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# SPORTS IT: DIGITAL MEDIA AND TECHNOLOGY FOR ENCOURAGING PHYSICAL ACTIVITY

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## ABSTRACT
Sport IT is an emerging global movement. Many research efforts have addressed the potential of IT for promoting physical activity, a countermeasure against the factors that cause welfare problems such as diabetes, high blood pressure, and heart disease. This paper presents an overview of research related to IT and physical activity and identifies three reoccurring themes; 1) Measurement and latforms, 2) Support for opportunistic individual training and finally, 3) Encouragement through Toys and Games. These themes or chategories of Sports IT, are furher explored in a detailed and systematic way. This is wrapped up in a discussion of what could be seen as impotant further research addressing the issues found in this body of research.

## General Terms
Interaction Design, Human-Computer Interaction, Sport IT, ubiquitous computing

## Keywords
Sports IT, Physical Activity, Training, Health.

## 1. INTRODUCTION
Information technology (IT) is the foremost emerging trend when it comes to health and training today. We measure puls, where we are with our GPS, how man steps we have walked etc., and the number of training Apps at the market grow rapidly. However, many of us would agree that information technology and how it has changed the way we live our lives is one of the main reasons for why this epidemic of overweight and sedentary behavior started in the first place [1], [2], [3]. The amount of people working in physically demanding sectors have for the last decades decreased and the proportions of people working with knowledge intensive, often heavily reliant on information technology, and sedentary work is constantly growing. According to Swedish Work Environment Authority, a person working in computer intensive professions spend six to seven out of eight hours in a chair in front of their computer. It might seem paradoxical but at the same time that IT is part of the problem, it can also be part of the solution. The scope of this paper is to highlight the

A special issue of Pervasive Computing (introduced by [4]) addressed the potential that ubiquitous computing technologies have for enhancing sports. In their guest editor introduction, Chi and colleagues put an emphasis on the possibilities that sensors embedded in everyday objects such as accelerometers, microphones, and cameras provide for enhancing athletes performance, injury prevention and rehabilitation [4]. A well-written and valuable review and analysis of ubiquitous computing in sports was published four years after the special issue mentioned above by Baca et al. [5]. Their publication places an emphasis on technology and computational techniques and further highlights the potential of ubiquitous computing technology for sports and leisure. Other areas of work within the HCI community that have touched upon this topic are embodied interaction [6] and persuasive computing [7] Embodied interaction i.e. interactions that place the human body in the center of an interaction experience, has the potential to make people move when interacting with computers such as when playing games. A branch of this area is exertion interactions that are associated with requirements for physical efforts from users [8], [9], [10]. Persuasive technology i.e. technology designed for changing users' attitudes or behaviors through persuasion and social influence has the potential to make users engage, commit and undertake physical activities.

Even if the publication of Baca et al. [5] and the special issue introduction of Chi and colleagues [4] include more groups than professional athletes, they do not specifically focus on ways to, through ubiquitous computing technology, get the general population with a need or desire to increase the volume of the physical activities they undertake. Previous work has identified great potential in technology for achieving this (e.g.[11], [12], [13], [14]) and that is the main focus of this paper.

In this paper, we present a research overview of previous and current work regarding the room for ubiquitous computing technologies for supporting physical activities among the general population. The categories we have developed are not mutually exclusive and many papers pick up on several attributes. In this process, we strived for categories that truthfully reflected common themes from several papers and offered concrete evidence in examples and citations for further analysis. The categories are Measurement and Platforms, Support for opportunistic individual training and Encouragement through Toys and Games. The overview in itself provides a significant contribution.However, on the basis of the overview we highlight some key challenges and suggestions for further research on ubiquitous computing technologies for supporting physical activities, or as described in this paper – Sports IT.

## 2. RESEARCH ISSUES FOR IT AND PHYSICAL ACTIVITIES

The intention was to find out where IT research is in relation to design and use of ubiquitous computing technologies for supporting people's physical activities, i.e. SportIT. In order to do this, The ACM Guide to Computing Library – digital library – was scanned, with the search terms of: "exercise", "training", "well-being", "physical activity". Some additional searches were also made through the Google Scholar search engine by adding "pdf" and "IT" or "technology" to the terms above. Even if not exhaustive, this should be considered a large cross-section of relevant work, spanning a range of contexts, technologies, and people. 54 central research papers were found, and these were recorded and chategorized. The result of this work is presented in this paper.

