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THE CORRELATION BETWEEN PHYSICAL ACTIVITY AND BODY COMPOSITION IN PRIMARY SCHOOL STUDENTS

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Original research:

Abstract
The aim of this study is to define the correlation between the variables for nutritional status in children with those for physical activity estimates. Regular physical activity is the only habit that helps reduce the risk of obesity. Insufficient physical activity in children and young adults negatively impacts the development of their abilities and knowledge as well as their health.
The research participants were 189 first and second grade students, of whom 93 were girls and 96 were boys between the ages of 7 and 9. The questionnaire "Fels physical activity questionnaire for children" (FPAQ) was used to estimate the amount of students' physical activity in their free time. The index of sports (IS), free time (ISV), house chores (IKP) and physical activity sum (UTA) were calculated based on their answers. Anthropometric measurements like height, weight, body mass index and body fat index were used to estimate their body constitution. Omron BF500 Body Composition Monitor was used for these measurements. Pearson's correlation coefficient was used to determine the relation between the nutritional status and physical activity.
The results show that 68.75% of boys and 66.67% of girls are of normal nutritional status. Also, 29.1% of first and second grade boys are either of excessive weight or overweight. In girls this percentage is somewhat lower (21.51%), but is still relatively high. Pearson's coefficient shows significant correlation between body mass index and sweating (0.16%). Sweating is also related to body fat index (0.15%). The research did not show any correlation between physical activity and body fat index. The results show very low values with several significant positive correlations indicating that physical activity has a great impact on body constitution.
All the research on physical activity in children indicates a negative trend in daily physical activity participation. Insufficient physical activity in children and young adults is becoming increasingly expressed, and is becoming a serious health issue in which becoming overweight is directly correlated with insufficient physical activity

Key words: physical activity,body composition, obesity, students, school

Introduction

Physical activity is defined as any movement of the body performed by activating the skeleton muscles and resulting in energy expenditure (Caspersen, Powell, and Christenson, 1985). Physical activity is positively linked to children's physical, psychological and social wellbeing (Parfitt, Pavey, and Rowlands 2009; Füssenich et al. 2015). In the contemporary lifestyle, the level of physical activity of both children and adults has decreased (Pratt, Norris, Lobelo, Roux, and Wang, 2014). Such a way of life negatively affects the population's health (Fan and Cao, 2017), ranking inactivity as fourth among the leading causes of mortality (WHO, 2009).
The sedentary lifestyle is becoming an increasingly serious problem throughout the world, as demonstrated by the deteriorating financial stability of the healthcare system. Due to inadequate physical activity, in 2013 international healthcare systems have spent 53.8 billion USD, of which 25.7 billion USD in North America and 11.7 billion USD in Europe. Among the developmental programs assisting in promoting and maintaining the level of physical activity with children and adults, the first and foremost is the world public health initiative (WHO, 2014). Eliminating physical inactivity would lead to increased average lifespan by 0.68 years on the global level (Lee et al., 2012). In the contemporary society, excess weight, i.e. obesity, is considered a determinant in the development of chronic diseases. The factors of chronic diseases, such as the sedentary lifestyle, are present not only among adults, but also among children and adolescents (Tremblay et al., 2011). The link between socio-economic status, physical environment and a number of other factors form the basis for obesity (Kopelman, Jebb and

Butland, 2007). A significant number of papers point to a series of societal (Rutten, Boen, and Seghers, 2013) and environmental factors (Eyre et al., 2015) which correlate with physical activity and the share of fat in the body composition. Childhood obesity is the starting point which leads to chronic diseases in adulthood and old age (Lobstein and Jackson-Leach, 2006). Though the imbalance between calorie intake and physical activity is the primary cause of childhood and teenage obesity, factors from the environment are extremely important for the development of obesity in the population of children and adolescents (Lee and Yoon, 2018). To fight the epidemic of obesity, it is essential to create a healthy environment and pre-emptive interventions on the community level (WHO, 2011). Treating obesity in children is also of utmost importance (Mead et al, 2017). Physical activity provides important health benefits for children and the young (Janssen and LeBlanc, 2010). Physical activity also has a positive effect on the development of the organism at a young age, as well as on reducing obesity and increasing the level of motor and functional skills and abilities (Badrić and Ravlić, 2017). Increasing physical activity has numerous positive effects, such as strengthening the child's self-efficiency and self-sufficiency (Bandura, 2004), developing cognitive abilities (Martin et al., 2018), providing the parents with additional support for model-based learning, strengthening the family bond and relationships among family members (Golan, 2006). Respective lifestyle factors have different impacts on the status of physical activity, which is why it is essential to investigate all the connective elements, such as physical activity, sedentary lifestyle or obesity status (Tambalis, Panagiotakos, Psarra, and Sidossis, 2019). Physical activity can facilitate serious health improvements (Bouchard, Blair, and Haskell, 2012). The objective of this research is to determine the correlations between variables for assessing nourishment in children with variables for assessing physical activity and body mass index.

