

EFFECTS OF ADAPTED PHYSICAL EXERCISE ON CHILDREN AND ADOLESCENTS WITH OVERWEIGHT OR OBESITY

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SUMMARY

Obesity or adiposity represents an excessive accumulation of fat in the body and an increase in mass by 10% or more compared to the ideal body mass. Today in the world, and in our country, obesity is one of the most common chronic diseases of children and adolescents. One of the main causes of obesity is reduced physical activity, and energy intake is significantly increased in relation to reduced activity. Accordingly, the goal of this research was a systematic review of previously published research that dealt with the effects of adapted physical exercise on children and adolescents with excessive body weight or obesity. When collecting previous research, the internet search engines "Google Scholar", "PubMed" and the academic network "ResearchGate" were used. Positive changes in the morphological status of children and adolescents can be caused by the equal action of adapted physical exercise and controlled nutrition. Due to its enormous importance, physical activity is a proven preventive measure in the fight against obesity and accompanying diseases, which is necessary and must be present in sufficient quantity in all ages, especially in children and adolescents. Physical activity and exercise as well as proper nutrition during childhood and adolescence, along with taking professional preventive measures to reduce obesity, is essential for the future of the population.

Key words: influence, adiposity, adapted physical activities, younger age.

INTRODUCTION

The human body is built for activity, not rest. Physical activity is one of the basic human movements and the most important health determinant related to lifestyle. The World Health Organization (WHO) defines physical activity as any voluntary activation of the body that is caused by the skeletal muscles during which a certain amount of energy is consumed (World Health Organization, 2020).

Over the years the human body has evolved and evolved into a complex organism capable of performing a vast number of motor tasks. In the last few decades, there have been marked changes in the way of life around the world and in all age categories of the population. The modern way of life has resulted in reduced physical activity and increased energy intake (Ignjatović and Cvecka, 2017). An inevitable consequence of the modern way of life and work in an industrialized society creates serious consequences for the health of all age categories of the population (Berentzen et al., 2014). The three most common causes of the occurrence of numerous diseases, which are the most common causes of death today, and which are increasingly affecting young people, are stress, lack of movement and poor nutrition (Suwarsi and Elizabeth, 2023). Today's civilization, and what is increasingly present in the younger population, is characterized by hypokinesia and overweight, which are mutually correlated (Miles, 2007; Carbone et al., 2019). When talking about the younger population, it gains special weight. The free time of young people and children is increasingly used for activities that require almost no muscular effort, which has led to a lack of movement and an unhealthy lifestyle (Friedenreich et al., 2021). Also, like other countries, Serbia, unfortunately, cannot boast of the quality of life and health, since it ranks first in Europe in terms of mortality from diseases of the cardiovascular system. A particularly disturbing fact about such data is that health vulnerability begins at the youngest ages (Đokić et al., 2011; Knežević and Jandrić-Kočić, 2023). According to research data conducted by the Institute for Public Health "Dr. Milan Jovanović" (2006), almost one fifth of children and youth aged seven to 19 in Serbia (18%) are moderately overweight and obese. The increase in the number of obese children in Serbia is a consequence of bad eating habits and insufficient physical activity. This problem does not occur only in Serbia, but also in other countries. At the global level, there is a justified concern that the younger population is increasingly living a sedentary lifestyle, that they are increasingly obese and that they are adopting more and more bad habits that endanger their health (Carson et al., 2010; World Health Organization, 2013; Southcombe, 2023).

Obesity or adiposity is an excessive accumulation of fat in the body and an increase in body weight by 10% or more compared to the ideal body weight (Haslam, 2007; Barton, 2012; Ng et al., 2014; Malenica and Meseldžić, 2022; Southcombe, 2023).). By definition, it is a pathological condition (when the possibility of increased bone and muscle mass and edema of different etiology is excluded), caused as a result of caloric imbalance (Barton, 2012; Lešović et al., 2018; Daniels et al., 2005; Abiri, 2023) . Adiposity is one of the most common chronic diseases of children and adolescents. The trend of increasing prevalence of obesity in children leads to an increase in the risk of associated endocrinological, metabolic, cardiovascular,

