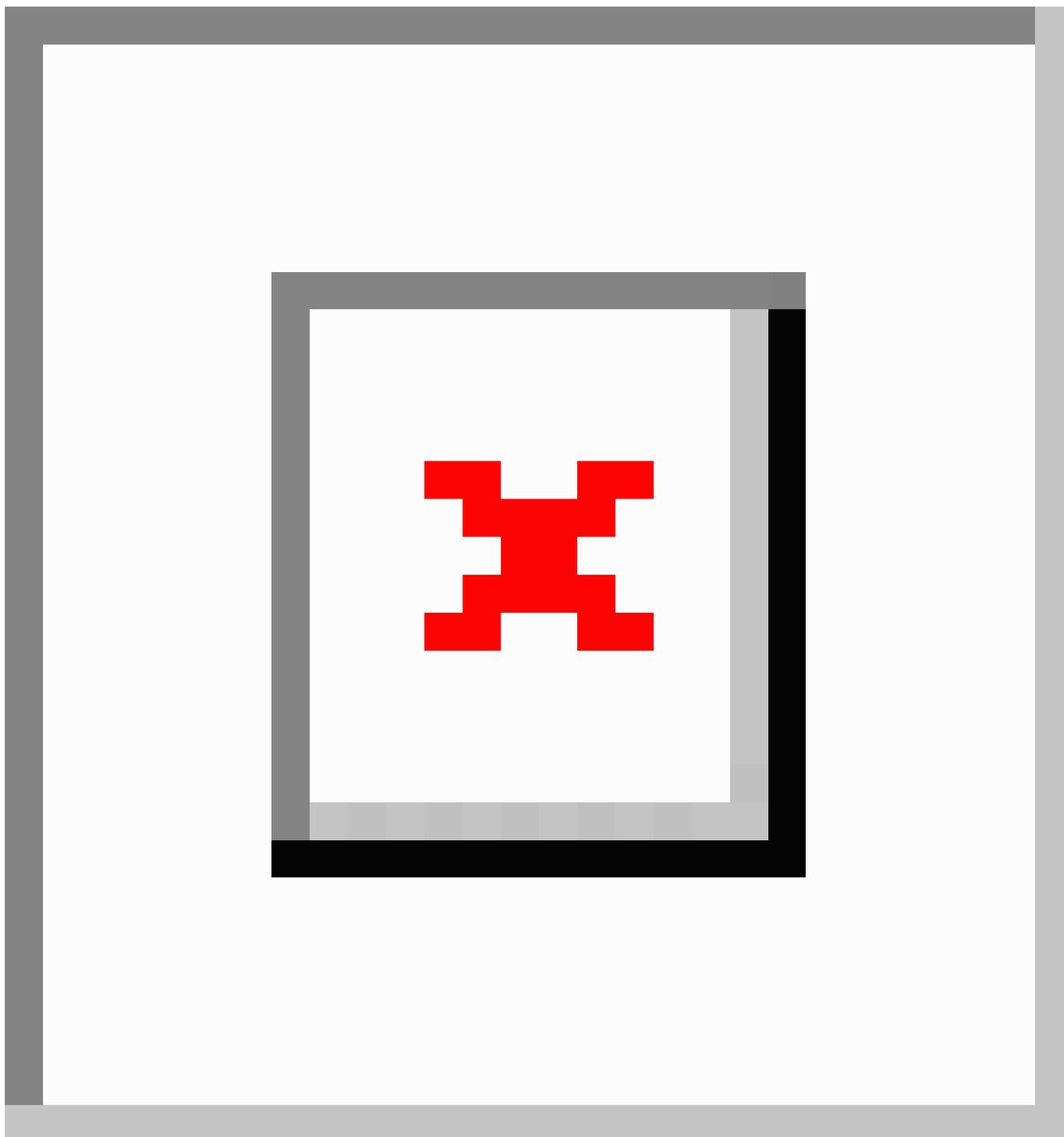


Discussion Forum

The discussion forum is a standard discussion forum with three levels of access (Figure 7 shows the forum). The first one is only accessible to all the registered users of the website. The

second level is for discussions that are only accessible by users that belong to the same monthly group. The third level of access is reserved for the administrators and the health professionals that can access all the discussions to moderate and give professional advice and motivation.

Figure 7. The discussion forum.



General Information

The health professionals involved in the project have developed and posted on the site general information regarding physical activity and training, cardiovascular disease, diabetes, lung problems, cholesterol, smoking cessation, and other topics that are relevant for the users. There is also information regarding motivation, self-management, and lifestyle change that are closely related to the concepts the intervention is built upon.

The information is accessible to all the visitors of the website, reflecting requests from participants of the rehabilitation program. It is a reliable and verified resource.

