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A Multi-Method Pilot Evaluation of An Online Diabetes Exercise System

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Abstract. The American Diabetes Association and The European Association of The Study of Diabetes recommend people with Type 2 diabetes to do moderate to vigorous aerobic exercise for 150 min per week to avoid late diabetic complications. However, most people with diabetes do not follow the recommendation. Consumer health information technology (CHIT) might play a role in supporting behavior changes that promote health and well-being. A CHIT prototype of an online diabetes exercise system, which contained the newest research of low volume high-intensity interval training (HIT), was developed. To test the system we used a multi-method pilot evaluation that includes; interviews, paper prototyping, heuristic evaluation, and test with patients. The patients expressed satisfaction with HIT and appreciated that the system was web-based. The findings from this pilot study inspire to further development and evaluation of online CHIT systems to diabetics.

Keywords. Diabetes, usability, evaluation methodologies, exercise therapy

Introduction

Type 2 diabetes is a chronic disease mainly caused by inactivity and overweight and often leads to late diabetic complications [1]. The most frequent complications are retinopathy, neuropathy, cardiovascular disease, and problems with wound healing [2]. The complications are expected to become an increasing burden in the future [3, 4].

To avoid this burden, The American Diabetes Association (ADA) and The European Association for The Study of Diabetes (EASD) recommend people with Type 2 diabetes to do at least 150 min/week of moderate to vigorous aerobic exercise [5, 6]. The literature points out that the patients deselect the recommendation because it takes too much time, and is described as unrealistic and unattainable [7-10].

An alternative to the existing recommendation is high-intensity interval training (HIT). Several studies substantiate that HIT prevents insulin resistance, glycaemic instability, diabetic complications, and is timesaving [7-15]. Recently Little and his colleagues have shown that people with diabetes only need to perform 3 minutes warm-up, followed by 10 times 60 seconds cycling bouts eliciting approximately 90% maximal heart rate, interspersed with 60 seconds rest, followed by 2 minutes cool down – in total 25 minutes of low volume HIT 3 times per week [13]. Even though this low volume HIT program might be very effective, it is unclear how the information can be

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used to motivate the patients. The general population's daily use of technology increases. A Danish survey shows that 75% of people between 55-64 years are using the Internet every day or almost every day – especially in relation to a disease [16]. The term *consumer health information technology* (CHIT) defines as computer-based system that facilitates access to information and behaviour changes that promote health and well-being [17]. To our knowledge, the CHIT presented and evaluated in the present study is the first system to implement the newest research about low volume HIT in a web-based system. According to Yu and her colleagues, critical assessment of a web-tool, such as usability, is paramount when designing a motivational system for management of diabetes and related cardiovascular risk factors [18].

In this pilot study, we present a prototype of an online diabetes exercise system designed to motivate people with Type 2 diabetes to do low volume HIT and we describe findings from a multi-method pilot evaluation of the system. The study did not require an approval from the ethical committee to accomplish.

1. Methods

The multi-method pilot evaluation was laid out in four steps: semi-structured interviews, evaluations of the paper prototype, heuristic evaluation with double specialists, and tests with patients [19]. Since the potential users will be Danish speaking people with diabetes, the language of the system was Danish.

1.1. Semi-structured interviews

Three people with Type 2 diabetes, two men and one woman, ages 48-60 years, participated in the initial semi-structured interviews. The purpose of the interviews was to achieve knowledge about the patients' attitude towards the topics: exercise, diabetes, technology, and daily life routines. Based on inputs from the interviews, and a literature search, a paper prototype was implemented [20].

1.2. Evaluation of the paper prototype

Using the thinking aloud technique the three diabetics were asked to use the paper prototype in various scenarios (log in, create an account, start the low volume HIT program, use the glucose diary, log out) [19]. After the evaluations, the prototype was updated in accordance with the evaluation results and was then implemented in an electronic web-based prototype.

1.3. Heuristic evaluation

Five double specialists participated in the heuristic evaluation [22]. Each double specialist had to identify usability issues with the prototype using the 10 heuristics suggested by Nielsen [19]. The heuristics cover problems related to: visibility of the system; match between the system and the real world; user control and freedom; consistency and standards; error preventing; recognition rather than recall; flexibility and efficiency of use; aesthetic and minimalist design; help users recognize, diagnose,

and recover; help and documentation. When identifying a usability issue the double specialists categorized it on a severity scale defined by Nielsen ranging from 1-4 [19]: *1: A cosmetic problem – 2: A minor usability problem - 3: A major usability problem - 4: A usability catastrophe*. The usability issues from the heuristic evaluation were used in a redesign of the system before testing the system with patients.

1.4. Test with patients

The goal of the test with the patients was to collect pros and cons related to the system and hear the users' overall opinion. Each user was asked to perform specific tasks using the system [19]. After finishing the tests, the suggestions from the patients were used in the following redesign of the system. The patients in this test were the same as those who participated in the interviews and the evaluation of the paper prototype.

