Enabling Older Adults to Exercise at Home with a Tablet: A Usability Study

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Abstract

Background: For older adults physical activity is vital for maintaining their health and their ability to live independently. Home-based programs can help them achieve the recommended exercise frequency. An application for a tablet computer was developed to support older adults in following a personal training. It featured goal setting, tailoring, progress tracking and remote feedback.

Objective: In line with the Medical Research Council Framework, which prescribes thorough testing before evaluating the efficacy with a randomized controlled trial, the aim of the present study was to assess the usability of a tablet-based application that was designed to support older adults in doing exercises at home.

Methods: A total of 15 older adults, ranging from 69 to 99 years old, participated in a usability study that utilized a mixed-method approach. Novice users were asked to complete 11 tasks as they verbalized their ongoing thoughts. The task ranged from looking up information about exercises and executing them to tailoring a weekly exercise schedule. The performance errors and time-on-task were calculated as proxies of effective and efficient usage. Overall satisfaction was assessed with a post-test interview. All responses were analyzed independently by two researchers.

Results: On average the participants spend 45 seconds time-on-task. 94% of the users completed the task with either no help (43%) or after having received one or two hints (51%). During the post-test interview participants made three times more positive remarks about the app, than negative remarks.

Conclusions: The app that was developed to support older adults in doing exercises at home is useable by the target audience. First-time users were able to perform common tasks in an effective and efficient manner. In general, they were satisfied with the app. Tasks that were associated with behavior execution and evaluation were performed with ease. Complex tasks like tailoring a personal training schedule needed more effort. Learning effects, usefulness and long-term satisfaction will be investigated with longitudinal follow-up studies.

Trial registration: NL56094.029.16 / NTR (TC = 5888; registered 03-06-2016)

Keywords: frail elderly; aged; activities of daily living; exercise; health behavior; telemedicine; mobile devices; tablet computers; usability testing
Physical Activity Interventions for Older Adults

Physical activity is vital to a healthy life. A sedentary lifestyle is associated with numerous health-related problems like obesity, diabetes, cardiovascular diseases, various forms of cancer and depression [1,2]. Furthermore, for older adults physical activity can prevent or delay the onset of functional impairments and prolong the ability to live independently [3]. Because of those well-acknowledged health benefits community-based physical activity programs have spawned across the world [4,5]. A prototypical example of such a program that has been running for over 35 years in The Netherlands is More Exercise for Seniors, abbreviated as MBvO in Dutch. Weekly 300.000 older adults exercise in a group under guidance of an instructor. Despite the popularity of this program, however, the effects appear to be insufficient [6]. Studies show a higher frequency and longer exercise duration is needed to capitalize on the health benefits of physical activity [7,8].

To achieve the recommended frequency and duration a home-based exercise program could prove a useful addition to a community-based program: in the convenience of their home, older adults can continue the exercises they have learnt during the weekly community classes. A focus-group study showed that the MBvO-participants believed additional home exercises would be useful, but also had worries about the safety, self-efficacy and adherence to such an intervention [9].

Technology Use

MHealth is increasingly being used to attain elusive health goals. MHealth is defined as the use of mobile devices and wireless technology for medical and health practices [10]. The popularity is reflected by the rate that health-related apps are being developed. In 2017 over 325.000 health apps were available for the general public through the various app stores [11]. Health professionals, policymakers and researchers recognize the opportunity to reach a large audience and have developed technology-enhanced interventions for various target populations and
health outcomes. Also to increase physical activity in older adults [12–16]. In contrast to popular belief that older adults are not inclined to use technology, the ownership of tablet computers amongst older adults is growing rapidly [17–19]. The popularity of tablets stems possibility from its usability. Studies show that due to its large touchscreen, older adults are able operate tablets better than personal computers [20,21] or smartphones [22]. It is not surprising that recent health interventions for older adults choose tablets as the primary mode of delivery [23–27].

**Development of a Tablet-based Intervention**

To increase the physical activity in older adults and capitalize on the potential of mHealth, a technology-enhanced intervention was developed as part of the MOTO-B (Motivating Technology for Older Adults’ Behavior) and VITAMIN (VITal Amsterdam elderly IN the city) projects. The Medical Research Council (MRC) framework was used to guide the development [28,29]. After conducting focus groups with prospective users and building on relevant literature, three design considerations were identified [9,30]. First, physical activity should be supported by functional exercises that can be executed safely within a home environment. Second, to facilitate behavior change the intervention should support self-regulation. Third, a blended approach allows the convenience of a home-based exercise program and the ability to tailor the intervention to individual needs to be combined with the effectiveness of rich feedback and social support.