The users can seek assistance in navigating the website by calling a physiotherapist responsible for it, during working hours. For technical issues, they can complete an Internet-based form and submit their comment or problem. When possible, they receive a response within three working days.

Additional Functionality for Intervention Group

Some additional functionality is available only for the members of the intervention group of the randomized controlled trial [58]. On the profile page, those users can see their weekly activity goals. The users set the weekly goals on a new page as minutes of activity in two categories: (1) high intensity, and (2) moderate intensity. The users receive feedback regarding the level of activity in comparison to the suggestions by the American College of Sports Medicine that are much in line with the suggestions from the Norwegian Directorate of Health [59]. The feedback is offered as advice and the user can proceed even without complying with the suggestions, this is to reflect the individual needs and exercise capacity of the user and the focus on self-management. The goals appear on the side of the profile page and are accompanied by feedback related to the planned activity and how it compares to the set weekly goals. Related to the achievement of the goals, is the graph that appears on the profile page. In a simple feedback graph, the user appears as a figure on a ladder with 5 steps and, according to completed activities, the figure is on one of the 5 steps (Figure 2). The figure on the top of the ladder represents the successful completion of the weekly goals, and it appears to be in a more cheerful position than when on the base of the ladder. The figure is different for male and female users. On the side of the profile the user can find certain strategies to increase physical activity or overcome barriers (depending on the stage of change of the user), and their most important reasons to be more physically active, again chosen by the user. The strategies and the reasons appear only for users in specific stages and the users have either chosen them from a list of suggestions or written them by themselves.

Tailoring Algorithm

Stages of Change

As the first step in tailoring, the participants' stage of change is assessed using the URICA-E2 [39]. In the next step, they follow different paths depending on stage.

Precontemplation

The participant is given immediate feedback on the current stage, and is then asked whether they would like to test their knowledge about physical activity. If yes, a quiz on benefits of physical activity is given, followed by the results. Then the participant is presented with a RFQ [41]. Depending on classification, the participant will be sent either prevention- or promotion-framed SMS messages concerning physical activity over the next two weeks (see Multimedia Appendix 2). After two weeks the participant is reassessed for stage of change.

Contemplation

The participant is given immediate feedback on the current stage, and is then presented with a decisional balance questionnaire [47]. Afterwards, the participant is presented with immediate feedback according to whether they perceive more pros or cons regarding regular physical activity. Next, the participant is presented with a list of potential reasons for becoming more physically active, and asked to tick off the relevant ones, before being asked to add some more in free text. This list is displayed on "My Page." The participant is then

asked if they want to plan their physical activity. If yes, they are presented with the "Exercise Agenda." There, they can add several entries by planning what kind of activity, when, and where for each entry, thus forming an implementation intention. After completing planning, they will be assessed for self-efficacy for this action plan. If it is very low, the user will be asked to revise the action plan to make it more realistic, while if it is moderately low, they will receive SMS messages concerning self-efficacy for action over the next two weeks. If the participant declines planning, they will be led to "My Page." All participants will be reassessed for stage again in two weeks.

Preparation

The participant is given immediate feedback on the current stage, and then self-efficacy for their action is assessed. The participant is asked to identify potential barriers and to generate strategies to address them. These strategies are then listed on "My Page." Next, social support is assessed and immediate feedback is given. Then, the participant is asked to plan physical activity in the activity calendar. Over the next two weeks the participant will receive SMS messages about self-efficacy and/or social support, depending on the above assessment, before stage is reassessed (see Multimedia Appendix 2).

Action

The participant is given immediate feedback on the current stage, and then self-efficacy for maintenance is assessed. The participant is asked to identify potential barriers and to generate strategies to meet them. The strategies are then listed on "My Page." The participant is also asked if they want to update their activity calendar. After planning activities, they are asked about self-efficacy for this plan. Over the next two weeks SMS messages about maintenance are sent to those who were low on self-efficacy for this, and then stage is reassessed.

Maintenance

The participant is given immediate feedback on the current stage, and then self-efficacy for relapse is assessed. The participant is asked to identify potential barriers and to generate strategies to meet them. The strategies are then listed on "My Page." The participant is then asked if they want to update their activity calendar. After planning activities, they are asked about self-efficacy for this plan. Over the next month SMS messages about relapse prevention are sent to those who were low on self-efficacy for this, and then stage is reassessed.

Discussion

Communication Design

The communication design of a website is an essential component of the intervention. There are several factors that have to be considered in relation to the target group and the communication channel that is going to be used, such as font style and size, balanced use of graphics and text, and intuitive structure and navigation menus [60,61]. Building credibility also has great potential; since it seems that it affects the confidence in one's thoughts, health behavior, and cognition [62]. This can be effectively done with visual and design cues [63], and for our intervention this was applied with the right

choice of communication design elements like template, colors, fonts, and of course the logos of the organizations.

