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ROLE OF SMARTPHONES IN INCREASING PHYSICAL ACTIVITY IN SECONDARY SCHOOL STUDENTS

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Abstract

In today's world, physical activity is gaining more importance, not only in academic community, but also with the general public. Nowadays, many students expect to see involvement of new technologies in school such as smartphones, tablets, and computers. The level of physical activity is very easily affected by various external influences such as smartphone apps, which may be ideal in increasing physical activity. Smartphone apps are considered motivational tools in increasing physical activity. The aim of the study was to analyse the role of smartphones in increasing physical activity in secondary school students. The study group was chosen purposively to meet the aim of the study. The following criteria applied: a) participants should not have health issues; b) participants should be from the same year of students. The group consisted of 113 secondary school students [(Male control group n = 30 (26.54 %); Male experimental group n = 25 (22.12 %); Female control group n = 30 (26.54 %); Female experimental group n = 28 (24.80 %)]. The current level of physical activity was detected by using the smartphone app - Samsung Health [(Samsung Electronics Co., Ltd.; Suwon, the Republic of Korea; Android 5.17.1.003; iOS 1.5)]. Two 14-day challenges were created to increase physical activity in the participants. To determine the statistical significance of 2 control groups (n = 60, 53.08 %) and 2 experimental groups (n = 53; 46.92 %) we applied the Wilcoxon Signed-rank Test (W_{test} $p < 0.01$, $p < 0.05$). To verify 4 independent study groups, we applied the Mann-Whitney U-test (M_{wtest} $p < 0.01$, $p < 0.05$). The material and practical significance was evaluated by using the effect size coefficient (r) (r = 0.10 - small, r = 0.30 - medium, r = 0.50 - large effect size). The first 14-day challenge resulted in improvements in both control and experimental groups of secondary school students ($p < 0.01$). After 28-day challenge, we recorded the improvements in the female experimental group ($p < 0.01$), male control and experimental groups ($p < 0.01$) and female control group ($p < 0.05$). When comparing the independent study groups, we recorded improvements, which were significant at 1.00 % and 5.00% level. Secondary school students are increasingly using smartphone apps routinely in more areas of their personal lives. Smartphone apps aimed at increasing physical activity are effective in helping secondary school students to achieve the required physical activity level. Our study provides evidence that the technique of challenges used in the smartphone app - Samsung Health significantly ($p < 0.01$, $p < 0.05$) increase the physical activity level of the secondary school students. According to our results, we recommend using the smartphone app - Samsung Health as a motivational tool in increasing the physical activity in secondary school students.

Key words: Challenge, physical activity, secondary school students, smartphones.

Introduction

The current century offers several improvements that lead to a connection of man with technology, so an improvement in health is expected, but more often there is a lack of physical activity, tending to sedentary lifestyle. The way of life has changed in the last decade, physical activity has decreased, and the health status of the population has deteriorated, which is associated with a high incidence of chronic diseases (Boreham and Riddoch, 2001; Bendíková, 2017; Marko and Bendíková, 2020). A common basis of these diseases is the inability to adapt to the current way of life, which results from time constraints and subsequent indifference to hobbies and active rest (Blum and Nelson, 2004; Janssen and LeBlanc, 2010; Rehor and Kornatovská, 2013).

Physical activity aligns closely with health, quality of life, and lifestyle (Nowák, 1997), but in its absence, the physical performance component decreases. This is a stagnant area in the Slovak Republic. This trend does not only affect the general school population (Antala et al., 2014). A lack of physical activity affects the human health, while significantly affecting the physical fitness and performance (Rozim 2012).

In terms of health, moderate to vigorous intensity physical activity is very important and necessary during the period of personality development (Hendl and Dobrý, 2011; Nemcová, 2019), as healthy lifestyle, in the form of regular physical activity, tends to move from adolescence to other periods of personality development. A long-term moderate to vigorous intensity physical activity improves academic performance (Sirin, 2005; Basch, 2010) and several health indicators such as better bone density, metabolism, and body weight (Wiley and Blackwell, 2010). It is very important to respect the objective and subjective determinants of both general and sports populations. Janssen and LeBlanc (2010) recommended physical activity during the adolescence period to be 14 hours per week (2 hours per day). The World Health Organization (2020) added that > 1 hour of moderate to vigorous intensity physical activity provides several health benefits, while aerobic physical activity should also be increased. Moderate to vigorous intensity physical activity should also include health-promoting exercises, in the range of 3 times per week, while the bone load should be realised through physical activities. Teplý (1995) did not agree and recommended 10 hours per week of physical activity within the period of adolescence, which also includes 2 hours per week of school physical education and 2 hours per week of spontaneous physical activity. Within the period of adolescence there is a trend to decrease the recommendations of physical activity, the values of which range from 6 to 8 hours per week (Teplý, 1995).

