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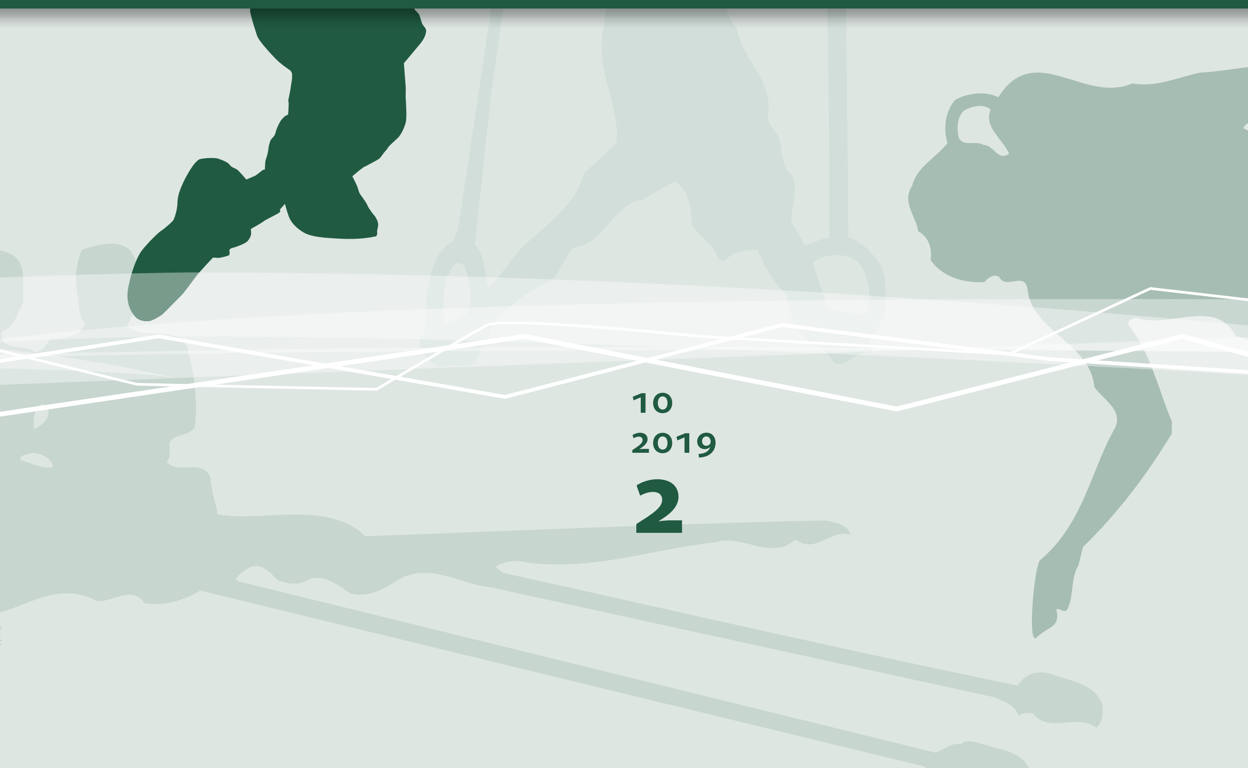

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EDITORIAL

Through the contributions of the authors of the next volume of the Annales Kinesiologiae, we continue the study of kinesiology − the science of human movement. A septagram of kinesiology in all its fields, from considering the **developmental** and **expressive** abilities that movement grants to the individual, to the role in learning about the world − **learning** or finding balance − **health**, its treatment in the everyday **work** environment, relaxation − **recreation** or with the aim of competing − in **sports**, it connects the whole of human activity and being from morning to evening, from birth to death. The articles in this issue present the authors' results, findings and confirmed facts, together with their supplements and elaborations of their content. The physical and social environment surrounding the individual, and indisputably influencing them, is further discussed in two contributions. The results of the original scientific articles thus provide us with guidance and solutions which should be considered by decision-makers in the professional and political public.

Knowledge is a quality product of science and plays a role of an added value for the individual and the wider society. Through research and development, over the last 50 years, we have become the best version of human, but at times some decisions of modern people seem to be backed up by just as much ignorance. Something has gone wrong along the way, and only listening to and understanding knowledge can help us find a way forward. Knowledge should be centred around the person and seek solutions for their own good. If we could put the welfare of the wider society at the centre of this process, and not only our own interests, we would win in any event.