Theoretical Implications

In this paper, we describe how we developed an intervention in which the existence of each of its functionality elements is grounded on both user input and theoretical constructs. Of course, the health behavior models that we used to create the theoretical framework were developed based on research of human behavior, which to a certain extent qualifies for user input. It was expected that those concepts about human behavior would be reproducible and would reappear in our focus group.

An example of the reflection of theory in the focus group appears in the themes of *planning* and *motivation*. According to the HAPA, there is a distinction between action planning and coping planning [49,50]. The participants of the focus group were clearly concerned in a different way about planning an activity, compared to preparing to cope with the barriers of physical activity once they completed their rehabilitation stay. It seemed that both are necessary, but prioritization and motivation are needed to make sure each participant will be ready to overcome any difficulties.

Another example of integration is concerning relapse prevention [64,65]. The focus group confirmed its relevance for the case of physical activity. The participants mentioned that after a health problem, like back pain, they might backslide and find it difficult to start physical activity again. For that reason, they would like to get support in dealing with such feelings as disappointment, sadness, and being a loser, in order to recover. Also, the relationship of the social support with the relapse prevention, as seen in the focus group, is coherent to the previous findings that indicated that social support is related to the resistance of relapse into physical inactivity in men [65].

Whereas the stage-based models that we applied may carry some merit for creating tailoring algorithms, they are not sufficient in accounting for all the determinants of physical activity [38]. Within health promotion, more ecological models [66] are used, including factors from within the individual, via the closest network, community to societal regulations, and resources. Although more inclusive, these kinds of models raise a number of methodological and logistical challenges [66]. Some, such as the purely Internet-based, might be even more difficult to tackle, while others might benefit from the improved trackability of an Internet-based intervention. A somewhat more limited ecological model that would fit well to our existing variables, while including more of the social ones, is the social cognitive theory [67]. Whereas self-efficacy is the most important variable in the social cognitive theory, social variables play several important roles—they influence our expectations about outcomes, self-efficacy, and they constitute direct facilitators as well as impediments for behavior. Thus, in a temporal perspective, social variables are important throughout the stages of behavioral change.

Nevertheless, as we add more variables to our models, we should be careful to measure our proposed mediators to make sure that we are actually intervening according to our proposed theoretical framework [68]. By gathering data on the relevant processes hypothesized to take place, not only can we further develop our interventions, but our theories as well [69]. We therefore aimed to design the randomized controlled trial of the current intervention [58] so that in addition to being able to conclude whether the intervention was effective or not, we will know something about what works and why. Ideally, we believe, the design of the intervention and the design of the trial should go hand in hand.

Acknowledgments

We thank Hanne Hoas for her very important contribution in the focus group, the design of the intervention, and the realization of the project. Håvard Pedersen for the contribution in the focus group, and Trine Hansen for the transcription. Special thanks to all the personnel of Skibotn Rehabilitering for their cooperation, their useful comments, and their support in running the intervention, and of course to all the participants of the focus groups for their time and useful feedback. The project is fully funded by a PhD grant of the Northern Norway Regional Health Authority (Helse Nord RHF, ID 3342/HST986-10). The Open Access Fund of the UiT The Arctic University of Norway supports this publication.

Authors' Contributions

KA and SCW participated in the design of the intervention as well as the study, analysis of data, and drafted the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

The authors have participated in the design of the interventions mentioned in the manuscript.

Multimedia Appendix 1

Interactive thematic map of the focus group themes and subthemes.

[\[ZIP File \(Zip Archive\), 139KB-Multimedia Appendix 1\]](#)

Multimedia Appendix 2

Video presenting an example of the tailoring algorithm.

[[MOV File](#), [12MB-Multimedia Appendix 2](#)]

