

# THE ANALYSIS OF OBJECTIVELY MEASURED WEEKLY PHYSICAL ACTIVITY OF ADOLESCENT BOYS

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## ABSTRACT

*Research background and hypothesis.* The objective methods for measuring PA are used more and more widely in various research studies all over the world. To our best knowledge, this pilot study is the first attempt in Lithuania to objectively assess physical activity of adolescents with an ambition to develop a more accurate methodology in assessing physical activity.

*Research aim* of this study was to analyze the objectively measured weekly physical activity results of adolescent boys.

*Research methods.* The PA of schoolboys was measured using Tri-axis ActiTrainer Activity Monitors. Boys were asked to wear the monitors for the whole week. The level of the intensity of PA was determined by calculating energy consumption in METs. Based on the frequency of vigorous and moderate PA per week, the participants of this study were divided into PA groups.

*Research results.* All of the schoolboys experienced LPA on each of the assessed days. MPA on each day was experienced by 59.6 % of the boys. No participants achieved VPA on a daily basis. The frequency of MPA and VPA experienced most often was 5–7 and 1–3 days per week, respectively. The total PA measured during the week was largely comprised by LPA, i. e. 79.8%; MPA and VPA were 18.8 and 1.4%, respectively.

*Discussion and conclusion.* Boys who achieve VPA, have a greater total PA during the week than those boys who do not experience VPA. If boys achieve VPA on more than 2 days during the week, even if it is just for 10 min, there is a significant increase in the total amount of weekly PA as well as a decrease in their body mass index (BMI). Boys' who do not experience MPA at least for 6 days/week, the total amount of weekly PA decreases.

**Keywords:** PA frequency, PA intensity, PA volume.

## INTRODUCTION

Physical activity is vital for maintaining person's health and body strength. Many diseases are related to physical inactivity, which may be a hypokinetic cause of illness (Welk, 2002). Continuous physical activity (PA) from an early childhood may improve metabolic function and regulate arterial blood pressure, which in turn may prevent from the chronic non-contagious disease risk factors (such as overweight, high blood pressure, hypercholesterolemia, etc.), and, therefore, may decrease the potential of occurrence of such chronic diseases as obesity or cardiovascular illnesses at an older age (Berenson, 2002; Gordon-Larsen et. al, 2004). There are

about fifty different questionnaires available to use when assessing person's physical activity (Sallis, Saelens, 2000). Most experts suggest using the so called "golden standard" – the energy consumption – in order to determine the level of PA accurately (Sirard, Pate, 2001). In practice, physical activity and energy consumed for it are measured using heart rate and activity monitors (i. e. pedometers and accelerometers). Recently, some scientists (Dencker et al., 2006) raised doubt whether a questionnaire is a reliable tool to collect the information regarding PA. To be more precise, the reliability of the questionnaires, attempting to assess physical activity rather than

training, is under scrutiny. It is only natural that other tools such as accelerometers are being used to evaluate PA. An accelerometer, as non-invasive research equipment, can accurately estimate body movement; be useful in the labs as well as in the research field; indicate the intensity, frequency and duration of activity; deliver information at one-minute intervals. The data is easy to collect, analyze and store for long periods of time (eg. for weeks). Nevertheless, this PA assessment method has its own shortcomings (Catellier et al., 2005; Trost et al., 2005; Ward et al., 2005). For example, the cost of these tools may limit the number of subjects to be assessed. Some limitations occur when registering certain type of PA such as upper body movement, downhill walking, or activity in the water. There is also a lack of practical comparison of certain social groups with regards to energy consumption. Besides, no guarantees are available that these monitors will be carried for a prolonged period of time, when the participants of the study are not being observed. It is thought that accelerometers provide accurate assessment of the total PA, but not energy consumption, especially during the leisure time (Brage et al., 2004).