Despite these recommendations, there has been a significant reduction in the implementation of regular physical activity within the general school population (Liba, 2000). Mitchell et al. (2012), Corder et al. (2015) and Harding et al. (2015) pointed to a decrease in the implementation of a moderate to vigorous intensity physical activity programme within general school populations. Within the school population in the Slovak Republic, the study “Health Behaviour in School-aged Children” (Currie et al., 2012) revealed that the male population was more physically active than the female population. Physical activity of school populations in the Slovak Republic revealed that physical activity among males tended to stagnate (28 % - 31 %), while it tended to decrease among females (11 - 13 years of age by 6%; 13 - 15 years of age by 3%). For that reason, the aim of the study was to analyse the role of smartphones in increasing physical activity in the secondary school students.

Material and Methods

Participants

In accordance with the study aim, the target population was adolescents (male and female) who attended the 4th year of the secondary vocational school in Banská Bystrica, Slovakia. The target population consisted of convenience sample, which was recruited through the school director and physical education teachers. The recruitment process was adjusted regularly (Covid-19), aiming for the intentional sampling of the target population, regarding the age, gender, and year of study. The inclusion criteria of the study group were as follows: a) participants should not have health issues; b) participants should be from the same year of students. After meeting the inclusion criteria of the study group, 113 secondary vocational school students (male and female) were included in the study data interpretation process. Distribution of the study group was as follows: a) Male control group (n = 30, 26.54 %, aged: 17.43 ± 0.32 years, body height: 178.93 ± 2.35 cm, body weight: 72. 72 ± 3.42 kg, body mass index: 22.71 ± 0.25); b) Male experimental group (n = 25, 22.12 %, aged: 17.35 ± 0.28 years, body height: 181.44 ± 4.35 cm, body weight: 76.24 ± 2.85 kg, body mass index: 23.09 ± 0.52); c) Female control group (n = 30, 26.54 %, aged: 18.12 ± 0.35 years, body height: 165.82 ± 3.85 cm, body weight: 57.76 ± 2.82 kg, body mass index: 21.04 ± 0.56); d) Female experimental group (n = 28, 24.80 %, aged: 18.10 ± 0.35 years, body height: 166.25 ± 3.25 kg, body weight: 55.72 ± 2.65 kg, body mass index: 20.12 ± 0.45). Not owning a smartphone with the smartphone app - Samsung Health (Samsung Electronics Co., Ltd.; Suwon, the Republic of Korea; Android 5.17.1. 003; iOS 1.5) was the exclusion criterion of the study group.

Measures

When collecting the data, the research instrument of quasi-experiment method was used (Montero and León, 2007). The quasi-experiment method comprised measures in free-living settings of the study group (n = 113). The current level of physical activity (number of steps) was detected by using the smartphone app - Samsung Health (Samsung Electronics Co., Ltd.; Suwon, the Republic of Korea; Android 5.17.1.003; iOS 1.5). According to its website, the smartphone app was designed to track participants' activity, nutrition, and sleep, and to increase active lifestyle (Beltrán-Carrillo et al., 2018). The smartphone app includes a pedometer function, which was used to monitor daily step counts. The pedometer function of the smartphone app - Samsung Health was chosen because it is inexpensive, requiring no extra battery. The survey group profile was created each time and required an identification number. The smartphone app also required the selection of activity level (3 levels), ranging from low to high activity level. In accordance with the study aim the average activity level was selected for the full study group. There was no incentive given for participation, however, the participants received the report with their personal results.