References

1. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012 Dec 15;380(9859):2224-2260. [doi: [10.1016/S0140-6736\(12\)61766-8](https://doi.org/10.1016/S0140-6736(12)61766-8)] [Medline: [23245609](https://pubmed.ncbi.nlm.nih.gov/23245609/)]
2. Illman J. WHO's plan to police health websites rejected. *BMJ* 2000 Nov 25;321(7272):1308-1308. [doi: [10.1136/bmj.321.7272.1308/b](https://doi.org/10.1136/bmj.321.7272.1308/b)]
3. Omboni S, Gazzola T, Carabelli G, Parati G. Clinical usefulness and cost effectiveness of home blood pressure telemonitoring: Meta-analysis of randomized controlled studies. *J Hypertens* 2013 Mar;31(3):455-467. [doi: [10.1097/HJH.0b013e32835ca8dd](https://doi.org/10.1097/HJH.0b013e32835ca8dd)] [Medline: [23299557](https://pubmed.ncbi.nlm.nih.gov/23299557/)]
4. Samoocha D, Bruinvels DJ, Elbers NA, Anema JR, van der Beek AJ. Effectiveness of web-based interventions on patient empowerment: A systematic review and meta-analysis. *J Med Internet Res* 2010 Jun;12(2):e23 [FREE Full text] [doi: [10.2196/jmir.1286](https://doi.org/10.2196/jmir.1286)] [Medline: [20581001](https://pubmed.ncbi.nlm.nih.gov/20581001/)]
5. Murray E, Burns J, See TS, Lai R, Nazareth I. Interactive Health Communication Applications for people with chronic disease. *Cochrane Database Syst Rev* 2005(4):CD004274. [doi: [10.1002/14651858.CD004274.pub4](https://doi.org/10.1002/14651858.CD004274.pub4)] [Medline: [16235356](https://pubmed.ncbi.nlm.nih.gov/16235356/)]
6. Jackson CL, Bolen S, Brancati FL, Batts-Turner ML, Gary TL. A systematic review of interactive computer-assisted technology in diabetes care. *Interactive information technology in diabetes care. J Gen Intern Med* 2006 Feb;21(2):105-110 [FREE Full text] [doi: [10.1111/j.1525-1497.2005.00310.x](https://doi.org/10.1111/j.1525-1497.2005.00310.x)] [Medline: [16390512](https://pubmed.ncbi.nlm.nih.gov/16390512/)]
7. Fanning J, Mullen SP, McAuley E. Increasing physical activity with mobile devices: A meta-analysis. *J Med Internet Res* 2012;14(6):e161 [FREE Full text] [doi: [10.2196/jmir.2171](https://doi.org/10.2196/jmir.2171)] [Medline: [23171838](https://pubmed.ncbi.nlm.nih.gov/23171838/)]
8. Lau PW, Lau EY, Wong del P, Ransdell L. A systematic review of information and communication technology-based interventions for promoting physical activity behavior change in children and adolescents. *J Med Internet Res* 2011;13(3):e48 [FREE Full text] [doi: [10.2196/jmir.1533](https://doi.org/10.2196/jmir.1533)] [Medline: [21749967](https://pubmed.ncbi.nlm.nih.gov/21749967/)]
9. McLean S, Nurmatov U, Liu JL, Pagliari C, Car J, Sheikh A. Telehealthcare for chronic obstructive pulmonary disease: Cochrane Review and meta-analysis. *Br J Gen Pract* 2012 Nov;62(604):e739-e749. [doi: [10.3399/bjgp12X658269](https://doi.org/10.3399/bjgp12X658269)] [Medline: [23211177](https://pubmed.ncbi.nlm.nih.gov/23211177/)]
10. Laplante C, Peng W. A systematic review of e-health interventions for physical activity: An analysis of study design, intervention characteristics, and outcomes. *Telemed J E Health* 2011 Sep;17(7):509-523. [doi: [10.1089/tmj.2011.0013](https://doi.org/10.1089/tmj.2011.0013)] [Medline: [21718092](https://pubmed.ncbi.nlm.nih.gov/21718092/)]
11. Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP, Gonder-Frederick LA. A behavior change model for Internet interventions. *Ann Behav Med* 2009 Aug;38(1):18-27 [FREE Full text] [doi: [10.1007/s12160-009-9133-4](https://doi.org/10.1007/s12160-009-9133-4)] [Medline: [19802647](https://pubmed.ncbi.nlm.nih.gov/19802647/)]
12. Murray E. Web-based interventions for behavior change and self-management: Potential, pitfalls, and progress. *Med* 2012 Aug 14;1(2):e3 [FREE Full text] [doi: [10.2196/med20.1741](https://doi.org/10.2196/med20.1741)]
13. Neville LM, O'Hara B, Milat A. Computer-tailored physical activity behavior change interventions targeting adults: A systematic review. *Int J Behav Nutr Phys Act* 2009;6:30 [FREE Full text] [doi: [10.1186/1479-5868-6-30](https://doi.org/10.1186/1479-5868-6-30)] [Medline: [19490649](https://pubmed.ncbi.nlm.nih.gov/19490649/)]
14. Revere D, Dunbar PJ. Review of computer-generated outpatient health behavior interventions: Clinical encounters "in absentia". *J Am Med Inform Assoc* 2001;8(1):62-79 [FREE Full text] [Medline: [11141513](https://pubmed.ncbi.nlm.nih.gov/11141513/)]
15. Kelders SM, Kok RN, Ossebaard HC, Van Gemert-Pijnen JE. Persuasive system design does matter: A systematic review of adherence to web-based interventions. *J Med Internet Res* 2012;14(6):e152 [FREE Full text] [doi: [10.2196/jmir.2104](https://doi.org/10.2196/jmir.2104)] [Medline: [23151820](https://pubmed.ncbi.nlm.nih.gov/23151820/)]
16. Strecher VJ, Shiffman S, West R. Moderators and mediators of a web-based computer-tailored smoking cessation program among nicotine patch users. *Nicotine Tob Res* 2006 Dec;8 Suppl 1:S95-101. [Medline: [17491176](https://pubmed.ncbi.nlm.nih.gov/17491176/)]
17. Brug J, Steenhuis I, van Assema P, Glanz K, De Vries H. Computer-tailored nutrition education: Differences between two interventions. *Health Educ Res* 1999 Apr;14(2):249-256 [FREE Full text] [Medline: [10387504](https://pubmed.ncbi.nlm.nih.gov/10387504/)]
18. Dijkstra A. Working mechanisms of computer-tailored health education: Evidence from smoking cessation. *Health Educ Res* 2005 Oct;20(5):527-539 [FREE Full text] [doi: [10.1093/her/cyh014](https://doi.org/10.1093/her/cyh014)] [Medline: [15701665](https://pubmed.ncbi.nlm.nih.gov/15701665/)]
19. Brug J, Campbell M, van Assema P. The application and impact of computer-generated personalized nutrition education: A review of the literature. *Patient Educ Couns* 1999 Feb;36(2):145-156. [Medline: [10223019](https://pubmed.ncbi.nlm.nih.gov/10223019/)]
20. Campbell MK, DeVellis BM, Strecher VJ, Ammerman AS, DeVellis RF, Sandler RS. Improving dietary behavior: The effectiveness of tailored messages in primary care settings. *Am J Public Health* 1994 May;84(5):783-787. [Medline: [8179049](https://pubmed.ncbi.nlm.nih.gov/8179049/)]
21. de Nooijer J, Lechner L, de Vries H. Tailored versus general information on early detection of cancer: A comparison of the reactions of Dutch adults and the impact on attitudes and behaviors. *Health Educ Res* 2002 Apr;17(2):239-252 [FREE Full text] [Medline: [12036238](https://pubmed.ncbi.nlm.nih.gov/12036238/)]

