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The Influence of BMI on Resistance Running Among Middle-School Students

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Abstract: This study focuses on middle schoolers who undergo a period of transformation from preteen to teenager years. The situation concerning this category is alarming worldwide because these children are prone to obesity. Our research aimed to study the results of middle schoolers in the trial of resistance running and determine whether these results suffered modifications because of the BMI. The study features the results for 800m resistance running for girls, 1000m for boys, and the differentiation indicator, i.e., the BMI. The research group comprised 94 seventh graders (40 boys and 54 girls) from Iași County (Romania). Upon interpreting the BMI values, we found modified scores in the case of 39% of the girls and 45% of the boys. Most students obtained good results (the grade average was 7-8), and none of them dropped out of the test. According to the marking scheme, the statistical results have proven that the girls obtained values between 4.39´ and 4.48´, while the boys scored between 4.31´ and 4.45´. Consequently, our findings show that the BMI may partially alter the results of the resistance running trials; hence, greater attention should be paid to this category of students by limiting harmful habits and replacing them with physical activities.

Keywords: *physical activity; middle schoolers; resistance run; risk factors; BMI.*

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Introduction

The preservation of an ideal body mass has become a social matter due to inactivity and the lack of exercise. At the same time, current data reported worldwide show a growing percentage among children and youths. It has become an epidemic in the United States (Bove & Olson, 2006). Still, it has also been reported in numerous other countries and underlined in various research studies, such as in Australia (Dollman et al., 2007), Finland (Huurre et al., 2003), France (Lioret et al., 2007), Great Britain (Brodersen et al., 2007), Germany (Kuepper-Nybelen et al., 2005), and Japan (Kurokawa et al., 2008).

The theories correlating physical activity and body mass index suggest a reversed relationship between the two variables. It derives from the hypothesis that the energetic intake of an individual with an average weight is equal or almost equal to the energetic consumption (Tiruneh, 2010).

Body mass index (BMI) is an available and non-expensive tool to monitor the health state of any person. Though it is usually used in a healthcare setting to categorise people as underweight, with average weight, or overweight, and obese (World Health Organisation, 1995), its validity for the sporting populations has been questioned because it is correlated with fat mass and lean mass. Irrespective of this limitation, one may evaluate an athlete's body weight for a certain height, contributing to weight control (Ode et al., 2007).

One of the benefits identified is the positive effect of resistance running on body weight values. Moreover, research has been conducted investigating multi-component interventions focusing on young overweight people (Alberga et al., 2012; Schranz et al., 2013).

In Romania, the percentage of overweight children is lower, but the trend is ascending, which should be a warning for all the authorities. In the last decade, students have increasingly requested an exemption from PE classes, and this aspect is crucial for middle schoolers during their preteenager or teenage years. The current guidelines for middle schoolers recommend 60 minutes of exercising daily and a reduction to the minimum of the time spent sitting in front of a computer (Faigenbaum et al., 2003). Students also get exemptions from PE classes due to failing to attain the performance standards and obtaining lower evaluation grades. The educational path of middle schoolers regarding the PE class is based on competencies meant to influence harmonious physical development, form

motor skills, develop exercise capacity, and favour integration into the natural and social environment (Ministry of Education, 2017).

One of the track and field trials comprised in the syllabus for the 7th graders is the resistance running – 800m girls and 1000m boys. Resistance must be developed when the body is mature and well-conditioned enough to face the rigours of this type of training. Metabolic and cardiovascular factors limit this type of running; many studies prove that resistance activities may provide BMI-related benefits.

The BMI assessment considers the age differences in body composition and the linear growth rate for children and teenagers. The interpretation of the BMI rate per se may vary significantly throughout childhood development (Zickgraf, 2020).

Among athletes, BMI is closely related to other body weight measurements (e.g., skinfold measurements). It must be emphasised, though, that a person's body mass may increase not only due to body fat but also muscle density, bone, and internal cellular fluid weight. For instance, the BMI of an athlete with a substantial muscle mass is more likely lower, even considered overweight. In most trials, BMI estimates body fat levels (Frederick et al., 2012).