respiratory and other health disorders, a decrease in the quality of life and the expected average length of life in the following generations of adults (Lešović et al., 2018). Children's obesity is mainly related to eating habits: irregular eating and skipping meals, choice of foods and excessive intake of certain foods (snacks, dough, sweets, carbonated drinks), volume and frequency of physical activity, factors from parents and the influence of educational institutions (Faik et al., 2017; Rose et al., 2021). As the lack of regular physical activity in children's nutrition is always second in importance, it is clear why regular physical activity is insisted on from an early age. The level of physical activity among children depends on individual influences, as well as on the influence of parents and the environment, and there are gender differences (boys are generally more physically active than girls), as well as age differences (children are more active than adolescents) (Bauman , 2012). The level of physical activity is also influenced to a certain extent by economic conditions, proximity to places for play and recreation, parental support, socio-economic status and education of parents and other factors (Zdravković et al., 2009). Regular physical activity prevents a sudden increase in body weight and the onset of obesity-related diseases (Suwarsi and Elizabeth, 2023). The combination of a dietary program of nutrition and physical activity can significantly influence the reduction of body weight and the change in metabolism, that is, the mechanism of fat deposition in the body (Mitić, 2011; Sente, 2020). Therefore, the goal of this research was a systematic review of previously published research that dealt with the effects of adapted physical exercise on children and adolescents with excess body weight or obesity.

RESEARCH METHODS

In this paper, the following methods were used: selection, systematic, theoretical analysis and comparison of the content of previous scientific and professional literature. All procedures relevant to the identification of papers were carried out in accordance with the Preferred Reporting Items for Systematic Reviews (PRISMA) statement (Page et al., 2021).

Inclusion criteria

The following inclusion criteria were defined for the selection of works to be included in the final analysis: (1) original scientific works; (2) works not older than 2000; (3) papers written in English and Serbian; (4) sample of respondents - obese younger age category (10-18 years).

Exclusion criteria

Based on the following criteria, papers were excluded from further analysis: (1) papers older than 2000; (2) works that are not written in English or Serbian; (3) inadequate sample of respondents; (4) works in which the results are not adequately presented or the parameters required for further analysis are missing.

Paper search strategy

When collecting previous research, the internet search engines "Google Scholar", "PubMed" and the academic network "ResearchGate" were used. The following keywords were searched in English individually or in combination: effect, adapted physical exercise, obesity, younger age, and keywords in Serbian individually or in combination: effect, adapted physical exercise, obesity, younger age. In the phase of collecting previous research on adapted physical exercise for obese people in the age category of 10-18 years, the initial database of research papers was made up of 37 papers that met the basic search criteria by title content. A further selection of works was carried out, where, after reading and analyzing the abstracts, 22 works were eliminated, and 15 works were singled out that meet narrower search criteria (Figure 1).