The analyzed body of research target very different use groups such as teenagers, adults, people with impairment etc. and different use contexts such as training facilities, the home, school or work. As our focus is on ways through which researchers have tried to increase the levels of physical activities that the general population perform we have excluded projects that have an ambition to enhance performance of athletes by for example supporting these in improving the efficiency of training exercises or to detect their most common mistakes and provide immediate feedback (e.g. [15]), to monitor, not encourage, physical activity of elderly people [16]or target user needs for technology supporting physical activity among people with chronic pain [17].

The result of our literature search and review is presented in the following sections and is divided into 1) Approach, i.e how the research studies were designed etc. 2) Technology, i.e. what type of technology was used in, or designed for the the studies. 3) The procecure in the research studies, and 4) (type of) results shown, and finally, 5) if any, proposals of further research. First, a description of the first chategory – Measurements and platforms.

### 2.1 Measurement and Platforms

Technology for measuring and platforms used for supporting exercise is already used in a wide range of devices and constructs such as treadmills and pedometers while many aspects of technologies such as location-based services, mobile devices, and social software systems, are still rather unexplored [18]. A number of research projects have taken on this exploration by breaking new ground about how the actual recognition of activities and ways to model and present these can be managed (e.g., [19]).

#### *2.1.1 Foundations*

Lester and collegues [20] motivate their work through identification of shortcomings of traditional healthcare monitoring that primarily rely on manual techniques such as paid observers or self-reporting (e.g. diaries or surveys). These methods have several weaknesses when it comes to cost, accuracy, obtrusiveness and scope. More automated techniques (e.g. pedometers and heart rate monitors) are considered as having potential but often suffer from inability to make distinctions between different types of physical activities. Fujikis team [19] address the effect of where on the body an accelerometer is placed. This is something that according to the authors has received little consideration in previous research.

#### *2.1.2 Approach*

Fujiki and collegues [19] create an experiment for understanding accelerometer output on the waist, wrist, arm, thigh as well as ankle of subjects in motion. They do also present experimental formulas transforming body measurements to more reliable measurements and in a next step caloric measurement.

#### *2.1.3 Technology*

Lester [20] developed a system called Multi-modal Sensor Board equipped with seven sensors that enable measuring of audio, barometric pressure, temperature and much more. Barhuus[18] on the other hand make use of Shakra, a system that measures activity through GSM fluctuations and proximate cell information to estimate patterns of how a mobile phone is moving. Fujiki[19] used a custom accelerometer system, a Bluetooth connection and a data logger in the shape of a computer or cell phone.

#### *2.1.4 Procedure*

Lester [20] relied on 28 hours of data gathered over the course of 4-6 weeks by two participants. Fujiki [19] used five custom accelerometers attached to different parts of the body of a subject walking on a treadmill. Data from these different accelerometers were then analyzed and transformation formulas calculated. In total ten healthy adults (8 males and 2 females) participated in the study.

Lester [20] developed a device that could distinguish between different physical activities including sitting, standing, jogging, riding in an elevator and much more. Fujiki [19] established a radical difference in logged data dependent upon where on the human body an accelerometer is attached. The best place is the waist, but the formulas presented in the paper open up for the possibility to get correct values independently of where on the body the accelerometer is attached.

### *2.1.5 Suggestions for future research*
Some of the research reports include suggestions for further research. One example is Fujiki [19], who want to expand the impact of their contribution by including other types of physical activities than walking.

Further, the second chategory, i.e. Support for opportunistic individual training, is presented.

## 2.2 Support for opportunistic individual training
Many researchers have identified the potential of encouraging opportunistic physical activities for reducing obesity, overweight and increasing health (e.g. [21], [3][22], [23], [24]). Most of these attempts address ways to encourage opportunistic physical activities among adults (e.g. [3], [25], [26]) whereas others focus on specific groups of people such as teenagers (e.g. [22]), female students [27], people suffering from chronic disease [23] and children [12].

### *2.2.1 Foundations*
The research in this chategory are based on some foundations as inspiration, i.e. obesity, testing one's ideas, and shortcomings of others. Below, these are further described.

*Obesity* - All research projects that adhere to this category are based upon an identified need, often but not always (e.g. [25]) based upon unhealthy levels of obesity and overweight, to achieve higher levels of physical activities for a category of people. In the case of [25] their effort is fueled by technological advancements such as heart rate monitors and GPS devices.

