cyberMarathon – increasing physical activity using health-enabling technologies

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Abstract. The prevalence of overweight and obesity has increased worldwide in the last years as well as in Germany. The goal of cyberMarathon is to increase daily activities and participation of children and adolescents on sport courses using health-enabling technologies. Our objective is to propose an approach of an interdisciplinary intervention program containing a concept for architecture for a sensor-enhanced health information system which will be evaluate in two studies. Using sensors and health-enabling technologies in the preparatory study daily physical activities increased by 7.7%. Measuring of daily physical activities, the feedback of the analyzed data and the deal with the own body and activity seems to be an effective prevention for adolescents.

Keywords. Telemedicine, patient monitoring, systems architecture, compliance, pediatrics

Introduction

Current studies and physical examinations in schools show an overweight of 10-12% and an obesity of 4-6% of children [1], [2]. Obesity in the childhood causes problems like hypertension, cardiovascular diseases, diabetes etc [3]. The lack of physical activities and excessive inactivity (e.g. caused by watching TV) might enhance overweight and obesity in childhood [3]. The prevention and treatment involves dietary strategies and being more physically active. The most effective programs are family-based and/or school-based approaches to reduce obesity [4].

The goal of this paper is the presentation and discussion of a new approach called cyberMarathon which contains a concept for architecture for a sensor-enhanced health information system and an overweight prevention program developed by the Peter L. Reichertz Institute for Medical Informatics, University of Braunschweig-Institute of Technology, in cooperation with the Institute for Sportsmedicine, Hannover Medical School, supported by the Federal Sports organization Lower Saxony.

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Using new technologies is an approach to increase transparency concerning daily activities to improve the self-management of children. The target groups consists of children aged between 11 and 13 years because in this age the children leave sports clubs and decrease the daily physical activities like scientifically proven [5].

We considered the following research questions:

- Q1: How can health-enabling technologies increase the physical daily activities?
- Q2: How can health-enabling technologies be integrated in a prevention program?

1. Methods

Research Question Q1 is answered by describing the cyberMarathon approach. The intervention implemented within cyberMarathon is based on several prevention strategies against overweight and obesity in childhood and experiences in sensor-based telemedicine.

Research Question Q2 is answered by a description of the architecture for a sensor-enhanced health information system. We propose an architectural model using the three-layer graph-based metamodel (3LGM²)-methodology for static modeling of health information systems [6].

For the integration of sensors in prevention program with the possibility to feed back the analyzed data to children, parents, physicians and coaches we had to accomplish different challenges. Bott et al. [7] describe the problems of an integration gap concerning a personalized health information system (which describes the system in the personal environment at home or in school) and the different institutional health information systems (e.g. in hospitals, sports medicine examination centers,…). They conclude that it is possible to increase the patient empowerment and the self-management. Additionally there has to be a change in the personal health management and therefore a challenge in new ways of healthy living beside the problems of architectural and technical aspects. Also Mattila et al. [8] define several functions which have to be considered if health-enabling technologies will be implemented. The conclusion is that the trustful and volitional utilization of health-enabling technologies is one of the important challenges concerning the implementation of sensor-enhanced health information systems.

2. Results

2.1. The cyberMarathon approach

The goal of cyberMarathon is to increase the daily physical activities as well as the participation in sport courses of children and adolescents. A special attention applies thereby for pupils with an increased obesity risk.

New technology structures, called health-enabling technologies, are used and developed by computer scientists in cooperation with schools, sports clubs and physicians. The goals will be achieved by a new sports and movement program as well as by incentives to increase daily activities in combination with an improved health behavior. Latest sensor technology for measuring energy rates and activity is used in
connection with computer programs to improve the self-management of children. The sensor data which represent the daily activities have to be analyzed and stored in an electronic activity diary. Changes in energy rates and activities can be identified and the success could be visualized and presented to the children.

Additionally the sports program will be offered after school. On the basis of entrance tests physicians and coaches develop the sports and movement programs for the children. A group of one or more coaches trains the children for approx. 4-6 weeks once a week depending upon season e.g. inliner, dancing etc. Constant practicing could guarantee that unsporty children learn the kind of sport in such a way that they can control their success and decide, whether they want to continue the sports program further on. After those 4-6 weeks cycles the children take part in a one-week match. This can consist e.g. of the fact that the children are equipped over several days with a sensor for measuring daily activities. In the end the group with the highest activity level or the best metabolic rates wins.