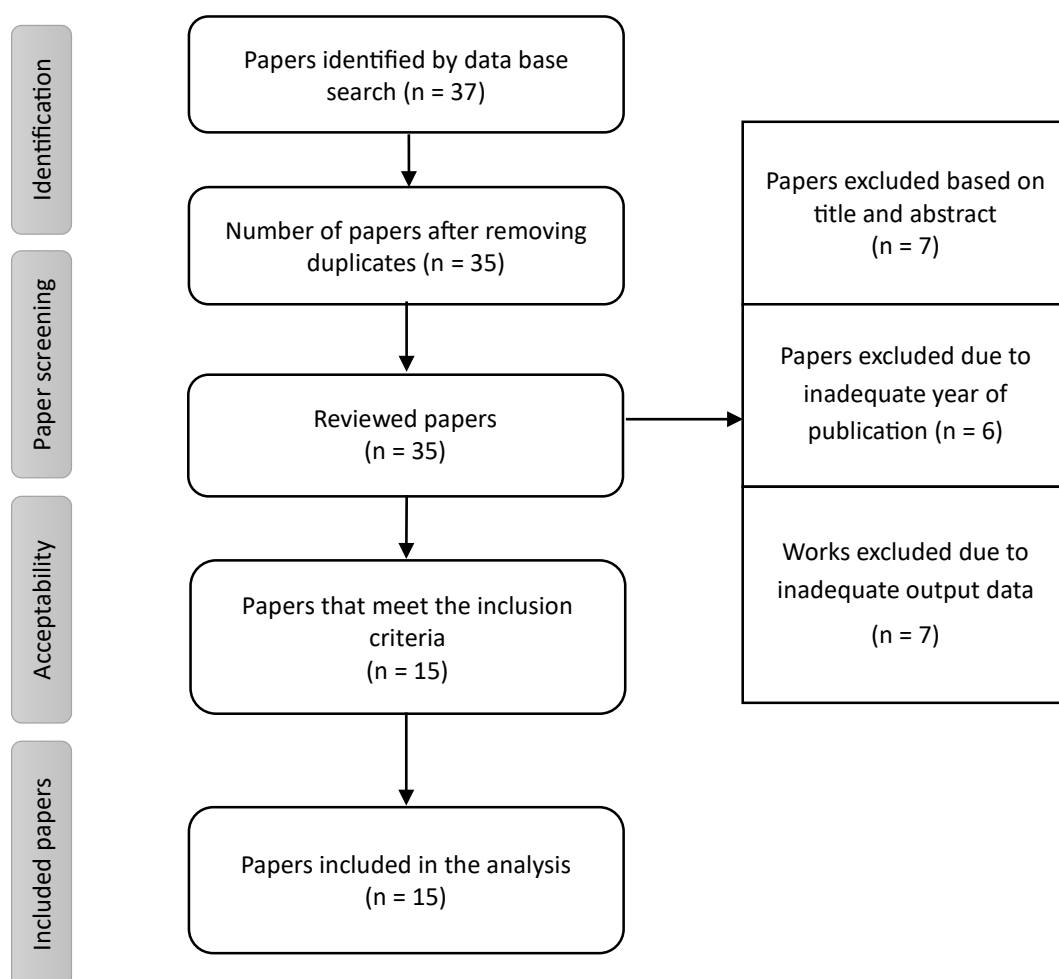


Figure 1. Schematic representation of the selection of collected works

RESULTS

The final analysis included 15 papers that were compiled and analyzed based on the above-mentioned methods. The results of the systematic review of the previous literature are shown in Table 1.

DISCUSSION

In the last three decades, there has been an increase in the prevalence of obesity in all age categories of the population, but not only in Serbia, but it is widespread throughout the world. Obesity is recognized as one of the most important public health problems and challenges in the 21st century. For this reason, numerous studies deal with problems related to obesity, hypokinesia, as well as their origin. Also, in addition to the basic problem of today, a considerable number of research aims to examine which factors and to what extent they influence the increased number of obese people, but also deal with obesity prevention. Certain studies have determined that children whose parents are both obese have a higher risk of obesity than those whose parents are not obese (Magarey et al., 2003; Fábryová, 2015; Knežević and Jandrić, 2023). In addition to hereditary factors, lifestyle changes that have occurred in the last few decades are one of the most significant factors affecting the increased number of obese people. Hypokinesia is caused by bad lifestyle habits and fast food (Ferreira et al., 2016; Nikolić, 2019). Obesity in younger ages, children and adolescents in the modern era is taking on the character of an epidemic, with which a large number of researchers agree (Suwarsi and Elizabeth, 2023; Pinho et al., 2022; Radovanović, 2017; Berentzen et al., 2014). The primary public health problem is the obesity epidemic, and thus the increased risk of many diseases (Zalewska et al., 2022). Diseases associated with excess body weight, which were previously associated only with adults, are now also present in younger categories of the population (Peco-Antić, 2009; Pelicic et al., 2021). The most common consequences of obesity in childhood and adolescence are the cardiovascular system (hypertension, dyslipidemia), the endocrine system (insulin resistance, impaired glucose tolerance, irregular menstruation), mental health (depression), but are increasingly present in respiratory diseases. (Pelicic et al., 2021; Jocić Stojanović et al., 2015; Jović et al., 2018; Jandric-Kočić, 2020; Mayer et al., 2006; Ferreira et al., 2014). Obesity as a phenomenon is easily noticeable and easily diagnosed clinically. Obesity occurs as a result of an imbalance of energy consumption and energy intake (Stojanović et al., 2016).

Research conducted by Mitić (2011) and Al-Ghamdi (2013) showed that watching TV is an important and significant risk factor for obesity in school-aged children. To similar results, in their research Berentzen et al. (2014) indicate that watching TV, with excessive and frequent consumption of sweets and snacks, is one of the most significant risk factors for obesity.