Methods

189 students of first and second grades took part in the research, of which 93 girls and 96 boys aged 7.74 ±0.66. Test sample comprised students from three primary schools from the area of the town of Petrinja. All students were in perfect health at the time the research was carried out. The parents provided their written consents for the children's participation. Measuring was conducted during April and May 2019. The level of physical activity was assessed using the Fels physical activity questionnaire for children (Fels PAQ for children, Treuth, Hou, Young and Maynard, 2005) a standardized questionnaire used to assess the level of physical activity of children and adolescents aged 7-19. The level of physical activity of a person is assessed in three types of activities; sports, free time and household chores, which is how the total level of physical activity is assessed. The sample of morphological variables consisted of anthropometric measurements: height and weight. Height was measured using the anthropometer. The research also put to use a body composition measuring device – Omron BF500 Body Composition Monitor. It represents an instrument which assesses the percentage of fat tissue by applying bioelectrical impedance. Using this instrument, we measured body mass, body mass index and the ratio of fat in the body.

Central and dispersive parameters were calculated for all the variables: arithmetic mean (X), standard deviation (SD), minimum result (MIN), maximum result (MAX), distribution asymmetry (SKEWNES) and distribution elongation (KURTOSIS). Variables' distribution normalcy was tested via the Kolmogorov-Smirnov test (K-S test). To determine the link between the indicator of nourishment status and the level of physical activity, the Pearson correlation coefficient was used. Statistical relevance was tested on the level $p < ,05$. Dana processing was conducted using the program STATISTICA version 13.4.0.14., TIBCO Software Inc.

Results

Research results are shown in the following tables.

Table 1 Nourishment status for boys and girls grades 1 and 2

Gender	Underweight %	Normal Weight %	Overweight %	Obese %
Boys	2.08	68.75	19.79	9.38
Girls	11.83	66.67	18.28	3.23

** Classification of subjects according to the percentage of body fat is made according to McCarthy et al. (2006)*

Results presented in Table 1 show that 68.75% of boys and 66.67% of girls are normally nourished. Also, it is clear that 29.17% of first- and second-grade boys are either overweight or belong to the obese group. For girls, that percentage is somewhat lower (21.51%), but still relatively high.

Table 2. Descriptive indicators of morphological characteristics and variables of the questionnaire on the level of physical activity of the total test sample

	N	AS	SD	Min	Max	K-S	Skew	Kurt
Height	189	132.53	7.36	116.00	154.00	p < .20	0.29	-0.13
Mass	189	30.98	7.89	16.70	63.80	p < .01	1.39	2.32
Body mass index (BMI)	189	17.70	3.32	13.00	29.50	p < .01	1.21	1.18
Percentage of fat	189	20.09	7.79	5.00	40.70	p < .20	0.49	-0.37
Sports at school	189	1.15	0.36	1.00	2.00	p < .01	2.00	2.01
Sports club	189	2.06	0.92	1.00	5.00	p < .01	0.05	-1.59
Perspiration during activity	189	2.42	1.99	0.00	5.00	p < .01	0.30	-0.62
Sports in free time	189	3.79	1.27	0.00	5.00	p < .01	-0.68	-0.42
Sedentary in free time	189	2.70	1.15	1.00	5.00	p < .01	-0.04	-0.56
Walking/cycling to school	189	3.01	1.60	0.00	5.00	p < .01	-0.06	-1.38
Household chores	189	2.72	1.01	1.00	5.00	p < .01	0.56	-0.11
Perspiration during household chores	188	2.14	1.47	0.00	5.00	p < .01	0.80	-0.61
Sport indeks	189	1.87	0.91	0.67	4.00	p < .01	-0.05	-1.29
Free time indeks	189	3.40	1.00	0.00	5.00	p < .01	-0.11	-0.04
Household chores indeks	189	2.43	0.97	0.50	5.00	p < .01	0,.6	-0.36
Total physical activity	189	7.70	1.92	1.17	12.83	p < .20	0.28	0.56