Procedures

After permission to conduct the study was required from the school director and parental consent and participants' assent form was secured, the study group (n = 113) was introduced to pedometer function of the smartphone app - Samsung Health and instructed on proper use. Each member of the cohort was directed to secure the pedometer function, how to open/ close the smartphone app - Samsung Health and carry their smartphone all day long, leaving it only for special circumstances (taking a shower, going swimming). At the end of each challenge (14 -day challenge), the authors met with the full study group to collect extra step count data, the activity log, address any issues and questions, and remind them of the instructions pertaining to data collection. Daily step count was monitored over two 14-day challenges.

The intervention (stimulus) consisted of the smartphone app - Samsung Health and two automated 14-day challenges, within which the study group monitored their daily increase of steps. Only the male (n = 28, 22.12 %) and female (n = 28, 24.80 %) experimental groups was shown the ranking (position). The intention of our intervention was to implement stimulus (two 14-day challenges) and show the ranking (position), which was intended to act as motivational factor to increase physical activity levels.

Analysis

In terms of the study group (n = 113), each 14-day challenge was compared and evaluated by using the programme of IBM SPSS Statistics for Windows (Version 23.0; IBM Corp., Armonk, NY, USA). Descriptive statistics were used to process the research data (percentage frequency analysis (%) in terms of measures of central tendency (mean ($\bar{x}$) and median ($\tilde{x}$) and measures of dispersion (standard deviation (σ). The research data were calculated for the step count data after the each 14-day challenge (2x). Two 14-day challenges were created to increase physical activity in the study group (n = 113). To determine the statistical significance of 2 control groups (n = 60, 53.08 %) and 2 experimental groups (n = 53; 46.92 %), we applied the Wilcoxon Signed-rank Test (W_{test} $p < 0.01$, $p < 0.05$). To verify 4 independent study groups, we applied the Mann-Whitney U-test (M_{wtest} $p < 0.01$, $p < 0.05$) (Kampmiller et al., 2010). The material and practical significance was evaluated by using the effect size coefficient (r) (r = 0.10 - small, r = 0.30 - medium, r = 0.50 - large effect size) (Kerlinger, 1972).

Results

After processing the data, 14-day challenge 0 ($\bar{x}$ = 138 908 step counts) of male experimental group (n = 25) confirmed their statistical increase of physical activity level (Z = 4.372, $p < 0.01$, r = 0.618) compared to the 14-day challenge 1 ($\bar{x}$ = 218 195 step counts). The male experimental group's (n = 25) mean step count difference between the two 14-day challenge 0 and 1 was 79 287 step counts, which was increase of 5 663 step counts per day. After implementing the 14-day challenge 2, the male experimental group's (n = 25) step count result reached the highest physical activity level ($\bar{x}$ = 227 927 step counts), however the step count increase of 9 732 step counts was not sufficient in terms of statistical significance and effect size (Z = 1.665, $p > 0.05$, r = 0.234). The processed data revealed the statistical significance ($p < 0.01$) and large effect size (r = 0.50) in terms of comparing the 14-day challenge 0 and 2 (Z = 4.372, $p < 0.01$, r = 0.618). The 14-day challenge 2 caused the mean step count increase of 89 019 step counts, which was the increase of 6 358 step counts per day within the male experimental group (n = 25).

Not seeing the ranking (position), the 14-day challenge 0 ($\bar{x}$ = 133 892 step counts) of male control group (n = 30) unexpectedly revealed the statistical increase of physical activity level (Z = 4.062, $p < 0.01$, r = 0.524), compared to the 14-day challenge 1 ($\bar{x}$ = 155 565 step counts) (Table 1). When comparing the mean step count difference of the 14-day challenge 0, the intergroup difference of the male study groups (n = 55) was not sufficient in terms of statistical significance and effect size (Z = -0.592, $p > 0.05$, r = 0.080) (Table 1). After implementing the 14-day challenge 2, the male control group's (n = 30) mean step count result revealed a small increase of physical activity level ($\bar{x}$ = 156 447 step counts). The step count increase of 882 step counts was not sufficient in terms of statistical significance and effect size (Z = 0.442, $p > 0.05$, r = 0.054). In terms of comparing the 14-day challenge 1, within the male study groups (n = 55), the intergroup difference revealed statistical significance ($p < 0.01$) and large effect size (r = 0.50) in favour of the male experimental group (n = 25) who realised 62 630 more step counts than the male control group (n = 30) (Z = -4.648 $p < 0.01$, r = 0.627). When comparing the 14-day challenge 0 and 2 of the male control group (n = 30), the processed data expectedly revealed the statistical increase of physical activity level (Z = 4.042, $p < 0.01$, r = 0.522). The male study groups (n = 25) mean step count difference in terms of the 14-day challenge 2, was 71 480 step counts ($\bar{x}$), which was the difference of 5 105 step counts per day and in favour of the male experimental group (n = 25). The mean step count difference was sufficient in terms of statistical significance and effect size (Z = -4.885, $p < 0.01$, r = 0.659).