Objective

The objective of this study is to evaluate resistance running as a relevant performance indicator concerning body mass index (BMI); this assessment allows a clear differentiation of the resistance capacity of middle schoolers.

The research hypothesis may be expressed as follows: We assume that body mass index can influence the results obtained in resistance running among 7th graders.

Literature Review

Modern society involves increasingly sedentary lifestyles and reduced exercise. Physical activity is essential for well-balanced physical development during the growth period (Barbieri & Zaccagni, 2013).

The essential indicator of health is physical activity, which is crucial for mitigating damage caused by the coronavirus.

Studies carried out in the USA and Germany on large teenage samples have reported reduced motor capacities due to the lack of physical activity compared to the past (Ghozy et al., 2021; Schmidt et al., 2020; Storch et al., 2020; Tison et al., 2020).

The literature highlights negative changes in teenagers' exercise capacity, which is alarming for their physical and mental health. It has been proven that regular physical activity practice may increase the immune system's effectiveness (Ghozy et al., 2021; Krüger et al., 2016).

Therefore, the visible increase in physical inactivity and excessive sedentary lifestyle in adolescents could lead to their physical deterioration, which may entail the risk of obesity, diabetes, and cardiovascular disease; it may also exacerbate the severity of existing conditions (Caron et al., 2006; Ghozy et al., 2021; Jean Vague, 1956; Kayapinar, 2012; Mattioli et al., 2020).

The literature specifies the age of adolescence as the most critical period of development, which can impact health significantly. Lack of exercise and ensuring an unhealthy diet can develop chronic diseases that will be observed in old age.

In the past few years, but also in the pandemic context, the lack of exercise among teenagers has become a significant healthcare issue (Kayapinar, 2012).

Numerous studies have reported that many teenagers have weight problems (D'Hondt et al., 2012; Rodrigues et al., 2016; Simon et al., 2014), which may be combated in the long term through the development of motor capacity through physical activities (De Meester et al., 2016).

The unsatisfactory acquisition of motor skills during childhood may cause academic, social, and motor performance issues, which may determine, in turn, low self-esteem and poor school performance among teenagers by avoiding physical activities (Cho et al., 2014).

Though the effects have not been determined clearly yet, upon studying the literature, evidence shows positive effects of resistance running on teenagers' weight. To prove this aspect beyond any doubt, many more studies are necessary, as well as an analysis that may provide an overview of the potential benefits of such interventions.

Given that resistance running offers potential benefits for young people in terms of weight, it is imperative to carry out more robust and qualitative studies to further and unequivocally investigate this issue. Based on the findings of this research, future studies should be designed as randomised controlled trials with large samples.

Methodology

Variables

The dependent variables of our study are the body mass index test and resistance running. The defined independent variables were gender or normal or increased body mass index.

Participants

The research sample included 94 students from a school in Iași, Romania. The gender repartition was uneven because we assessed all the 7th graders, accounting for 54 girls and 40 boys.

Procedures and instruments for data collection

According to the annual planning schedule and the school syllabus, we applied the tests to all the students during the PE classes. We quantified the test performance per the benchmarks established by the National Evaluation System for Physical Education and Sport.

The students were measured and weighed to calculate their BMI. We assessed the 800m resistance running for the girls and the 1000m resistance running for the boys. We divided the students into four distinct groups: the group of boys with a normal BMI, the group of boys with increased BMI, the group of girls with a normal BMI, and the group of girls with high BMI. The results were calculated for each group and gender, and correlations were made between the BMI and the values obtained in the resistance running.

Resistance running test

It is carried out on the timer from the start (4-6 students at a time). At the "start" signal, the students start running, the girls 800m, and the boys 1000m. The test ends at the finish line, and the time of arrival is noted when the timer stops. The time obtained by the student is written down in the summary table and will be graded according to the evaluation system. Any form of pushing or abruptness is prohibited, and the test is performed only once.