N= number of respondents; AS= arithmetic mean; SD= standard deviation; MIN= minimum result; MAX= maximum result; K-S=Kolmorgov-Smirnov normality test; SKEW= skewness; KURT= kurtosis

Descriptive results of variables on the whole sample of students (N=189) are shown in Table 1. Tested participants are on average 132.53±7.36 cm tall, with body mass of 30.98± 7.89 kg, which, according to reference values on the level of the Republic of Croatia (Jureša, Kujundžić Tiljak and Musil, 2011), places them in the group of children with normal height and weight. The average body mass index (BMI) result is 17.70±3.32, and those values are somewhat higher than the reference values on the level of the Republic of Croatia (Jureša i sur., 2011). The percentage of body fat (%TM) is 20.90±7.79, which places subjects of that age in the normally nourished group, according to reference values (McCarthy et al., 2006). Kolmogorov-Smirnov test established deviations from the normal distribution of almost all researched variables. Due to the nature of this test on larger samples, we tested for asymmetry and curve of distribution. The values were within -2 to 2 limits, thus by meeting that criterion (Tabachnick and Fidel, 2013), researched variables have been included in the analysis. From observing average results in variables estimating physical activity, it is evident that students are most physically active in their free time. Most commonly, they walk or cycle to school. The lowest values have been observed in the area of sports at school (1.15), as well as in activities in sports clubs (2.06). Increased physical activity has also been observed when doing household chores (2.72).

Table 3 Pearson correlation coefficient between variables to determine nourishment status and variables to assess the level of physical activity on the total test sample

	Mass	BMI	% BF
Sports at school	0.00	-0.03	-0.13
Sports club	0.05	0.10	0.09
Perspiration during activity	0.16*	0.14	0.15*
Sports in free time	0.00	-0.06	-0.04
Sedentary in free time	0.10	0.04	0.06
Walking/cycling to school	0.02	0.02	-0.04
Household chores	0.16*	0.17*	0.09
Perspiration during household chores	0.12	0.10	0.07
Sport indeks	0.14	0.13	0.12
Free time indeks	0.02	-0.02	-0.06
Household chores indeks	0.17*	0.17*	0.09
Total physical activity	0,16*	0,13	0,08

** significance level p <0.05*
BMI – Body mass index
% BF – Body fat percentage

On the total sample of first- and second-grade students (Table 3), using the Pearson correlation coefficient, we observed a statistically relevant

positive correlation between physical activity and perspiration during physical activity (0.16) as well as household chores during free time (0.16). Furthermore, we observed a positive correlation at the BMI variable with household chores (0.17). With other variables, no such statistically relevant correlation has been noted. Moreover, no statistically relevant correlation has been observed between the body fat percentage (%BF) and variables to assess physical activity, as well as physical activity indices. Also, it is clear that the variables of school sports are negatively connected to the percentage of fat (%BF), though that correlation is not significant.

Table 4 Pearson correlation coefficient between variables to determine nourishment status and variables to assess the level of physical activity on the test sample according to sex

	Mass		BMI		% BF	
	Girls 96	Boys 92	Girls 96	Boys 92	Girls 96	Boys 92
Sports at school	-0.03	0.04	0.04	-0.09	-0.09	-0.17
Sports club	0.05	0.02	0.15	0.03	0.11	0.07
Perspiration during activity	0.13	0.18	0.16	0.10	0.16	0.12
Sports in free time	-0.01	-0.01	-0.11	-0.04	-0.14	0.02
Sedentary in free time	0.12	0.10	-0.02	0.12	0.04	0.09
Walking/cycling to school	0.13	-0.09	0.18	-0.14	0.11	-0.17
Household chores	0.17	0.16	0.17	0.19	0.11	0.06
Perspiration during household chores	0.10	0.12	0.06	0.14	0.07	0.06
Sport index	0.11	0.14	0.17	0.07	0.15	0.09
Free time index	0.10	-0.08	0.08	-0.14	0.01	-0.12
Household chores index	0.16	0.18	0.13	0.21*	0.11	0.08
Total physical activity	0.18	0.12	0.18	0.06	0.13	0.01

** significance level p <0.05*
BMI – Body mass index
% BF – Body fat percentage

When observing the results presented in Table 4, it is clear that with either sex there have not been noticed relevant correlations with any nourishment indicator, apart from boys, where there is a significantly higher positive correlation (0.21) of the body mass index (BMI) with the household chores index. Other correlations are low and most of them positive. Those that are negative mostly relate to school sports.