The three design considerations were implemented with a tablet-based app called VITAMIN that delivered a home-based exercise program. Key components were goal setting, the ability to tailor the program to individual needs, video demonstration of functional exercises, rating of exercises, progress tracking and feedback of a personal coach that could remotely monitor performance. See Mehra et al. [30] for a detailed account of how behavior change principles were translated into the blended intervention.

Prior to evaluating the efficacy of the intervention in term of health outcomes, the feasibility should be assessed. This stage is often overlooked, leading to efficacy studies of interventions that haven’t matured yet and problems that could have been prevented with sufficient pilot testing.
Usability issues is one of the key factors that determine the success of mHealth interventions. Usability is defined as the extent that devices can be operated by users to achieve the specified goals with effectiveness, efficiency and satisfaction in a specified context of use. In line with the MRC framework, the current study was sets out to investigate the usability of the tablet-supported intervention. The aim was to assess whether first-time users could operate the VITAMIN app that was designed to support older adults in doing home-based exercises.

Methods

Study Design
Zapata et al. conducted a systematic review how usability of mHealth applications is being evaluated. The majority of studies use either interviews or questionnaires to investigate usability. These methods rely on self-report of prospective users after having used the device. These methods are suitable to gauge user satisfaction, but in lesser degree effectiveness and efficiency. In contrast, other studies investigate the usability by observing users as they try to complete prescribed tasks on the device. This method is a reliable estimate of effectiveness and efficiency, but not user satisfaction. Combining various methods to evaluate usability is there for the recommended approach, although only a few studies do so.

To investigate the usability of the VITAMIN app, the current study used mixed methods. To evaluate effectiveness and efficiency, user performance was recorded and assessed as they executed tasks in a laboratory setting. To evaluate satisfaction, participants were instructed to ‘think aloud’ during the execution of tasks. This is a common technique used in usability studies where users are requested to verbalize their ongoing thoughts as they execute a task. After performing the tasks, participants were interviewed about the general use.
Participants

Fifteen older adults, 4 men and 11 women, were recruited from local community centers. Their ages varied from 69 to 99 years old, with an average of 77 years (SD = 8,5). The participants signed an informed consent before they participated in the study.

Materials

The VITAMIN app was designed for a 10 inch Android tablet. The main functions of the app were delineated by five distinct tabs:

1. Exercises: a library that contained 16 functional exercises designed by human movement scientist that were devised to be executed in a home setting with ordinary household objects as aids. Each exercise consisted of three versions that varied in difficulty. For each variation a custom made video with a voiceover was shot, 48 in total, that depicted how the exercise could be executed safely (modelling). The video was accompanied by a factsheet that contained background information about the exercise. See Figure 1 and 2.

2. Profile: the possibility to formulate personal goals and an interactive wizard that helped users to set up a weekly schedule with suitable exercises (goal setting & tailoring).

3. Weekly Schedule: an overview with icons depicting which exercises were planned for each day of the week. Users could checkmark exercises that were been performed and see, in a glance, what still had to be done (progress tracking). See Figure 3.

4. Today: contained a reel of exercises that were planned for today. To aid the execution a countdown timer depicted the remaining seconds. Prior to the execution the user could customize each exercise with three parameters: the duration of the exercise, the amount of repetitions of the exercise and the difficulty level. See Figure 4 to 6. After completion of each exercise the user could rate the exercise with three scales on difficulty, effort and fun. See Figure 7.

5. Video Calling: the possibility to video call an appointed coach that could motivate and assist the user from distance (motivational interviewing). This coach could also remotely monitor the weekly schedule and the user ratings of each exercise. See Figure 8.
Figure 1: Exercise library.

Figure 2: Selecting exercise variation.

Figure 3: Personal training schedule.

Figure 4: Today’s program.

Figure 5: Modifying execution parameters.

Figure 6: Count-down timer during executing.
Procedure
Participants were received in a usability lab on campus grounds. They were seated behind a desk where after a short introduction they were asked to perform 11 tasks on the tablet. See Table 1 for a description of the tasks. The participants were instructed to think aloud as they performed each task. If participants stranded, they were given a hint after 30 seconds. Due to time constraints, after 30 minutes the assignments were ceased, even if not all 11 tasks were completed. Furthermore task 4, 7 and 10 were considered non-essential tasks and were only given if participants had ample remaining time. After completing the tasks, the tablet was put aside and the participants were shortly interviewed about their general impression of the app. In total the session lasted 45 minutes. The entire session was recorded by video. Furthermore, the user interaction with the tablet was recorded by screen capture software.