Table 1 Male control and experimental groups' analysis and comparison - Challenge 0, 1, 2

Study group (n = 55)

Descriptive statistics	Symbol	Male control group			Male experimental group		
		0	**1**	**2**	**0**	**1**	**2**
Measures of Central Tendency	$\bar{x}$	133 892	155 565	156 447	138 908	218 195	227 927
	$\tilde{x}$	131 978	150 381	156 615	141 554	223 813	230 171
Measures of Dispersion	σ	24 248	37 535	35 515	21 100	41 249	46 583

Wilcoxon Signed-rank Test (W_{test} p < 0.01, p < 0.05)

Challenges	**Male control group**	**Male experimental group**
Challenge 0 - Challenge 1	Z = 4.062, p < 0.01, r = 0.524 **	Z = 4.372, p < 0.01, r = 0.618 **
Challenge 1 – Challenge 2	Z = 0.442, p > 0.05, r = 0.054	Z = 1.665, p > 0.05, r = 0.234
Challenge 0 - Challenge 2	Z = 4.042, p < 0.01, r = 0.522 **	Z = 4.372, p < 0.01, r = 0.618 **

Mann-Whitney U-test (M_{wtest} p < 0.01, p < 0.05)

Challenges	**Male control group**	**Male experimental group**
Challenge 0 - Challenge 0	Z = -0.592, p > 0.05, r = 0.080	
Challenge 1 - Challenge 1	Z = -4.648, p < 0.01, r = 0.627 **	
Challenge 2 - Challenge 2	Z = -4.885, p < 0.01, r = 0.659 **	

Note: *$\bar{x}$ - Mean, $\tilde{x}$ - Median, σ - Standard deviation,* ***0*** *- Challenge 0,* ***1*** *- Challenge 1,* ***2*** *- Challenge 2,* ***** *- Significance level of 0.05,* ****** *- Significance level of 0.01.*

Following processing of data from the male (n = 55) and female study groups (n = 55), very similar results in terms of statistical significance was found (p < 0.01, p < 0.05) (Table 1). The 14-day challenge 0 ($\bar{x}$ = 115 252 step counts) of the female experimental group (n = 28) confirmed their statistical increase of physical activity level (Z = 4.632, p < 0.01, r = 0.618) compared to the 14-day challenge 1 ($\bar{x}$ = 176 234 step counts) (Table 1). The mean step count difference between the two 14-day challenge 0 and 1 was 60 982 step counts, which was the increase of 4 355 step counts per day. After implementing the 14-day challenge 2, the processed data expectedly revealed the highest physical activity level ($\bar{x}$ = 188 712 step counts), which was in fact sufficient in terms of statistical significance and effect size (Z = 3.165, p < 0.01, r = 0.423). Nothing was expected other than the statistical significance (p < 0.01) and large effect size (r = 0.50) in terms of comparing the 14-day challenge 0 and 2 (Z = 4.632, p < 0.01, r = 0.618). The 14-day challenge 2 caused the mean step count increase of 73 460 step counts, which was the increase of 5 247 step counts per day within the female experimental group (n = 28).

