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Paper review
Pregledni rad

Aerobic Physical Exercise and BMI Values in Students With Overweight

Aerobno fizičko vežbanje i vrednosti BMI kod učenika sa viškom kilograma

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Abstract: *The modern lifestyle and insufficient physical activity are an increasing problem among the younger generation. The question arises as to how the educational system can influence the resolution of this issue. One way is to introduce additional physical exercise classes within the regular curriculum or to improve the program of organized physical exercise with students. This study analyzed three individual studies that dealt with the impact of organized aerobic physical exercise on BMI values and body fat percentage in adolescent students. In this meta-analysis, standardized mean differences and relative risk with 95% confidence intervals were calculated using random effects. The combined value of the standardized mean difference calculated from the random effects model is 0.32 (95% CI; -2.74; 3.38). The combined RR value from the random effects model is 0.34 (-1.15; 1.83). The RR is not statistically significantly different from one (p=0.6527). No statistically significant difference was observed between students who, in addition to the regular classes, participated in organized aerobic physical exercise aimed at regulating excess weight. Due to the small number of participants, it is not possible to generalize the conclusion in this study.*

Keywords: *Aerobic physical exercise, Students, Primary school, BMI, Overweight.*

Sažetak: *Savremeni način života i nedovoljno fizičke aktivnosti sve češće postaju problem mlađeg naraštaja. Postavlja se pitanje na koji način vaspitno-obrazovni sistem može uticati na rešavanje navedenog problema. Jedan od načina jeste da se u okviru redovne nastave uvedu dodatni časovi fizičkog vežbanja ili da se unapredi program organizovanog fizičkog vežbanja sa učenicima. Ova studija je izvršila analizu tri individualne studije koje su se bavile uticajem organizovanog aerobnog fizičkog vežbanja na vrednosti BMI i procenta masnog tkiva učenika adolescentne dobi. U ovoj meta-analizi standardizovane srednje razlike i relativni rizik sa 95% intervala poverenja prikupljene su iz slučajnih efekata. Objedinjena vrednost standardizovane razlike aritmetičkih sredina izračunata je iz modela slučajnih efekata i iznosi 0,32 (95% CI; -2,74; 3,38). Objedinjena vrednost RR iz modela slučajnih efekata iznosi 0,34 (-1,15; 1,83). RR nije statistički značajno različit od jedinice (p=0,6527). Nije uočena statistički značajna razlika između učenika koji su pored redovne nastave imali organizovano aerobno fizičko vežbanje radi regulisanja viška kilograma. U ovom radu nije moguće generalizovati zaključak zbog malog broja ispitanika.*

Ključne reči: *fizička aktivnost, vaspitno-obrazovni sistem, BMI*

Introduction

Excess body weight can represent one of the risk factors for the development of cardiovascular diseases in children and adolescents (Toriola & Monyeki, 2012; Tremblay & Williams, 2003). The development of chronic diseases and spinal deformities, as well as the onset of sedentary behavior, can be attributed to the unhealthy lifestyle inherent to by modern times. Due to the uncontrolled use of technological devices, children lose interest in daily physical activity. On the other hand, insufficient movement contributes to the development of excess body weight, which can negatively affect the quality of life during the growth

Uvod

Prekomerna telesna masa može da predstavlja jedan od rizika za razvoj kardiovaskularnih bolesti kod dece i adolescenata (Toriola & Monyeki, 2012; Tremblay & Williams, 2003). Razvoj hroničnih bolesti i deformiteta kičme, kao i razvoj sedentarnosti može se pripisati nepravilnom načinu života koji nudi savremeno doba. Nekontrolisanom upotrebom tehnoloških sredstava deca gube interesovanje za svakodnevnu fizičku aktivnost, dok nedovoljno kretanja utiče na pojavu prekomerne telesne mase, koje može imati negativnog uticaja na kvalitet života tokom perioda odrastanja. Smatra se da deca

period. It is believed that children with excess weight have a low level of physical fitness (Toriola & Monyeki, 2012; Pahkala et al., 2013; Ng M. et al., 2014). Changing lifestyle and developing healthier habits can positively influence the regulation of body weight (Bull et al., 2020).

In order to have a positive impact of continuous physical activity on reducing obesity during adolescent growth, it is important to motivate students to participate in all forms of physical exercise (Martin et al., 2018). The World Health Organization recommends continuous moderate to vigorous physical activity for children and youth lasting 60 minutes throughout the day (Bull et al., 2020; Davis et al., 2009). The problem arises from adolescents' insufficient interest in sports and recreation. A large number of adolescents are unable to meet even the minimum recommendation of the World Health Organization (Martin et al., 2018). Besides the duration of the activity, the manner of exercising also has a significant impact. The same holds for high intensity that can negatively affect the motivation of obese children to participate in PE classes (PE classes), (Deforche et al., 2011).

It is obvious that the problem of hypokinesia in school-aged children is becoming increasingly significant. Many studies have investigated how physical exercise should be organized, how to motivate students to participate in PE classes, and how organized physical exercise programs affect the morphological status of students. This paper covers the period of adolescence, during which there are rapid changes in the body, as well as the occurrence of obesity due to students' insufficient physical activity. The problem of obesity has become a societal phenomenon that many authors are addressing today. Additionally, there has been a recent increase in obesity among young people (Han et al., 2000). However, differences in the degree of obesity are observed among students of different ages, with older students being more prone to weight gain, as well as male students (Kim et al., 2008). It is known that continuous physical activity of light to moderate intensity, at least three times a week, positively affects the quality of life (Lipnowski et al., 2012). Authors note that an organized physical exercise program with physically inactive students who are overweight generally leads to improvements in physical fitness, regulation of BMI, and reduction of body fat. Furthermore, organized training can positively influence the maintenance or increase of muscle and bone mass (Kwan, 2001; Back & Ji, 2015).