22. Oenema A, Brug J, Lechner L. Web-based tailored nutrition education: Results of a randomized controlled trial. *Health Educ Res* 2001 Dec;16(6):647-660 [FREE Full text] [Medline: [11780705](#)]
23. Webb MS, Simmons VN, Brandon TH. Tailored interventions for motivating smoking cessation: Using placebo tailoring to examine the influence of expectancies and personalization. *Health Psychol* 2005 Mar;24(2):179-188. [doi: [10.1037/0278-6133.24.2.179](#)] [Medline: [15755232](#)]
24. Webb MS, Hendricks PS, Brandon TH. Expectancy priming of smoking cessation messages enhances the placebo effect of tailored interventions. *Health Psychol* 2007 Sep;26(5):598-609. [doi: [10.1037/0278-6133.26.5.598](#)] [Medline: [17845111](#)]
25. Kreuter MW, Holt CL. How do people process health information? Applications in an age of individualized communication. *Current Directions in Psychol Sci* 2001 Dec;10(6):206-209. [doi: [10.1111/1467-8721.00150](#)]
26. Schwarzer R. Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology* 2008 Jan;57(1):1-29. [doi: [10.1111/j.1464-0597.2007.00325.x](#)]
27. Velicer WF, Prochaska JO. Stage and non-stage theories of behavior and behavior change: A comment on Schwarzer. *Applied Psychology* 2008 Jan;57(1):75-83. [doi: [10.1111/j.1464-0597.2007.00327.x](#)]
28. Sheeran P. Intention-behavior relations: A conceptual and empirical review. In: Stroebe W, Hewstone M, editors. *European review of social psychology*. Chichester, UK: John Wiley & Sons, Ltd; 2005:1-36.
29. Miller WR, Rollnick S. *Motivational interviewing, third edition: Helping people change (applications of motivational interviewing)*. New York, NY: The Guilford Press; 2012.
30. Martins RK, McNeil DW. Review of motivational interviewing in promoting health behaviors. *Clin Psychol Rev* 2009 Jun;29(4):283-293. [doi: [10.1016/j.cpr.2009.02.001](#)] [Medline: [19328605](#)]
31. Lundahl BW, Kunz C, Brownell C, Tollefson D, Burke BL. A meta-analysis of motivational interviewing: Twenty-five years of empirical studies. *Research on Social Work Practice* 2010 Jan 11;20(2):137-160. [doi: [10.1177/1049731509347850](#)]
32. Hardcastle SJ, Taylor AH, Bailey MP, Harley RA, Hagger MS. Effectiveness of a motivational interviewing intervention on weight loss, physical activity and cardiovascular disease risk factors: A randomised controlled trial with a 12-month post-intervention follow-up. *Int J Behav Nutr Phys Act* 2013;10:40 [FREE Full text] [doi: [10.1186/1479-5868-10-40](#)] [Medline: [23537492](#)]
33. Hardcastle S, Taylor A, Bailey M, Castle R. A randomised controlled trial on the effectiveness of a primary health care based counselling intervention on physical activity, diet, and CHD risk factors. *Patient Educ Couns* 2008 Jan;70(1):31-39. [doi: [10.1016/j.pec.2007.09.014](#)] [Medline: [17997263](#)]
34. Hardcastle S, Hagger MS. "You can't do it on your own": Experiences of a motivational interviewing intervention on physical activity and dietary behaviour. *Psychology of Sport and Exercise* 2011 Jun;12(3):314-323. [doi: [10.1016/j.psychsport.2011.01.001](#)]
35. Hardcastle S, Blake N, Hagger MS. The effectiveness of a motivational interviewing primary-care based intervention on physical activity and predictors of change in a disadvantaged community. *J Behav Med* 2012 Jun;35(3):318-333. [doi: [10.1007/s10865-012-9417-1](#)] [Medline: [22476812](#)]
36. Noar SM, Benac CN, Harris MS. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychol Bull* 2007 Jul;133(4):673-693. [doi: [10.1037/0033-2909.133.4.673](#)] [Medline: [17592961](#)]
37. Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. *Am J Health Promot* 1997;12(1):38-48. [Medline: [10170434](#)]
38. Adams J, White M. Why don't stage-based activity promotion interventions work? *Health Educ Res* 2005 Apr;20(2):237-243 [FREE Full text] [doi: [10.1093/her/cyg105](#)] [Medline: [15253998](#)]
39. Marcus BH, Selby VC, Niaura RS, Rossi JS. Self-efficacy and the stages of exercise behavior change. *Res Q Exerc Sport* 1992 Mar;63(1):60-66. [Medline: [1574662](#)]
40. Higgins ET. Beyond pleasure and pain. *Am Psychol* 1997 Dec;52(12):1280-1300. [Medline: [9414606](#)]
41. Higgins ET, Friedman RS, Harlow RE, Idson LC, Ayduk ON, Taylor A. Achievement orientations from subjective histories of success: Promotion pride versus prevention pride. *Eur. J. Soc. Psychol* 2001 Jan;31(1):3-23. [doi: [10.1002/ejsp.27](#)]
42. Bandura A. Self-efficacy mechanism in human agency. *American Psychologist* 1982 Apr 22;37(2):122-147. [doi: [10.1037/0003-066X.37.2.122](#)]
43. Gollwitzer PM. Implementation intentions: Strong effects of simple plans. *American Psychologist* 1999;54(7):493-503. [doi: [10.1037/0003-066X.54.7.493](#)]
44. Latimer AE, Rivers SE, Rench TA, Katulak NA, Hicks A, Hodorowski JK, et al. A field experiment testing the utility of regulatory fit messages for promoting physical activity. *J Exp Soc Psychol* 2008 May;44(3):826-832 [FREE Full text] [doi: [10.1016/j.jesp.2007.07.013](#)] [Medline: [19543443](#)]
45. Latimer AE, Williams-Piehot P, Katulak NA, Cox A, Mowad L, Higgins ET, et al. Promoting fruit and vegetable intake through messages tailored to individual differences in regulatory focus. *Ann Behav Med* 2008 Jun;35(3):363-369 [FREE Full text] [doi: [10.1007/s12160-008-9039-6](#)] [Medline: [18670833](#)]
46. Prochaska JO, Velicer WF, Rossi JS, Goldstein MG, Marcus BH, Rakowski W, et al. Stages of change and decisional balance for 12 problem behaviors. *Health Psychol* 1994 Jan;13(1):39-46. [Medline: [8168470](#)]
47. Cancer Prevention Research Center. Exercise: Decisional balance cancer prevention research center URL: <http://www.uri.edu/research/cprc/Measures/Exercise05.htm> [accessed 2013-04-10] [WebCite Cache ID 6Fm8T31qY]