Having the same condition of not seeing the ranking (position), the 14-day challenge 0 ($\bar{x}$ = 116 309 step counts) of the female control group (n = 30) unexpectedly revealed the statistical increase of physical activity level ($Z = 2.993$, $p < 0.01$, $r = 0.386$) compared to the 14-day challenge 1 ($\bar{x} = 128\ 014$) (Table 1). In terms of intergroup difference of the female study groups (n = 58), the mean step count difference ($\bar{x} = 1\ 057$ step counts) was not sufficient in terms of statistical significance and effect size ($Z = -0.140$, $p > 0.05$, $r = 0.018$). The intergroup difference was in favour of the female control group (n = 30). After implementing the 14-day challenge 2, the female control group's (n = 30) mean step count result revealed a decrease of physical activity level ($\bar{x} = 124\ 753$ step counts). The step count decrease of 3 261 step counts was not sufficient in terms of statistical significance and effect size ($Z = 1.143$, $p > 0.05$, $r = 0.147$). The mean step count difference decreased by 2.54 %. In terms of comparing the 14-day challenge 1 of the female study groups (n = 58), the intergroup difference revealed the statistical significance ($p < 0.01$) and large effect size ($r = 0.50$) in favour of female experimental group (n = 28) who realised 48 220 more step counts than the female control group (n = 30) ($Z = -4.248$, $p < 0.01$, $r = 0.558$). When comparing the 14-day challenge 0 and 2, the mean step count result revealed the statistical significance ($p < 0.05$) and small effect size ($r = 0.10$) ($Z = 1.985$, $p < 0.05$, $r = 0.256$). Nothing was expected other than the statistical significance ($p < 0.01$) and large effect size ($r = 0.50$) in terms of comparing the 14-day challenge 2 within the female study groups (n = 58) ($Z = -5.337$, $p < 0.01$, $r = 0.701$). The 14-day challenge 2 caused the mean step count difference of 63 959 step counts, which was the difference of 4 568 step counts per day in favour of the female experimental group (n =28).

Table 2 Female control and experimental groups' analysis and comparison - Challenge 0, 1, 2

Study group (n = 58)

Descriptive statistics	**Symbol**	**Female control group**			**Female experimental group**		
		0	**1**	**2**	**0**	**1**	**2**
Measures of Central Tendency	$\bar{x}$	116 309	128 014	124 753	115 252	176 234	188 712
	$\tilde{x}$	116 354	128 594	127 499	109 151	174 053	185 661
Measures of Dispersion	**σ**	24 411	29 740	30 604	25 334	41 043	38 608

Wilcoxon Signed-rank Test (W_{test} $p < 0.01$, $p < 0.05$)

Challenges	**Female control group**	**Female experimental group**
Challenge 0 - Challenge 1	$Z = 2.993$, $p < 0.01$, $r = 0.386$ **	$Z = 4.632$, $p < 0.01$, $r = 0.618$ **
Challenge 1 – Challenge 2	$Z = 1.143$, $p > 0.05$, $r = 0.147$	$Z = 3.165$, $p < 0.01$, $r = 0.423$ **
Challenge 0 - Challenge 2	$Z = 1.985$, $p < 0.05$, $r = 0.256$ *	$Z = 4.632$, $p < 0.01$, $r = 0.618$ **

Mann-Whitney U-test (M_{wtest} $p < 0.01$, $p < 0.05$)

Challenges	**Male control group**	**Male experimental group**
Challenge 0 - Challenge 0	$Z = -0.140$, $p > 0.05$, $r = 0.018$	
Challenge 1 - Challenge 1	$Z = -4.248$, $p < 0.01$, $r = 0.558$ **	

Challenge 2 - Challenge 2	$Z = -5.337$, $p < 0.01$, $r = 0.701$ **

Note: ***$\bar{x}$*** *- Mean,* ***$\tilde{x}$*** *- Median,* ***σ*** *- Standard deviation,* ***0*** *- Challenge 0,* ***1*** *- Challenge 1,* ***2*** *- Challenge 2,* ***** *- Significance level of 0.05,* ****** *- Significance level of 0.01.*

