

# User Perceptions on Interacting with Mobile Fitness Devices

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## ABSTRACT

In this paper, we present a mobile fitness proof-of-concept demonstrator that includes several sensors for measuring physiological issues in a human body, i.e., heart rate meter, 3-axis accelerometer for step counter and energy consumption, and bioresistance meter for fat percentage, body water content and galvanic skin response. In addition, we describe user perceptions representing various different target groups on selected measures.

## Keywords

Mobile devices, human-computer interaction, wellness, fitness, health care, user studies.

## 1. INTRODUCTION

During recent years, the use of mobile devices in healthcare and wellness has gained increasing amount of attention, including both research and commercial development. There is interest to use mobile technologies in health-related work and activities, and this has given rise to different types of applications for monitoring one's physical data or accessing to this information. Common off-the-self mobile devices that are targeted to fitness purposes include e.g. heart rate monitors, step counters, and devices measuring the user's energy consumption.

Mobile communication technology has also been harnessed to improve people's awareness of their physical activity. Examples of these are PmEB and Wellness Diary mobile phone applications. PmEB allows users to record their food intake and physical activity for tracking their energy balance and provides SMS reminders [6]. Wellness Diary application is also targeted for the weight management, and helps the users to monitor and record different factors related to their lifestyle [5]. Nokia 5500 mobile phone, which has an integrated step counter, includes a training diary and several tests of the user's physical condition [7]. Consolvo et al. [4] present a mobile phone application, where the users get the information not only of their own step count and progress towards a set goal, but the corresponding situation of their friends as well. The research looking at mobile technologies and health care has demonstrated several concepts how mobile technology could support doctors and nurses, for instance in accessing the patients' data and histories [2], [3]. Alros et al. [1] look at the preferred interaction techniques with mobile healthcare application, but concentrate to hospital settings and use case scenarios of patients and physicians. Their study results highlight the benefits of distributed user interfaces (UIs) and adaptation that

takes into account the social setting and specific ergonomic factors required for the situation.

There exist only few studies that investigate the interaction techniques, usability, and user perceptions of mobile wellness applications. Nevertheless, when designing applications targeting to large audiences, the devices features should map to the preferences and expectations of the target users. Thus it is important to investigate the user perceptions when interacting with such devices. In our study we wanted to investigate how potential users and health-care professionals perceived the usefulness, benefits and drawbacks of different physical activity measurements conducted with a mobile fitness device. In addition, we wanted to understand which fitness parameters users would like to monitor in their everyday life. With this, we sought to gain information on user interaction with mobile fitness applications, as this can affect on the user interface design and usability of such applications.

## 2. PROTOTYPE

For the study, a prototype of a mobile fitness device was built. The demonstrator included the following technologies:

- Heart rate meter
  - o Receiver for Polar chest belt T31
- 3-axis accelerometer, LIS3L02AQ
  - o Step counter
  - o Energy consumption
- Bioresistance meter, 4-point measurement from fingers of both hands
  - o Fat percentage
  - o Body water content – dehydration
- Bioresistance, 2-point for contact resistance
  - o Galvanic skin response (GSR)
- Environmental data
  - o Pressure and temperature, Intersema MS5534
  - o Humidity, Sensirion SHT11

The technology was packed in a 15 x 9.5 cm plastic box with a display and 3 keys that were used to navigate in the UI, see Figure 1. There were 4 fat pads on the device, 2 on both sides. For measuring GSR, there was an external cable with two contact sensors for forefingers.



Figure 1. Fitness demonstrator and a heart rate belt.

### 3. EVALUATION SET-UP

The main focus of the evaluation was to study the usefulness of different parameters of the mobile fitness prototype from several points of view. The data collecting methods for charting user perceptions with the prototype and mobile fitness applications in general were semi-structured interviews and group-interviews. In the interview sessions, all participants tried out different features of the prototype. In total, there were 19 participants, the sample including both health-care professionals and potential users of the product. The evaluation was carried out in Finland.

The interviewed health-care professionals were 3 medical doctors who were specialized in sports and exercise medicine. A group interview was carried out with additional 2 doctors and a nutrition therapist. Most of the health-care professionals belonged to an age group of 41-45.

With potential users, 3 semi-structured group interviews were carried out in the laboratory premises. Voluntary participants were recruited from different backgrounds: weight watchers (5 persons), motivated exercisers (4 persons) and young game players (4 persons). Weight watchers were 49-66 years old with different professional backgrounds, and they were contacted via Weight Watchers organization in Finland. Exercisers were 28-51-year-old, employed people with technical background and a motivation towards physical exercise. Game players were 20-year-old students, who spent a lot of time with computer games in daily basis. Each group had their own interview session.