In this journal, the authors offer a number of interesting facts and findings, and they summarize the findings of other experts written in the monograph or presented at the conference. With the ability to connect the presented research issues, we can create a comprehensive picture and make contact with all the areas that kinesiology wants to address.

Prof. Rado Pišot, PhD
Editor in Chief

UVODNIK

S prispevki avtorjev drugega zvezka Annales Kinesiologiae v letu 2019 nadaljujemo obravnavo pojava kineziologije – znanosti o gibanju človeka. Septagram kineziologije s svojimi področji, od obravnave **razvojnih** in **ekspresivnih** zmožnosti, ki jih posamezniku omogoča gibanje, prek njegove vloge v spoznavanju sveta – **učenju** ali iskanju ravnovesja – **zdravja**, obravnave v vsakdanjem **delovnem** okolju, sprostitvi – **rekreaciji** ali zaradi dokazovanja – v športu, povezuje celotno človekovo dejavnost in bivanje od jutra do večera, od rojstva do smrti. Prispevki avtorjev člankov s predstavljenimi rezultati, ugotovitvami in potrjenimi dejstvi nadgrajujejo in dopolnjujejo omenjene vsebine. Fizično in družbeno okolje, ki obdaja posameznika in nanj nedvomno vpliva, pa je v dveh prispevkih še dodatno poglobljeno obravnavano. Rezultati izvirnih znanstvenih člankov nam tako ponujajo usmeritve in predloge rešitev, o katerih bi morala razmišljati strokovna in politična javnost odločevalcev.

Znanje, ki je lahko kakovosten produkt znanosti, se šele v rokah teh udejanji kot dodana vrednost za posameznika in širšo družbo. Z raziskavami in razvojem smo v zadnjih 50 letih postali najboljša izvedba človeka, samega sebe, vendar se včasih zdi, da so nekatere odločitve sodobnega človeka utemeljene z neizmerno ignoranco. Nekaj se nam je na tej poti zalomilo ter le posluh in dojemljivost za znanje nam lahko pomagata najti tudi pot naprej. Znanje, ki je osredinjeno na človeka in njemu v dobro, išče rešitve. Če bi zmogli v tem procesu v središče postaviti še blagor širše družbe in ne le lastnega, bi zmagali v vseh pogledih.

V reviji, ki je pred vami, avtorji ponujajo številna zanimiva dejstva in ugotovitve ter povzemajo ugotovitve drugih strokovnjakov, zapisane v monografiji oz. predstavljene na konferenci. Z zmožnostjo povezovanja predstavljene raziskovalne problematike si lahko ustvarimo celovito sliko in najdemo stik z vsemi področji, ki jih želi obravnavati kineziologija.

Prof. dr. Rado Pišot,
glavni in odgovorni urednik

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CHARACTERISTICS OF ADOLESCENTS' ACTIVE LIFESTYLE IN THE CITY OF LJUBLJANA

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ABSTRACT

Purpose: *The aim of our study was to analyse the characteristics of the adolescents' active lifestyle and their relationship to some environmental correlates in the city of Ljubljana.*

Methods: *The characteristics of active lifestyle on the sample of 269 students of Secondary School of Nursing Ljubljana (206 females, 63 males), aged 16−18 years) via an online questionnaire were evaluated. Descriptive statistics and Fisher's exact test were used (at p < 0.05 - 5 %. level). In the second part, we used half-structured interviews with former students of the same school (no. 6); to evaluate their attitude to physical education lessons, their general active lifestyle and their evaluation of the environmental correlates: physical (facilities, equipment), social (social support and social norms) or institutional (policies).*

Results: *Results show that the majority of students (44.96 %) was physically active at least two to three times per week. The students partly agree (3.7/5) that sports activities play an essential role in their general lifestyle. Furthermore, they care about leading a healthy lifestyle (3.7/5) and eating healthy food (3.7/5). Students evaluated both physical factors (at the municipality level 76.15%, at the state level 71.49%), and social (parents) support as appropriate. The former students believe that physical environmental factors around their school (facilities, equipment) are optimal, but they regret that they did not use them enough; neither during PE lessons nor in their leisure time.*