Also, in research conducted by Mitić (2011) and Robinson (2001), in addition to watching TV as one of the causes of obesity, he found that obese children go to bed later and get up earlier in order to have more time to watch TV and playing games. Nikolić and Pandurević (2018) in their sample of 70 respondents, as many as one third were inadequately fed, and one fifth of the sample of respondents was overweight. In addition to free time spent in front of the TV, computer, and poor diet, there is another risk factor for obesity, which is reduced physical activity (Reinehr et al., 2010). Also, Reinehr et al. (2010) in their research point out that children's physical activity has significantly decreased in recent years, energy intake has significantly increased in relation to reduced activities. A considerable amount of

research deals with the effects of adapted physical exercise on overweight people. Mayer et al. (2006) conducted an experimental study lasting six months. Regular physical exercise in overweight individuals restores the function of the cardiovascular system and improves anthropological status (Mayer et al., 2006; Sente et al., 2012). Similar results were achieved in a one-year experimental study by Blüher et al. (2014). Children and adolescents who are more active, around 45-55 minutes have a normal body weight, while children who spend less time on physical activities (>18 minutes per day) become obese (Mitić, 2011; Ferreira et al., 2016). A more recent study by Malićević (2022) found that the prevalence of overnutrition is significantly lower in children who regularly play sports, compared to children without any organized physical activities. Twelve-week recreational adapted indoor soccer programs improved strength and anaerobic capacity in obese boys (Pinho et al., 2022). Research conducted by Sente et al. (2012), Carson (2015) and Malićević (2022) show that adapted physical exercise in combination with a dietary diet led to a reduction primarily of total body mass. In his research, Radovanović (2017) determined that strength training is an effective way of exercising to achieve a healthier body composition of overweight children and adolescents, but with an adapted exercise program, because overweight children and adolescents often experience aerobic physical activities as an inconvenience or discomfort. In their research, Suwari and Elizabeth (2023) did not find that there is a statistically significant difference between the level of physical activity and quality of life in overweight adolescents.

Numerous studies followed the official announcements of the world's leading professional and health organizations indicating that if performed correctly and dosed, strength training can have a positive effect on children and adolescents who are overweight (Behm et al., 2008; Faigenbaum et al., 2009). All previous research points to the importance and positive effects of adapted physical exercise with a controlled diet in reducing body weight in obese people.

CONCLUSION

The prevalence of childhood obesity is increasing worldwide, especially in developed industrialized countries, but also in many developing countries. Physical activity and exercise are an integral and irreplaceable part of non-drug obesity therapy. It should be emphasized that adapted physical activity is not the only process that leads to a rapid reduction of body weight in children and adolescents, but in combination with proper nutrition, it facilitates the achievement and maintenance of the achieved therapeutic effect. Positive changes in the morphological status of children and adolescents, body composition can be caused by the equal action of adapted physical exercise and controlled nutrition. Due to its enormous importance, physical activity is a proven preventive measure in the fight against obesity and accompanying diseases, which is necessary and must be present in sufficient measure in all ages, especially in children and adolescents. Physical activity and exercise as well as proper nutrition during childhood and adolescence, along with taking professional preventive measures to reduce obesity, is essential for the future of the population. Regular physical activity and exercise for children, adolescents and adults should be an integral part of everyday

life in combination with a proper and healthy diet, which represents an effective investment for future generations.