*Testing one's ideas* – Some work, perhaps due to their explorative nature, do not go further into the foundations behind their work than to mention some factors that have previously been shown to have an impact on training levels (e.g. [21], [23], [26]).

*Shortcomings of previous research*– Others base their work on more specifically on identified shortcoming in previous attempts. One example is Ojala team [25] that motivate their attempt to develop social features in online sports communities. Another example is Edwards and colleagues [22] system that was developed to find ways to use technology for creating a long-term impact for teenagers' levels of physical activity, a quest motivated by the fact that most such technologies are primarily designed for adults and that other, non-technical, attempts to encourage physical activity among teenagers have only had short-term impact.

### *2.2.2 Approach*
Most projects approach the problem of reduced levels of physical activity in a certain group by suggesting a specific design that they evaluate for a period of time (e.g. [23], [3], [26]). Often these attempts rely either on 1) Functionality for informing a user about his/her activity levels or2) leveraging social pressure or combining these two [25].

*Individual info* – Harm op den Akker an collegues[23] present a Feedback Agent that offer possibilities for users to monitor their current activity level in relation to a suggested reference and send text messages in case of too drastic deviations. The feedback agent is customizable by basing feedback upon user preferences that are both manually entered and a result of a machine-learning algorithm. Anderson et al. [28] develop Shakra, a low cost and lightweight physical activity monitor and health promotion application with no specialized sensors or attachment strapped to the body.

*Individual info and social pressure* – Foster et al [3] provide each user with information about their activity levels but also wanted to see if a social and competitive context could motivate physical activities and combine pedometers with a Facebook application. Lim et al. [26] equipped a number of people with a footwear accessory to see whether it influenced their activity levels and if the fact that it was visible for people around them had an impact on those levels while Ojala and Saarela[25] wanted to build the motivational effect that sport communities have on individuals level of training. Another example of a project promoting personal awareness of activity levels and social pressure/support through competition is found in Gil-Castiñeira et al. [29]. An interesting function in their RunWithUs application is that it also helps in finding a suitable jogging partner.

### *2.2.3 Technology*
Different types of technology were used in the different studies and these could be chategorized into either technology for individual use or for social influence. Cases with both of these types are further discussed below.

*Technology for individual use* – The most common technology used for supporting opportunistic training is the pedometer [27], [21], [3], sometimes as a standalone technology and sometimes in combination with other technologies. Lim et al. [26] used a shoe accessory similar to a pedometer that signaled to its user and also people nearby if the user had been physically active or stationary. Another device that is frequently used is the cellular phone, often a smartphone and its ability to host various applications (e.g. [18], [28], [23]). Consalvo et al. [21] complemented a pedometer with a mobile phone-based fitness journal, The Shakra activity tracker [18], [28] makes use of the mobile phone and fluctuations in GSM signals and proximate cell information to estimate patterns of how the device (and its user) is moving. Harm op den Akker et al. [23] developed a Java/android application for smartphones and an inertial sensor node attached to the user's hip, while Foster et al. connected pedometers to the Facebook application StepMatron.

*Social influence technology* – Several projects use social influence as a way to boost training levels [21], [3], [25], [22] This is done on different ways by for example sharing a social website [3] making indications of activity levels visible for others through the actual measuring device [26] or as with Houston [21] through functionality for sending information about activity levels, see the progress of others, send messages to others and request information about activity levels of others. Ojala and Saarela[25] made use of three different web-based services (SuuntoMovescount, Nokia Sports Tracker, and Polar Personal Trainer) to explore social needs and motivations for sharing data around training. RunWithUs[29] is a web application that is either launched at home or at specific hotspots in central Oulu, Finland. The user can enable tracking functionality and when doing so, they need to estimate for how long they expect to run. When the time is out the movements of the jogger is no longer tracked. The application also suggests routes and records the track that is followed. While running the user need to carry a Wi-Fi device in order for their movements to be tracked and displayed. Any person can then visit a hotspot and see where a specific person (i.e. the nickname of a person) is located and their level of physical condition (fair, regular, very good or professional). Once logged in the runners can filter users on the map to show only friends or members of the same team. Friends can be added from Facebook or the RunWithUs database. Users can also review their own, their friends or their teams statistics.