Conclusion: *Based on our results, we propose better cooperation between all the included factors, which can result in the improvement of adolescents' active lifestyle.*

Keywords: *lifestyle, sport, adolescents, Ljubljana, environmental correlates.*

ZNAČILNOSTI AKTIVNEGA ŽIVLJENJSKEGA SLOGA MLADOSTNIKOV V MESTNI OBČINI LJUBLJANA

IZVLEČEK

Namen: *Namen naše raziskave je bil analizirati značilnosti aktivnega življenjskega sloga mladostnikov in odnos do nekaterih okolijskih dejavnikov v mestu Ljubljana.*

Metode: *S pomočjo spletnega vprašalnika so bile ovrednotene značilnosti aktivnega življenjskega sloga na vzorcu 269 dijakov Srednje zdravstvene šole Ljubljana (206 žensk, 63 moških, starih 16-18 let). Uporabljeni so bili opisni statistični podatki in Fisherjev natančni test (pri p <0,05 - 5% stopnja). V drugem delu so bili izvedeni polstrukturirani intervjuji z nekdanjimi dijaki te šole (6), s katerimi so bila opredeljena njihova stališča do aktivnega življenjskega sloga sploh ter posebej odnosa do športne vzgoje in je bil ovrednoten njihov odnos do okolijskih dejavnikov: fizičnih (objekti, pogoji, oprema), socialnih (socialna podpora in socialne norme) ali institucionalnih (predvsem lokalne politike).*

Rezultati: *Rezultati kažejo, da je bila večina dijakov (44,96%) vsaj dva do trikrat na teden telesno dejavnih. Dijaki se delno strinjajo (3.7/5), da imajo športne aktivnosti bistveno vlogo v njihovem življenjskem slogu. Poleg tega dijaki navajajo, da skrbijo za zdrav življenjski slog (3,7/5), uživajo zdravo hrano (3,7/5). Dijaki so okolijske (fizične) dejavnike ocenili kot ustrezne (na ravni občine 76,15%, na državni ravni 71,49%) in socialno oporo (starši), kot primerno. Nekdanji dijaki tudi ocenjujejo fizične oz. prostorske možnosti v okolici šole kot optimalne, vendar obžalujejo, da jih niso uporabljali v večji meri tako med poukom, kot v prostem času.*

Zaključek: *Na podlagi rezultatov predlagamo boljše sodelovanje med vsemi navedenimi dejavniki, kar lahko pripomore k izboljšanju aktivnega življenjskega sloga mladostnikov.*

Ključne besede: *življenjski slog, šport, mladostniki, Ljubljana, dejavniki okolja.*

INTRODUCTION

Physical activity (PA) is one of the key health determinants in life (Fletcher et al., 1996; Gunter, Almstedt, & Janz, 2012; Janssen & Leblanc, 2010). It is one of the sources of total energy expenditure, which incorporates active energy expenditure, metabolism in resting state, the thermal effects of food digestion and body growth in children and adolescents (Armstrong & Welsman, 2006). The existing evidence shows that PA has positive effects on psychosocial health, and the functional capacity and wellbeing of people (Brettschneider & Roland, 2004; Lima et al., 2017; Powell & Pratt, 1996)Inc. Background: The current study evaluated the reciprocal longitudinal relationship between physical activity (PA, whereas physical inactivity increases health risks (Hallal et al., 2012). Despite these established benefits, a substantial proportion of children are not meeting (Aubert et al., 2018) PA recommendations of 60 min moderate to vigorous PA (MVPA) daily (World Health Organization, 2010). Moreover, participation declines during the transition from childhood to adolescence (Dalene et al., 2018; Farooq et al., 2018; Kimm et al., 2002), with PA increasingly replaced with sedentary activities (Brodersen, Steptoe, Boniface, & Wardle, 2007; Volmut, Pišot, & Šimunič, 2013)ethnicity and socioeconomic status (SES. Given that young people spend approximately half of their waking day at school, schools represent an essential setting for promoting physical activity and reducing sedentary behaviours (Morton, Atkin, Corder, Suhrcke, & Van Sluijs, 2016).