Since 2001 there have been more studies available in which the three-axial accelerometers were used to assess PA in children (Eisenman et al., 2004). The mono-axial accelerometers are usually worn, and their sensor is oriented in vertical plane. Multi-axial accelerometers are most sensitive in vertical plane, but they also sensitively react to a movement in other directions (Chen, Bassett, 2005). On the contrary, the three-axial accelerometers display the readings in each plane separately as well as integrated results (Rowlands, 2007).

Nowadays, researchers trust those methods of data analysis of speed monitor, which allows determining the type and intensity of physical activity when the activity is known (Poerber et al., 2006).

The objective methods of measuring physical activity are used more and more widely in various research studies all over the world. To our best knowledge, this pilot study is the first attempt in Lithuania to objectively assess physical activity of adolescents with an ambition to develop a more accurate methodology in assessing physical activity.

The aim of this study was to analyze the objectively measured weekly physical activity results of adolescent boys.

## RESEARCH METHODS

The participants of this study were 104 healthy adolescent boys ( $15.3 \pm 0.06$  years of age;  $63.0 \pm 1.32$  kg of weight, and  $175.8 \pm 0.78$  cm of height). The boys were selected using cluster screening, i.e. the schools were randomly selected, and their 9<sup>th</sup> grade schoolboys were randomly invited to take part in the assessment. Initially, the data was collected from 112 boys, but 8 cases were withdrawn from the final analysis due to incomplete results and failure to wear the monitor throughout the defined period of time.

The physical activity of schoolboys was measured using actigraphs (*Tri-axis ActiTrainer Activity Monitors*). Boys were asked to wear the monitors for 7 consecutive days, i. e. whole week. The PA assessment monitors were placed on a special belt on the right hip site. The level of the intensity of physical activity was determined by calculating energy consumption in METs; bouts of physical activity (PA) had to last for at least 10 minutes without interruptions. Light PA (LPA) equals up to 3 METs, moderate PA (MPA) – 3–6 METs, and vigorous PA (VPA) – 8 or more METs. Based on the frequency of vigorous (VPA) and moderate physical activity (MPA) per week, the participants of this study were divided into physical activity groups.

The study was undertaken in spring 2010 during the second PE lesson on the measurement day in four randomly selected secondary schools of Kaunas. At first anthropometric measurements (standing height and weight) were performed. Then the Actigraphs were placed on the boys to register PA data for the whole week, i. e. from Monday 10 am to the next Monday 10 am. All of the participants and their parents or foster parents gave their informed consent to take part in the study. The time and location of the measurements to be taken were agreed upon in advance with the administration of the schools as well as the teachers. The volunteers were free to withdraw from the study at any time without any consequences.

Statistical analysis was carried out using SPSS 14.0 package for Windows. Standard statistical methods were used to calculate means and standard error ( $\pm$  SE). A one-way analysis of variance (ANOVA) was used to establish the differences between the measurements. A significance level of 0.05 was used.

### RESEARCH RESULTS

The results of our study indicate that all participants experienced LPA on each of the assessed days. MPA on each day was experienced by 59.6% of the boys. No participants achieved VPA on a daily basis. A more detailed data on physical activity frequency are presented in Figure 1.

Moderate PA, which corresponds to 3–6 METs, is most often achieved 5–7 days/week (Figure 1). Only one case indicated MPA to be experienced less often than that. On the contrary, VPA was

most often experienced by the boys on 1–3 days/week; in separate cases – 4–6 days/week.

The total physical activity measured during the week was largely comprised by LPA, i. e. 79.8%; while MPA and VPA were 18.8 and 1.4%, respectively.

Based on the frequency of the experienced VPA during the week, the participants were divided into groups, and their weekly physical activity, with regards to the intensity, was analyzed (Figure 2).