REFERENCES

1. Abiri, B., Valizadeh, M., Amini, S., Kelishadi, R., & Hosseinpanah, F. (2023). Risk factors, cutoff points, and definition of metabolically healthy/unhealthy obesity in children and adolescents: A scoping review of the literature. *Obesity Reviews*, e13548.
2. Al-Ghamdi, S. H. (2013). The association between watching television and obesity in children of school-age in Saudi Arabia. *Journal of family & community medicine*, 20(2), 83.
3. American Academy of Pediatrics. (2016). *Early Childhood: 1–4 years*. Preuzeto sa <http://www.brightfutures.org/physicalactivity/pdf/EarlyChild.pdf>.
4. Barton, M. (2012). Childhood obesity: a life-long health risk. *Acta Pharmacologica Sinica*, 33(2), 189-193.
5. Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J., & Martin, B. W. (2012). Correlates of physical activity: why are some people physically active and others not?. *The lancet*, 380(9838), 258-271.
6. Behm, D. G., Faigenbaum, A. D., Falk, B., & Klentrou, P. (2008). Canadian Society for Exercise Physiology position paper: resistance training in children and adolescents. *Applied physiology, nutrition, and metabolism*, 33(3), 547-561.
7. Berentzen, N. E., Smit, H. A., van Rossem, L., Gehring, U., Kerkhof, M., Postma, D. S., ... & Wijga, A. H. (2014). Screen time, adiposity and cardiometabolic markers: mediation by physical activity, not snacking, among 11-year-old children. *International journal of obesity*, 38(10), 1317-1323.
8. Blüher, S., Panagiotou, G., Petroff, D., Markert, J., Wagner, A., Klemm, T., ... & Mantzoros, C. S. (2014). Effects of a 1-year exercise and lifestyle intervention on irisin, adipokines, and inflammatory markers in obese children. *Obesity*, 22(7), 1701-1708.
9. Carbone, S., Del Buono, M. G., Ozemek, C., & Lavie, C. J. (2019). Obesity, risk of diabetes and role of physical activity, exercise training and cardiorespiratory fitness. *Progress in cardiovascular diseases*, 62(4), 327-333.
10. Carson, V., Clark, D., Ogden, N., Harber, V., & Kuzik, N. (2015). Short-term influence of revised provincial accreditation standards on physical activity, sedentary behavior, and weight status in Alberta, Canada child care centers. *Early Childhood Education Journal*, 43, 459-465.
11. Daniels, S. R., Arnett, D. K., Eckel, R. H., Gidding, S. S., Hayman, L. L., Kumanyika, S., ... & Williams, C. L. (2005). Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. *Circulation*, 111(15), 1999-2012.
12. Đokić, Z., Međedović, B., & Smiljanić, J. (2011). Stanje uhranjenosti, posturalni status i kvalitet sprovođenja nastave fizičkog vaspitanja u osnovnim školama. *TIMS Acta-Journal of sport sciences, tourism and wellness*, 5(1), 10-19.
13. Fábryová, Ľ. (2015). Epidemiológia a zdravotné dôsledky obezity. *Via practica*, 12(1), 8-14.
14. Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the national strength and conditioning association. *The Journal of Strength & Conditioning Research*, 23, S60-S79.
15. Faik, A., Vanderhulst, E., Rossem, V. I., & Devroey, D. (2017). Influence of physical activity and interest for food and sciences versus weight disorders in children aged 8 to 18 years. *Journal of Preventive Medicine and Hygiene*, 58(2), E105.
16. Ferreira, M. S., Mendes, R. T., de Lima Marson, F. A., Zambon, M. P., Paschoal, I. A., Toro, A. A. D. C., ... & Ribeiro, J. D. (2014). The relationship between physical functional capacity and lung function in obese children and adolescents. *BMC Pulmonary Medicine*, 14(1), 1-14.
17. Friedenreich, C. M., Ryder-Burbidge, C., & McNeil, J. (2021). Physical activity, obesity and sedentary behavior in cancer etiology: epidemiologic evidence and biologic mechanisms. *Molecular oncology*, 15(3), 790-800.
18. Haslam, D. W. (2007). Obesity: gaining recognition in primary care. *Trends in Urology, Gynaecology & Sexual Health*, 12(1), 12-14.
19. Ignjatovic, A. C., & Cvecka, J. (2017). J. Resistance exercises programs as a part of physical education curriculum for prevention of obesity and inactivity in children. *Colella D, Antala B, Epifani S, edsitors. Physical education and best practices in primary schools. Lecce: Pensa Multimedia Editore*, 97-108.