Numerous authors who have investigated the effects of organized physical exercise on reducing body weight and fat tissue claim that time spent at school is the best period for physical activity, as children spend most of

sa viškom kilograma imaju nizak nivo fizičke kondicije (Toriola & Monyeki, 2012; Pahkala et al., 2013; Ng M. et al., 2014). Promenom načina života i razvojem zdravijih navika može se pozitivno uticati na regulisanje telesne mase (Bull et al., 2020).

Da bi kontinuirana fizička aktivnost imala pozitivan uticaj na smanjenje gojaznosti tokom odrastanja adolescenata, važna je motivacija učenika radi učešća u svim vidovima fizičkog vežbanja (Martin et al., 2018). Svetska zdravstvena organizacija preporučuje za decu i mlade kontinuirano fizičko vežbanje umerenog do visokog intenziteta u trajanju od 60 minuta u toku dana (Bull et al., 2020; Davis et al., 2009). Problem postaje nedovoljna zainteresovanost adolescenata za sport i rekreaciju. Veliki broj adolescenata ne može da zadovolji ni preporučeni minimum Svetske zdravstvene organizacije (Martin et al., 2018). Osim trajanja opterećenja značajan uticaj ima i način vežbanja. Visok intenzitet može imati negativan uticaj na motivaciju gojazne dece za učešće u nastavi fizičkog vaspitanja (Deforche et al., 2011).

Očigledno je da problem hipokinezije u dečijem školskom uzrastu postaje sve veći. Mnoge studije su istraživale na koji način je potrebno organizovati fizičko vežbanje, motivisati učenike za učešće u nastavi fizičkog vaspitanja, kao i na koji način program organizovanog fizičkog vežbanja utiče na morfološki status učenika. U ovom radu obuhvaćen je period adolescencije u kome dolazi do burnih promena u organizmu, kao i pojava gojaznosti usled nedovoljne fizičke aktivnosti učenika. Problem gojaznosti postaje fenomen u društvu kojim se danas bave mnogi autori. Takođe, u poslednje vreme je sve veći porast gojaznosti među mladima (Han et al., 2000). Međutim, uočava se razlika u stepenu gojaznosti među učenicima različite životne dobi, pa su tako stariji učenici podložniji povećanju telesne mase, kao i učenici muškog pola (Kim et al., 2008). Poznato je da kontinuirana fizička aktivnost lakog do umerenog intenziteta, najmanje tri puta nedeljno, pozitivno utiče na kvalitet života (Lipnowski et al., 2012). Autori navode da organizovani program fizičkog vežbanja sa fizički neaktivnim učenicima koji imaju višak kilograma uglavnom dovodi do poboljšanja fizičke kondicije, regulacije BMI, kao i smanjenja telesne masti u organizmu. Takođe, organizovani trening će pozitivno uticati na održavanje ili povećanje mišićne i koštane mase (Kwan, 2001; Back & Ji, 2015).

Brojni autori koji su istraživali problem koji se tiče efektata organizovanog fizičkog vežbanja na smanjenje telesne mase i masnog tkiva, navode da je boravak u školi najbolje vreme za fizičko vežbanje jer deca najviše vremena provode u školskom okruženju (Gray et al., 2016).

their time in a school environment (Gray et al., 2016). The quantitative presentation of the impact of this research problem is best demonstrated by selecting relevant scientific studies and calculating the effect size through meta-analysis. This paper deals with a systematic review of the impact of organized and systematically guided continuous aerobic physical exercise on BMI values and the percentage of body fat in overweight students. This meta-analysis may highlight the importance of organized aerobic physical exercise for adolescents in terms of regulating body weight. Due to the small number of participants, the research problem in this paper cannot be generalized to the population of adolescent students. Future research should include a larger number of studies and a greater number of participants in order to achieve more reliable results.

Methods

Search Method

The literature search and selection of references were conducted in accordance with the rules and recommendations for systematic reviews and meta-analyses (PRISMA) (Moher et al., 2009). A systematic review of the scientific literature and the selection of individual studies based on clearly defined selection criteria was followed by an analysis of the selected individual studies. The selection of scientific studies was carried out using two bibliographic databases ("PubMed" and "Mlibrary"). The following keywords were used during the search: "Physical Education," "High School," "Running," "BMI," as well as a defined publication type referring to randomized clinical trials (RCT), with no time limitation, and exclusively in the English language.

Literature Selection

A detailed presentation of the selected individual studies is shown in the Flow Diagram (Figure 1). The following studies were excluded from this meta-analysis: those with duplicate titles, inappropriate design, method of physical exercise, research outcomes, as well as studies with an inappropriate research problem. For this meta-analysis, RCT scientific studies that met the established criteria (method of physical exercise, participants, primary outcomes, and research problem) were selected. Additionally, only studies that had two measurements (pretest and posttest) were chosen, thus allowing an investigation of how organized aerobic physical exercise influenced the measured outcomes.

Kvantitativni prikaz uticaja navedenog problema istraživanja najbolje se prikazuje odabirom relevantnih naučnih studija i izračunavanjem veličine efekta kroz meta-analizu. U ovom radu kroz sistematski pregled prikazan je uticaj organizovanog i planski vođenog kontinuiranog aerobnog fizičkog vežbanja na vrednosti BMI i procenat masnog tkiva učenika koji imaju višak kilograma. Ova meta-analiza može da ukaže na značaj organizovanog aerobnog fizičkog vežbanja sa adolescentima na regulaciju telesne mase. Zbog malog broja ispitanika istraživani problem ovog rada se ne može generalizovati na populaciju učenika adolescentne dobi. Buduća istraživanja bi trebala da uvrste mnogo veći broj studija, kao i veći broj ispitanika kako bi rezultat bio pouzdaniji.