Discussion

Research results, according to the percentage of body fat, indicate that most subjects (68.75% boys, 66.67% girls) are normally nourished. The percentage of malnourished subjects is relatively low (2.08 boys, 11.83% girls), yet we have obtained a higher and rather worrying number of obese and overweight children (29.17% boys, 21.51% girls). Previous studies have presented similar results (Bosch, Wells, Lum and Reid, 2019., Ostojić, Stojanović, Stojanović, Marić and Njaradi, 2011), even though there have been some studies with opposing results (Karakaš, Osmani, Paklarčić and Kukića, 2014., Nsibambi, 2013).

As the objective of this research was to determine the correlations between variables to assess the level of nourishment in children with variables to assess physical activity and physical activity indices, Pearson correlation coefficient revealed a significant correlation of the body mass index and perspiration (0.16). Significant correlation with perspiration is also evident in the variable to assess the percentage of body fat (0.15). Throughout the research, correlation between physical activity and body fat percentage has not been observed, while in other research (Hallstrom et al., 2013., Jimenez-Pavon, Kelly and Reilly, 2010) obtained results pointed to a significant correlation between those two variables. Significant correlation has been observed in variables for total physical activity and body mass. Research (Gralla, McDonald, Breneman, Beets and Moore 2016) confirms the effect of physical activity on the body fat percentage, as well as on body mass. Body mass has also been linked to the sports index and household chores index. Activities such as sleeping, sedentary activities and light physical activity have not been linked to differences in body composition. (Dumuid et al., 2019).

Results show very low values with several significant positive correlations not indicating the effect of body composition on participation in physical activity. This claim surely lies in the fact that the test sample was either inadequate for studying this segment or not large enough to obtain meaningful results. In their research, Song et al. (2012) demonstrated that added physical activity in the test sample showed a significant improvement in observed parameters for children's body composition. Unfavourable differences in body composition were greater for a certain decrease of moderate to intense physical

activity than useful differences for the equivalent increase in physical activity (Dumuid i sur. 2019). Although it is true that the correlations between variables are very low and positive, negative correlations still occur in the school sports, free time sports and walking from home to school variables in relation to the percentage of body fat. The Salmon, Campbell, Crawford (2006) research also revealed a negative correlation of body composition with organized physical activity and free time sports. To an extent, this negative correlation indicated that participation in some form of physical activity might contribute to decreasing the percentage of body fat in children. Zahner et al. (2009) have not established a significant correlation between doing sports on a regular basis in one's free time with the body fat percentage.

The body of evidence on preventive correlation between everyday physical activity and body composition is still controversial (Conn, Hafdahl, Phillips, Ruppar and Chase 2014). Papers investigating the sedentary lifestyle demonstrate that a great quantity of such behaviour cannot have an autonomously harmful effect on body composition when in one's youth one takes part in moderate to intense physical activity (Biddle, Bengoechea and Wiesner, 2017). When analysing correlation results according to sex, one notices a negative correlation of school sports with the body mass index, and in the group of girls with weight and the percentage of body fat as well. A positive correlation in both groups, boys and girls, has been observed in all variables of body composition and doing sports in a sports club, perspiration during activity, perspiration when doing household chores, sports index, household chores index and total physical activity. Such a correlation is also evident at the body mass variable and sedentary free time, active commute to school and free time index with girls. Body composition correlation for boys in first and second grades is negative for sedentary free time, active commute to school and free time index.

Measuring the body mass index in the select sample produced somewhat higher results (17.70 ± 3.32) to reference values. When measuring the body mass index (BMI), one research (Mayor of London, 2011) established that the results of measuring were in line with the values on the national level. Measured body mass index (BMI) has not demonstrated a significant correlation with physical activity in the subjects, while another research (Bosch et al., 2019) showed that children who do or play sports have a lower body mass index. What is visible is a statistically relevant correlation of the body mass index and household chores index for boys, whereas no such significant correlation has been found for girls. Forsell et al. (2019) conducted a similar study measuring the body mass index (BMI), but on experimental groups, attempting to increase physical activity. Research results further confirmed the significant impact of physical activity to the body mass index (BMI) level.