48. Schwarzer R. Self-efficacy in the adoption maintenance of health behaviors: Theoretical approaches a new model. In: Schwarzer R, editor. *Self-efficacy: Thought control of action*. Washington, DC: Hemisphere; 1992:217-242.
49. Sniehotta FF, Scholz U, Schwarzer R. Action plans and coping plans for physical exercise: A longitudinal intervention study in cardiac rehabilitation. *Br J Health Psychol* 2006 Feb;11(Pt 1):23-37. [doi: [10.1348/135910705X43804](https://doi.org/10.1348/135910705X43804)] [Medline: [16480553](https://pubmed.ncbi.nlm.nih.gov/16480553/)]
50. Sniehotta FF, Schwarzer R, Scholz U, Schütz B. Action planning and coping planning for long-term lifestyle change: Theory and assessment. *Eur. J. Soc. Psychol* 2005 Jul;35(4):565-576. [doi: [10.1002/ejsp.258](https://doi.org/10.1002/ejsp.258)]
51. Terry DJ, O'Leary JE. The theory of planned behaviour: The effects of perceived behavioural control and self-efficacy. *Br J Soc Psychol* 1995 Jun;34 (Pt 2):199-220. [Medline: [7620846](https://pubmed.ncbi.nlm.nih.gov/7620846/)]
52. Trafimow D, Sheeran P, Conner M, Finlay KA. Evidence that perceived behavioural control is a multidimensional construct: Perceived control and perceived difficulty. *Br J Soc Psychol* 2002 Mar;41(Pt 1):101-121. [Medline: [11970777](https://pubmed.ncbi.nlm.nih.gov/11970777/)]
53. Barrera M. Distinctions between social support concepts, measures, and models. *Am J Commun Psychol* 1986 Aug;14(4):413-445. [doi: [10.1007/BF00922627](https://doi.org/10.1007/BF00922627)]
54. Wagner J, Burg M, Sirois B. Social support and the transtheoretical model: Relationship of social support to smoking cessation stage, decisional balance, process use, and temptation. *Addict Behav* 2004 Jul;29(5):1039-1043. [doi: [10.1016/j.addbeh.2004.02.058](https://doi.org/10.1016/j.addbeh.2004.02.058)] [Medline: [15219355](https://pubmed.ncbi.nlm.nih.gov/15219355/)]
55. Marlatt GA, George WH. Relapse prevention: Introduction and overview of the model. *Br J Addict* 1984 Sep;79(3):261-273. [Medline: [6595020](https://pubmed.ncbi.nlm.nih.gov/6595020/)]
56. Hajek P, Stead LF, West R, Jarvis M, Hartmann-Boyce J, Lancaster T. Relapse prevention interventions for smoking cessation. *Cochrane Database Syst Rev* 2013;8:CD003999. [doi: [10.1002/14651858.CD003999.pub4](https://doi.org/10.1002/14651858.CD003999.pub4)] [Medline: [23963584](https://pubmed.ncbi.nlm.nih.gov/23963584/)]
57. Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 1982;14(5):377-381. [Medline: [7154893](https://pubmed.ncbi.nlm.nih.gov/7154893/)]
58. Antypas K, Wangberg SC. E-Rehabilitation - an Internet and mobile phone based tailored intervention to enhance self-management of cardiovascular disease: Study protocol for a randomized controlled trial. *BMC Cardiovasc Disord* 2012;12:50 [FREE Full text] [doi: [10.1186/1471-2261-12-50](https://doi.org/10.1186/1471-2261-12-50)] [Medline: [22776554](https://pubmed.ncbi.nlm.nih.gov/22776554/)]
59. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, American College of Sports Medicine. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Med Sci Sports Exerc* 2011 Jul;43(7):1334-1359. [doi: [10.1249/MSS.0b013e318213fefb](https://doi.org/10.1249/MSS.0b013e318213fefb)] [Medline: [21694556](https://pubmed.ncbi.nlm.nih.gov/21694556/)]