Metode

Metod pretraživanja

Pretraživanje literature i odabir referenci realizovan je u skladu sa pravilima i preporukama za sistematske preglede i meta-analize (PRISMA) (Moher et al., 2009). Pored sistematskog pregleda naučne literature i izbora pojedinačnih studija, prema jasno definisanim kriterijumima za odabir, izvršena je analiza odabranih individualnih studija. Selekcija naučnih studija izvršena je korišćenjem dve bibliografske baze podataka („PubMed" i „Mlibrary"). Prilikom pretrage korišćene su sledeće ključne reči: „Physical Education", „High School", „Running", „BMI", kao i definisan tip publikacije koji se odnosio na randomizovane kliničke studije (RCT), bez vremenskog ograničenja i koje su isključivo na engleskom jeziku.

Izbor literature

Detaljan prikaz izabranih individualnih studija predstavljen je u Dijagramu toka (Slika 1). Iz ove meta-analize isključene su sledeće studije: sa dupliranim naslovima, neodgovarajućim dizajnom, načinom fizičkog vežbanja, ishodima istraživanja, kao i studije sa neodgovarajućim problemom istraživanja. Za ovu meta–analizu izdvojene su RCT naučne studije koje ispunjavaju postavljene kriterijume (način fizičkog vežbanja, ispitanici, primarni ishodi i problem istraživanja). Takođe, izabrane su samo one studije koje su imale dva merenja (pretetst i posttest), a samim tim i mogućnost da se istraži na koji način je organizovano aerobno fizičko vežbanje imalo uticaja na merene ishode.

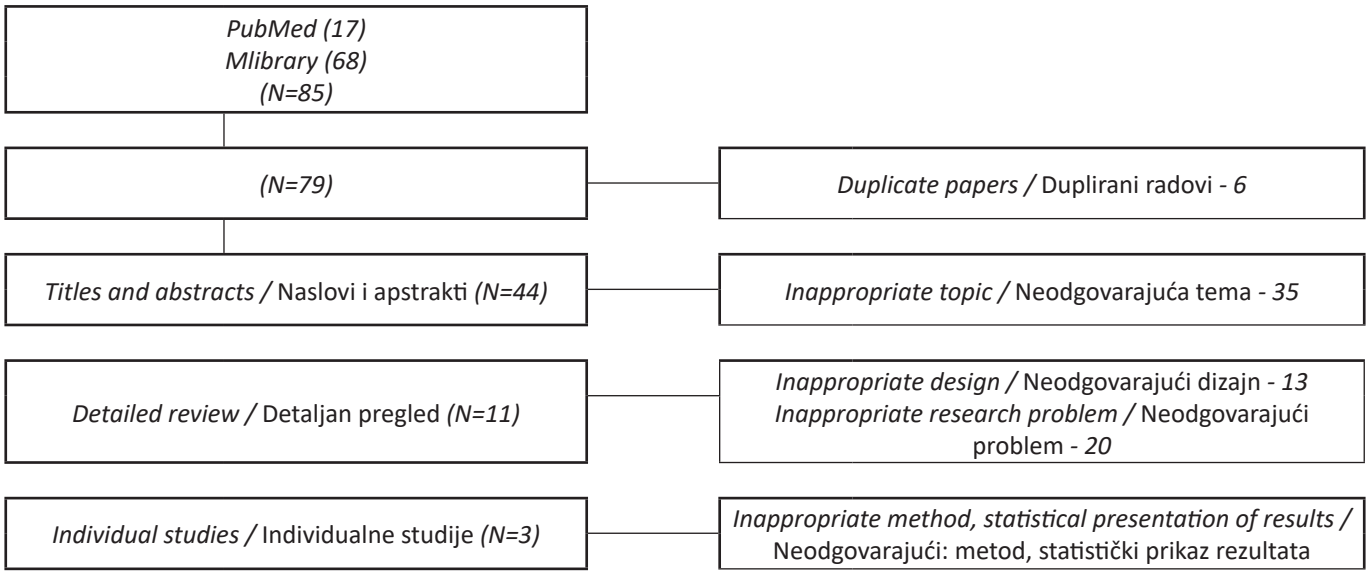


Figure 1. *Flow diagram of the systematic review of individual studies*

Slika 1. *Prikaz sistematskog pregleda individualnih studija Dijagram toka*

Participants

The criterion for selecting participants was the school age of children who were in the prepubertal or pubertal period. In the individual studies of this meta-analysis, students aged between 8 and 16 years. The students were randomized into two research groups. Many students were overweight and had not been sufficiently physically active in the past six months. In the experimental group, students participated in organized aerobic physical exercise in addition to regular PE classes, while the control group attended only the regular physical education lessons.

Organized Physical Exercise

The significance of this meta-analysis lies in presenting the impact of organized aerobic physical exercise on the measured outcomes (BMI and body fat percentage). Therefore, the main criterion for selecting studies was the type of physical exercise, that represents aerobic physical activity (running or other aerobic physical activities). In addition to running or aerobic exercises, strength exercises are also described in the individual studies as an integral part of the program (a more detailed description is provided in the individual studies: Back, 2015; Meng, 2022; Zuo, 2023). The organized aerobic physical exercise program was conducted at school by physical education teachers and/or trainers.