The cyberMarathon approach contains of two scopes (Fig. 1):
1. The personal environment with the pupils at home or in school and different sensors to measure the activities and
2. The clinical environment with physicians, sports scientists etc.

Figure 1. The cyberMarathon concept
2.2. A concept for the cyberMarathon architecture

Figure 2 shows the 3LGM² model of the architecture for the cyberMrathon approach described in the chapter before, with all entities, functions and relationships subdivided into three distinct architectural layers: the domain layer, the logical and the physical tool layer.

In the physical tool layer the different devices are illustrated described in the two scopes. In the personal environment the measuring and data collection takes place, in the clinical environment we have the possibilities to analyze the sensor data and the storage system for the activity diary.

All data are collected by the “data collector” and will be analyzed by an “ad hoc module” to allow a real-time feedback. The data are transferred by a gateway to the diary. The “diary” and the “analyzing module” in the logical tool layer are part of the electronic health record used by patients and physicians. The model architecture also contains a second loop of feedback to the patient: beyond the real-time feedback another loop with reports is available via an interface, e.g. internet browser.

Figure 2: The three-layer graph-based metamodel (3LGM²) of the proposed cyberMarathon concept.
2.3. Case studies

With the preparatory study we have evaluated the measuring of data and the possibilities to feed back analyzed data described in the cyberMarathon architecture. In the preparatory study our focus of attention was the compliance of the children using this sensor and their problems understanding the presented measured and analyzed data. We decided to evaluate the effects of this intervention consisting additional sport courses and new technologies in a 6th grade school class.

We decided to use the sensor SenseWear Pro 2 distributed by Bodymedia to measure daily physical activities. The multi-sensor enables a personalized configuration by using weight, height, age, sex, left- or right-handed and smoker or non-smoker for calculation. The sensor measures acceleration, temperature of skin and air temperature close by the body, galvanic skin response and heat flow of the skin. The analyzing software calculates the parameter metabolic equivalent, activity duration, lying down, sleeping, number of steps and activity level. Over six months we had an increase of daily activities by 7.7%.

A second study with a sample of 44 children was realized from September 2006 to July 2007. The children were randomly sampled and examined in a school nearby Hannover, Germany. We chose the 6th grade of school forms which corresponds to children aged between 11 and 13 years. The main focus of attention of the second study was the investigation whether sensors and sensor-enhanced health information system have an effect on the health status measured by the body-mass-index. Over nine months we had an increase of daily activities by 11.4%. The results will be analyzed and published soon.

3. Discussion

Self-management is one of the key aspects to increase physical activities. Nevertheless the integration of the family is necessary, too. The correlation between the behavior of children and adolescents and the behavior of their parents is very noticeable [9]. The described support of self-management using health-enabling technologies [7], [10] could exemplary be implemented with cyberMarathon. Due to the fact that the inactivity of parents could affect the inactivity of their children it is important to implement a school-based intervention with coaches, teachers and e.g. scientists to motivate the children.

The cyberMarathon approach shows in a small setting that the compliance and acceptance of health-enabling technologies can improve healthy living. As well as other prevention strategies and studies like FITOC [11] or Jump-In [12] the cyberMarathon approach increases the physical activities. Instead of the often used method of increasing the number of sport lessons we have achieved this goal by increasing the transparency into the body and the daily activities using sensor technology. Bravata et al. achieved similar results using pedometers [13].

The task of prevention programs to clarify and educate children and parents as requested by the German workgroup for obesity in childhood and adolescence [14] can be supported by these technologies. Mattila et al. [8] define five categories for applications in pervasive computing. Among fitness and wellness cyberMarathon could be assigned to prevention and risk management. Subgroups of these categories are technical challenges described by Bott et al. [7] and challenges to prove efficiency and
effectiveness of health-enabling technologies [8]. Implementation of cyberMarathon and the results of the first study could contribute to prove the effectiveness.

4. Conclusion

There is considerable research in prevention and intervention of overweight and obesity in youth. Health-enabling technologies can support the different programs and studies concerning educational aspects. More transparency of the own body and more understanding about energy consumption, physical activities and the ratio of energy and movement increases patient empowerment and self-management of care and activity. The utilization of these new technologies seems to be accepted by the test persons over a long time period. This paper shows one possibility to integrate sensors and a sensor-enhanced health information system in an interdisciplinary intervention. Further research is needed for the optimal connection between sensor and the different infrastructures, the fusion of different data and the analysis algorithms.

References