Table 1 - National Evaluation Standards for the 7th grade

No.	Resistance running	Standard /Grade					
		5	6	7	8	9	10
1.	800M - GIRLS	4.45	4.43	4.41	4.39	4.37	4.35
2.	1000M - BOYS	4. 45	4.43	4.41	4.39	4.37	4.35

The body mass index

Known as the Quetelet Index, it is an indicator set by the World Health Organisation to determine a person's health according to their weight group or category. BMI is calculated by dividing an individual's weight (expressed in kilograms) by the squared height (expressed in meters).

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Table 2 - The values of body mass indices

BMI	GIRLS - 54	BMI values	Mean of values	BOYS - 40	BMI VALUES	Mean of values
NORMAL	33 -61%	≤15.7 – 24.99	19.16	22-55%	≤15.8-24	21.38
INCREASED	21-39%	≥25	25.76	18-45%	≥24.1	25.90
Mean of values			22.46			23.64

Statistical procedures

The statistical analysis applied in this study aimed to find correlations between the two gender groups and the four subgroups regarding BMI and whether the differences between the results are related to increased BMI.

The Student Test was applied using the IBM SPSS Statistics 20 software program to validate the hypothesis and thoroughly analyse the research findings.

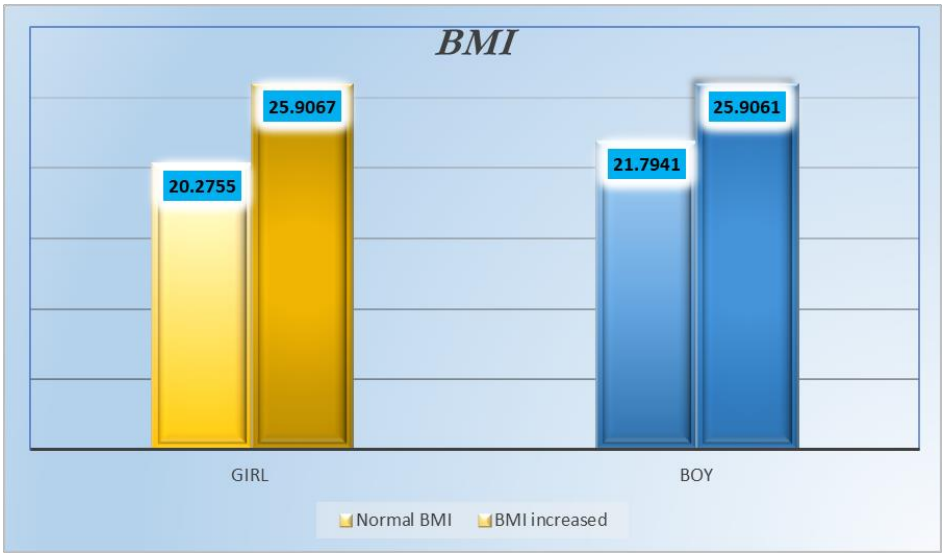
Results

The study focuses on two directions: the first is to differentiate the students with a normal BMI from those with increased BMI and determine whether these values can influence the result of resistance running trials; the second is to quantify the values obtained into grades.

Table 3 - BMI values – girls and boys

Statistical indicator	NORMAL BMI- girls	INCREASED BMI -girls	NORMAL BMI - boys	INCREASED BMI -boys
X+S	20.2755±2.54639	25.9067±1.17699	21.7941±1.66100	25.9061±0.88709
Paired samples test	t-43.485; p<0.00	t-93.080; p<0.00	t-58.719; p<0.00	t-114.334; p<0.00

