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ČESTNÉ PROHLÁŠENÍ

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TRI-AXIAL ACCELEROMETER USAGE IN PEDAGOGICAL PROCESS IN CZECH ELEMENTARY SCHOOL

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Abstract

Hypoactivity and sedentary lifestyle are pandemic problems across all population groups and regions. The objective is to describe current trend of physical activity (PA) and to integrate motivational factors to everyday life.

The aim of the study is to find, discover or establish algorithm how to evaluate PA characteristics and give pupils, their parents, and their teachers a fast feedback about daily PA by using modern digital technologies.

We designed a method that can provide well-timed information about the activity of a child, which is useful especially for their parents to help them prevent children from negative impacts of PA insufficiency. The method also provides data that can help the pedagogical process to be more active and to change stereotypes in schoolchild behaviour. The research is focused on pupils at the age of 7 – 9 years and the method will be used in a post-doctoral project to collect data from elementary schools in the Czech Republic.

Key words: *physical activity, accelerometer, pedagogical process, bone health*

Introduction

PA of all age and social groups is currently being discussed in the whole society. Mainly its relation to the trends of obesity and hypokinesis in the whole population are alarming not only in North America where this trend occurred first but also in the regions familiar to Czech population. Based on the current research, this issue has also emerged in the regions which did not suffer from this problem before. Authors point out this new phenomenon mainly in context with dynamic development of economics in Asian countries.

In many studies, intentional PA is suggested as a key preventing factor in civilization effects of the decrease in PA. There is a frequent demand to restore original natural spectrum of physical activities with respect to a decrease in both work and leisure organism loading as well as a shift to sedentary way of working and use of means of transport.

It is of course important to target preventive and educational projects on the whole population without making age differences. However, from pedagogical point of view, the most important group seems to be younger school age, i.e. the age range from 6 to 11. This ontogenetic period still manifests bigger natural need of PA which is a logical consequence of games connected to PA in the pre-school period. At the same time, individuals in this age range are faced with the start of compulsory school education, which brings about the need to conform to a new pace and schedule of the day. Even though there are modern trends in the pedagogical process to provide more varied range of activities, entering school education means a radical change in PA for children mainly with respect to spending day in a sedentary way. Moreover, it is assumed that habits built in this developmental period leave long-term tracks in memory and affect the need for PA of an individual in succeeding developmental periods.

More opportunities of PA for children in this age period are usually offered in physical education lessons at school and the activities that take place outside school. However, the role of the teacher is quite limited and the parents should take the main motivational role. A frequent problem is parents' insufficient knowledge of needs of their children with respect not only to evaluation and results at school but mainly with respect to the complex physiological development of a young organism.

All the above-mentioned factors initiated the idea to offer a more complex tool and form of feedback for both teachers and parents.

From the point of view of a teacher and pedagogical process, the most important thing is to evaluate the time spent doing PA, its intensity during the time spent both at school and in individual lessons, and effectiveness of teaching physical education etc.

Similarly, it is good to give parents a tool which could easily provide information about the amount of PA done by children during the day. At the same time, it could show them the difference between the results of their child and the recommendations on adequate PA during the day in longer time periods.

Further, it seems beneficial to make PA monitoring available and more detailed, namely monitoring measured date which could enable to assess the influence on other physiological indicators and risk factors, with a suitable database tool.

A less discussed topic is the influence of PA on the structure of bone tissue. Some studies (for all Hindt & Burrows, 2007 or Mackelvie et al., 2002) have shown that sufficient intensity of PA affects the structure of bones to a considerable extent, mainly the structure of child bones.

After a longer examination, a possible optimal method seems to be using a tri-axial accelerometer functioning in the form of an autonomous device with a possibility to store data in a built-in memory via wireless transfer into the storage database for analysis.

Material and methods

In the first stage, it was necessary to select a suitable device and diagnostic methods as well as the way of transferring, storing and assessing data.

The device had to meet the following requirements:

- as big autonomy as possible without the necessity of user interaction (minimizing possible effect on the results through interaction of the tested person with the device)
- as long battery life as possible without the necessity of regular recharging (minimizing loss of data caused by forgetting to recharge the battery)
- ability to store data with sufficient frequency for a long time
- possibility for the tested person to wear the device comfortably on the body (low weight, ergonomic shape)
- adequate price (to make it possible to examine a large number of people at the same time)
- easy data transfer without the interaction of the user (wireless data readers or mobile phone connection)
- mechanical resistance and, if possible, water resistance

During planning, we declined all devices functioning on the principle of monitoring heart rate because they usually require using breast monitoring belt which can result in subjectively-perceived worsened breathing with some people. Further, it is necessary to download data regularly through connecting it to PC.