In the groups of boys experiencing VPA on more than two days per week weekly LPA amount

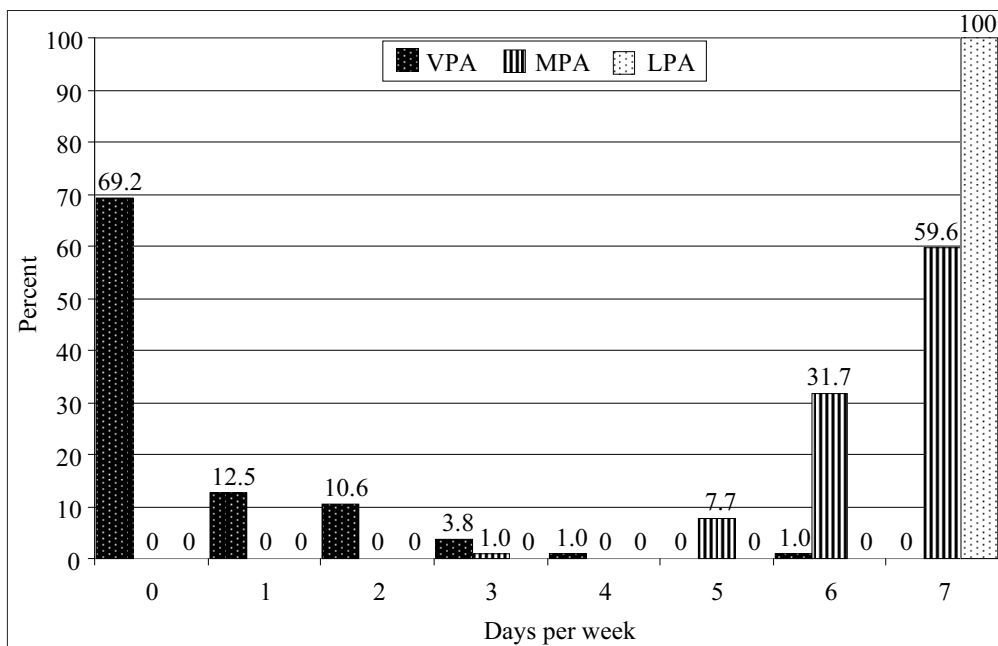


Figure 1. The frequency of different intensity physical activity experienced by schoolboys