Most subjects' commute to school is active, yet the connection between the nourishment indicator and total physical activity in the research conducted is not evident, not excepting active commute. Numerous studies have pointed to a positive effect of the active commute to school on children's body composition (Wen, Merom, Rissel and Simpson, 2010., Pabayo, Gauvin, Barnett, Nikiéma and Séguin, 2010., Mendoza et al., 2011). Research results (Lander et al. 2019.) show that active commute to school is reversely linked to the BMI, while earlier studies provided implausible evidence on its effects in reducing obesity (Heelan et al., 2005.). This study measured the average values of the body mass index. Students are most active in their free time, household chores, and only then sports activities. The questionnaire reveals that sports activities at school are neglected, giving the lowest score (1.15), while children are most physically active in their free time (3.40). They do spend their free time at sports clubs, but only a small percentage of children conducts physical activity in sports clubs (2.06). Connection to body composition is not visible when doing sports at a sports club. Danish studies have shown that children who do club sports, especially those doing sports involving a ball, have a better ability of exercising and a significantly better body composition in comparison to those children who are not active in sports clubs (Larsen et al., 2017). Total physical activity on average amounts to (7.70). This average result of total physical activity does not enter the framework of the norms of recommended physical activity (according to Treuth et al., 2005), thus it can be concluded that this sample of first- and second-grade students is on average insufficiently physically active.

Furthermore, the link between height and weight shows significant correlation, yet they do not

define facts in the ratio of height and weight to a student's physical activity. Very low values are primarily positive and fail to comprehensively explain the research objective. Since a sudden increase in the percentage of body fat has been noticed in students as they age, with the level of physical activity stagnating, the positive correlation observed here should be understood as a worrying factor which may in the end have negative repercussions to further growth and development of children and youth.

Conclusions

The development of obesity is significantly linked, and with a negative trend, with insufficient amount of movement, i.e. reduced physical activity in the population of children and youth. Physical activity of children in primary education must be primarily focused on continued implementation of P.E. classes, constantly seeking how to increase the number of physically active students. Results show very low values with two significant correlations not demonstrating that taking part in physical activity affects body composition. This claim surely lies in the fact that the test sample was either inadequate for studying this segment or not large enough to obtain meaningful results. Future research of this type should, therefore, focus on determining the level of participating in physical activity in the students' free time, whereas an important contribution has been made in the physical education of students, as well as the basics in systematic planning as regards intervention programs aimed at obesity prevention.

References

Badrić, M., Ravlić, K. (2017). Relationship between Pupils'Functional Capacity and Physical Activity, *Croatian Journal of Education.* Vol.19; Sp.Ed.No.2/2017, pages: 109-123

Bandura, A. (2004). Health promotion by social cognitive means. *Health Educ Behav* ; 31: 143–64

Biddle, S. J. H., García Bengoechea, E., & Wiesner, G. (2017). Sedentary behaviour and adiposity in youth: A systematic review of reviews and analysis of causality. *The International Journal of Behavioral Nutrition and Physical Activity*, 14 (1), Article ID 43.

Bosch, L.S.M.M., Wells, J,.C.K., Lum, S., Reid, A.M. (2019). Associations of extracurricular physical activity patterns and body composition components in a multi-ethnic population of UK children (the Size and Lung Function in Children study): a multilevel modelling analysis. *BMC Public Health* 20;19(1):573

Bouchard C, Blair SN, Haskell L (2012). *Physical Activity and Health*. Second edition. Human Kinetics.

Caspersen, CJ., Powell, KE., Christenson, GM. (1985). Physical activity, exercise, and physical fitness: definitions and distinctionsfor health-related research. *Public Health Rep*. 100:126-31.

Conn, V.S., Hafdahl, A., Phillips, L. J., Ruppar, T. M. & Chase, J. A. (2014). Impact of physical activity interventions on anthropometric outcomes: systematic review and meta-analysis. *J Prim Prev* 35, 203–215

Dumuid, D., Wake, M., Clifford, S., Burgner, D., Carlin, J.B., Fiona K. Mensah, F.K., Fraysse, F., Lycett, K., Baur, L., Olds, T., (2019). *T*he Association of the Body Composition of Children with 24-Hour Activity Composition, *Journal of Pediatrics.* 208, 43–49.e9