Source: Author's own conception



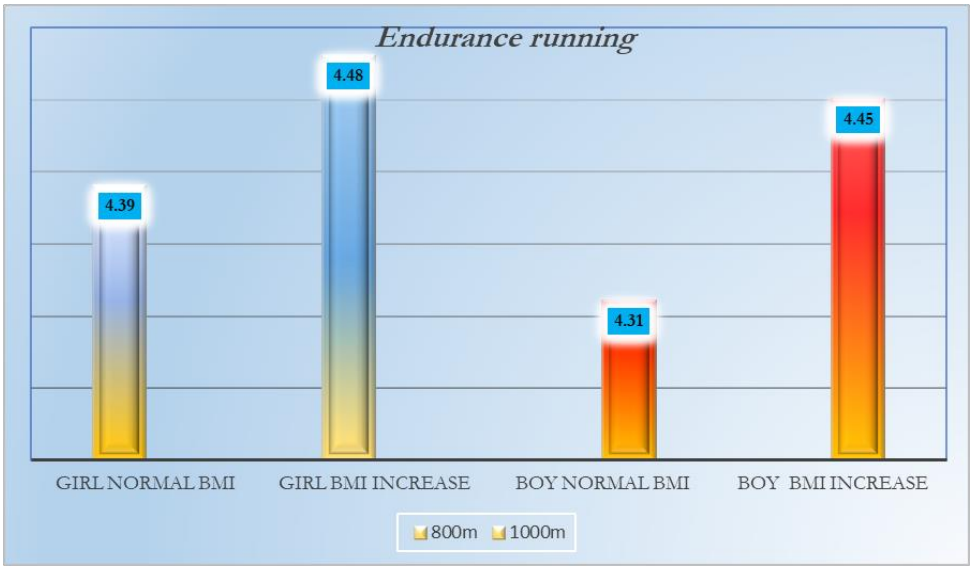
Source: Author's own conception

The values of the measurements concerning the body mass indices were the following: girls with a normal BMI 20.2755±2.54639, t-43.485; with a significance threshold p<0.00, girls with increased BMI 25.9067±1.17699; t-93.080 with a significance threshold p<0.00; boys with a normal BMI 21.7941±1.66100; t-58.719; the significance threshold p<0.00; boys with increased BMI 25.9061±0.88709; t-114.334; the significance threshold p<0.00. In all four groups, the significance threshold is p<0.00, which proves that the differences between means are significant.

Table 4 - Resistance running – 800m girls; 1000m boys

Statistical indicator	NORMAL BMI- girls	INCREASED BMI -girls	NORMAL BMI - boys	INCREASED BMI -boys
X+S	4.3994±04886	4.4833±0.17402	4.31±03936	4.45±04771
Paired samples test	t-93.080; p<0.00	t-65.395; p<0.00	t-395.157; p<0.00	t-217.922; p<0.00

Source: Author's own conception



Source: Author's own conception

The values of the arithmetic mean and standard deviation regarding resistance running are the following: girls with a normal BMI scored 4.3994±0.4886, girls with an increased BMI 4.4833±0.17402, boys with a normal BMI 4.31±0.3936, while boys with an increased BMI 4.45±0.4771. The significance threshold of p<0.00 is present in all groups, which proves that the differences between means are significant.

Table 5 - The correlation between variables concerning the tests carried out

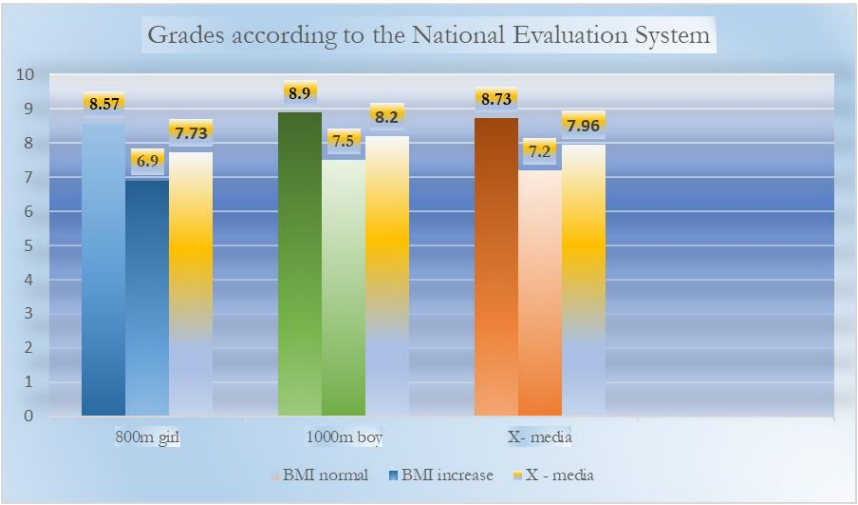
Variables	Levene´s Test Equality of variance- sig	t-Test	Sig. (2-tailed)
BMI- girls	+0.4887	t = -9786	P < 0.01
BMI - boys	+0.010	t = -9.444	P < 0.01
Results - girls	+0.29	t = -4.190	P < 0.01
Results - boys	+0.02	t = -9.485	P < 0.01