A quite common way to make use of social influence is to provide competition functionality (e.g. Foster et al. 2010). In their work, they found that participants spent more time on comparing their results with others than on monitoring their own levels of activity. Worth mentioning, however, is also that in this case the participants had previous relationships as co-workers. Lim et al. [26] placed an indicator of physical activity on the actual sensing device, visible for others, with the purpose of promoting social pressure.

### 2.2.4 Procedure

The procedure in the cases included in the studies covering the opportunistic individual training included 1) arranged user tests and 2) ongoing use. A more detailed description is found below.

*Arranged user tests* – The main procedure for evaluating the effect of suggested support is to equip a number of subjects with the technology and have them use it for a limited period of time. Sugano and Hirano [27] arranged a rather longitudinal test that lasted for 96 days, but most empirical studies are much shorter and span only days or a few weeks and in some cases no empirical testing is performed at all (e.g. [23]) Anderson and team [28] tested their Shakra activity tracker for a working week (five days) with nine participants. Lim et al. [26] tested their Pediluma system with five participants for a period of one week (and lost data from one of these). Before that week, a group of 18 users (including these five) wore pedometers for measuring their ordinary activity levels and during the second week five used Pediluma, four used only pedometers, four used a Pediluma that presented random lightning and four used Pediluma with no light at all. Edwards et al. [22]recruited 18 adolescents and had them participate in a baseline week (including providing data about their attitudes regarding training via questionnaires, and parent questionnaires to gain insight into family attitudes) and a six-week main study and usage tracking via a associated website. Foster et al. [3] recruited ten Facebook using nurses who wore the selected pedometers and tested the StepMatron application for 21 days. Data was also gathered, through Google Analytics, concerning the use of the Facebook application.

Often the data gathering via the technology is complemented with some kind of data collection technique that makes before and after assessments possible. Questionnaires are often used [27], [22], [26] but some make us of activity diaries [28] and interviews [18],[28] There are also examples of less conventional data collection such as Sugano and Hirano [27] who measured weight, muscle mass and body fat ratio before and after their test.

*Ongoing use* – There are also examples of researchers that draw upon already existing use of technology for analyzing the role of IT for promoting training (e.g. [25]). Ojala and Saarela[25] used 20 users of three different sporting communities for gathering empirical data regarding social needs and motivations to share data in these communities through a series of interviews. Gil-Castiñeira et al. [29] made a survey-based evaluation of their RunWithUs application with 30 users.

### 2.2.5 Type of results

The types of results presented in this chategory are; 1)Increased level of activity, 2) Design requirements, 3) Importance of social support, 4) Social comparison, and finally, an odd type of result, 5) Measuring problems. Why the last is considered a type of result will be further developed in that section.

*Increased level of activity* – The results often show upon increased level of physical activity[26], [27]. This is used as an argument for a specific prototype, technology or system, which was tested in the study. In Ojala and Saarela[25] many respondents stated that to record and analyze exercise data was the primary function and reason for using online sporting services.

*Design requirements* – As a second step reports often have a more general ambition and promote design requirements [21], [26]. Consolvo et al. [21] present four fundamental requirements for supportive technology i.e. providing proper credits to users for their activities provide personal awareness of their activity levels, supporting social influence and considering practical constraints of individuals' lifestyles. These are quite typical results that are to some extent supported by several other contributions (e.g. [22]). Edwards et al. [22] focused on teenagers and were able to some differences in what makes that group more physically active. They found that teenager' activity levels seemed to be only marginally influenced by persuasions (e.g. positive messages after an activity or provisions of rewards) and that motivational negative messages caused by too little physical activity were considered as demotivating. This is in line with the results of Lim et al. [26] Edwards et al. [22]also found that factors such as workload in school had an impact on the level of training and how authority figures affected when, where and what devices that participants could use.

*Importance of social support* – Edwards et al. [22] also found that social support is of importance, which is a result that was also found in several other reports [28], [3], [25]. Ojala and Saarela[25] also showed how participants in their study viewed online social interaction as adding a new dimension to their exercise. This dimension was manifested primarily in communication, interaction and knowledge sharing between users. In the survey study conducted by Gil-Castiñeira et al.[29]

*Social comparison* – In [26] no support was found for claiming that the social visibility of activity indications had a positive effect, quite the contrary. Encouragements did not occur, likely because of the test design and some participants actually wanted to remove the sensing device during the test period. When it comes to effects of social competition, this was not considered as important among the teenagers participating in the study reported in Edwards et al. [22]. It has however had such an effect among other groups of users (e.g. 28],[21], [13], [3]. Foster team [3] found for example that nine out of 10 subjects walked more when their data could be compared with others.

