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Evaluation of daily physical activity levels with metabolic holter in adolescents

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Abstract

The aim of this study was to evaluate daily physical activity levels in adolescents, aged 11, 12 and 13 with metabolic holter. Totally 99 healthy and volunteer male students, aged 11-13 years, participated in this study. The participants were divided into three groups according to their chronological age: 11 age group (n: 35), 12 age group (n: 34) and 13 age group (n: 30). The physical activity levels of the children's were measured by SenseWear Armband (SWA) for 3 consecutive days (72 hours), in the absence of physical education class days. Height, weight, body mass index, daily total energy consumption, physical activity level, daily average number of steps (STEP), daily average length of stay and daily average sleep time were measured. The data obtained in the study were determined by one way ANOVA and multiple comparison test. $P<0.05$ was considered significant in all tests. There was a significant difference in the mean values of height ($F=20.3$; $p=0.00$), weight ($F=12.55$; $p=0.00$), and STEP ($F=7.64$; $p=0.01$) in the study group. The difference in height and weight mean was significant in favor of 13 age group ($11<12<13$, respectively) and STEP was in favor of 11 years ($13\leq12<11$, respectively). The differences between the remaining variables were not significant ($p> 0.05$). In this study, it was concluded that the adolescents who were in different age groups and did not have physical education classes, the duration of physical activity was low, but their duration of inactivity was high.

Keywords: Physical activity, anthropometry, SenseWear Armband, adolescent child

INTRODUCTION

It is known that many behaviors and habits that give direction to human life are gained in childhood. With the adoption of modern life, developing technology has also affected children, and parents have introduced their children to computers and internet at very early ages, causing them to become undesirable. Nowadays, it is known that computer and internet habits have reached dependency level especially among children and youth (35). The factors such as rapid urbanization, traffic density, air pollution, lack of parking, walking, sports and recreation areas, excessive increase in population and increase in crime rates (7) have led to the increase in children's residence time and the adoption of sedentary lifestyle.

Physical activity (PA); it is defined as activities that can increase energy consumption by using muscles and joints in daily life, increase heart and respiratory rate and result in fatigue at different intensities. Increasing PA with many positive effects or adequate physical activity is of great importance for all age groups. Each individual's PA level is different. Accurate determination of individual PA level will also be a response to the question of how much and what kind of PA a person should perform. Early age behaviors related to PA habits will enable future life to be formed on a healthier basis (22). According to data in Turkey PA guideline (33), sedentary increased in association with decreased functional capacity, and chronic diseases of lifestyle is stated that the cause of mortality and morbidity. It is not only limited in terms of health, but it is also the main cause of obesity, the most important disease of our time. Obesity is associated with adverse health outcomes in both children and adults, and approximately 80% of overweight children are becoming overweight adults (8). Therefore, the experts recommend that obesity prevention be started in pre-school or school-aged children (29). PA is an important component in the prevention of obesity, as it results in increased energy expenditure and resting metabolic rate (16). PA, which plays an important role in the prevention of obesity in many chronic diseases, is also an important factor in the development of cognitive

skills, attention, behavior and social interaction (21,8).

In our country with a young population, it will be a successful strategy to increase the PA and to take early measures for the health problems that may occur in adulthood (19). The national health guidelines, however, indicate that, although they advocate for increased PA in children and adolescents, there are still no reach to specific goals (27). The same data indicates that 41.4% of men in the 12-14 age group did not exercise at all. Numerous studies have been conducted on adults and these studies have clearly documented the relationship between daily PA and health. However, studies on adolescents are more limited than adults (13,23,32) and the survey in the measurement tools used in a limited number of data, qualitative methods such as observation, or indirect studies with different measuring devices such as pedometer make the interpretation difficult. The methods that can be used to determine PA levels have advantages and disadvantages compared to each other (4).

The SenseWear® Armband (SWA) metabolic holter is a newly developed device that can assess energy consumption and is used to determine the level of PA in this study. The purpose of this study, the PA levels and daily energy expenditures of the adolescents, 11, 12 and 13 years of age accepted by the World Health Organization (37), were investigated by using SWA metabolic holter, which is the direct measurement method for the evaluation of the differences between the groups.