The organized aerobic physical exercise implemented in the individual studies of this meta-analysis can be summarized and described as follows: The first part of the program consisted of a 5-10 minute warm-up. The main part of the program involved aerobic physical exercise consisting

Ispitanici

Kriterijum za izbor ispitanika odnosio se na školski uzrast dece koja su u periodu predpuberteta ili puberteta. U individualnim studijama ove meta-analize učenici su imali od 8 do 16 godina. Učenici su randomizovani u dve istraživačke grupe. Mnogi učenici su imali višak kilograma i nisu bili dovoljno fizički aktivni u poslednjih šest meseci. U eksperimentalnoj grupi učenici su pored redovne nastave fizičkog vaspitanja učestvovali i u organizovanom aerobnom fizičkom vežbanju, dok je kontrolna grupa pohađala samo redovne časove fizičkog vaspitanja.

Organizovano fizičko vežbanje

Značaj ove meta-analize ogleda se u prikazu uticaja organizovanog aerobnog fizičkog vežbanja na merene ishode (BMI i procenat masnog tkiva). Stoga, glavni kriterijum za odabir studija bio je način fizičkog vežbanja koji predstavlja aerobnu fizičku aktivnost (trčanje ili druge aerobne fizičke aktivnosti). Pored trčanja ili aerobnih vežbi u individualnim studijama se opisuju i vežbe snage kao sastavni deo programa (detaljniji opis je dat u individualnim studijama: Back,2015; Meng, 2022; Zuo, 2023). Program organizovanog aerobnog fizičkog vežbanja je realizovan u školi od strane nastavnika fizičkog vaspitanja i/ili trenera.

Organizovano aerobno fizičko vežbanje koje je realizovano u individualnim studijama ove meta-analize može se objediniti i prikazati kroz sledeći opis: U prvom delu programa realizovano je zagrevanje u trajanju od 5 do 10 minuta. U glavnom delu programa realizovano je aerobno fizičko vežbanje kroz: specifičan program 108

of a specific program 108 – Bae, training on an athletic track running with changes in intensity and rest pauses between sets, and continuous running for 30 minutes at moderate intensity with a gradual increase in load. At the end of each organized aerobic physical exercise program, a cool-down and muscle stretching was performed.

Apart from PE classes, the students were not involved in other extracurricular sports activities. Both groups of participants regularly attended PE classes. Parental consent was obtained for participation in the individual study research.

Outcome Measurement

The primary outcome measures in this study were the total BMI value and the percentage of body fat in overweight students. Outcome values were measured before and after the experimental program of organized aerobic physical exercise. BMI was calculated using the formula BMI = kg/m², while the percentage of body fat was calculated using a body composition scale. All measured values were recorded in the teacher's work log.

Data Extraction and Risk of Bias

The reliability of a meta-analysis can depend on the assessment of risk, as well as a bias in the individual studies selected. The quality assessment of the data in this meta-analysis was performed by two independent authors (D.G. and V.Z.). In cases of disagreement during the analysis of the extracted data, the final decision was resolved through discussion between the reviewer and a third author (K.B.). Table 1 presents the extracted data included in the analysis.

Data Analysis

The unit of measurement in this meta-analysis was the individual scientific study. The pooling of results was performed by determining the relative risk (RR) and calculating the standardized mean differences from a total of three studies. Additionally, an analysis of the study heterogeneity and publication bias was conducted. The obtained results were tested at a statistical significance level (alpha level) of 0.05. Data analysis was performed in the R programming language and environment using the "metafor" and "meta" packages (Viechtbauer, 2010; Schwarzer et al., 2015).

Results

The standardized mean of all measured outcomes was calculated from three studies. The total number of participants in both groups was 93 students. Funnel plots for all measured outcomes were symmetrical (BMI at

– Bae, trening na atletskoj stazi – trčanje sa promenom intenziteta i pauzama odmora između serija i istrajno trčanje u trajanju od 30 minuta umerenog intenziteta sa postepenim povećanjem opterećenja. Na kraju svakog programa organizovanog aerobnog fizičkog vežbanja realizovano je istrčavanje i istezanje mišića.

Osim nastave fizičkog vaspitanja učenici nisu bili uključeni u druge vannastavne sportske aktivnosti. Obe grupe ispitanika su redovno pohađale nastavu fizičkog vaspitanja. Za učestvovanje u istraživanjima individualnih studija autori su dobili saglasnost roditelja.

Merenje ishoda

Primarni ishodi merenja u ovoj studiji bili su ukupna vrednost BMI i procenat masnog tkiva kod učenika sa viškom kilograma. Vrednosti ishoda mereni su pre i nakon eksperimentalnog programa organizovanog aerobnog fizičkog vežbanja. BMI je izračunat korišćenjem formule BMI=kg/m², dok je procenat masnog tkiva izračunat uz pomoć vage za merenje kompozicije tela. Sve izmerene vrednosti beležene su u dnevnik rada nastavnika.

Ekstrakcija podataka i rizik od pristrasnosti

Pouzdanost meta-analize može da zavisi od procene rizika, kao i od pristrasnosti u izabranim pojedinačnim studijama. Procenu kvaliteta podataka u ovoj meta-analizi izvršila su dva nezavisna autora (D.G. i V.Z.). Ukoliko je došlo do neslaganja prilikom analize izdvojenih podataka, konačna odluka se rešavala diskusijom između recenzenta i trećeg autora (K.B.). U Tabeli 1. prikazani su izdvojeni podaci uključeni u analizu.