Source: Author's own conception

Each variable was tested independently for both groups, specifying Levene's significance; the significance threshold between subjects, the t-test proved equal assumed variances, while the difference between means (dm) corresponds to the statistics of the t-test.

Variables	Normal BMI	Increased BMI	X
800m girls	8.57	6.90	7.73
1000m boys	8.90	7.50	8.20
X	**8.73**	**7.20**	**7.96**

Source: Author's own conception



Source: Author's own conception

Limits

A limitation of this study is the small number of participants (only 7th graders). The results might be different if the study were extended to other Romanian schools and maybe internationally. In addition, the lack of research in this respect prevented us from comparing our findings with those concerning other students of the same age.

Another limitation would be that in Romania, there are very few epidemiological studies on obesity in children and adolescents and no studies on BMI on endurance running.

Discussions

In a study conducted in China, the authors analysed 45 teenage boys. They were divided into three groups (a group performing HIIT training, a group performing moderate exercise, and a control group), and the study took 12 weeks. Their findings show that resistance running has decreased BMI (Meng et al., 2022).

Another research was conducted in 2012 at a university in Poland on first-year university students. This study collected BMI and resistance running data using the 3-minute Burpees test. The authors have concluded that the students varied considerably in terms of body mass and that their BMI resumed average values (Podstawski et al., 2013a). Other studies have reported that overweight students have lower resistance skills than their peers with a normal BMI. Similar research was carried out on girls aged 7-9

using the 3-minute Burpees test (Scharhag-Rosenberger, 2010) and on the influence of the anthropometrical parameters concerning the resistance skills obtained in 1000 m canoeing on an ergometer (Bogataj et al., 2021). Several authors have reported body mass as the most relevant anthropometrical parameter negatively influencing the results obtained in resistance running (Kong, 2016; Larsen et al., 2017; Léger et al., 1988; Tjønna, 2009) through comparative resistance tests (Bogataj et al., 2021).

Another study has shown that increased body mass leads to higher absolute resistance but a lower relative resistance among individuals characterised by similar conditioning levels (Podstawski et al., 2013b).

Consequently, when resistance is related to an individual's body mass, higher values of this parameter are recorded; hence, persons with an increased BMI find it more difficult to perform physical activities involving relative resistance.

Conclusions

Following the study conducted thus far, several conclusions may be drawn: body mass index can influence the results obtained in resistance running among 7th graders but to a small extent.

Similar studies are necessary to provide a better insight into the results of middle schoolers in the resistance running trials in correlation with BMI and to determine unequivocally whether higher BMI may be due to an increase in the skeletal mass that may be determined by an augmentation of the basal metabolic rate.

However, because there were no available significant sizes of the apparent effect for the lean or fatless mass in this analysis, it suggests that these modifications may be due to an increase in total energy consumption that may occur through active participation and the increase in metabolically active lean mass. The results obtained concerning resistance running correspond to a grade of 8.57 (out of 10) for girls with a normal BMI and 6.90 for girls with an increased BMI, with a mean grade of 7.73. For the boys with a normal BMI, the average grade is 8.90, while the boys with a high BMI obtained a mean of 7.50 and an average grade of 8.20.

Upon comparing the means of grades, it is worth noting that the difference is not high and that there are no significant differences between the 7^{th} graders.