MATERIALS AND METHODS

Study group: Totally 99 healthy and volunteer male students aged 11-13 years old in public schools under the Ministry of National Education was participated in this study. Participants were divided into three groups according to their chronological age: 11 age group (n: 35; height: 147.66 ± 6.13 cm; weight: 38.13 ± 7.79 kg), 12 age group (n: 34; height: 152.47 ± 5.80 cm; weight: 42.23 ± 5.48 kg); and 13 age group (n: 30; height: 158.67 ± 8.81 cm; weight: 47.10 ± 8.12 kg). Some criteria were taken into consideration in the selection of the children in the research group: Firstly, their families allowed their children. Secondly, no physical activity or being in any sports branch on a regular basis except for physical education classes. Thirdly, children who were not smokers, did not use regular drugs and had no chronic diseases were included in the study group. Before starting work, necessary permits were obtained from Provincial Directorate of National Education and school administration. Subsequently, "the student/parent information form" and "the student/parent consent form" which were prepared according to the rules in the Helsinki Declaration, were sent to each participant. Parents gave written and signed consent, after reviewing all forms.

Anthropometric measurements: A stadiometer (Holtain Ltd. UK) with a precision of ±1 mm was used for height measurement. Body weight and BMI were determined by the body analyzer (Tanita BC-418 MA Professional, Japan).

Measurement of daily PA parameters with SenseWear Armband (SWA): SWA has been frequently used in the determination of total energy consumption in all age groups; in children (10), in adolescents (13) and in elderly (20). SWA is one of the combined systems produced by BodyMedia, and it is placed in the mid-point of the triceps muscle of the dominant arm. With the help of SWA software (version 7.0; BodyMedia Inc.), the participant features (gender, age, height, body weight, demographic information such as the cigarette use and the dominant hand) were uploaded from the computer to the device. At least 72 hours after insertion, the data on the removed device was transferred back to the computer.

The experimental setup: This study was done in spring. For each volunteer who participated in our study, the experiment consisted of two parts. On the first day, between 10:00-11:00 hours, the subjects were measured in their gyms and the device was placed on their arms as indicated above. At the end of 72 hours following the intervention days, the participants came to the gym once again to remove the device from the arm and the data was transferred to the computer. During the whole study, participants were warned to avoid changing their daily routines and not to use drugs or caffeine which would affect metabolic measurements. Also, participants were asked to remove this device only when they were taking a bath, and to wear them on their arms at all other times. In this study, the participants wore SWA for 3 consecutive days during 24 hours in the absence of physical education classes. Total energy expenditure (TEE), physical activity level (MET), step (STEP), physical activity duration (PAD), lying-down duration (LD) and sleep duration (SD) values were taken with SWA.

Statistical Analysis: Shapiro-Wilk test was used for the normality tests of all data. Since all of

the data showed normal distribution (p>0.05), parametric tests were performed. The variances between the groups were determined by one-way ANOVA, and in case of any difference between the groups, multiple comparison (post-hoc) test was used in order to determine which group was the difference. The statistical calculations of the study were done with IBM SPSS 25.0 statistics program, and P<0.05 level was accepted as significant in all tests.

RESULTS

The physical properties and PA levels of the groups, obtained after 72 hours are shown in Tables 1 and 2 below.