Fan X, Cao ZB. (2017). Physical activity among Chinese school-aged children: national prevalence estimates from the 2016 Physical Activity and Fitness in China—The Youth Study. *J Sport Health Sci;* 6:388–94

Forsell C. , Gronowitz E. , Larsson Y. , Kjellberg, B.M. , Friberg P., Marild S. (2019). Four-year outcome of randomly assigned lifestyle treatments in primary care of children with obesity*. Acta Paediatr*; 108(4):718-724

Füssenich,L.M.,Boddy,L.M.,Green,D.J.,Graves,L. E.F.,Foweather,L.,Dagger,RM.,McWhannell, N., et al. (2015). Physical Activity Guidelines and Cardiovascular Risk in Children: A Cross Sectional Analysis to Determine Whether 60 Minutes Is Enough. *BMC Public Health* 16 (1): 1–7.

Golan, M., (2006). Parents as agents of change in childhood obesity– from research to practice. *Int J Pediatr Obes*; 1: 66–76

Gralla, M.H., McDonald, S.M., Breneman, C., Beets, M.W. , Moore, J.B. (2016). Associations of Objectively Measured Vigorous Physical Activity With Body

Composition, Cardiorespiratory Fitness, and Cardiometabolic Health in Youth: A Review. *Am J Lifestyle Med.*6;13(1):61-97

Hallstrom, L., Labayen, I., Ruiz, J.R., Patterson, E., Vereecken, C.A., Breidenassel, C., Gottrand, F., Huybrechts I, Manios Y, Mistura L, Widhalm K, Kondaki K, Moreno, LA, Sjöström M,(2013). Breakfast consumption and CVD risk factors in European adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr* ;16(7):1296-1305.

Heelan, K.A., Donnelly, J.E., Jacobsen, D.J., Mayo, M.S., Washburn, R., Greene, I. (2005). Active commuting to and from school and BMI in elementary school children – preliminary data. *Child Care Health Dev* ;31(3):341–9.

Janssen I, LeBlanc AG. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act.*;7:40.

Jimenez-Pavon, D., Kelly, J., Reilly, J.J. (2010) Associations between objectively measured habitual physical activity and adiposity in children and adolescents: Systematic review. *Int J Pediatric Obes*;5(1):3-18.

Jureša, V., Kujundžić Tiljak, M., Musil, V. (2011). *Hrvatske referentne vrijednosti antropometrijskih mjera školske djece i mladih tjelesna visina, tjelesna masa, indeks tjelesne mase, opseg struka, opseg bokova.* Zagreb: Sveučilište u Zagrebu, Medicinski fakultet, Škola narodnog zdravlja „Andrija Štampar“

Karakaš S., Osmani, Z., Paklarčić, M., Kukić, E., (2015). Analiza preferencije i učestalosti bavljenja tjelesnom aktivnošću kod djevojčica uzrasta 7-14 godina sa područja Srednjobosanskog kantona. *Glasnik Antropološkog društva Srbije / Journal of the Anthropological Society of Serbia*. 50,17-24

Lander S. M. M. Bosch, Jonathan C. K. Wells, Sooky Lum & Alice M. Reid (2019). Associations of extracurricular physical activity patterns and body composition components in a multi-ethnic population of UK children (the Size and Lung Function in Children study): a multilevel modelling analysis. *BMC Public Health;* 573,(19)

Larsen ,M.N., Nielsen, C.M., Ørntoft, C.Ø., Randers, M.B., Manniche, V., Hansen, L., Hansen, P.R., Bangsbo, J., Krustrup, P. (2017). Physical Fitness and Body Composition in 8–10-Year-Old Danish Children Are Associated With Sports Club Participation. *Journal of Strength & Conditioning Research*; 31(12), 3425–3434

Lee, E.Y., Yoon, K.H.(2018). Epidemic obesity in children and adolescents: risk factors and prevention. *Front Med*.; 12(6), 658-66.

Lobstein, T., Jackson-Leach, R. (2006). Estimated burden of paediatric obesity and co-morbidities in Europe. Part 2. Numbers of children with indicators of obesity-related disease. *Int J Pediatr Obes*; 1, 33–41.