A widely shared result is also that requirements vary between participants regarding many factors. Edwards et al. [22] found that the attitude towards displaying activity levels (in their case the number of steps) differed among individuals. Other reasons to promote customization was also found in [28] as the Shakra system was used in very different ways by different users. Lim et al. [26] also found differences in the attitudes towards their prototype. Two participants described it as an ice-breaker while others felt that they wanted to remove it and would feel more comfortable wearing it in different contexts and if placed elsewhere on the body. Even if it is not explicitly related to social comparison, users participating in Ojala and Saarela[25] also expressed an interest in customization both when it comes to flexible features for interaction and modifiable privacy settings to be able to modify what and with whom they shared their training data.

*Measuring problems* **-** Several projects report on problems with and importance of accurately measuring and being able to distinguish between different forms of physical activity [21], [28], experienced some problems with their pedometers as these failed to provide correct measurement of overall physical activity, as some activities were not logged (e.g. cycling, weight-lifting and swimming). Similar challenges of making inference between different types of training are also found in [21] This type of result could be argued to not be a real type of result, rather an obstacle for retrieving real results. However, it is very interesting how central measuring problems are in the use of this type of ubiquitous technology, and how frustrated people are when the logging of sessions and runs not have happened. The reason for this is, of course, that measuring is the primer task of the technology in this case. That is why this, seemingly,flaw, became a part of the results of the studies.

This was the description of the body of research scanned. This is now used as a basis for some thoughts about required future research.

## 2.3 Encouragement through toys and games

Several researchers have addressed the possibilities of IT for encouraging physical activity through various forms of toys [30] and games (e.g. [31], [8], [11], [32]). The purpose is to create some degree of enjoyment through individual activities or through social bonding and enjoyment [8], [10]. Even if the focus of exertion games is not primarily on encouraging physical activity it is, without a doubt, an explicit, obvious and positive side effect that help address obesity and overweight [33] [34]. Others make use of enjoyment with the primary purpose of achieving higher levels of physical activity in different groups such as adults [31] teenagers [11] and children [14], children with visual impairments [32]. The most common application area of exertion systems consists of various games that promote activity by for example encouraging people to cycle [35], play soccer [8] or play air hockey [9].

### *2.3.1 Foundations*

Some efforts in this category are primarily technology-driven in that they are focusing on ways to get people more engaged in an activity through use of sophisticated and new technology than what would be possible with more traditional technology (e.g. [8], [12], [31]. Others have a more explicit focus on encouraging physical activity (e.g. [14], [32], [31]). [14])base their contribution on the notion that most previous projects for encouraging physical activity were not adopted enough to reach the intended purpose while Kurniawan et al. [11] motivate their work based upon an identified lack of persuasive systems for physical activities among teenagers. Morelli et al. [32] argue for their exergame

Pet-N-Punch by addressing the difficulties related to being physically active if you are visually impaired and the lack of such games for playing with both arms. They are also interested in trying to understand the optimum rate of response time for non-visual cues. Neustaedter and Judge [31]want to promote a healthier lifestyle through a location-based treasure hunt game called See It and are also interested into which extent it is possible to make such a game scalable and to maintain players' interest for a longer period of time. Leal Penados et al. [12] finds the foundation for their effort in the reported increase of overweight children and an interest in exploring the possibility to use interactive toys and social interaction for promoting physical activity of children.

### *2.3.2 Approach*

Many of the research projects in this category are design oriented and have as their primary approach to developing a prototype and test and evaluate it with users (e.g. [32], [31]). Sometimes a prototype is developed primarily based upon shortcomings of previous attempts (e.g. [31]), sometimes on theory and sometimes for testing novel technology [30].