Table 1. Descriptive values of the study group according to the age group

				95% Confidence Interval for Mean	
Variables	Age Group	N	X±SD	Lower Bound	Upper Bound
Height (cm)	11	35	147.66±6.13	145.55	149.76
	12	34	152.47±5.80	150.45	154.49
	13	30	158.67±8.81	155.38	161.95
	Total	99	152.65±8.20	151.01	154.28
Weight (kg)	11	35	38.13±7.79	35.46	40.81
	12	34	42.23±5.48	40.32	44.14
	13	30	47.10±8.12	44.07	50.13
	Total	99	42.26±8.00	40.66	43.85
BMI (kg/m^2)	11	35	17.45±3.01	16.42	18.49
	12	34	18.17±2.30	17.37	18.97
	13	30	18.37±1.78	17.71	19.04
	Total	99	17.98±2.45	17.49	18.47
TEE ($Kcal.day^{-1}$)	11	35	1799.54±495.77	1629.24	1969.84
	12	34	1769.29±502.04	1594.12	1944.46
	13	30	1798.07±624.41	1564.91	2031.23
	Total	99	1788.71±534.53	1682.10	1895.32
STEP ($number.day^{-1}$)	11	35	15025±2206	14267.51	15783.12
	12	34	13709±2093	12978.58	14439.36
	13	30	13014±2048	12248.91	13778.29
	Total	99	13964±2260	13512.93	14414.32
MET ($kcal.kg^{-1}.day^{-1}$)	11	35	1.75±0.35	1.63	1.87
	12	34	1.64±0.55	1.45	1.83
	13	30	1.57±0.48	1.39	1.75
	Total	99	1.66±0.47	1.56	1.75
PAD ($min.day^{-1}$)	11	35	221.26±71.42	196.72	245.79
	12	34	210.53±78.88	183.01	238.05
	13	30	190.13±63.47	166.43	213.83
	Total	99	208.14±72.25	193.73	222.55
LD ($min.day^{-1}$)	11	35	505.60±81.19	477.71	533.49
	12	34	517.35±57.30	497.36	537.34
	13	30	536.20±60.35	513.67	558.73
	Total	99	518.91±68.01	505.34	532.47
SD ($min.day^{-1}$)	11	35	385.20±88.91	354.66	415.74
	12	34	383.56±67.50	360.01	407.11
	13	30	371.57±69.98	345.43	397.70
	Total	99	380.51±75.91	365.37	395.64

Abbreviations: *BMI:body mass index; TEE:total energy expenditure; MET:physical activity level;PAD: physical activity duration; LD:lying-down duration; SD:sleep duration.*

The mean BMI values of our study group (17.98±2.45 kg/m2) were observed to be in the weak category.

Table 2. Between-group ANOVA and multiple comparison values according to age groups

			95% Confidence Interval for Mean				
Variables	N	X±SD	LB	UB	F	*p*	Post-hoc test
Height (cm)	99	152.65±8.20	151.01	154.28	20.30	0.00*	11<12<13
Weight (kg)	99	42.26±8.00	40.66	43.85	12.55	0.00*	11<12<13
BMI (kg/m^2)	99	17.98±2.45	17.49	18.47	1.29	0.28	11≤12≤13
TEE (Kcal.day^{-1})	99	1788.71±534.53	1682.1	1895.32	0.03	0.97	12≤13≤11
STEP (number.day^{-1})	99	13964±2260	13513	14414	7.64	0.01*	13≤12<11
MET (kcal.kg^{-1}.day^{-1})	99	1.66±0.47	1.56	1.75	1.26	0.29	13≤12≤11
PAD (min.day^{-1})	99	208.14±72.25	193.73	222.55	1.54	0.22	13≤12≤11
LD (min.day^{-1})	99	518.91±68.01	505.34	532.47	1.67	0.19	11≤12≤13
SD (min.day^{-1})	99	380.51±75.91	365.37	395.64	0.30	0.74	13≤12≤11

Abbreviations: **p<0.05; LB:lower bound; UB:upper bound; <:mean difference is significant; ≤:mean difference is not significant; BMI:body mass index; TEE:total energy expenditure; MET:physical activity level; PAD:physical activity duration; LD:lying-down duration; SD:sleep duration.*

In the comparison of inter-group ANOVA of the 95% confidence interval of the study group; there was a significant difference in mean values of height (F=20.3; p=0.00), weight (F=12.55; p=0.00) and STEP (F=7.64; p=0.01). Although there was a difference between the mean of the remaining variables, these differences were not significant (p>0.05). In the inter-group multiple comparison (post-hoc) tests of the 95% confidence interval; the difference between the averages of the height and weight of the age groups were significant in favor of the 13 age group. The difference of these variables between the ages of 11 and 12 was significant in favor of the 12 age group (post-hoc result was 11<12<13, respectively). The differences between the STEP mean values of the age groups were significant in favor of the 11 age group. On the other hand, although this variable in favor of the 12 age group, the difference between the ages of 12 and 13 was not significant (post-hoc result was 13≤12<11, respectively; Table 2).