Discussion

Lack of physical activity affects human health, while also significantly affecting physical fitness and performance (Rozim, 2012). However, it is not enough to just use stairs instead of elevators, because less than 5 000 step counts per day are seen as a sedentary lifestyle and 5 000 - 7 499 step counts per day are seen as a physical inactivity while more than 10 000 step counts per day required for an adequate physical activity. Above 12 500 step counts per day, we speak of high levels of physical activity (Bassett and Tudor-Locke, 2004). Seven years later, Tudor-Locke et al. (2011) again conducted further research, in which the author elucidated the appropriate number of step counts depending on the school population and revealed that normative values range from 12 000 to 16 000 step counts per day in the male population and from 10 000 to 13 000 step counts per day in the female population (adolescence period). Our study results partially correlate with Tudor-Locke et al. (2011) because the mean step count result of the male control group ($n = 30$) ($\bar{x} = 10\ 616$ step counts) and female control group ($n = 30$) ($\bar{x} = 8\ 787$ step counts) do not reach the lower normative values, however the male experimental group ($n = 25$) ($\bar{x} = 13\ 929$ step counts), as well as female experimental group ($n = 28$) ($\bar{x} = 11\ 433$ step counts) reach the normative values. The intervention (stimulus), which consisted of the smartphone app - Samsung Health and two automated 14-day challenges 1 and 2 acted as motivational tool in increasing the physical activity level of secondary school students ($n = 113$). Frömel et al. (1999) recommended that the male population, aged 14 – 18 should realise 11 000 step counts per day and female population in the same age 9 000 step counts per day. According to Sigmund and Sigmund (2015), the male population must take at least 13 000 step counts per day and female population 11 000 step counts at least 4 times per week. Similarly, Behrens and Dinger (2003) revealed that male population realises more step counts on average than the female population.

The aim of accumulating 10 000 step counts per day is a popular trend, by which a minimum level of physical activity for health can be achieved (Hackmann and Mintah, 2010). Le Masurier et al. (2003) agreed with the 10 000 step counts per day. However, the minimum step counts needed to meet physical activity guidelines may vary between the periods of personality development (Tudor-Locke and Myers, 2001; Morgan et al., 2010). Choi et al. (2007) claimed that 10 000 step counts is not usually achievable in daily routines. Of course, individual variations in daily routines may have caused the fluctuation of step counts taken, however counting the number of steps is an effective way to measure the physical activity levels.

During the period of adolescence, mean values of step counts tend to decrease, reaching the interface between physical activity and inactivity (8 000 - 9 000 step counts), but at present the average population takes only a few steps towards the car, or other means of transport, which represents 4 000 to 6 000 step counts per day. Several studies pointed to the fact that the moderate to vigorous intensity physical activity such as walking can produce up to 3 300 - 3 500 step counts per day over a period of 30 minutes (Tudor-Locke et al., 2011). 6 600 - 7 000 step counts per day over a period of 60 minutes reduces the risk of obesity by 24 % and diabetes by 34 %.

The pedometer function of the smartphone app - Samsung Health (any step-counting technology) has been associated with the significant increases of physical activity levels (Bravata et al., 2007; Lee et al., 2010; Freak et al., 2011). Bradford et al. (2020) indicated that the pedometer function can assist as a motivational tool in increasing physical activity level. The use of the pedometer function has been associated with several educational levels. For example, Butcher et al. (2008) implemented the pedometer function with primary school pupils (aged 9) and found that the direct feedback of step counts was associated with a significant increase of physical activity levels. Very similarly, Schofield et al. (2005) realised a 12-week intervention programme in the secondary school students (aged 15), while the significant improvements of physical activity levels were achieved in just 6 weeks.

The prescription of our intervention programme (Samsung Health) for a certain period of time at a large scale and a low cost is an example of a first step toward increasing physical activity in secondary school students is recommended.

Conclusions

Secondary school students are increasingly using smartphone apps routinely in more areas of their personal lives. Smartphone apps aimed at increasing physical activity are effective in helping secondary school students to achieve the required physical activity level. Our study provided the evidence that the technique of challenges (two 14-day) used in the smartphone app - Samsung Health ($p < 0.01$, $p < 0.05$) increased physical activity levels (daily step counts) of secondary school students. According to our results, we recommend using the smartphone app - Samsung Health:

- as a motivational tool in increasing the physical activity in the secondary school students;
- to increase the secondary school students' awareness of impact of using the smartphone app in increasing physical activity;
- to realise the physical education lessons more creative and interesting, in terms of using the smartphone app;
- to set and use the goals suggested by the smartphone app to increase the secondary school students' physical activity level.
- to invite more secondary school students to a step off challenge and increase their physical activity level.