Another possibility is devices functioning on the principle of GPS. However, in this case, monitoring in roofed buildings is complicated. The devices are also too energy consuming.

Yet another possible category is pedometers. The devices are usually quite simple and user-friendly. However, for the purpose of our work, they do not provide sufficient sensitivity and precise data.

An ideal option seems to be devices functioning on the principle of tri-axle accelerometer. Still, there are again more possibilities. The easiest would be using 3D sensor from a mobile phone which is nowadays owned by all school children. However, the result of a previous research showed (Fedrová, 2013) a disadvantage in different location for placing the device on the tested person and different sensitivity of used chips. Another complication is that when using such device at school, it is not possible to carry the phone during some activities, e.g. in physical education lessons. Therefore, we chose the option which seemed the most practical – using autonomous accelerometer in the form of a small device with its own battery and incorporated memory. Apart from the benefit of relatively long battery life, the device can also be easily placed on the body of the tested person which does not limit the person during common PA. In accordance with the previous studies, the location for the device was chosen to be the left or right hip at the back of the person (for all Rowlands & Stiles, 2012).

Moreover, such accelerometers can be bought also in commercial make, e.g. Actigraph, Tritrac, or Actiwatch. Further, similar devices are also produced as personal training and monitoring units. The disadvantage, however, is high price starting at approx. $ 100.

Still, last year we succeeded in initiating cooperation with UIIL Champaign, Department of Kinesiologoy and Human Health. The result is the development of a device which meets all the required criteria and the price would be less than $ 50. At present time, we already have pre-production samples which are being tested and software is being adjusted.

The method of fastening the device is shown in the following figure.

The device, which is carried by the individual on the hip on an elastic stripe, is supplied with a high-capacity battery that ensures the functionality for a minimum of one month. After the start of measuring, the device stores accelerometric data with the frequency of 100Hz in the incorporated memory. During the detection of telemetric scanner, a wireless module activates and during a short time it transfers the stored data from the device to the central storage on the server. At the same time it deletes the memory of the device. Data can be transferred also via Bluetooth into a mobile phone and then from the mobile phone to the server.

Then the data can be accessed online from a webpage and they are accessible to the research team, teachers and parents, following the settings (figure 1).