DISCUSSION

Participation in regular PA has a large number of health benefits for adolescents (5), and young people are advised to exercise moderate to severe physical exercise every day for one hour. This means that at least three times energy as is used energy at rest. Estimated energy expenditure is reported to be at least 51% more active than sedentary games during active play. However, many adolescents often have sedentary lifestyles as a result of various factors (17), and unfortunately, most children do not comply with the proposed activity rules. As the focus on academic achievement increases, it limits the opportunity for children to be physically active throughout the school day (5). Studies have shown that traditional physical education classes increase PA (3). Therefore, this study was carried out with SWA on the days when the PA parameters of the children were not especially in physical education classes and for 3 consecutive days (72 hours).

Generally, there was a significant difference between the average height, weight and STEP scores of the study group in the 95% confidence interval (p>0.05). In the multiple comparison (post-hoc) tests of the mean variables, the difference between the mean and weight averages of age groups was significant in favor of the 13 age group. The difference between the ages of 11 years and 12 years was significant in favor of the 12 age group (post-hoc result was 11<12<13, respectively). It is thought that height and weight development is in favor of children of 13 years of age due to rapid developments "pubertal growth spurt" in the body limbs (arms and legs) during adolescence (1). In addition, this increase in height and weight in favor of the 13 age group, the direct BMI values in favor of this age group. So, while the increase of height and weight in favor of the 13 age group, it ensured the direct BMI values in favor of this age group. However, although the BMI values were in favor of the 13 age group, this difference was not significant (p>0.05; Table 2). Therefore, when the average BMI values of our study group are examined, it is seen that they are close to each other and weak category. According to the age group we obtained in this study, height, weight and BMI values were consistent with the literature findings (28).

Conventional PA has a significant effect on the highest physical performance, especially in

adolescence. Also, TET consists of three components: resting energy expenditure, dietary energy expenditure and operating energy expenditure. Activity-driven energy expenditure increases with body size and physical activity during growth. TET increases from early age to adulthood and decreases with age (36). On the other hand, our research group spent enough energy close to each other on the intervention day, or the activities were not intense enough to contribute to the daily recommended amount of TET for children (17). Although there is a significant difference in favor of the 11 age group (post-hoc result was 12≤13≤11, respectively), these findings may explain the absence of a difference between the TET mean of the intervention group.

Children going to school by walking or cycling have the potential to significantly increase their daily steps as well as their PAs (3). In this study, the differences between the post-hoc STEP averages of the age groups were significant in favor of the 11 age group (post-hoc result was 13≤12<11, respectively). In addition, according to the classification of daily step counts of Tudor-Locke and colleagues (34), the 11 age group was in the gold category (15.025 steps/day), and 12 and 13 age group (13.708, and 13014 steps/day, respectively) were in the silver category. In the same way, also, Craig and his friends according to the daily step count classification of boys aged 11-14 years (12); the 11 age group was the highest, and 12 and 13 age group was seen above the average category. In addition, it has been reported that there is a two-fold increase in walking and cycling to the school by encouraging active transportation by increasing family participation and awareness (12). Hence, while the present study did not assess how the intervention group went to or return from the school, these cases may be presented as evidence that the STEP averages were in favor of the 11 age group.

PA is defined as any body movement that causes energy expenditure to be higher than rest (26). METs are used to express the energy costs of PAs. The energy cost of performing submaximal activities increases with age when expressed in kilocalories per minute (kcal/kg/min), but decreases with age when expressed according to body mass. Age-dependent MET values vary depending on the type and intensity of the activity. Furthermore, the energy costs of walking and running vary depending on age and speed (9,26). It is important to emphasize that there is no gold standard for classifying PA intensities, and it is essential to determine the exact intensity of PA. The guidelines, therefore, have recommended the use of the metabolic equivalent (MET) of the task as reference thresholds for absolute densities (26). In this study, it was expecting that the MET values in the voluntary intervention group would show greater differences between the age groups due to the factors such as the intensity, motivation of the child and the given experimental conditions and instructions. However, there was no significant difference between the MET averages of the intervention group (F=1.26; p=0.29; post-hoc result was 13≤12≤11, respectively). The fact that there was no significant difference between the groups despite the amount of energy spent at different age and PA concentrations suggests that our intervention group was in a homogeneous structure.