20. Jandrić, K. M. (2020). Lifestyle, knowledge and attitude about obesity among overweight and obese persons. *Zdravstvena zaštita*, 49(2), 50-67.
21. Jandrić-Kočić, M. (2020). Stil života, znanje i percepcija gojaznosti prokomerno uhranjenih i gojaznih osoba. *Zdravstvena zaštita*, 49(2), 50-67.
22. Jocić Stojanović, J., Živković, Z., Šumarac Dumanović, M., & Veković, V. (2015). Kvalitet života gojazne dece sa astmom. *Timocki Medicinski Glasnik*, 40(4).
23. Jović, D., Petrović-Tepić, S., & Knežević, D. (2018). Assessment of the quality of life in children and adolescents with asthma. *Obzornik zdravstvene nege*, 52(2), 81-89.
24. Knežević, S. B., & Jandrić, K. M. C. (2023). Obesity: The modern age pandemic of special significance. *Medicinski glasnik Specijalne bolnice za bolesti štitaste žlezde i bolesti metabolizma 'Zlatibor'*, 28(89), 56-75.
25. Knežević, S. B., & Jandrić-Kočić, M. C. (2023). Gojaznost–pandemija našeg vremena od posebnog značaja. *Medical Gazette*, 28(89), 58-65.
26. Lešović, S., Smiljanić, J., & Ševkušić, J. (2018). Deset godina uspešnog rada multidisciplinarnog Centra za prevenciju i lečenje gojaznosti kod dece i adolescenata. *Medicinski glasnik Specijalne bolnice za bolesti štitaste žlezde i bolesti metabolizma "Zlatibor"*, 23(69), 7-29.
27. Magarey, A. M., Daniels, L. A., Boulton, T. J., & Cockington, R. A. (2003). Predicting obesity in early adulthood from childhood and parental obesity. *International journal of obesity*, 27(4), 505-513.
28. Malenica, M., & Meseldžić, N. (2022). Oksidativni stres i gojaznost. *Arhiv za farmaciju*, 72(2), 166-183.
29. Malićević, S. (2022). Uticaj različitih vrsta sporta na prevalenciju gojaznosti kod dece osnovnoškolskog uzrasta. *Univerzitet u Beogradu*.
30. Meyer, A. A., Kundt, G., Lenschow, U., Schuff-Werner, P., & Kienast, W. (2006). Improvement of early vascular changes and cardiovascular risk factors in obese children after a six-month exercise program. *Journal of the American College of Cardiology*, 48(9), 1865-1870.
31. Miles, L. (2007). Physical activity and health. *Nutrition bulletin*, 32(4), 314-363.
32. Mitić, D. (2011). Značaj fizičke aktivnosti u prevenciji i terapiji gojaznosti u detinjstvu i adolescenciji. *Medicinski glasnik Specijalne bolnice za bolesti štitaste žlezde i bolesti metabolizma 'Zlatibor'*, 16(39), 107-112.
33. Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., ... & Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The lancet*, 384(9945), 766-781.
34. Nikolić, I. D. (2019). Uticaj sporta i fizičkog vaspitanja na rast, razvoj i zdravlje dece školskog uzrasta. *Poslovna ekonomija*, 15(1).
35. Nikolić, N., & Pandurević, M. (2018). Uticaj fizičke aktivnosti na redukciju telesne mase kod dece uzrasta od 10 godina. *Sport i zdravlje*, 12(2), 50-55.
36. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International journal of surgery*, 88, 105906.
37. Peco-Antić, A. (2009). Arterijska hipertenzija gojazne dece i adolescenata. *Srpski arhiv za celokupno lekarstvo*, 137(1-2), 91-97.
38. Pelicic, D., Saveljic, M., Nejkov, S., & Fazanaro, M. C. S. (2021). A Pandemic of the Modern Age of Special Significance – Obesity. *Biomedical Journal of Scientific & Technical Research*, 35(2), 27472-27475.
39. Pinho, C. D. F., Farinha, J. B., Lisboa, S. D. C., Bagatini, N. C., Leites, G. T., Voser, R. D. C., ... & Cunha, G. D. S. (2022). Effects of a small-sided soccer program on health parameters in obese children. *Revista Brasileira de Medicina do Esporte*, 29.
40. Radovanović, D. (2017). Efektivnost treninga snage kod dece i adolescenata sa prekomernom telesnom masom ili gojaznošću. *Preventivna pedijatrija*, 3(1-2), 9-12.
41. Reinehr, T., Kleber, M., Lass, N., & Toschke, A. M. (2010). Body mass index patterns over 5 y in obese children motivated to participate in a 1-y lifestyle intervention: age as a predictor of long-term success. *The American journal of clinical nutrition*, 91(5), 1165-1171.
42. Robinson, T. N. (2001). Television viewing and childhood obesity. *Pediatric Clinics of North America*, 48(4), 1017-1025.
43. Rose, K., O'Malley, C., Eskandari, F., Lake, A. A., Brown, L., & Ells, L. J. (2021). The impact of, and views on, school food intervention and policy in young people aged 11–18 years in Europe: a mixed methods systematic review. *Obesity Reviews*, 22(5), e13186.
44. Sente, J. (2020). Metabolički sindrom i programirano fizičko vežbanje kod juvenilne gojaznosti. *Univerzitet u Novom Sadu*.