PA interventions tend to focus on increasing knowledge through health education and implementing curriculum to increase the number of time students are engaged in PA (Morton et al., 2016) during the school day. Generally speaking, these interventions have not been successful for adolescent populations (Dobbins, Husson, DeCorby, & LaRocca, 2013). A general criticism directed at many school-based interventions is the lack of attention paid to the role of the wider environment (Doak, Visscher, Renders, & Seidell, 2006). PA behaviour is not driven only by consideration of knowledge, attitudes and beliefs; but can also be automatically enriched by environmental stimuli (Dunton, Cousineau, & Reynolds, 2010; Marteau, Hollands, & Fletcher, 2012). These factors may be physical (facilities, equipment), social (social support and social norms) or institutional (policies) (Morton et al., 2016).

Sport is an increasingly important human activity and part of the general culture, which considerably enriches the life of an individual and is a significant element in quality of life.

In the literature review of the correlates of sports activity, some differences emerge. First, the empirical analyses use different measures of sport participation. A large number of studies analyse whether or not individuals perform sports activities (e.g. Bauman et al., 2012). The second set of studies also analyses the frequency of participation or duration of the activity and expenditures (e.g., Farooq et al., 2018, Bon, Lavrič, Gradišar-Saifet, & Kambic, 2019).

One of the environmental correlates are state and city policies. Sport in the Municipality of Ljubljana is based on the Sports Act (2017) and other municipality regulations.

Sports Policy in the City of Ljubljana is one of the health-enhancing acts of the City Council of Ljubljana (CCL), which is the supreme body that determines all matters within the framework of the rights and obligations of the City of Ljubljana. The most important strategic goals in the document titled "Strategy for the Development of Sport in the City of Ljubljana 2008-2012" (Bon, Kolenc, Peršolja, & Tomc, 2008) were mostly connected with sport facilities: to improve and increase the number of outdoor facilities (outdoor fitness, recreational areas near the Sava river, skate parks, etc.) and to build new indoor facilities such as the Sports Centre Stožice, Gymnastic Centre Ljubljana, Kolezija Swimming Pool, etc. (Bon et al., 2008).

Our study aimed to examine some characteristics of adolescents' lifestyle and evaluate the perception of environmental correlates, especially all settings and conditions around the Secondary School of Nursing Ljubljana (r=2 km).

METHODS

Our study combined qualitative and quantitative methods. In the first part, we analysed the data about lifestyle and conditions (Bon et al., 2019) obtained via e-survey (no. 269). The second part included structured interviews (no. 6) to evaluate the characteristics of physical education (PE) in school and school surroundings in the City of Ljubljana.

A total number of 269 adolescents (206 females), aged 16−18, students of the Secondary School of Nursing Ljubljana participated in the study. Each participant was informed about the purpose of the study and a written informed consent was obtained from all adolescents. The participation was anonymous, and participants were free to withdraw from the study at any time and for any reason.

All respondents' answers were rated on a 5-point Likert scale. Responses on the subscale ranged on a scale 1−5, where one represents not satisfied or very unimportant and five very satisfied or very important. The validity of the used questionnaire (alpha 0.78) is sufficient. Apart from the descriptive statistics, Fisher's exact test was used (at $p < 0.05$ - 5 %. level).

Data were collected on the "1ka" platform (Faculty for Social Sciences, University of Ljubljana) and analysed in the program IBM SPSS 19 (SPSS Inc., Chicago, USA).

Additionally, in the qualitative part six semi-structured interviews were conducted with an aim to shed further light on the results with three female and three male students all finishing school within three years (born 1998 or younger). At the end an overview of sports facilities around the school (2 km) was made by analysing available documentation about sports facilities in the city of Ljubljana.

The transcription of the semi-structured interviews and data organization was followed by the descriptive encoding and the data validation process. The first validation phase was about the accuracy of the design/methods, and the second about the reliability of the procedures to produce consistent and dependable results. Finally, the data analysis stating the findings and research outcomes based on the research objectives were concluded. Our goal was to find a valid link between the analysed data and the research questions.