In a study conducted on children, it is estimated that daily total PA, although the clinical importance of this in children is not known exactly, leads to a decrease in the risk of stroke, transient ischemic attacks and coronary heart disease in adults between 6% and 15% (6). At the same time, different climates, seasons, environments and PA cultures can be found in the same global region and the potential impact of geographical location is important (6). For this reason, there was no significant difference between the mean DPA averages of the intervention group (F=1.54; p=0.22; post-hoc result was 13≤12≤11, respectively). As a result, this variability due to similar settlements may have hidden the differences. In addition, the SWA measured the level of DPA in children outside the physical education classes, and it could be attributed to leading a significant reduction in PA levels on the school day (24,2). Also, in addition to biological and psychosocial factors, the reduction of PA opportunities in schools could be another potential factor (5). Because, while the school offers the opportunity to participate in a higher intensity activity at certain times of the day, it can be assumed that the dominant necessity to sit in class times decreases the average activity intensity while considering the school day as a whole. Therefore, interventions targeting a specific time period other than physical education courses may have had little impact on children in the intervention group.

LD activities contain like quietly lying down or sitting, watching TV/DVD, computer or mobile phone games, reading or writing for homework (9), and resting energy expenditure is usually the largest

amount of TET (36). Some studies have shown significant differences in PA levels between certain periods of the day and week (6). For example; watching television can cause obesity by reducing the participation in PA, which allows the use of excess energy, and by increasing the consumption of high-calorie foods as a result of food advertisements or watching television (25). However, in the case of supporting the use of treatment components aimed at reducing sedentary behavior such as watching television or playing computer games, it was noted that participants had a decrease in immobility and an increased orientation to PA (15). In this study, no significant difference was observed between the LD mean scores of the intervention group ($F=1.67$; $p=0.19$; post-hoc result was $11\leq12\leq13$, respectively). Additionally, the mean values of LD were (208.14 ± 72.25 min.day^{-1}) quite high in average values of both DPA (518.91 ± 68.01 min.day^{-1}) and SD (380.51 ± 75.91 min.day^{-1}). This difference could be partly due to school programs and homework expectations. Because, 54% of the children reported that the homework was an obstacle to PA participation after school (2). This and similar effects may have prevented the difference in LD between age groups.

Recent reports have shown that sleep problems in children are becoming more common. In a study conducted in Belgium, for example, 1/3 of the children in the 6-13 age groups were reported to have problems in initiating or maintaining sleep (31). It has also been associated with a range of health risk behaviors such as inadequate sleep, low academic performance (14), obesity (30), anxiety and depression (18) during childhood and adolescence. There was no significant difference in the mean SD of the volunteer intervention group in this study ($F=0.30$; $p=0.74$; post-hoc result was $13\leq12\leq11$, respectively). These all case, the homework tasks, biological and psychosocial factors, and potential impacts of the spring season (2) may have had prevent participation of intervention groups to the PA. Finally, these and similar effects can be interpreted as not having an effect on the mean SD value of the intervention group.

RESULT

In this study, it was concluded that the adolescents who were in different age groups, and did not have physical education classes, the duration of PA was low but the duration of inactivity was high. In particular, interventions aimed at PA and sedentary behavior to minimize negative changes that would pose a risk to health should begin at an early age. Therefore, considering the significant contributions of PA to children especially during adolescence, school administrators and teachers can take important responsibilities for the PA of adolescent students in this age group. In addition, in order to determine the PA levels of adolescents aged 11-13 years in our country, it is necessary to determine daily step number intervals with appropriate mathematical calculations.

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