60. Stevens VJ, Funk KL, Brantley PJ, Erlinger TP, Myers VH, Champagne CM, et al. Design and implementation of an interactive website to support long-term maintenance of weight loss. *J Med Internet Res* 2008;10(1):e1 [FREE Full text] [doi: [10.2196/jmir.931](https://doi.org/10.2196/jmir.931)] [Medline: [18244892](https://pubmed.ncbi.nlm.nih.gov/18244892/)]
61. van Weert JC, van Noort G, Bol N, van Dijk L, Tates K, Jansen J. Tailored information for cancer patients on the Internet: Effects of visual cues and language complexity on information recall and satisfaction. *Patient Educ Couns* 2011 Sep;84(3):368-378. [doi: [10.1016/j.pec.2011.04.006](https://doi.org/10.1016/j.pec.2011.04.006)] [Medline: [21550757](https://pubmed.ncbi.nlm.nih.gov/21550757/)]
62. Lehto T, Oinas-Kukkonen H. Persuasive features in web-based alcohol and smoking interventions: A systematic review of the literature. *J Med Internet Res* 2011;13(3):e46 [FREE Full text] [doi: [10.2196/jmir.1559](https://doi.org/10.2196/jmir.1559)] [Medline: [21795238](https://pubmed.ncbi.nlm.nih.gov/21795238/)]
63. Harris PR, Sillence E, Briggs P. The effect of credibility-related design cues on responses to a web-based message about the breast cancer risks from alcohol: Randomized controlled trial. *J Med Internet Res* 2009;11(3):e37 [FREE Full text] [doi: [10.2196/jmir.1097](https://doi.org/10.2196/jmir.1097)] [Medline: [19709989](https://pubmed.ncbi.nlm.nih.gov/19709989/)]
64. Irvin JE, Bowers CA, Dunn ME, Wang MC. Efficacy of relapse prevention: A meta-analytic review. *J Consult Clin Psychol* 1999 Aug;67(4):563-570. [Medline: [10450627](https://pubmed.ncbi.nlm.nih.gov/10450627/)]
65. Kahn EB, Ramsey LT, Brownson RC, Heath GW, Howze EH, Powell KE, et al. The effectiveness of interventions to increase physical activity. A systematic review. *Am J Prev Med* 2002 May;22(4 Suppl):73-107. [Medline: [11985936](https://pubmed.ncbi.nlm.nih.gov/11985936/)]
66. Glanz K, Rimer BK, Viswanath K. Health behavior and health education: theory, research, and practice. San Francisco: Jossey-Bass; 2008. Ecological models of health behavior URL: [http://www.sanjeshp.ir/phd_91/Pages/References/health%20education%20and%20promotion/\[Karen Glanz, Barbara K. Rimer, K. Viswanath\] Heal\(BookFi.or.pdf](http://www.sanjeshp.ir/phd_91/Pages/References/health%20education%20and%20promotion/[Karen%20Glanz,%20Barbara%20K.%20Rimer,%20K.%20Viswanath]_Heal(BookFi.or.pdf) [accessed 2013-12-31] [WebCite Cache ID 6MHgqSYL2]
67. Bandura A. Health promotion from the perspective of social cognitive theory. *Psychology & Health* 1998 Jul;13(4):623-649. [doi: [10.1080/08870449808407422](https://doi.org/10.1080/08870449808407422)]
68. Baranowski T, Anderson C, Carmack C. Mediating variable framework in physical activity interventions. How are we doing? How might we do better? *Am J Prev Med* 1998 Nov;15(4):266-297. [Medline: [9838973](https://pubmed.ncbi.nlm.nih.gov/9838973/)]
69. Rothman AJ. "Is there nothing more practical than a good theory?": Why innovations and advances in health behavior change will arise if interventions are used to test and refine theory. *Int J Behav Nutr Phys Act* 2004 Jul 27;1(1):11 [FREE Full text] [doi: [10.1186/1479-5868-1-11](https://doi.org/10.1186/1479-5868-1-11)] [Medline: [15279674](https://pubmed.ncbi.nlm.nih.gov/15279674/)]