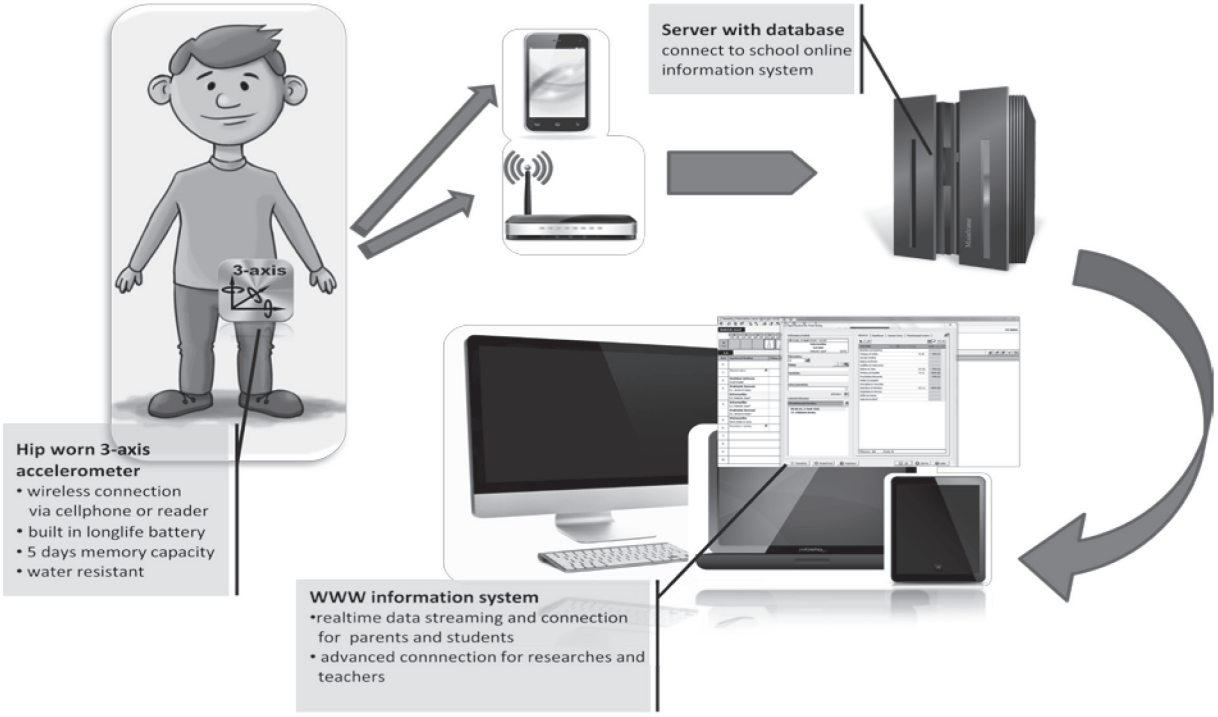

Figure 1: Algorithm of data recording, transfer and evaluation

Method of measuring and data processing

The measuring itself as well as the information output can be divided into three categories.

PA monitoring

PA monitoring provides data about the PA amount and intensity of a tested person during the whole day. It records physical activity through the so-called epochs, each lasting for 5 seconds, whereas PA is divided into categories: low, moderate and vigorous. This type of recording makes it possible to evaluate whether the tested person has reached the desired level of PA during one day. It also allows displaying the entire PA for a longer period, it alerts on insufficient PA etc. The method of dividing PA into categories shall be set similarly to the ActiGraph device so that the results could be compared with other studies.

The limiting criteria are assumed to be the recommendations of WHO, EU Sport Ministers and ACSM to perform at least 30 minutes of moderate PA every day. This shall be then verified in a pilot study.

Another method of data monitoring shall make it possible to evaluate the effectiveness of pedagogical process, whereas it will be possible to tell with a considerable level of precision the amount of effectively used time during one lesson. The distribution of PA during one lesson can be evaluated quite precisely, which gives the teacher precise feedback about the real use of time of the lesson.

Another possibility is to create a motion profile of each individual with respect to the parts of the day, days of the week and other time periods. This method will help to assess the amount and duration of static positions which the tested person takes during the day and on the basis of this information to set precautionary measures.

The influence of PA on the quality and structure of bone tissue

This type of monitoring uses RAW data from the device which makes it possible to reveal and diagnose practically any deviations in acceleration and bursts. Within the diagnostic output we are solving incorporating this factor on the basis of the work of Ahola (2010) whom, together with the research team, specified the formula for calculating the score of the influence on bone tissue. However, we realized that this tool is objective only with regard to the vertical part of motion and does not take into consideration the horizontal application of force on the organism. This area shall be further subject to a possible adjustment in cooperation with our partner in order to create a diagnostic tool which would enable

objective and complex application on the organism and educe a suitable index. This would serve as a quantitative value assessing the sufficiency of PA during the day as the influence on the quality of bone tissue.

Further outputs from the device and their use

The output of "RAW data" can be further used in the area of safety and injury prevention. The database allows filtering data which exceed the set factor. The factor can be the size of acceleration, frequency of acceleration, its duration etc. In this way, the risky parts of the PA of the tested person can be diagnosed and help reveal risk activities or areas and time. This can be considered a relatively objective tool for preventing school and outside-school injuries, thus making greater the possibility of feedback of the pedagogical unit. It is easy to reveal possible risk activities during a lesson and also alert on individual specific dangers of each tested person, for example by doing the given activity in a wrong way.

Conclusion

The testing carried out by the authors as well as the previous studies suggested that the tri-axle accelerometer could be an optimal device for monitoring quality and quantity in school and outside-school practice. As long as it is possible to solve the problem of high price of the device so that it could be used on a large scale with a larger number of school children, this method can bring about large amount of precise data describing the quantity and quality of PA, not only with school children. With respect to some alarming data about children obesity and hypokinesis, it is necessary to discover and know the real composition of motional habits of this population group.

Of no less importance is the possibility of feedback on the quality of pedagogical process; easily accessible qualitative and quantitative data about the PA of school children make it possible for the teacher to adjust the lesson with respect to effectiveness.

There is a growing importance of the necessity of training and checking sufficiency of substitute PA of individuals in such a way that insufficient PA caused by the sedentary way of life could be compensated. PA insufficiency can be manifested on a long-time scale in regressive physiological changes of organism. In this area, there is also space for education and motivation of the youngest population group to ensure at least minimal recommended PA. Accelerometry together with qualitative and simple interpretation software can be a suitable tool for this.

Naturally, the set of data collected in this study has a potential for further use; whether in the area of injury prevention and safety at schools or the data can be further analysed using modern technology of "big data" and "data mining".

All these activities have been incorporated into one of the postdoctoral program of one of the authors and shall be practically employed in the summer and autumn periods of 2014 within a pilot measuring at an elementary school in Brno.

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