45. Sente, J., Jakonić, D., Smajić, M., Mihajlović, I., Vasić, G., Romanov, R., & Marić, L. (2012). Redukcija juvenilne gojaznosti programiranim fizičkim vežbanjem i kontrolisanom ishranom. *Vojnosanitetski pregled*, 69, 9-15.
46. Southcombe, F., Lin, F., Krstic, S., Sim, K. A., Dennis, S., Lingam, R., & Denney-Wilson, E. (2023). Targeted dietary approaches for the management of obesity and severe obesity in children and adolescents: A systematic review and meta-analysis. *Clinical Obesity*, 13(2), e12564.
47. Stojanović, J. J., Veković, V., Živković, Z., & Prijjić, A. (2016). Gojaznost kod dece—prevencija. *Preventive Paediatrics*, 017-020.
48. Suwarsi, S., & Elizabeth, M. (2023). Quality of Life and Physical Activities of Overweight Adolescents. *Jurnal Keperawatan Respati Yogyakarta*, 10(2), 71-77.
49. World Health Organization, T. (2020). *Global recommendations on physical activity for health*. World Health Organization.
50. World Health Organization. (2013). Meeting to develop a global consensus on preconception care to reduce maternal and childhood mortality and morbidity: World Health Organization Headquarters, Geneva, 6–7 February 2012: meeting report.
51. Zalewska, M., Jamiołkowski, J., Chlabicz, M., Łapińska, M., Dubatówka, M., Kondraciuk, M., ... & Kamiński, K. A. (2022). How Unawareness of Weight Excess Can Increase Cardiovascular Risk?. *Journal of Clinical Medicine*, 11(17), 4944.
52. Zdravković, D., Banićević, M., & Petrović, O. (2009). Novi standardi rasta i uhranjenosti dece i adolescenata. *Udruženje pedijatara Srbije*, 5-7.

TABLES

Table 1. Overview of previous literature included in the analysis.

Num.	References	Sample			Num. Of groups	Research objective	Experimental treatment		Results and conclusions
		No.	Year	Sex			Exercise program, measuring instrument, duration and frequency		
1.	Meyer et al. (2006)	67	14±0,7			This study aimed to evaluate the effect of a 6-month exercise program in obese children.	The experimental treatment lasted 6 months.	This study documented increased IMT, impaired endothelial function, and various elevated cardiovascular RFs in young obese individuals. Regular exercises restore function.	
2.	Reinehr et al. (2010)	663	4-16			The aim was to identify predictors of long-term changes in body mass index (BMI) following a lifestyle intervention.	Changes in BMI during the five-year program were analyzed.	Younger age was associated with the best long-term outcome after participation in a lifestyle intervention, supporting the need for early intervention in childhood obesity. Children aged 8 to 10 may need a modified intervention, as BMI-SDS increased more in older children in the long term.	
3.	Đokić et al. (2011)	810	9-12±0,5	404 w 406 w		Comparison of obesity between third and sixth graders.	Method of comparison.	Overnutrition and obesity in boys in the third and sixth grades is represented to the same extent, while there are noticeable deviations in girls in overnutrition in older grades.	
4.	Mitić (2011)	4511	7-9 ±0,5	2237w 2274 m	2	The aim of one study was to examine whether there are differences in the lifestyle of obese children compared to those who are not obese.	A questionnaire about how physically active children are was filled out by parents and anthropometric measurements were taken. BMI was measured and based on that, the children were divided into two groups: obese and normally well-nourished. Variables used to examine lifestyle were: time spent watching TV, computer, playing, studying, and time of getting up and going to bed were recorded.	The results showed that obese children go to bed later and wake up earlier, and spend more time watching TV, using the computer and studying, and less time playing.	
5.	Sente et al. (2012)	136	13±0,6	76 w 60 m		Determining and quantifying the effects of reduction therapy in obesity.	Study lasting 3 months. The 12-week training program was specially designed by the researchers.	The results of the applied univariate and multivariate analyzes in the final compared to the initial measurement in the examined group of obese children show that the application of the program of physical exercise and controlled diet resulted in a significant reduction of all anthropometric parameters, as well as anthropological indicators of the state of nutrition.	
6.	Al-Ghamdi (2013)	397	10-14			The aim of the study is to examine the association between TV viewing and obesity in school-age children in Saudi Arabia.	The study was conducted in the period from February to April, the instrument used was a 20-item questionnaire.	The results obtained from the research showed that watching TV is an important significant risk factor for obesity in school-age children.	