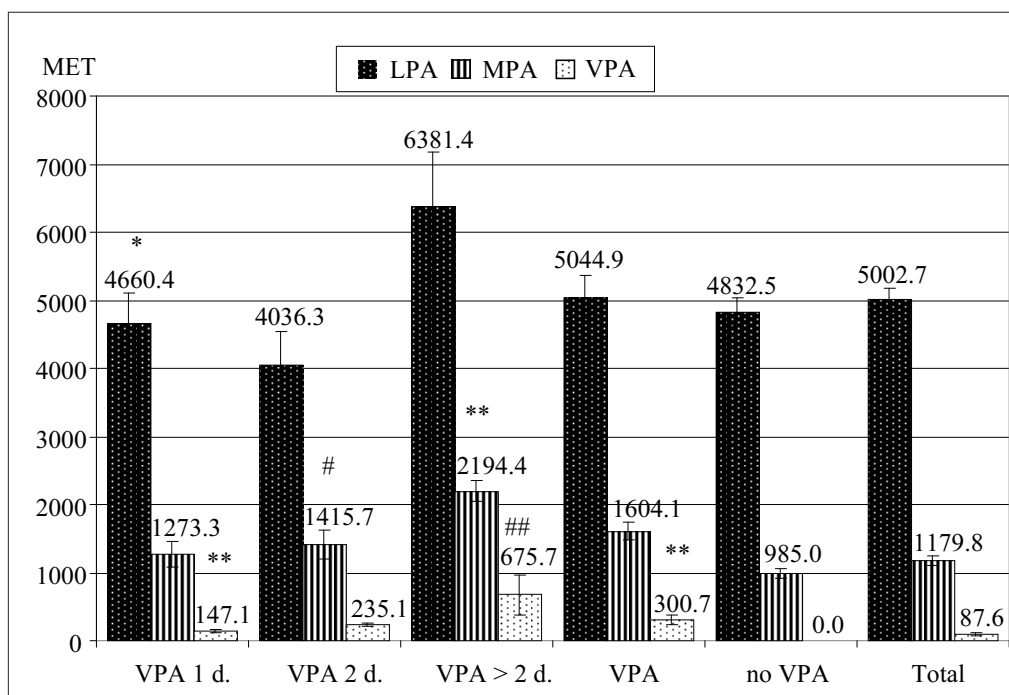


Figure 2. The intensity-based weekly physical activity of the adolescent boys

**Note.** The participants are divided into the groups according to the frequency of the experienced VPA during the week). \* –  $p < 0.05$  comparing with the groups of VPA experienced more than 2 days/week; \*\* –  $p < 0.05$  comparing with all of the groups except VPA 2 days/week; # –  $p < 0.05$  comparing with a group having experienced no VPA group; ## –  $p < 0.05$  comparing with all groups.

was greater than these who experience VPA only on 1 day/week ( $p < 0.05$ ). Boys who achieved the level of VPA on two or more days per week had greater MPA amount than the boys who did not achieve the level of VPA during the week at all ( $p < 0.05$ ). Furthermore, for boys who experience VPA more than two days per week, the total weekly VPA amount was significantly greater than for those boys who experienced VPA less often or not at all ( $p < 0.05$ ).

After dividing the participants into groups according to the MPA frequency during the week,

the weekly physical activity regarding the intensity was analyzed (Figure 3). There were no significant differences in weekly LPA amount.

The analysis of the intensity-based weekly physical activity indicated no significant differences in any of the PA levels. It was observed that the group of boys achieving MPA on less than 6 days/week was the one which did not experience VPA during the week.

The sum of the total amount of weekly PA, consisting of LPA, MPA and VPA, is presented in Figure 4.

Figure 3. The intensity-based weekly physical activity of the adolescent boys (the participants are divided into the groups according to the frequency of the experienced MPA during the week)