In the first part of the study, the invitation for voluntary participation was sent to all students of the Secondary School of Nursing Ljubljana of the year 2018/19, followed by life face-to-face or phone conversation to explain the purpose of the study. After a positive response from the students, participants completed an online survey on the “1ka” platform. After a descriptive analysis of the answers from all students, the interview process was organized. It included six students of the Secondary School of Nursing (3 females, 3 males), aged 16−18, who have already finished the first two years of school. The individuals who agreed to participate in interviews, signed an informed consent after a detailed description of the purpose of the study and their participant’s rights. The interviews lasted 30 to 40 minutes and were conducted by one person (first author).

All steps in the testing procedure were conducted in accordance with the ethical standards of a responsible local human experimentation committee and with the Helsinki Declaration as revised in 2013.

RESULTS

Results of the Questionnaire

The results of the questionnaire are presented in Table 1. The students partly agree (3.7/5) that sports activities play an important role in their lifestyle. Furthermore, they care about leading a healthy lifestyle (3.7/5) and eating healthy food (3.7/5).

More than half of adolescents occasionally (69. 42%) consume alcohol, and some of them even take drugs. Only 44.9 % of the included students reaches the recommendations for PA of 150 min PA/week. 31 students (12.0%) are physically active only once per week and 21 (8.14%) even less than once per month. Results show that there is no significant difference between gender (p=0,159) and age (p=0.753) regarding PA. The majority of respondents (84.40%) see the social and emotional support of their parents as appropriate, and the results are similar for those within the school (69.26 %). Most of them also perceive the environmental correlates − physical (conditions, facilities) and social support (parents, teachers) as appropriate (in municipality 76.15%, at the state level 71.49%). On average, they spend 123.6 EUR (from 6 to 1000 EUR) per month for sports activities. According to official data, students have many possibilities for indoor sports (in Ljubljana around 130,000m2) and outdoor sports (outdoor fitness, trim trails, and especially Golovec hill and Kodeljevo sports park), which create a near-optimal environment for an active lifestyle.

We asked them about social support (family, school). Out of all, 86.4% announced that they have appropriate social support from parents, and 73.6 % are happy with the support in school.

Table 1: Results of the questionnaire.

Question/variable s	1. Strongly disagree	2. Disagree	3. Neither agree nor disagree	4. Agree	5. Strongly agree	SUM	M	SD
Sports activity is of great value to me.	20	23	45	90	73	251	3.7	1.21
	7.97%	9.16%	17.93%	35.86%	29.08%	100.00%		
I lead a healthy lifestyle.	6	11	78	111	40	246	3.7	0.88
	2.44%	4.47%	31.71%	45.12%	16.26%	100.00%		
I eat healthily.	8	33	117	71	15	244	3.2	0.87
	3.28%	13.52%	47.95%	29.10%	6.15%	100.00%		
I consume alcohol.	74	36	53	62	17	242	2.6	1.34
	30.58%	14.88%	21.90%	25.62%	7.02%	100.00%		
I smoke.	166	34	18	15	10	243	1.6	1.12
	68.31%	13.99%	7.41%	6.17%	4.12%	100.00%		
I use soft drugs.	192	27	12	6	5	242	1.4	0.86
	79.34%	11.16%	4.96%	2.48%	2.07%	100.00%		
I take hard drugs.	209	23	6	2	1	241	1.2	0.55

SUM sum of questions answered, M mean, SD standard deviation.

Qualitative Results

An evaluation of the survey results clearly shows that there were different opinions about the degree to which (living/physical) environment affected PA level of adolescents of Ljubljana. Students are of the opinion that PE teachers could ask more from them during physical education lessons.

- Student W 1: "*We never go to Golovec, a hill near the school, or to any facility around the school. We once used Kodeljevo sports park, only for a 2400m run test.*"

Students also agree that they were not motivated enough for sports activities, they tended to avoid sports activities and rest during PE lessons;

- Student W 2: "*We were happy when our PE teacher allowed us to sit and talk... and we were gossiping .... I must admit that it was only in the first class when we had one old teacher.*"

It was also pointed out that especially the participation of female students in PE classes was additionally limited due to personal and hygiene reasons.