In the following, the results of the user evaluation are presented by highlighting the perceptions of the different user groups.

## 4. USER PERCEPTIONS

### 4.1 Heart Rate Monitoring

*Weight watchers* were positive towards heart rate monitoring. They said that they could use it (and actually one of them was already using) when exercising to follow-up their condition and to know how to move effectively to burn fat. They would also like to see symptoms of arrhythmia so that they would not train too much. However, the heart rate belt was considered uncomfortable to wear. They thought that it could be more comfortable if it was worn, for example, around the wrist.

*Exercisers* used heart rate monitors mostly because it helped them to keep the heart rate in a certain, healthy level. Average heart rate was interesting information for them. Other usable features in current heart rate monitors were highest heart rate from certain time period and the sound signal when heart rate limits were exceeded. The participants commented that the usage of a heart rate monitor required information on, e.g., personal heart rate limits, and thus the efficient use of the device was not as straightforward as it should have been. The current heart rate monitors were commented to suffer often from complicated UIs and usability problems, and thus required some prior knowledge of the technology. The participants argued that this also discouraged them to use some of the more advanced features in their own heart rate monitors.

The members of the *game player-group* reported that they had noticed their heart rate increasing and decreasing while playing, even when only sitting. Game players commented that connecting physical activity measurement to the gaming would bring concreteness to the exercise. They were not very motivated to do physical training, but they thought that seeing results concretely in the game would increase motivation. The players suggested that the heart rate could be integrated to gaming so that heart rate of the player would affect to the game. For example, the players would need to raise their heart rate to perform better in the game, or variations in the heart rate could change the abilities of the game character. Here, the player should keep her heart rate in a certain level to perform well – e.g., the gun would shake more if the player was not calm down. In addition, in the scary games, players could be hearing their own heart beat to create better feeling.

*The health care professionals* pointed out that heart rate should be measured several times during the day to get proper data for analysis. Heart rate was considered to be very individual and thus following the changes of the own heart rate would be more interesting scenario than comparing it to other people's records. It was criticized that the value of heart rate measurement to ordinary people was somewhat questionable if they were not aware of, e.g., their maximum heart rate.

### 4.2 Step Counter

*Weight watchers* considered step counter as a good feature because with it one got evidence about being physically active.

*Exercisers* were not very familiar with the idea of counting steps. They were not satisfied with the feature, and wanted to have reliable information about the distance, i.e. how long distance they had run.

*The game players* proposed that step counter or some other suitable technology could be used to record the activity of the player that could be transferred to the game.

*Health care professionals* were not very interested in the step counters for their profession. They commented however, that the usage was simpler than the heart rate monitor because the belt was not needed, and seeing the amount of steps could motivate people to do more physical exercise.

### 4.3 Energy Consumption

*Weight watchers* commented that energy consumption was important information, especially if they were able to easily compare in-taken and consumed energy, as they now did with

their conventional paper-format food diaries. In the weight watchers' group, they had sometimes converted energy to some tangible food units, because "decreasing my weight by 10 packets of butter feels better achievement than 5 kilos", as one participant commented. Related to this, some participants had also tried to carry a bag of 5 kilos to feel the difference.

Opinions of seeing energy consumption were divided between the *exercisers*. Some of them considered it very important and checked the value regularly in their heart rate monitors, whereas others did not believe in the measurements at all mainly because of the calculation techniques it involved. During the interview there was a short conversation about seeing energy as something more concrete than just a number, for example as carrots. It was perceived that this might make the interpreting of the data more straightforward.

*Game players* did not consider energy consumption as beneficial information. They did not want to get data about energy consumption, but commented that it might be more relevant for those who were trying to lose weight.

*Health care professionals* were somewhat worried if ordinary people understood the meaning of energy consumption, which is usually presented with kilocalories. The participants said that it would be important and motivating to know the balance between energy consumption and intake. However, the current technologies did not allow an easy-to-use way to measure the energy one receives by eating.

#### 4.4 Fat Percentage

*Weight watchers* claimed that they did not want to measure their fat percentage because they "could see it in the mirror anyway". They thought that fat percentage measurement would be more useful for 'fitness people'.

*Exercisers* considered fat percentage measurement interesting and motivating information, as it told more than just their weight. However, the participants commented also that it should not be measured too often, because the changes were very slow.

*Game players* did not want to measure fat percentage, as they were not interested in it. Also as the weight watchers, the game players considered fat percentage information to be more interesting for athletes.