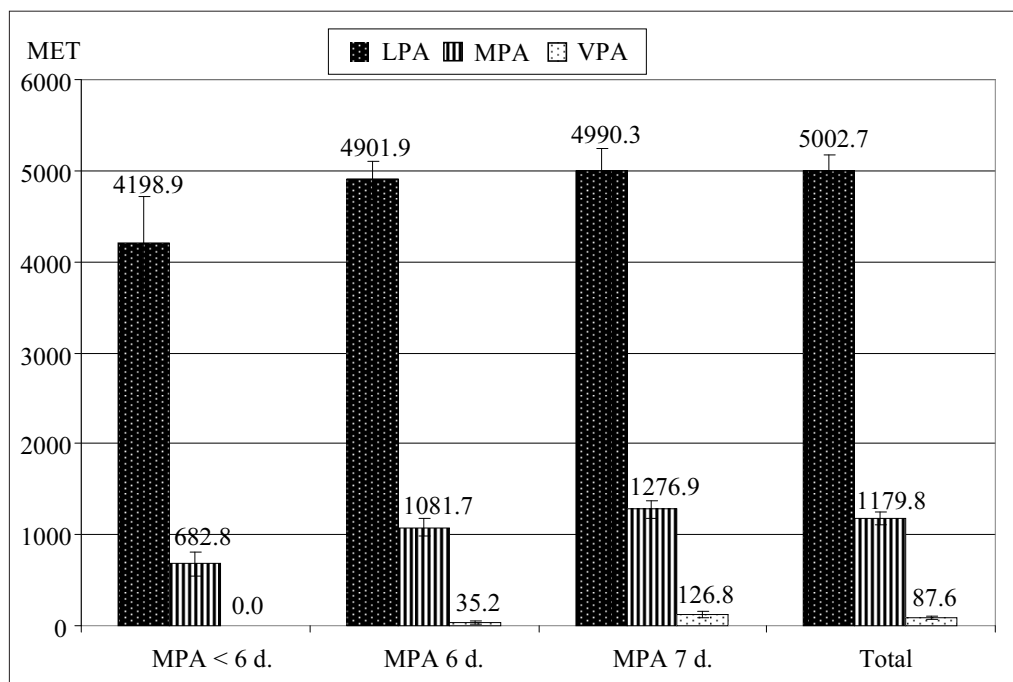
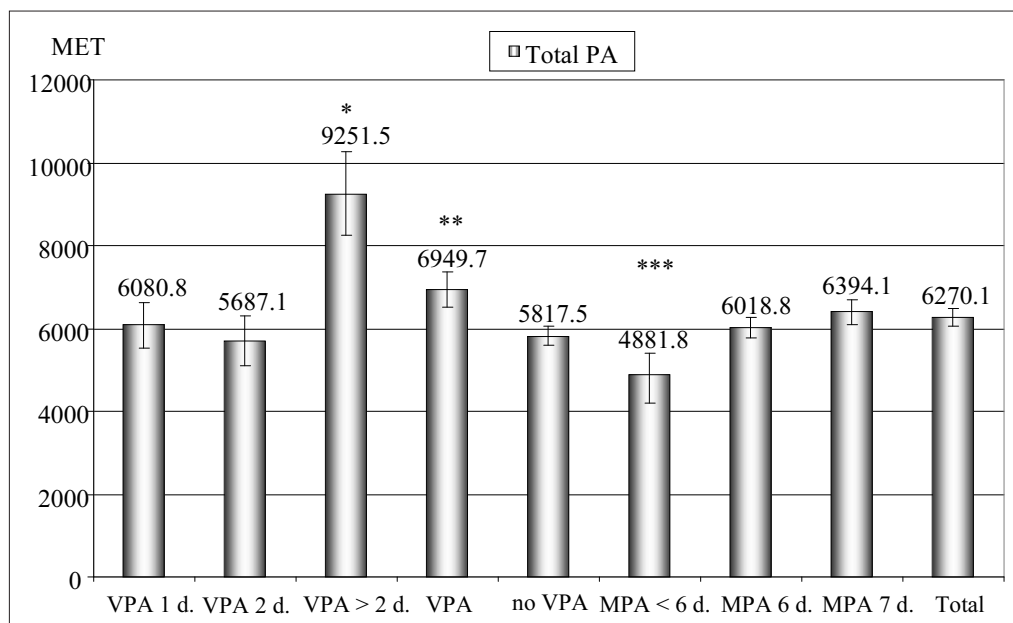


Figure 4. The total amount of weekly physical activity of the adolescent boys



Note. \* –  $p < 0.05$  comparing with other groups; \*\* –  $p < 0.05$  comparing with no VPA and MPA < 6 days/week; \*\*\* –  $p < 0.05$  comparing with MPA 7 d/week.