<table>
<thead>
<tr>
<th>Task #</th>
<th>Task description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Execute the exercises that is scheduled for today. Adjust the duration to 10 seconds and set the repetition to 1.</td>
</tr>
<tr>
<td>2</td>
<td>After completing an exercise, rate the difficulty, effort and fun by using three scales</td>
</tr>
<tr>
<td>3</td>
<td>Find and watch the instructional video of exercise X</td>
</tr>
<tr>
<td>4</td>
<td>During the execution of an exercise, pause the count-down timer</td>
</tr>
<tr>
<td>5</td>
<td>Add an exercise to your weekly schedule that will increase your capacity to pick up objects from the floor</td>
</tr>
<tr>
<td>6</td>
<td>In the weekly schedule, remove exercises so that the maximum exercises for day is three</td>
</tr>
<tr>
<td>7</td>
<td>Set an alarm so that you will get a daily reminder at 12.00</td>
</tr>
<tr>
<td>8</td>
<td>Yesterday you forgot to mark your exercises as completed. Do this in retroaction</td>
</tr>
<tr>
<td>9</td>
<td>Look up information about exercise X</td>
</tr>
</tbody>
</table>
Table 1: Description of the tasks that had to be performed by the participants.

Data Analysis
All recordings were transcribed and coded with software for qualitative analysis (MaxQDA). Two researchers coded independently four metrics of the aggregated dataset:

1. Time-on-task: the average time the participants spent on executing the task
2. Hints: the average amount of hints that were given during the execution of the task
3. Success-rate: the proportion of participants that
   a. completed the task successfully without any hints
   b. completed the task successfully with hints
   c. could not complete the task successfully
4. Errors: the average amount of errors that were made by participants during the execution of the task. A distinction was made between:
   a. strategy errors: not knowing how to approach the task, for instance not knowing how to proceed in adding exercises to the weekly schedule
   b. interaction errors: not knowing how to execute the strategy, for instance not being able to find the play button
   c. operating errors: not being able to operate the device, for instance swiping.

Furthermore, remarks of participants during the execution of the task (think-aloud protocol) and post-test interview were classified either as positive, neutral, negative or as a suggestion for improvement.

After both coders annotated the data independently, they compared the results. Differences were resolved via discussion. If no consensus was achieved, the first author settled the rare dispute.

Results

Of the 15 older adults that participated in the study, the data of one participant was excluded. She was not sufficiently proficient in the Dutch language to understand the assigned tasks and
her responses could not be coded reliably. Therefore the authors decided to exclude her results from the data-analysis.

On average the remaining 14 participants spent 46 seconds time-on-task (ranging from 13 to 85 seconds, SD=30). Approximately 94% of the participants completed the task successfully with either no help (43%) or after having received 1 to 2 hints (51%). See Table 1 for the average time-on-task, amounts of hints given and success rate per task.

The type of errors ranged from strategy- and interaction errors to operating errors. See Table 2 for the type of errors made per task. Note that not all participants completed all the tasks (see in Table 1 and Table 2 the N per task). Within the time constraints, some participants managed to complete more tasks than others. As described earlier, also some tasks were only given to ‘advanced users’ whose pace was high.

<table>
<thead>
<tr>
<th>Task</th>
<th>N</th>
<th>Time-on-task (sec.)</th>
<th>Hints</th>
<th>Success without hints (%)</th>
<th>Success with hints (%)</th>
<th>Failure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>78</td>
<td>1,0</td>
<td>69,2</td>
<td>23,1</td>
<td>7,7</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>59</td>
<td>0,9</td>
<td>42,9</td>
<td>57,1</td>
<td>0,0</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>20</td>
<td>0,8</td>
<td>57,1</td>
<td>38,1</td>
<td>4,8</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>14</td>
<td>3,5</td>
<td>60,0</td>
<td>20,0</td>
<td>20,0</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>85</td>
<td>0,9</td>
<td>14,3</td>
<td>64,3</td>
<td>21,4</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>60</td>
<td>0,9</td>
<td>00,0</td>
<td>90,9</td>
<td>9,1</td>
</tr>
<tr>
<td>7</td>
<td>13</td>
<td>85</td>
<td>1,1</td>
<td>42,9</td>
<td>52,4</td>
<td>4,8</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>58</td>
<td>1,5</td>
<td>12,5</td>
<td>62,5</td>
<td>25,0</td>
</tr>
<tr>
<td>9</td>
<td>13</td>
<td>19</td>
<td>0,8</td>
<td>42,9</td>
<td>50,0</td>
<td>7,1</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>18</td>
<td>3,5</td>
<td>33,3</td>
<td>66,7</td>
<td>0,0</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>13</td>
<td>1,1</td>
<td>58,3</td>
<td>41,7</td>
<td>0,0</td>
</tr>
<tr>
<td>average (standard dev.)</td>
<td>11</td>
<td>46</td>
<td>1,5</td>
<td>39,4</td>
<td>51,5</td>
<td>9,1</td>
</tr>
</tbody>
</table>

Table 2: Average time-on-task, amount of hints given and success rate per task.
Table 3: Average amount of errors participants made per task.