*The health care professionals* considered 4-point fat percentage measurement to be unreliable because it was partly based on calculations. This kind of fat percentage monitoring was perceived to be more suitable for monitoring changes in person's own values that comparing them to others. It was also pointed out that it was not necessary to measure fat percentage very often, as couple of times a week was enough. Also, it was mentioned that it was very important factor with the measurement process that the fat percentage was always measured in the same conditions, e.g., in the morning before eating the breakfast, as otherwise the results could be even more imprecise. It was highlighted that the actual fat percentage number did not tell the whole truth, as it was equally important where the fat was located. For example, middle waist fat was more dangerous than fat on thighs. The location of the fat could be determined with ultrasound.

Using the prototype for fat percentage measurement is illustrated in Figure 2.



Figure 2. Measuring fat percentage with the prototype.

## 5. DISCUSSION

Measuring fitness and health care parameters is challenging, because the measurements have to be very reliable. Health is considered as a very sensitive area and currently people trust more to experienced professionals than devices in health-care analysis. An important issue considering the use of such technology in healthcare is the liability - who takes the responsibility in case of potential health risks. This affects also to the design of the commercial devices. Also the need to develop easy-to-use and -carry devices is a challenge. Users may not want to attach sensors to themselves if they are not merged to convenient items such as wristwatches or wearable items. However, there is very much potential in fitness and health care measurement development as people have interest towards measuring own body attributes.

Table 1 summarizes the perceived usefulness of different features for different types of user groups. In the conducted user evaluation, the familiarity of the heart rate monitoring may be a reason that has made it acceptable for large audiences. Other features of the prototype were clearly not so well known. It was a surprise to the authors that e.g. the exercisers were not very familiar with a step counter functionality.

The authors found the evaluation with different user groups very interesting as the differences between the perceptions of fitness application could be clearly seen. This emphasizes the meaning to carefully selecting the target user group and taking their special requirements into account when designing mobile wellness applications. There may be cultural differences in the user perceptions on different fitness applications, and the results may somewhat depend e.g. on the cultural and geographical setting of the study. As a long-term usage period of the device was not included in this study, one should make the generalization of the findings carefully. However, the authors believe that the reported findings still offer valuable insight to the research field

**Table 1. Summary of the perceived usefulness of the features**

<i>Description of user</i>	<i>Useful features</i>	<i>Reason to use</i>	<i>Other findings</i>
Young person for whom doing physical activity should offer fun and entertainment	Prototype: heart rate, step counter Additional: total activity measurement, distance	To view total activity concretely, to see even the minor change, to increase activity by offering something fun	Doing exercise alone is boring, physical activity should be turned to be fun
Middle-aged or a bit older person with health-related goals, e.g., decreasing weight	Prototype: heart rate, step counter, dehydration, energy, Additional: blood pressure, cholesterol, energy intake,	To support the change in way of living, to see the change, to have evidence of activity, to monitor health-related parameters	Social network is the best supporting factor for maintaining goals
Person for whom doing physical exercise is an essential part of life	Prototype: heart rate, fat percentage, dehydration, energy, environmental data Additional: lactate, recovery, resting, stress, distance, terrain profile	To guide healthy and accurate training, to see improvement of condition, to prevent overload, to save data	Exercising does not need to be fun. Training is a good possibility to maintain mental balance.
Health-care professional	Prototype: heart rate, step counter, energy Additional: blood pressure, total activity, long-term data, intaken energy	Used by patients to log life-long data of way of living to help making diagnosis, self-monitoring of illnesses	Need for automated analysis of data if it was reliable

The findings of the evaluation can be used when designing wellness applications. For example, the finding that health-care professionals might benefit from patients' long-term self-collection of activity data raises new application concepts. Also, knowing which parameters the overweight persons might be interested helps in designing an appropriate and user-friendly weight management tool. As a general finding, an easy-to-use configuration of the application is a must, i.e. users should be able select what parameters they will follow-up. As a future-work it would be interesting to arrange a long-term pilot study with the same user groups.

## 6. CONCLUSIONS

In our study we have introduced a mobile fitness device capable of monitoring several fitness and health related parameters, such as heart rate, step count, energy consumption and fat percentage.

The study indicates that there are differences between different user groups on how useful mobile fitness application's functions are perceived and how different features are prioritized. This should be taken into account in the application design. The results indicate that user groups with different goals want different features for the fitness and health-care device. Youngsters do not want to measure health-related things, but those who are overweight seem to be interested in following up several wellness related measures and their progress. On the other hand, those who have a motivation to do sports actively, are interested in monitoring recovery and proper exercising level, while those who are still looking for healthier lifestyle want to have something that motivates them to be more physically active.

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