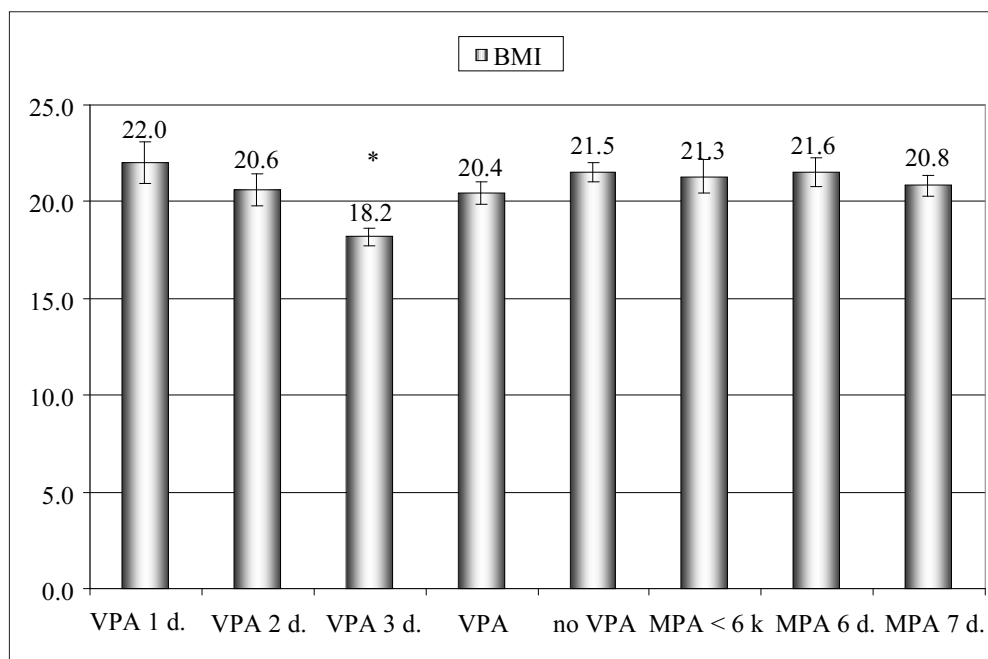


Figure 5. The BMI of the boys of different weekly physical activity

Note. \* –  $p < 0.05$  – comparing with “VPA 1 day/week?”. “no VPA”. and “MPA 6 days/week”.

Boys who experienced VPA more often than 2 days/week had a greater total amount of the weekly physical activity ( $p < 0.05$ ) (Figure 4). For boys achieving VPA, physical activity amount was significantly greater than for those, who did not experience VPA or achieve MPA less than 6 days/week ( $p < 0.05$ ). Boys whose MPA was less than 6 days/week had a significantly lower amount of weekly physical activity than those who achieved MPA for 7 days/week. The body mass index (BMI) of the boys of different weekly physical activity is presented in Figure 5.

These results indicate that boys experiencing VPA 3 or more days/week had significantly lower BMI than those who experienced VPA on 1 day/week, not experiencing VPA at all during the week, or than those who experienced MPA 6 days/week ( $p < 0.05$ ).

The study revealed significant influence of the VPA experienced during the week for the total amount of PA; therefore, the duration of the VPA was also analyzed. The greatest duration of VPA was 69 minutes per day. On a singular occasion, one participant achieved VPA level 6 times per week, which amounted to 266 min, i. e. 1596 METs. Ten boys achieved VPA for more than 20 min/day. In all those groups, where boys achieved VPA, their mean VPA per day ranges from 14 min 28 s to 19 min 47 s, although no significant differences between them were observed.

## DISCUSSION

Evidence exists that regular physical activity improves children’s physical, mental and social health (Louie et al., 2003). Continuous physical activity from an early childhood may improve metabolic function and regulate arterial blood pressure, which in turn may prevent from the chronic non-contagious diseases’ risk factors (such as overweight, high blood pressure, hypercholesterolemia, etc.), and, therefore, may decrease the potential of occurrence of such chronic diseases as obesity or cardiovascular illnesses at an older age (Berenson, 2002). More physically active children have greater self-esteem (Kirkcaldy et al., 2002). Also, their academic achievements are greater (Wong, Louie, 2002).

The effect of PA on health depends on the amount of physical activity and is not adequate in all cases. The most legitimate PA recommendations for children and youth are recognized by the World Health Organization: moderate-to-vigorous PA (i. e. more than 3 METs) for at least 60 minutes each day. Research has shown that positive effects of more intensive PA to children’s and adolescents’ cardiovascular fitness are greater than that of a lower intensity, which is an important factor in the prevention of obesity (Ruiz et al., 2006). Our study indicated that adolescent boys who experience VPA and MPA more often during the week have



lower BMI ( $p < 0.05$ ). Therefore, prescribing physical activity of a particular intensity should be one of the most important strategic elements in the enhancement of children's and adolescents' health and the prevention of diseases (Strong et al., 2005).

In 2002, a study attempted to compare physical activity of schoolchildren from 35 different countries: the means of physically active days per week were calculated using J. J. Prochaska et al. (2001) method. It was found that boys were physically active for 4.6 days per week, while girls – 3.9 days per week. The better results were observed in boys from Ireland, USA, and Great Britain; and in girls from Canada, Ireland, USA, Check Republic and Netherlands. If we attempt to evaluate physical activity based on this indicator, which reflects not only exercise and sport, but other types of physical activity as well, Lithuanian schoolboys' physical activity is rather promising, comparing with other countries.