Also the performance varied greatly across the different tasks. Watching an instructional video (task #3), executing an exercise (task #1) and video calling a coach (task #12) were relatively easy, seeing the high success-rate without any help. In contrast, adding an exercise to the weekly schedule (task #6), pausing an exercise during execution (task #5) or marking an exercise in retroaction as completed (task #9) were difficult or unclear tasks, indicated by the high failure rate. This latter task also elicited relatively the most critique; 8 negative remarks against 4 positive remarks (a ratio of 0,5).

Nevertheless, during the post-test interview the participants were overall positive; 31 positive remarks were made against 10 negative remarks (a ratio of 3,1). Typical remarks were “Nice. I found easy to operate and fun”, “it was pretty clear and straightforward” and “it’s nice to do different exercises now and then”. See Table 4 for the valuation of the remarks that were made during the execution of the tasks (think-aloud protocol) and during the post-test interview.
Table 4: Valuation of the remarks made during the execution of the tasks and during the post-test interview.

**Discussion**

**Principle Results**

Overall the app that was designed to support older adults in doing exercises at home appears to be useable for first-time users. After a brief introduction, the vast majority of the users could complete the assigned tasks. Not only did they do this effectively, indicated by the high success rate, but also efficiently. On average they succeeded performing the tasks within a minute.

Furthermore, the think-aloud remarks and post-test interview revealed that users were satisfied with the app.

The performance did vary. Tasks that were associated with supporting behavior execution (looking up information about exercises, watching demonstration video’s) and evaluation (making a video call) were done well. Tasks that were associated with tailoring the weekly schedule were more difficult for the users, indicated by longer task-completion times and a higher rate of errors.

The fact that the older adults in this usability study needed some minor help with performing the assigned tasks, is not considered by the authors to be a major issue. First of all, the average age of the participants was 77 years old. The majority had never operated a tablet before and only received a short introduction of a few minutes before they had to perform the assigned tasks under scrutiny of two observers. Observer effects and the think aloud protocol are known to decrease performance for complex tasks in usability studies [35–37]. It is plausible that the participants would have performed better in the privacy of their own home where they feel more
free from prying eyes. Second, some tasks, for instance #4 and #8, were developed with a ‘power user’ in mind. It was designed in an unobtrusive manner not to clutter the interface for first-time users. Therefore it wasn’t surprising that the participants in the study had difficulties executing those tasks. Third, the app is designed to be implemented in a blended intervention where a coach will be appointed. This coach will give hands-on support, face-to-face as well as remotely. Thus, in this particular case receiving help to operate the app is not an artefact of the usability study, but reflects the actual context of use.

Limitations and Future Work
The app is part of blended intervention, where older adults participate in weekly group-based classes, perform tablet-supported exercises at home and receive feedback by a personal coach. The current study only evaluates if the app that is part of the blended intervention is usable for older adults. It does not evaluate other aspects of the intervention. Furthermore, the usability study was conducted in a lab where users interacted with the app for a short period of time. It provides an indication of the usability for first-time users, but not for long-term users. Learnability and user acceptance can only properly be studied when older adults have used the app for an extensive period of time. To investigate these matters follow-up studies are planned. A randomized controlled trial will evaluate the efficacy of the blended intervention in terms of health outcomes [38]. Parallel to this RCT participants that have been using the app for 6 to 12 months will be questioned about the perceived usefulness, ease of use, learnability and satisfaction on the long term [39]. To optimize reliability and validity both questionnaires and interviews will be used.

Conclusion
In line with the MRC framework, an evidence-based blended intervention was developed to support older adults in performing functional exercises at home. The feasibility of the tablet-based app that was designed for this purpose has been validated by a usability study with mixed methods. Older adults that were first-time users, and whom the majority had little to no experience with tablets, were able to use the app in effective and efficient manner. They were
also satisfied with the app. These findings pave the way to implement and evaluate the
intervention in practice.

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Conflicts of Interest

None

Abbreviations

VITAMIN: VITal Amsterdam elderly IN the city

MOTO-B: Motivating Technology for Older Adults’ Behavior

MBvO: More Exercise for Seniors, a Dutch community-based physical activity program for adults aged 55 and above

MRC: Medical Research Council, UK

PA: physical activity
RCT: randomized controlled trial

mHealth: mobile health

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