Mueller et al. [8] designed and evaluated an exertion interface that enabled disparate individuals to play soccer together through a life-size video conference screen with the primary purpose to test whether such an interface, in comparison to a traditional keyboard interface, could promote social bonding across distance. Bielik et al. [14] base their design of their system Move2Play on existing theories regarding behavior adoption among teenagers. Move2Play recommends the appropriate amount of physical activity as a personalized daily plan in combination with automatic tracking and evaluations of completed physical activity with the ambition to encourage long-term sustainability. Morelli et al. [32]) developed a game in which players could play either in one-hand or two-hands mode. The game consists of a plot taking place on a farm and the player is supposed to use one or two hammers to get rid of these by hitting them. Two hypothesis was tested: The error rate is higher if both arms are used and the physical effort demanded as well. Neustaedter and Judge [31] developed a location-based treasure hunt game called See It in which players use different media such as pictures or videos to find hidden "treasures" (i.e. containers called spots or caches) with a paper logbook inside that players can sign. Increased levels of physical activity were encouraged through providing players with clues about the location of treasures in different locations. It was further possible for players to create their own content. Leal Penados et al. [12] developed their toy in order to be able to measure the inactive time of children and to motivate them to be more physically active. The toy named Gum, is designed to envision the central fantasy that the toy needs to be taken care off and it promotes physical activity from a child by signaling its happiness as a result of physical activity. Gum can also interact with the child and encourage activity by demanding food, going to the toilet, taking a shower or a need to play with other toys or Gums.

### *2.3.3 Technology*

Most systems are developed for either smartphone or for/through different game platforms. The most apparent exception is perhaps the cuddly toy developed by Leal Penados et al. [12].

Bielik et al. [14] developed the system Move2Play for mobile phones and collects data from different sensors like GPS, GSM, and accelerometer. The system of motivation in the Move2Play system consisted of four parts: Informative (including self-assessment/monitoring, daily target, goal-setting), Social (including social encouragement, pressure and support, competition, commitment), Gamified (including achievements, badges, unlockable features), Rewards (including virtual market, external games), and Avatar (provides feedback on activity levels and provides advice). Kurniawan et al.[11] made use of iPhone/iPod Touch compatible games and created an interface presented on these platforms. Morelli et al. [32] used the Nintendo WiiMote for their game design and had the application running on a computer with Windows XP, Vista or Windows 7 equipped with Bluetooth for communication with the WiiMote. Neustaedter and Judge [31] developed a web-based game. Leal Penados et al. [12] developed a cuddly toy named “Gum”. Gum possesses interactional capabilities and is designed to envision the central fantasy that the toy needs to be taken care off.

### *2.3.4 Procedure*

Several of the contributions belonging to this category did not contain any empirical testing (e.g. [31]) while others conducted some brief (e.g. [14]) or some more extended tests (e.g. [11]). Leal Penados et al. [12] developed their toy based upon a literature review, but also upon interviews with parents and generative sessions.

Bielik et al. [14] made some brief testing of the Move2Play game with 12 children aged 12 to 13. This study consisted of only briefly testing the functionality the game provides and was not thoroughly analyzed.Kurniawan et al. [11] initiated their project by distribution surveys to school children and receiving 28 completed surveys. This was followed up by focus group discussions with five teenagers and testing of the application for a period of four weeks.

Morelli et al. [32] arranged tests with twelve blind children for two days. The group was divided into two groups where one group tested the one-arm version of the game the first day and the two-armed version the next and the other way around with the other group. Children tested the two versions of the games for ten minutes each and their heart rates were measured and accelerometers used to capture their activity levels. Participants finally completed a subjective survey in the end of the study.

The toy developed by Leal Penados et al. [12] was grounded in previous research regarding motivational factors for behavioral change as well as interviews and generative sessions. The key elements considered in the design of the toy were among others that social interaction, curiosity, control, challenge and surmounting environmental and cultural barriers is of utmost importance. The concept was later tested on partially developed prototypes in two test setups. The first tests were conducted with a Gum attached by wire to a computer. It involved eleven children (age range 4 to 8) and lasting 2 hours each. The second set-up involved one boy (age 7) who used a wireless Gum for one hour per day in 10 days.

### *2.3.5 Results*

Most of the contributions belonging to this category found an increased level of physical activities to be a result of playing a game (e.g. [32]) or playing with a toy (e.g. ). [14] Their contributions are related to social bonding but also to fun, which is, of course, useful motivation for being physically active. Kurniawan et al. [11] found that different personality traits are important to consider when developing applications for physical activity. They need to be customizable to appeal to the need of different personality traits. It was also found that games can be used to encourage positive behavioral beliefs and that they should support playing outdoors, socialization and/or competition, easy to learn and provide plenty variations. All teenagers participating in the study want to be encouraged by positive phrases and an anthropomorphic characteristic of the device. It was also found that the system in total induced internal motivators for being more physically active. Kurniawan et al. [11]found that users wanted automatic logging of user activities and that customization is important.