Analiza podataka

Jedinicu mere u ovoj meta-analizi predstavljala je individualna naučna studija. Objedinjavanje rezultata izvršeno je određivanjem relativnog rizika (RR) i utvrđivanjem standardizovanih razlika aritmetičkih sredina iz ukupno tri studije. Takođe, izvršena je analiza heterogenosti studija, kao i publikaciona pristrasnost. Dobijeni rezultati analize su testirani na nivou statističke značajnosti (alfa nivo) od 0,05. Analiza podataka je izvršena u R programskom jeziku i okruženju korišćenjem paketa „metafor" i „meta" (Viechtbauer, 2010; Schwarzer et al., 2015).

Rezultati

Standardizovana aritmetička sredina svih merenih ishoda izračunata je iz tri studije. Ukupan broj ispitanika u obe grupe iznosio je 93 učenika. Za sve merene ishode levkasti dijagrami su bili simetrični (BMI u prvom mere-

first measurement p=0.0043; BMI at second measurement p=0.0001; Body fat percentage at first measurement p=0.0009; Body fat percentage at second measurement p=0.0009). No publication bias was observed in the individual studies.

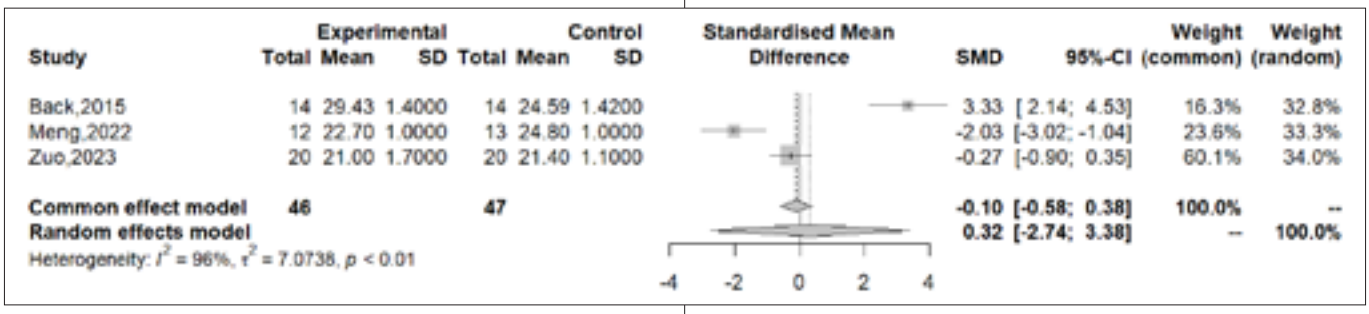
The combined standardized mean difference for BMI values at the first measurement, calculated using a random-effects model, was 0.81 (95% CI; -0.24; 1.86). Physically active and insufficiently active students did not differ statistically significantly regarding BMI at the first measurement (p=0.1293). High heterogeneity among studies was observed. The data were statistically significantly heterogeneous (p<0.01; I^2=82%; τ^2=0.6973). The combined relative risk (RR) value from the random-effects model for body fat percentage at the first measurement was 0.90 (-0.46; 2.26). RR was not statistically significantly different from 1 (p=0.1941). The difference in body fat percentage at the first measurement between physically active and sedentary students was 10%.

The combined standardized mean difference for BMI values at the second measurement, calculated using a random-effects model, was 0.32 (95% CI; -2.74; 3.38). Physically active and insufficiently active students did not differ statistically significantly regarding BMI at the second measurement (p=0.8362). High heterogeneity among studies was observed. The data were statistically significantly heterogeneous (p<0.01; I^2=96%; τ^2=7.0738) (Graph 1).

nju p=0,0043; BMI u drugom merenju p=0,0001; Procenat telesne masti u prvom merenju p=0,0009 i Procenat telesne masti u drugom merenju p=0,0009). U individualnim studijama nije uočena publikaciona pristrasnost.

Objedinjena vrednost standardizovane razlike aritmetičkih sredina za vrednosti BMI u prvom merenju izračunata je iz modela slučajnih efekata i iznosi 0,81 (95% CI; -0,24; 1,86). Fizički aktivni i nedovoljno fizički aktivni učenici se ne razlikuju statistički značajno u odnosu na BMI u prvom merenju (p=0,1293). Uočena je visoka heterogenost studija. Podaci su statistički značajno heterogeni (p<0,01; I2=82%; τ2=0,6973). Objedinjena vrednost RR iz modela slučajnih efekata za vrednosti procenta masti u prvom merenju iznosi 0,90 (-0,46; 2,26). RR nije statistički značajno različit od jedinice (p=0,1941). Razlika u vrednosti procenta masti u prvom merenju između fizički aktivnih i sedentarnih učenika iznosti 10%.

Objedinjena vrednost standardizovane razlike aritmetičkih sredina za vrednosti BMI u drugom merenju izračunata je iz modela slučajnih efekata i iznosi 0,32 (95% CI; -2,74; 3,38). Fizički aktivni i nedovoljno fizički aktivni učenici se ne razlikuju statistički značajno u odnosu na BMI u drugom merenju (p=0.8362). Uočena je visoka heterogenost studija. Podaci su statistički značajno heterogeni (p<0,01; I2=96%; τ2=7,0738) (Grafikon 1).