References

Antala, B., Labudová, J., Šimonek, J., Strešková, E., Peráčková, J., Kyselovičová, O., Argaj, G., Kršjaková, S. & Melek, P. (2014). *Telesná a športová výchova a súčasná škola*. Bratislava: Univerzita Komenského v Bratislave. 343.

Basch, C. (2010). Healthier Children Are Better Learners. *Future of Children.* 2(3), 1-8.

Bassett, D. & Tudor-Locke, C. (2004). How Many Steps/ Day Are Enough? *Sports Medicine*. 36(1), 134-143.

Behrens, T., & Dinger, M. (2003). A Preliminary Investigation of College Students' Physical Activity Patterns. *American Journal of Health Studies*. 18(2), 169-172.

Beltrán-Carrillo, V., Jimémez-Loaisa, A., Alarcón-López, M., & Elvira, J. (2018). Validity of the "Samsung Health" Application to Measure Steps. *Journal of Sports Sciences.* 37(7), 788-794.

Bendíková, E. (2017). *Theory of Health, Movement and Lifestyle of Human Beings.* Debrecen: Debrecen University in Debrecen. 120.

Blum, I. & Nelson, K. (2004). Health of Young People in Global Context. *Journal of Adolescent Health*. 35(5), 402-418.

Boreham, C. & Riddoch, C. 2001. Physical Activity, Fitness and Health of Children. *Journal of Sports Sciences*. 19(12), 915-929.

Bradford, B., Howorko, A., Jacula, E., Daniels, J., Hunt, S., & Correia, N. (2020). Tracking Daily Steps: An Investigation on a Small Post-secondary Campus. *Central European Journal of Sport Sciences and Medicine.* 31(3), 75-86.

Bravata, D., Smith-Spangler, C., Sundaram, V., Gienger, A., Lin, N., Lewis, R., Stave, C., Olkin, I., & Sirard, J. (2007). Using Pedometers to Increase Physical Activity and Improve Health: A Systematic Review. *Journal of the American Medical Association.* 298(19), 2296-2304.

Butcher, Z., Fairclough, S., Stratton, G., & Richardson, D. (2007). The Effect of Feedback and Information on Children's Pedometer Step Counts at School. *Paediatric Exercise Science*. 19(1), 29-38.

Choi, B., Pak, A., Choi, J., & Choi, E. (2007). Daily Step Goal of 10,000 Steps: A Literature Review. *Clinical and Investigative Medicine*. 30(3), 146-151.

Corder, K., Collings, P. & Wijndaele, K. (2015). Magnitude and Determinants of Change in Objectively Measured Physical Activity, Sedentary Time and Sleep Duration from Ages 15 to 17. *International Journal of Behavioural Nutrition, Physical Activity.* 12(1), 61-70.

Currie, C., Zanotti, C., Morgan, A. & Currie, D. (2012). *Health Behaviour in School-aged Children.* [Online]. [Cited 27.1.2020]. Available at: <http://www.euro.who.int/data/assets/pdf_file/0003/1638 57/Social-determinants-of-health-and-well-being-amongyoungpe>.

Freak, R., Wolfe, R, Backholer, K., De Courten, M., & Peeters, A. (2011). Impact of a Pedometer-based Workplace Health Program on Cardiovascular and Diabetes Risk Profile. *Preventive Medicine.* 53(3), 162-171.

Frömel, K., Novosad, J. & Svozil, Z. (1999). *Pohybová aktivita a sportovní zájmy mládeže*. Olomouc: Univerzita Palackého v Olomouci. 173.

Hackmann, D. & Mintah, J. (2010). Pedometers: A Strategy to Promote Increased Physical Activity among College Students. Journal of Instructional Pedagogies. 2(3), 1-28.

Harding, S. - Page, S. & Falconer, C. (2015). Longitudinal Changes in Sedentary Time and Physical Activity. *International Journal of Behavioural Nutrition and Physical Activity.* 12(1), 44-50.

Hendl, J. & Dobrý, L. (2011). *Zdravotní benefity pohybových aktivit*. Praha: Univerzita Karlova v Praze. 300.

Janssen, I. & LeBlanc, G. (2010). Systematic Review of Health Benefits of Physical Activity and Fitness for School-aged Children and Youth. *International Journal of Behavioural Nutrition and Physical Activity*. 7(40), 20-30.