7.	Ferreira et al. (2014)	133	5-17		The aim of the study was to determine whether obesity is associated with poor physical fitness and impaired lung function in children and adolescents, as well as to correlate lung function with the results of the six-minute walk test.		In this study, the obese group walked shorter distances and showed lower values in some lung function markers. However, there is no relationship between their physical condition and these test results. Therefore, we cannot say with certainty that poor physical performance is the result of impaired lung function.	
8.	Blüher et al. (2014)	64	7-18		The aim was to analyze their relationship with weight status and metabolic risk.	The effect of exercise and lifestyle intervention during one year on irisin, adipokines (leptin, adiponectin, resistin) and inflammatory markers (C-reactive protein (CRP), soluble tumor necrosis factor receptor II (sTNFR-II),	A one-year lifestyle intervention program is associated with an improvement in anthropometric and metabolic parameters and leads to an increase in irisin levels in obese children.	
9.	Berentzen et al. (2014)	1447	11-14		The aim of the research was to examine the association between television viewing and snacking with adiposity.	Instruments that were used: blood pressure, cholesterol, glucose.	Watching television with snacks has a significant impact on adolescent overweight.	
10.	Radovanović (2017)				A systematic review of previously published research that dealt with the effects of strength training on body composition, muscle strength and psychosocial status of overweight or obese children and adolescents.	Original and review papers, as well as meta-analyses, from the most important electronic databases (MEDLINE, Web of Science, Embase, Scopus, SPORTDiscus, ProQuest, Cochrane library) were searched and included in the review.	Strength training is an effective way of exercising to achieve a healthier body composition in children and adolescents with excessive body mass or obesity, through an increase in lean body mass and a decrease in the percentage of fat tissue, with potentially positive effects on their psychosocial status.	
11.	Nikolić & Pandurević (2018)	70	10	38 w 32 m	The aim of this paper is to determine the nutritional status of school-aged children aged 10 years in relation to their level of physical activity.	Body mass was measured with a medical digital scale with an accuracy of 0.1 kg. A standard questionnaire was used to assess physical activity, socioeconomic parameters and eating habits. The questionnaire was composed of questions based on which data were obtained about the time spent in some physical activity during seven days with the answers: never, occasionally, often and always.	The results obtained from this research lead to the conclusion that one third of the examined sample of children is inadequately fed, and that as many as 20% of children are overweight and obese.	
12.	Sente (2020)		11-14±0,5		In order to check the effects of multidisciplinary treatment, all investigated parameters were measured at three time points.	The study lasts 3 months.	Descriptive results in all three groups of investigated parameters show statistically significant changes in all subjects in all three time periods, as well as the results of one-factor univariate analysis of variance for repeated measurements for sig.<0.05.	
13.	Malićević (2022)	7880	9-15	2893 FA 4987 FN	2	The main goal of this study was to investigate the prevalence of excessive nutrition in representative samples of children who regularly play sports (more than 2 years and more than 3 hours per	Examined the differences between the prevalence of nutritional levels in the studied groups obtained by applying the definitions of the World Health Organization, the Centers for Disease Control and Prevention of the United	It was found that the prevalence of overnutrition is significantly lower in children who regularly play sports, compared to children without any organized physical activities.

				<p>week) and children without any organized physical activity, aged 9 to 15 years.</p>	<p>States of America, as well as the criteria of the International Working Group on Obesity.</p>	
14.	Pinho et al. (2022)	13	8-12	<p>The purpose was to measure the effects of a 12-week recreational indoor soccer program on cardiometabolic risk and individual responses to cardiometabolic risk factors in obese younger individuals.</p>	<p>Anthropometric characteristics, cardiorespiratory fitness, metabolic profile, individual responses to maximal oxygen intake (VO₂peak), maximal exercise (V_{max}), blood glucose, insulin, HOMA-IR, LDL-C, HDL-C, TC and TG were measured.</p>	<p>Twelve-week recreational indoor soccer programs were able to improve maximal strength and anaerobic capacity and maintain cardiometabolic risk factor levels in obese younger individuals.</p>