Martin, A., Booth, J.N., Laird, Y., Sproule, J., Reilly, J.J., Saunders, D.H., (2018). Physical activity, diet and other behavioural interventions for improving cognition and school achievement in children and adolescents with obesity or overweight. *Cochrane Database of Systematic Reviews 2018, Issue 1. Art. No.: CD009728. DOI: 10.1002/14651858.CD009728.pub3.*

Greater London Authority (GLA) Intelligence Unit (2011) *Childhood Obesity in London*

McCarthy HD, Cole TJ, Fry T, Jebb SA, Prentice AM.(2006). Body fat reference curves for children. *Int J Obes*; 30: 598-602

Mead, E., Brown, T., Rees, K., Azevedo, L.B., Whittaker, V., Jones, D., Olajide, J., Mainardi, G.M., Corpeleijn, E. , O'Malley, C., Beardsmore, E., Al-Khudairy, L., Baur, L., Metzendorf, M.I., Demaio, A., Ells, LJ. (2017) Diet, physical activity and behavioural interventions for the treatment of overweight or obese children from the age of 6 to 11 years. *Cochrane Database of Systematic Reviews 2017, Issue 6. Art. No.: CD012651. DOI: 10.1002/14651858.CD012651*

Mendoza, J.A., Watson, K., Nguyen,N., Cerin, E., Baranwski, T., Nicklas, T.A.(2011) Active commuting to school and association with physical activity and adiposity among US youth. *J Phys Act Health.* ;8(4):488–495

Nsibambi, C. A. N. (2013). Body Composition Analysis of Pupils in Urban Schools in Central Uganda. *IJBSS,* 4 (7), 135-141

Ostojić, S. M., Stojanović, M. D., Stojanović, V., Marić, J. i Njaradi, N. (2011). Correlation between Fitness and Fatness in 6-14-year Old Serbian School Children. *J Health Popul Nutr*, 29 (1), 53-60

Pabayo, R., Gauvin, L., Barnett, T.A., Nikiéma, B., Séguin, L.(2010) Sustained active

transportation is associated with a favorable body mass index trajectory across the early school years: Findings from the Québec Longitudinal Study of Child Development birth cohort. *Prev Med*;50(Suppl. 1):S59–S64.

Parfitt, G.,Pavey,T., and Rowlands, AV. (2009). Children's Physical Activity and Psychological Health: The Relevance of Intensity. *Acta Paediatrica, International Journal of Paediatrics* 98 (6): 1037–1043.

Pratt M, Norris J, Lobelo F, Roux L, Wang G. (2014). The cost of physical inactivity: moving into the 21st century. *Br J Sports Med*;48:171–3.

Salmon , J., Campbell, K.J., Crawford, D.A.(2006). Television viewing habits associated with obesity risk factors: a survey of Melbourne schoolchildren. *Medical Journal of Australia*; 184(2):64–67.

Song, J., Stebbins, C., Kim, T., Kim, H., Kang, H., Chai, J.(2012). Effects of 12 weeks of aerobic exercise on body composition and vascular compliance in obese boys. *J Sports Med Phys Fitness*; 52(5): 522-529.

Tabachnick, B.G. and Fidell, L.S. (2013). *Using Multivariate Statistics*. Pearson, Boston.

Tambalis, K.D., Panagiotakos, D.B., Psarra,G., Sidossis, L.S. (2019). Concomitant Associations between Lifestyle Characteristics and Physical Activity Status in Children and Adolescents, *J Res Health Sci;* 19(1)

Tremblay, M.S., LeBlanc, A.G., Kho, M.E., Saunders, T.J., Larouche, R., Colley, R.C., et al.(2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act.* 8: 98.

Treuth, M. S., Hou, N., Young, D. R., i Maynard, L. M. (2005). Validity and Reliability of the Fels Physical Activity Questionnaire for Children. *Med Sci Sports Exerc*, 37 (8), 488-495

Wen, L.M., Merom, D., Rissel, C., Simpson, J.M. (2010). Weight status, mode of travel to school and screen time: a cross-sectional 226 Larouche et al survey of children 10-13 years in Sydney. *Health Promot J Austr* ;21:57–63.

World Health Organization-WHO (2011). Obesity and overweight *Media centre.* Fact sheet N°311

World Health Organization-WHO (2009). Global health risks, Mortality and burden of disease attributable to selected major risks. https://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf ?ua=1&ua=1(accessed 24 Oct 2019).

Zahner ,L., Muehlbauer, T., Schmid, M., Meyer, U., Puder, J.J., Kriemler, S. (2009). Association of sports club participation with fitness and fatness in children. *Medicine and Science in Sports and Exercise* ;41(2):344–350.

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