However, the data specific to the pre-puberty subjects of our study may have also impacted the results.

Acknowledgement

Throughout this study, all the ethical standards have been observed. All the respondents were made aware of the purpose and intent of the research; they were provided with instructions regarding the assessment trials and the measuring tools; their anonymity was ensured, and they could withdraw without any consequences. They were also informed that the resulting data would be used for scientific purposes exclusively. The Ethics Committee of the school approved the study.

References

Alberga, A. S., Sigal, R. J., Goldfield, G., Prud' Homme, D., & Kenny, G. P. (2012). The critical period of adolescence. *Pediatric Obesity, 7*, 261-273. https://doi.org/10.1111/j.2047-6310.2011.00046.x

Barbieri, D., & Zaccagni, L. (2013). Strength training for children and adolescents: benefits and risks. *Collegium antropologicum*, *37(2)*, 219–225. https://pubmed.ncbi.nlm.nih.gov/23914510/

Bogataj, Š., Trajković, N., Cadenas-Sanchez, C., & Sember, V. (2021). Effects of School-Based Exercise and Nutrition Intervention on Body Composition and Physical Fitness in Overweight Adolescent Girls. *Nutrients*, *1*, 238. https://doi.org/10.3390/nu13010238

Brodersen, N. H., Steptoe, A., Boniface, D. R., & Wardle, J. (2007). Trends in physical activity and sedentary behavior in adolescence: ethnic and socioeconomic differences. *British journal of sports medicine*, *41*(3), 140-144. http://dx.doi.org/10.1136/bjsm.2006.031138

Caron, F., Bove, M. D., & Olson, C. M. (2006). Obesity in Low-Income Rural Women: Qualitative Insights About Physical Activity and Eating Patterns. *Women & Health*, *44*(1), 57-78. https://doi.org/10.1300/J013v44n01_04

Cho, H., Ji, S., Chung, S., Kim, M., & Joung, YS. (2014). Motor function in school-aged children with attention-deficit/hyperactivity disorder in Korea, *Psychiatry Investigation*, *11*(3), 223-227. https://doi.org/10.4306/pi.2014.11.3.223

De Meester, A., Stodden, D., Brian, A., True, L., Cardon, G., Tallir, I., & Haerens, L. (2016). Associations among Elementary School Children's Actual Motor Competence, Perceived Motor Competence, Physical Activity and BMI: A Cross-Sectional Study. *PLoS ONE, 11*(10), e0164600. https://doi.org/10.1371/journal.pone.0164600

D'Hondt, E., Deforche, B., Gentier, I., De Bourdeaudhuij, I., Vaeyens, R., Philippaerts, R., & Lenoir, M. (2013). A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-

weight peers. *International Journal of Obesity*, 37(1), 61-67. https://doi.org/10.1038/ijo.2012.55

Dollman, J., Ridley, K., Olds, T., & Lowe, E. (2007). Trends in the duration of school-day sleep among 10- to 15-year-old South Australians between 1985 and 2004. *Acta Paediatrica*, *96*, 1011-1014. https://doi.org/10.1111/j.1651-2227.2007.00278.x

Faigenbaum, A. D., Milliken, L. A., & Westcott, W. L. (2003). Maximal strength testing in healthy children. *Journal of strength and conditioning research*, *17*(1), 162–166. https://www.researchgate.net/publication/10905313

Frederick, D. A., Jafary, A. M., Gruys, K., & Daniels, E. A. (2012). Surveys and the Epidemiology of Body Image Dissatisfaction. *Encyclopedia of Body Image and Human Appearance, 2.* https://ur.booksc.me/book/75769210/b71066

Ghozy, S., Abdelaal, A., Shah, J., Parker, K. E., & Islam, S. (2021). COVID-19 and physical inactivity: Teetering on the edge of a deadlier pandemic? *Journal of global health*, *11*, 03031. https://doi.org/10.7189/jogh.11.03031