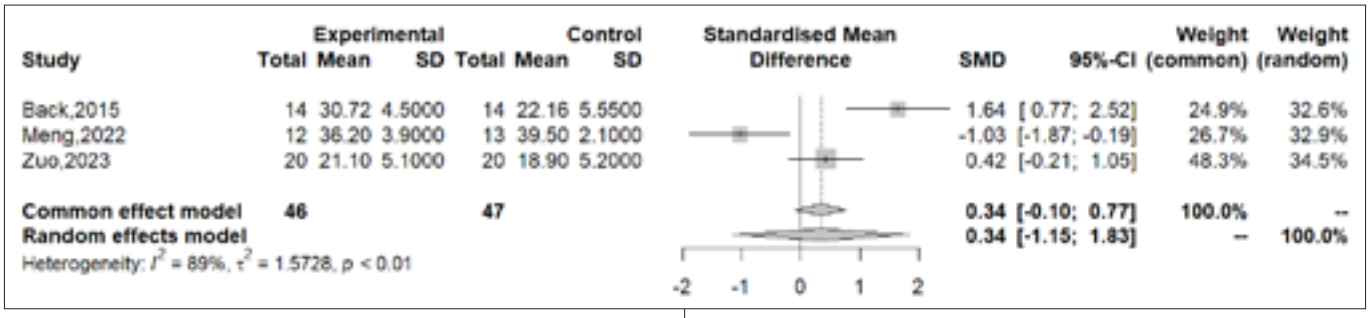


Graph 1. *Display of individual results and the combined value of the standardized mean difference of BMI at the second measurement*

Grafikon 1. *Prikaz individualnih rezultata i objedinjena vrednost standardizovane razlike aritmetičkih sredina BMI u drugom merenju*

The combined RR value for body fat percentage at the second measurement, calculated using a random-effects model, is 0.34 (-1.15; 1.83). The RR is not statistically significantly different from one (p=0.6527). The difference in body fat percentage at the second measurement between physically active and sedentary students is 66% (Graph 2).

Objedinjena vrednost RR za vrednosti procenta masti u drugom merenju izračunata je iz modela slučajnih efekata iznosi 0,34 (-1,15; 1,83). RR nije statistički značajno različit od jedinice (p=0,6527). Razlika u vrednosti procenta masti u drugom merenju između fizički aktivnih i sedentarnih učenika iznosti 66% (Grafikon 2).



***Graph 2**. Display of individual results and combined RR value for body fat percentage at the second measurement*

***Grafikon 2.** Prikaz individualnih rezultata i objedinjena vrednost RR za vrednost telesne masti u drugom merenju*

Research limitations

The main problem in this study can be attributed to the meta-analysis of a small number of individual studies that met the established selection criteria. No statistically significant differences were found for the measured outcomes in this study. Most studies related to research results were based on a single measurement. Additionally, many studies included students of different ages, as well as male students. None of the studies assessed the prior level of students' physical activity. In some studies, the average daily caloric intake, which was higher than the recommended values, was controlled (Meng et al., 2022; Zuo et al., 2023). Future research should revise this study and include in the meta-analysis only individual studies that cover a clearly defined age group of students of both sexes, provide a detailed and clear description of the aerobic physical exercise program, and include pretest and posttest measurements. The research groups should be identical in selection, meaning that both groups of participants should have a similar BMI level, so as to demonstrate the effect of the organized aerobic physical exercise program. Besides the method and type of physical exercise, intensity also plays a significant role. The inconsistency of the physical exercise programs applied in the individual studies certainly influenced the final measurement outcomes in this meta-analysis.

Discussion

This paper presents a meta-analysis of data describing the impact of organized aerobic physical exercise on the measured values of BMI and body fat percentage in overweight students. It is not possible to generalize the obtained results or draw definite conclusions, as the research was conducted on a small number of studies. The following factors influenced this issue: the type of experimental physical exercise program, the sample of participants, the primary outcome measures, the methodology, and the statistical data processing. During the

Nedostaci istraživanja

Glavni problem u ovom istraživanju može se pripisati meta-analizi malog broja individualnih studija koje su zadovoljile postavljene kriterijume za odabir. U ovoj studiji nisu dobijene statistički značajne razlike za merene ishode. Većina studija se odnosila na rezultate istraživanja prikazanih na osnovu jednog merenja. Takođe, u mnoge studije uvršteni su učenici različite starosne dobi, kao i učenici muškog pola. Ni u jednom radu nije utvrđivan prethodni nivo fizičke aktivnosti učenika. U pojedinim studijama vršena je kontrola prosečne vrednosti dnevnog kalorijskog unosa koji je bio veći od preporučenih vrednosti (Meng et al., 2022; Zuo et al., 2023). Buduća istraživanja bi trebalo da izvrše reviziju ovog istraživanja i u meta-analizu uključe isključivo individualne studije koje obuhvataju jasno definisanu uzrast učenika oba pola, detaljan i jasan opis programa aerobnog fizičkog vežbanja, kao i istraživanja sa pretestom i posttestom. Istraživačke grupe bi trebalo da su identične po odabiru, odnosno da obe grupe ispitanika imaju podjednak nivo BMI kako bi se mogao prikazati uticaj organizovanog programa aerobnog fizičkog vežbanja. Pored načina i vrste fizičkog vežbanja, veliku ulogu igra i intenzitet. Neujednačenost primenjenih programa fizičkog vežbanja individualnih studija sigurno je imala uticaja na konačan ishod merenja u ovoj meta-analizi.

Diskusija

U ovom radu izvršena je meta-analiza podataka koji opisuju uticaj organizovanog aerobnog fizičkog vežbanja na merene vrednosti BMI i procenta masnog tkiva kod učenika sa viškom kilograma. U radu nije moguće uopštavati dobijene rezultate i doneti konačne zaključke, jer je istraživanje realizovano na malom broju studija. Na navedeni problem su uticale sledeće stavke: vrsta eksperimentalnog programa fizičkog vežbanja, uzorak ispitanika, primarni ishodi merenja, metod rada, kao i statistička obrada podataka. Prilikom pregledanja naučnih studija

review of scientific studies, it was observed that some authors conducted their research exclusively with boys, and that the ages of students in these studies varied. Additionally, there is an inconsistency in the experimental programs related to the form of organized aerobic physical exercise programs on which the data analysis and the final result of the effect size calculation were based. For this reason, it was difficult to select studies that would meet the criteria set for this meta-analysis. The analysis of the selected individual studies did not yield statistically significant results, but it did show a positive effect of organized aerobic physical exercise on regulating students' body weight. The individual studies are described further in the text.