2. Results

A picture of the evaluated paper prototype and a screenshot of the final user interface of the system, are shown in figure 1. To get access to the functionalities, the online diabetes exercise system requires the patient to be logged in after an account has been created. After logging in, the patient has access to:

- Information about the diabetes exercise program
- Start the low volume high-intensity interval training program
- Add another training program
- Use the blood glucose diary
- Log off from the system

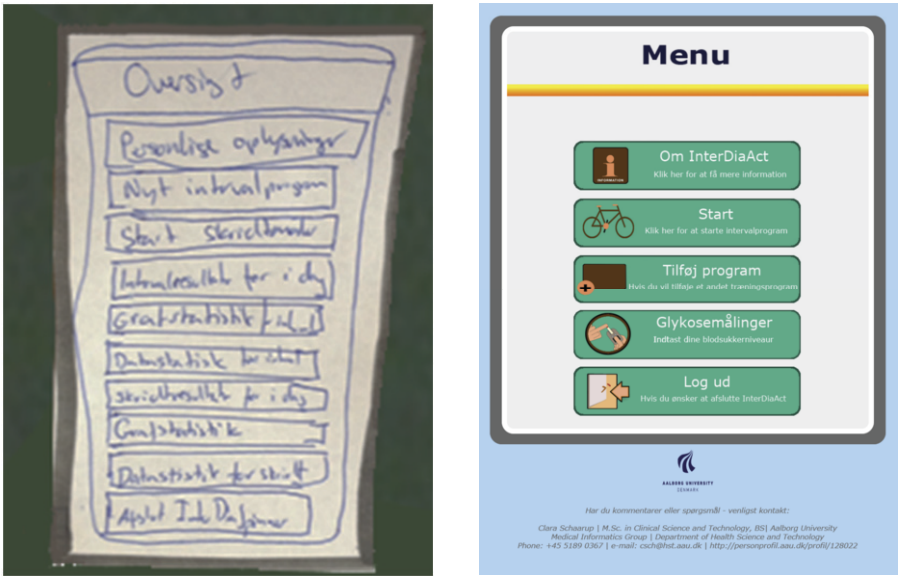

Figure 1. The online diabetes exercise system. To the left – the welcome screen of the paper prototype. To the right - the final user interface of the system, where it is possible to choose between five different actions. Contact information is placed at the bottom of the page.

In the heuristic evaluation, the most denoted heuristics were:

- Heuristic no. 4, *Consistency and standards* referred to 16 times
- Heuristic no. 8, *Aesthetic and minimalist design* referred to 8 times

Findings in the test with the patients showed that they were motivated to do low volume HIT, which they found timesaving as compared to conventional exercise. The patients expressed satisfaction with CHIT and appreciated that the system was web-based. Patients also expressed satisfaction with the digitized blood glucose diary.

3. Discussion

In this study, we used a multi-method pilot evaluation consisting of the four elements: interview, paper prototyping, heuristic evaluation, and tests with users. The use of the multi-method evaluation leads to a prototype of an online diabetes exercise system aimed at motivating the patients to do low volume HIT.

From the results we saw that the most frequently denoted heuristics were heuristic no. 4, Consistency and standards, and heuristic no. 8, Aesthetic and minimalist design - referred to 16 and 8 times, respectively. In the tests with the users, none of them mentioned any problems with the consistency. The users said that it was easy to log on to the system and start the low volume HIT-program. The findings indicate that the different elements in the multi-method evaluation contribute to a holistic way to develop a system.

The first element in the development and evaluation process was the interview, which was used to investigate the patients' experience with exercise and to hear their attitudes towards the recommendation by ADA and EASD. The second element in the process was the paper prototyping. According to Nielsen it is a low cost and easy way to let the users test the early design ideas and thereby remove the most severe usability issues [20]. It should be noted that this step requires the users to have a good imagination of the paper system. The results indicated that the users did understand the conditions related to the paper prototyping. The literature points out that paper prototyping feels like cheating because you don't waste money on implementing a system that does not work [20]. The third element in the process was the heuristic evaluation. We selected five double specialists to conduct the heuristic evaluation [21]. Calculations have shown that it is possible to identify approximately 75% of the total number of usability issues by using five specialists. There is a risk that the specialists focus on unrealistic usability problems when they conduct the heuristic evaluation [20]. Therefore, it is essential to conduct the last element in the multi-method evaluation, the user tests. By conducting these tests it is possible get the users' perspective and conform or disconfirm the usability issues identified by the specialists.

In conclusion, the multi-method pilot evaluation was found to be a holistic approach to developing and evaluating a system. The method was found to be good balance between double specialists' advice and the users' views. Furthermore, it requires a relatively small number of participants. Future work should include testing the system in real life situations.

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