Huurre, T., Aro, H., & Rahkonen, O. (2003). Well-being and health behaviour by parental socioeconomic status. *Social Psychiatry and Psychiatric Epidemiology, 38*, 249–255. https://doi.org/10.1007/s00127-003-0630-7

Jean Vague, M. D. (1956). The Degree of Masculine Differentiation of Obesities: a factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. *The American Journal of Clinical Nutrition*, *4*(1), 20. https://doi.org/10.1093/ajcn/4.1.20

Kayapinar, F. C. (2012). Physical activity levels of adolescents. *Procedia-Social and Behavioral Sciences*, *47*, 2107-2113. https://doi.org/10.1016/j.sbspro.2012.06.958

Kong, Z., Fan, X., Sun, S., Song, L., Shi, Q., & Nie, J. (2016). Comparison of high-intensity interval training and moderate-to-vigorous continuous training for cardiometabolic health and exercise enjoyment in obese young women: a randomized controlled trial. *PloS One*, *11*(7). https://doi.org/10.1371/journal.pone.0158589

Krüger, K., Mooren, F. C., & Pilat, C. (2016). The Immunomodulatory Effects of Physical Activity. *Current pharmaceutical design*, *22*(24), 3730–3748. https://doi.org/10.2174/1381612822666160322145107

Kuepper-Nybelen, J., Lamerz, A., Bruning, N., Hebebrand, J., Herpertz-Dahlmann, B., & Brenner, H. (2005). Major differences in prevalence of overweight according to nationality in preschool children living in Germany: determinants and public health implications. *Archives of disease in childhood*, *90*(4), 359–363. https://doi.org/10.1136/adc.2004.052423

Kurokawa, N., Nakai, K., Suzuki, K., Sakurai, K., Shimada, M., Kameo, S., Nakatsuka, H., & Satoh, H. (2008). Trends in growth status among schoolchildren in Sendai, Japan, 1994-2003: Leveling-off of mean body

height and weight. *Tohoku Journal of Experimental Medicine*, *216*(4), 371-375. https://doi.org/10.1620/tjem.216.371

Larsen, M. N., Nielsen, C. M., Ørntoft, C., Randers, M. B., Helge, E. W., Madsen, M., Manniche, V., Hansen, L., Hansen, P. R., Bangsbo, J., & Krustrup, P. (2017). Fitness Effects of 10-Month Frequent Low-Volume Ball Game Training or Interval Running for 8-10-Year-Old School Children. *BioMed Research International*. https://doi.org/10.1155/2017/2719752

Léger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences*, *6*(2), 93-101. https://doi.org/10.1080/02640418808729800

Lioret, S., Maire, B., Volatier, J. L., & Charles, M. A. (2007). Child overweight in France and its relationship with physical activity, sedentary behaviour and socioeconomic status. *European journal of clinical nutrition, 61*(4), 509-516. https://doi.org/10.1038/sj.ejcn.1602538

Mattioli, A. V., Pinti, M., Farinetti, A., & Nasi, M. (2020). Obesity risk during collective quarantine for the COVID-19 epidemic. *Obesity medicine*, *20*, 100263. https://doi.org/10.1016/j.obmed.2020.100263

Meng, C., Yucheng, T., Shu, L., & Yu, Z. (2022). The effects of high-intensity school training on body composition, cardiorespiratory fitness, and cardiometabolic markers in obese adolescent boys: a randomized controlled trial. *BMC Pediatrics, 22*, 112. https://doi.org/10.1186/s12887-021-03079-z

Ministry of Education. (2017, 28 February). *The Physical Education and Sport Syllabus for Middle School*. Ministry of Education. https://www.ise.ro/wp-content/uploads/2017/01/Educatie-fizica-si-sport.pdf

Ode, J. J., Pivarnik, J. M., Reeves, M. J., & Knous, J. L. (2007). Body mass index as a predictor of percent fat in college athletes and nonathletes. *Medicine and science in sports and exercise*, *39*(3), 403–409. https://doi.org/10.1249/01.mss.0000247008.19127.3e