In Lithuania, there is lack of studies that would be designed to objectively evaluate physical activity (using pedometers, accelerometers, etc.) in various populations, which would allow more precise and

comprehensive analysis and comparison of the results with other studies.

## CONCLUSIONS AND PERSPECTIVES

Boys who achieve VPA, have a greater total physical activity during the week than those boys who do not experience VPA. If boys achieve VPA on more than 2 days during the week, even if it is just for 10 min, there is a significant increase in the total amount of weekly physical activity as well as a decrease in their body mass index (BMI). If boys do not experience MPA at least for 6 days/week, the total amount of their weekly physical activity decreases. These preliminary results of objectively measured physical activity of adolescent boys revealed the proportions in weekly physical activity based on intensity and frequency; therefore, further research is necessary when analyzing the difference in schoolchildren's physical activity; and relationships with body composition and health-related physical fitness.

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## OBJEKTYVIAI NUSTATYTO PAAUGLIŲ BERNIUKŲ SAVAITINIO FIZINIO AKTYVUMO REZULTATŲ ANALIZĖ

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### SANTRAUKA

*Tyrimo pagrindimas ir hipotezė.* Pasaulinėje mokslo praktikoje fizinio aktyvumo (FA) objektyvūs nustatymo metodai naudojami vis dažniau, tačiau Lietuvoje aptikti tokio pobūdžio tyrimų mums nepavyko. Taigi mes atlikome bandomąjį tyrimą objektyviai nustatydami paauglių FA ir norime pradėti plėtoti Lietuvoje tikslesnę FA nustatymo metodiką.

*Tikslas* – išanalizuoti objektyviai nustatyto paauglių berniukų savaitinio fizinio aktyvumo rezultatus.

*Metodai.* Mokinių FA nustatytas naudojant *Tri-axis ActiTrainer Activity Monitor* prietaisus. Berniukų buvo prašoma prietaisus nešioti savaitę kas minutę fiksuojant fizinę veiklą. Fizinio aktyvumo lygmuo buvo nustatomas taikant MET'ų skaičiavimo metodą, kai fizinė veikla trunka vienu metu ilgiau negu dešimt minučių. Analizuojant fizinio aktyvumo duomenis, FA standartizuotas pagal energijos suvartojimą, t. y. intensyvumo lygius. Pagal juos tiriamieji buvo suskirstyti į FA grupes pagal didelio ir vidutinio FA dažnį per savaitę.

*Rezultatai.* Tyrimo rezultatai parodė, kad visi tiriamieji patiria mažą FA kiekvieną dieną, vidutinį kasdien patiria 59,6% tiriamųjų. Tuo tarpu kasdien didelį FA patiriančių berniukų nenustatyta. Tiriamieji patiria vidutinį FA dažniausiai 5–7 dienas per savaitę, o didelį – nuo 1 iki 3 dienų per savaitę ir atskirais atvejais 4 ar 6 dienas per savaitę. Didžiąją dalį bendro FA sudaro mažo intensyvumo fizinė veikla – tai sudaro 79,8% nuo bendro per savaitę patirto FA, kai vidutinis FA sudaro 18,8%, didelis FA – 1,4%.

*Aptarimas ir išvados.* Didelį FA patiriančių berniukų bendras savaitinis FA didesnis, negu jo nepatiriančių berniukų. O patiriant didelį FA daugiau negu dvi dienas per savaitę bent po 10 minučių, reikšmingai padidėja bendro savaitinio FA apimtis, ir šie tiriamieji turėjo mažesnę KMI. Berniukams nepatiriant vidutinio FA bent šešias dienas per savaitę, sumažėja bendras savaitinis FA.

**Raktažodžiai:** FA dažnis, FA intensyvumas, FA apimtis.

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