Kampmiller, T., Cihová, I., & Zapletalová, L. (2010). *Základy metodológie výskumu v telesnej výchove a športu.* Bratislava: Icm Agency. 192.

Kerlinger, F. (1972). *Základy výskumu chování.* Praha: Státní pedagogické nakladatelství. 705.

Lee, L., Watson, M., Mulvaney, C., Tsai, C., & Lo, S. (2010). The Effect of Walking Intervention on Blood Pressure Control: A Systematic Review. *International Journal of Nursing Studies*. 47(12), 1545-1561.

Le Masurier, G., Sidman, C., & Corbin, C. (2003). Accumulating 10,000 Steps: Does This Meet Current Physical Activity Guidelines. *Research Quarterly for Exercise and Sport*. 74(4), 389-394.

Liba, J. (2000). *Výchova k zdraviu a pohyb.* Prešov: Prešovská univerzita v Prešove. 120.

Marko, M. & Bendíková, E. (2020). *Physical Program and Its Impact on Muscular and Skeletal Systems of Female High School Students within Physical and Sport Education.* Banská Bystrica: Matej Bel University in Banská Bystrica. 89.

Mitchell, A., Pate, R. & Dowda, M. (2012). Prospective Study of Sedentary Behavior in Large Cohort of Youth. *Medicine and Science in Sports and Exercise.* 44(1), 1081-1087.

Montero, I., & León, G. (2007). A Guide for Naming Research Studies in Psychology. *International Journal of Clinical and Health Psychology.* 7(3), 847-862.

Morgan, A., Tobar, D., & Snyder, L. (2010). Walking toward a New Me: The Impact of Prescribed Walking 10,000 Steps/ Day on Physical and Psychological Well-being. *Journal of Physical Activity and Health*. 7(1), 299-307.

Nemcová, L. (2019). Voľný čas stredoškolskej mládeže. *Mládež a spoločnosť.* 25(3), 35-50.

Nowák, M. 1997. Chosen Aspects of the Health Related Behaviour of Women Retained Physical Fitness in the Past. *Women and Sport.* 1(3), 131-138.

Rehor, P. & Kornatovská, Z. (2013). Measuring of Health-related Benefits of Physical Activity in High School Students. *Acta Salus Vitae*. 1(2), 148-158.

Rozim, R. (2012). Monitorovanie telesného rozvoja, pohybovej výkonnosti u študentov Športového gymnázia v Banskej Bystrici. *Slovak Journal of Sports Sciences.* 4(1), 90-98.

Schofield, L. Mummery, W., & Schofield, G. (2005). Effects of Controlled Pedometer-intervention Trial for Low-active Adolescent Girls. *Medicine & Science in Sports & Exercise.* 37(8), 1414-1420.

Sigmund, E. & Sigmundová, D. (2015). *Trendy v pohybovém chování českých dětí a adolescentů.* Olomouc: Univerzita Palackého v Olomouci. 160.

Sirin, S. (2005). Socioeconomic Status, Academic Achievement. *Review of Educational Research*. 75(3), 417-453.

Teplý, Z. (1995). *Zdraví, zdatnost, pohybový režim*. Praha: Iris. 120.

Tudor-Locke, C., & Myers, A. (2001). Challenges and Opportunities for Measuring Physical Activity in Sedentary Adults. *Sports Medicine*. 31(2), 91-100.

Tudor-Locke, C., Craig, C., Aoyagi, Y., Bell, R., Croteau, K., Bourdeaudhu, I., Ewald, B., Gardner, A., Hatano, Y., Lutes, L., Matsudo, S., Ramitez-Marrero, F., Rogers, L., Rowe, D., Schmidt, M., Tully, M. & Blair, S. (2011). How Many Steps/ Day are Enough? For Older Adults and Special Populations. *International Journal of Behavioral Nutrition and Physical Activity*. 8(80), 78-90.

Wiley, M. & Blackwell, B. (2010). Regular Exercise Reduces Number of Health Risk Including Dementia and Some Cancers. *Science Daily*. 1(1), 20-30.

World Health Organization. (2020). *Physical Inactivity*. [Online]. [Cited 20.2.2022]. Available at: <https://www.who.int/dietphysicalactivity/factsheet_inactivity/en/>.