### *2.3.6 Suggestions for future research*

Below, some of the suggested future research proposed by authors of the papers, are presented. The types of suggestions are: 1) Change of target group, 2) True ubiquity, 3) Long-term use 4) Accuracy of data, and finally 5) Limited timeframe of studies

*Change of target group* – Bielik et al. [14] focused on children in their paper and suggest as a step forward to address adults and seniors with the Move2Play system, a move that requires different motivational schemes and a new design for data visualization.

*True ubiquity* – A large proportion of the research projects has made use of devices that on their own, or through some additional functionality, support physical activity monitoring and reporting and do not take into consideration the context in which a large extent of all physical activities take place, the gym. When taking the most popular forms of exercise, according to the American Time Use Survey about Sports and Exercise [36], many of these are possible to perform at a well-equipped training facility. In such a context a wide range of technologies are ubiquitous and data about the activities of individuals are as a consequence gathered and stored within that context. Instead of trying to capture data on activity levels through the use of a single device an interesting step forward would be to gather all activity data available in well-equipped training facilities and present and use that information to encourage increased levels of physical activity. That would be an interesting step towards reaping the harvest that ubiquitous computing environments actually saw.

*Long-term use* – Undeveloped thought. Many papers address the difficulty of promising longitudinal use of a system (e.g. [11]; [28]). This could be used for arguing that a different approach should be applied in which a system supports flexibility in training patterns over time.

*Accuracy of data* – Many share the same problems of losing data that is gathered through their devices. A tool that can overcome this is welcome.

*Limited timeframe of studies* – When reviewing the research projects addressing IT and physical activity that rely on empirical data it is apparent that most of these are based on rather short empirical studies. As highlighted by Anderson et al. [28], and as experienced by most of us having experienced bursty nature of increased levels of training and diets, an important step in future research is addressing which factors that contribute longitudinal, uninterrupted, habits of physical activities and the role for IT for achieving that.

## 3. PRESENT AND FUTURE CHALLENGES IN SPORTS IT RESEARCH

One challenge that this overview raises is the possibility for longitudinal effect of the suggested approaches. This is specifically addressed by Anderson et al. [28] and as most of the work is based upon shorter periods of use this is an important step for future research. Several reports argue for embedding exercise technologies into products that are already in use to truly benefit from the possibilities that ubiquitous computing technology provides (e.g. [22]) or developing them to better blend in into the context where they are used [26].

Another challenge is related to the problem of inferring different activities in data collection. Consolvo et al. (2006) elaborate on the issue of choosing between manual and automatic journaling. Previous reports indicate a positive effect of manual journaling as it has a documented positive effect on levels of training and improves the feeling of control of what is logged and shared. Other reports e.g. Edwards and colleagues [22] argue for seamless and automatic upload and storing of captured data. One benefit of this approach is how it helps to take the burden of remembering from the user. Related to this challenge is also how supportive technology can handle days without training due to sickness, trips or extremely busy schedules. This is an especially important challenge when data collection about activity levels is gathered automatically. For example, when learning algorithms are used [23]).

A third challenge is related to pre-existing motivation for increased levels of physical activity. The teenagers that partook in the study of Edwards et al. [22] did not exhibit health problems and the needs of those that do might differ, nor did the nurses taking part inthe Foster [3] study.

A fourth suggestion would be to explore the effect of competitive aspects in supportive technology. As shown above, there are different reports about that and a way forward could be to use the same platform for testing support for physical activity among a more diverse user population than what is often the case in previous research. Another interesting thing would be to explore how competition is influenced by whether or not previous relations exist between peers.

## 4. DISCUSSION

Research on SportIT is today a subfield in, for instance, the Human-Computer Interaction (HCI) research community. It could be seen as a primer candidate to become a research field of it's own soon, since the body of research is becoming so large. That will shed light to some of the initial challenges and these will be solved when more and more research becomes conducted and published. This is important in order to design better and more useful digital tools and artefacts to be used as SportIT. Hopefully, this development will help for many people in the struggle to become more healthy in life.

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