Abbreviations

- HAPA:** Health Action Process Approach
RFQ: Regulatory Focus Questionnaire

SMS: short message service

TTM: Transtheoretical model

URICA-E2: University of Rhode Island Change Assessment – Exercise 2

Edited by G Eysenbach; submitted 22.05.13; peer-reviewed by E Brindal, J Carreine, D Cianflone, S Fraser, R Schwarzer, H Oh; comments to author 14.06.13; revised version received 02.10.13; accepted 27.10.13; published 10.01.14

Please cite as:

Antypas K, Wangberg SC

Combining Users' Needs With Health Behavior Models in Designing an Internet- and Mobile-Based Intervention for Physical Activity in Cardiac Rehabilitation

JMIR Res Protoc 2014;3(1):e4

URL: <http://www.researchprotocols.org/2014/1/e4/>

doi: [10.2196/resprot.2725](https://doi.org/10.2196/resprot.2725)

PMID: [24413185](https://pubmed.ncbi.nlm.nih.gov/24413185/)

©Konstantinos Antypas, Silje C Wangberg. Originally published in JMIR Research Protocols (<http://www.researchprotocols.org>), 10.01.2014. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Research Protocols, is properly cited. The complete bibliographic information, a link to the original publication on <http://www.researchprotocols.org>, as well as this copyright and license information must be included.