In the first individual study (Back & Ji, 2015), a program (108 – Bae) suitable for sedentary individuals with excessive body weight was implemented. Compared to other studies, this research shows positive results in reducing BMI values, body fat percentage, and visceral fat. The limitation of this study lies in the analysis of a smaller number of students, solely males. Furthermore, the conclusion regarding the quality and effectiveness of the organized physical exercise 108 – Bae is questioned, as the study results obtained in this research are compared with the results from studies conducted on women and older adult dancers (Lee, 2008; Seo et al., 2008; Kim, 2004). Compared to the students in the control group who had normal BMI values, the experimental group experienced a positive impact due to continuous aerobic physical exercise, and a reduction in BMI and body fat percentage. The authors state that the 108 – Bae program positively affects the development of physical abilities and is suitable for all ages. In this study, the program lasted 12 weeks (4 times per week) with participants (N=28) aged 16 years.

In the second individual study (Meng et al., 2022), the authors presented data on the average daily caloric intake, which could have influenced the research outcome. The study did not find statistically significant differences in results between the two groups of participants: the experimental group that exercised at high intensity (HIT) and the control group (CON), which did not engage in additional physical exercise except regular PE classes. This study shows that, although there is no significant difference in the results of body mass and body fat percentage after intense and moderate physical exercise, there is a significantly more efficient use of time, with exercise duration reduced from 30 minutes to as little as 11 minutes. The study analyzed three groups of students, one of which exercised at moderate intensity (MICT).

uočeno je da je jedan broj autora sproveo svoja istraživanja isključivo sa dečacima, kao i da je uzrast učenika u studijama bio različit. Takođe, uočava se neujednačenost eksperimentalnog programa u vidu organizovanog programa aerobnog fizičkog vežbanja na kome se zasniva analiza podataka i konačan rezultat kroz dobijanje veličine efekta. Iz tog razloga, bilo je teško izvršiti selekciju studija koje bi zadovoljile postavljene kriterijume ove meta-analize. Analiza izdvojenih individualnih studija nije dala statistički značajne rezultate, ali je pokazala pozitivan uticaj organizovanog aerobnog fizičkog vežbanja na regulaciju telesne mase učenika. Dalje u tekstu su opisane individualne studije.

U prvoj individualnoj studiji (Back, & Ji, 2015) realizovan je program (108 – Bae) koji je prigodan za sedentarne osobe sa prekomernom telesnom masom. U poređenju sa ostalim istraživanjima, ova studija pokazuje pozitivne rezultate na smanjenju vrednosti BMI, procenta telesne masti i visceralne masti. Nedostatak ove studije ogleda se u analizi manjeg broja učenika i to isključivo muškog pola. Takođe, dovodi se u pitanje zaključak o kvalitetu i efikasnosti organizovanog fizičkog vežbanja 108 – Bae, jer se rezultati studije dobijene u ovom istraživanju porede sa rezultatima studija u kojima su istraživanja vršena sa ženama, kao i plesačima starije životne dobi (Lee, 2008; Seo et al., 2008; Kim, 2004). U poređenju sa učenicima u kontrolnoj grupi koji su imali normalne vrednosti BMI, u eksperimentalnoj grupi je došlo do pozitivnog uticaja usled kontinuiranog aerobnog fizičkog vežbanja i smanjenja vrednosti BMI i procenta masnog tkiva u organizmu. Autori navodi da program 108 – Bae pozitivno utiče i na razvoj fizičkih sposobnosti, kao i da je pogodan za sve uzraste. U ovoj studiji program je trajao 12 nedelja (4 puta nedeljno) sa ispitanicima (N=28) uzrasta 16 godina.

U drugoj individualnoj studiji (Meng et al., 2022) autori su prikazali podatke prosečne vrednosti dnevnog kalorijskog unosa koji bi mogli imati uticaja na ishod istraživanja. U studiji nisu uočene statistički značajne razlike u rezultatima između dve grupe ispitanika, odnosno između eksperimentalne grupe koja je vežbala visokim intenzitetom (HIT) i kontrolne grupe (CON) koja nije imala dodatno fizičko vežbanje osim redovnih časova nastave fizičkog vaspitanja. Ova studija pokazuje, da iako ne postoji značajna razlika u rezultatima nakon intenzivnog i umerenog fizičkog vežbanja na vrednosti telesne mase i procenta masnog tkiva, postoji značajno efikasnija potrošnja vremena koje je sa 30 minuta vežbanja smanjeno na čak 11 minuta. U studiji su analizirane tri grupe učenika od kojih je jedna grupa vežbala umere-

Additionally, shorter exercise duration positively affects motivation to exercise and is less demanding for school-age children. Therefore, this type of physical exercise is easier to implement during PE classes (Millard et al., 2018). An increase in body mass was observed in the control group, which may indicate insufficient load during regular PE classes. In this study, the program lasted 12 weeks (3 times per week) with participants (N=25) aged 11 years.