Podstawski, R., Kasietczuk, B., Boraczyński, T., Boraczyński, M. And Choszcz, D. (2013a). Relationship Between BMI and Endurance-Strength Abilities Assessed by the 3 Minute Burpee Test. *International Journal of Sports Science*, *3*(1), 28-35. https://doi.org/10.5923/j.sports.20130301.06

Podstawski, R., Kasietczuk, B., Boraczyński, T., Boraczyński, M., & Choszcz, D. (2013b). Relationship Between BMI and Endurance-Strength Abilities Assessed by the 3 Minute Burpee Test. *International Journal of Sports Science*, 3(1), 28-35. https://doi.org/10.5923/j.sports.20130301.06

Rodrigues, L. P., Stodden, D. F., & Lopes, V. P. (2015). Developmental Pathways of Change in Fitness and Motor Competence Are Related to Overweight and Obesity Status at the End of Primary School. *Journal of Science and Medicine in Sport*, *19*, 87-92. https://doi.org/10.1016/j.jsams.2015.01.002

Scharhag-Rosenberger, F., Meyer, T., Gäßler, N., Faude, O., & Kindermann, W. (2009). Exercise at given percentages of VO2max: heterogeneous metabolic responses between individuals. *Journal of science and medicine in sport*, *13*(1), 74-79. https://doi.org/10.1016/j.jsams.2008.12.626

Schmidt, S. C. E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., & Nigg, C. (2020). Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. *Scientific Reports*, *10*, 21780. https://doi.org/10.1038/s41598-020-78438-4

Schranz, N., Tomkinson, G., & Olds, T. (2013). What is the effect of resistance training on the strength, body composition and psychosocial status of overweight and obese children and adolescents? A systematic review and meta-analysis. *Sports Medicine*, *43*(9), 893-907. https://doi.org/10.1007/s40279-013-0062-9

Simon, C., Kellou, N., Dugas, J., Platat, C., Copin, N., Schweitzer, B., & Blanc, S. (2014). A socio-ecological approach promoting physical activity and limiting sedentary behavior in adolescence showed weight benefits maintained 2.5 years after intervention cessation. *International journal of obesity*, *38*(7), 936-943. https://doi.org/10.1038/ijo.2014.23

Storch, E. A., Schneider, S. C., Guzick, A., McKay, D., & Goodman, W. K. (2020). Impact of COVID-19 on exposure and response prevention for obsessive-compulsive disorder: Present and post-pandemic considerations. *Psychiatry research*, *292*, 113310. https://doi.org/10.1016/j.psychres.2020.113310

Tiruneh, G. (2010). Age and Winning Professional Golf Tournaments. *Journal of Quantitative Analysis in Sports*, *6*(1). https://doi.org/10.2202/1559-0410.1209

Tison, G. H., Avram, R., Kuhar, P., Abreau, S., Marcus, G. M., Pletcher, M. J., & Olgin, J. E. (2020). Worldwide effect of COVID-19 on physical activity: a descriptive study. *Annals of Internal Medicine*, *173*(9), 767-770. https://doi.org/10.7326/M20-2665

Tjønna, A. E., Stølen, T. O., Bye, A., Volden, M., Slørdahl, S. A., Ødegård, R. & Wisløff, U. (2009). Aerobic interval training reduces cardiovascular risk factors more than a multitreatment approach in overweight adolescents. *Clinical Science*, *116*(4), 317-326. https://doi.org/10.1042/CS20080249

World Health Organization. (1995). *World Health Organization Western Pacific Regional Environmental Health Centre (EHC) summary of 1994 activities*. World Health Organization. https://apps.who.int/iris/handle/10665/206814

Zickgraf, H. F. (2020). Treatment of pathologic healthy eating (orthorexia nervosa). *E.* In A. Storch, D. McKay & J. S. Abramowitz (Eds.), *Advanced Casebook of Obsessive-Compulsive and Related Disorders. Conceptualizations and Treatment* (21-40). Academic Press. https://doi.org/10.1016/B978-0-12-816563-8.00002-4