In the third individual study (Zuo et al., 2023), which investigated organized aerobic physical exercise in students performing high-intensity running and those engaged in moderate-intensity running, no significant difference was observed between the groups in muscle mass percentage. However, high-intensity physical exercise proved more useful for the analysis of body composition, body fat percentage, and cardiorespiratory function. The study reports average daily caloric intake values. The organized physical exercise program, which included a 50-meter running test, showed a positive effect on leg muscle strength. However, no major differences between the groups were observed, which can be explained by the continuous aerobic physical exercise performed by participants in both groups. It can be considered that the effect of reducing body weight and body fat percentage, and consequently increasing muscle mass, is directly related to the type and method of physical exercise. In this study, the program lasted 8 weeks (3 times per week) with participants (N=40) aged 8 years.

A review of the existing literature reveals there is a problem with standardized research methods regarding the mentioned issue. One meta-analysis that addressed this problem included students aged from 6 up to 18 years in its research. Additionally, inconsistent physical exercise programs due to the application of different intensities lead to results in individual studies that are difficult to compare later (Guerra et al., 2013). Therefore, this meta-analysis can be considered significant due to the clearly defined criteria for selecting individual studies, which influenced the effect size outcome. Although a very small number of studies were included in this meta-analysis, the obtained results indicate the possibility of a positive impact of organized aerobic physical exercise on the measured research outcomes. This research may highlight the need for studies with a larger number of participants so that the investigated problem can be generalized to the population of prepubertal and pubertal students.

nim intenzitetom (MICT). Takođe, kraće trajanje vežbanja pozitivno utiče na motivaciju za vežbanjem i manje je zahtevno za decu školskog uzrasta. Stoga, takav vid fizičkog vežbanja je lakše realizovati tokom nastave fizičkog vaspitanja (Millard et al., 2018). U kontrolnoj grupi uočava se povećanje vrednosti telesne mase što može da ukaže na nedovoljno opterećenje u okviru redovne nastave fizičkog vaspitanja. U ovoj studiji program je trajao 12 nedelja (3 puta nedeljno) sa ispitanicima (N=25) koji su imali 11 godina.

U trećoj individualnoj studiji (Zuo et al., 2023) u kojoj je istraživano organizovano aerobno fizičko vežbanje sa učenicima koji su primenjivali visok intenzitet trčanja i učenicima koji su primenjivali umeren intenzitet trčanja, uočeno je da nema značajne razlike između grupa u procentu mišićne mase. Ipak, fizičko vežbanje visokim intenzitetom pokazalo se uspešnijim pri analizi sastava telesne mase, procenta masnog tkiva i kardiorespiratorne funkcije. U studiji se navode prosečne vrednosti dnevnog kalorijskog unosa. Program organizovanog fizičkog vežbanja koji je obuhvatio test trčanja na 50 m pokazao je pozitivan efekat na snagu mišića nogu. Međutim, nisu uočene veće razlike između grupa što se može objasniti kontinuiranim aerobnim fizičkim vežbanjem ispitanika u obe grupe. Može se smatrati da je efekat smanjenja telesne mase i procenta masnog tkiva, a samim tim i povećanje mišićne mase u direktnoj vezi sa vrstom i načinom fizičkog vežbanja. U ovoj studiji program je trajao 8 nedelja (3 puta nedeljno) sa ispitanicima (N=40) koji su imali 8 godina.

Dosadašnjim pregledom istražene literature uočava se da postoji problem sa ujednačenim metodama istraživanja pomenutog problema. Jedna od meta-analiza, koja se bavila istraživanjem navedenog problema, navodi da je u svoje istraživanje uvrstila učenike od 6 do čak, 18 godina. Takođe, neujednačeni programi fizičkog vežbanja usled primene različitog intenziteta dovode do rezultata u pojedinačnim studijama koji se kasnije teško mogu porediti (Guerra et al., 2013). Stoga, ova meta-analiza se može smatrati značajnom zbog jasno definisanog kriterijuma za odabir individualnih studija koje je imalo uticaj na rezultat veličine efekta. Iako je u ovu meta-analizu uvršten veoma mali broj studija, dobijeni rezultati ukazuju na mogućnost pozitivnog uticaja organizovanog aerobnog fizičkog vežbanja na merene ishode istraživanja. Ovo istraživanje može da ukase na potrebu da se izvrše istraživanja sa većim brojem ispitanika kako bi se istraživani problem mogao generalizovati na populaciju učenika predpubertetskog i pubertetskog doba.

Conclusion

This meta-analysis examined three individual studies that analyzed organized aerobic physical exercise of students who were insufficiently physically active and overweight. Based on the small number of studies, it is not possible to obtain a reliable effect size result wherefrom a generalized conclusion could be drawn. However, although the study results did not show a statistically significant difference between the measured outcomes (BMI and body fat percentage), differences between groups were observed in individual studies. It is necessary to analyze data from a much larger number of studies, as well as with a greater number of participants who can be compared by age, gender, level of physical fitness, and BMI values.

Zaključak

Ovom meta-analizom izvršena je analiza tri individualne studije koje su izvršile analizu organizovanog aerobnog fizičkog vežbanja sa učenicima koji nisu dovoljno fizički aktivni i imaju i višak kilograma. Na osnovu malog broja studija nije moguće dobiti pouzdan rezultat veličine efekta na osnovu kog bi se zaključak mogao generalizovati. Međutim, iako rezultati studija nisu pokazali statističku značajnu razliku između merenih ishoda (BMI i procenat masnog tkiva), u pojedinačnim studijama uočene su razlike između grupa. Neophodno je izvršiti analizu podataka na mnogo većem broju studija, kao i sa većim brojem ispitanika koji se mogu porediti po: uzrastu, polu, nivou fizičke sposobnosti, kao i vrednostima BMI.

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