- Student W3: *"I like sport, but I did not participate much in PE classes, because I really hated to sweat, I hate to be wet and to stink after a PE class... For all of us, the "sweating situation" was the biggest problem."*

It is difficult to determine if these are excuses, or these hygiene reasons are a legitimate influencing factor, and it is necessary to find an organisational solution (bathrooms, showers, time-space for showering…). Student W3 also admitted: *"From today's perspective, I am sorry that I wasn't more active during PE classes: But we really did not have time to take a shower afterwards."*

Students also honestly admitted that they were trying to avoid PE classes to study for other tests and exams.

- Student W1: *"Many of us were studying for a test (in one of the next periods) during our PE classes. "*
- Student W2: *"I'm really not quite sure what the main reason that girls didn't do much sport in PE classes was. It was a sort of combination of girls' laziness, conditions (only half of the sports hall) and teachers' insufficient motivation, which all resulted in sport not having any real value in our school. "*

It is evident that male students have an entirely different perception. They did not mention hygiene reasons (sweating) and showed ambition to be even more active (M1, M2, M3)

- Student M*1: "I liked that we could suggest to our PE teacher what we wanted to do - mostly it was football."*
- Student M2: "*Mostly we were in the school sports hall. Only once we were on Golovec Hill and once at the Kodeljevo stadium. I liked it very much, and I'm still sorry that we didn't use these possibilities more.*"
- Student M 3: *"I would have liked our lessons to be more intensive and that we would have had PE every day."*

From these results, we can conclude that for female students the hygiene concern is a significant barrier to participating more in PE and leading a more active lifestyle, while male students would like to participate in more activities and dedicate more time to PE. Male students are aware of the wide range of possibilities in the school surroundings, and they would have liked to use those facilities around school more. Female students, on the other hand, are not so aware of these facilities and possibilities, their answers were mainly "*I'm not quite sure*", *"I didn't care"*. It seems that during PA, their focus was more on body aesthetics and 'good looks'.

Sports Facilities around the School in Connection with City Sports Policies

Sports policy in the city is of vital importance, as the majority of sports facilities are in the domain of the City of Ljubljana. The basic goals in the field of sports in the City of Ljubljana are sustainability, accessibility, the competence of professional staff and fairness. More than 11% of the city budget is intended for sport, for the implementation of the sports strategy – to manage sports facilities, in one of the first priority.

Sports facilities and natural environment correlates, within 2 km radius around the school:

- Golovec Hill (250m–2,5km),
- Kodeljevo Park (football, tennis, swimming pool) – (200m),
- outdoor fitness (in front of the school) (10m) and
- Ljubljana Caste hill (300m).

Those are physical factors which are of free of charge, available for all people. In this circle of 2 km there are, besides the sports hall at the Secondary School of Nursing Ljubljana, also: Sports Hall Kodeljevo, Sports Hall Poljane, facilities at the Faculty of Sport and some with private owners.

DISCUSSION AND CONCLUSION

Regular PA during adolescence provides numerous benefits; that why it is important to organize and implement the environmental correlates in the supportive way − to improve the level of adolescents' active lifestyle. In general, our results show insufficient level of sports activity, according to the recommendation of the World Health Organization (WHO), which states that youngsters, from 5 to 17 years of age, should engage in moderate to vigorous physical activity (MVPA) daily for at least 60 min, and in vigorous physical activity (VPA) at least three times a week.

As in many countries all over the world, where there is an increasing academic and policy interest (e.g. Van Hecke et al., 2016; Farooq et al., 2018) in interventions aiming to promote young people's health by ensuring that the school environment supports healthy and active (sports) behaviours, we can see similar strategies also in Slovenia, particularly in Ljubljana, where the City of Ljubljana has more than 103 indoor and 83 outdoor facilities, which can all be used to promote active lifestyle for adolescents. Regarding environmental correlates, the majority of our respondents perceive conditions in Ljubljana as appropriate. Our adolescents are aware that sport and physical education are an important part of their lifestyle, but it is evident that adolescents, as well as teachers of PE, are not motivated enough to make full use of the facilities available to them. Many factors influence the complex behaviour of adolescents PA (Bauman et al., 2012; Gustafson & Rhodes 2006; Telama, Nupponen, & Laakso, 2007). Support from peers, socio-economic status, parental education, school policies and environmental correlates emerged as potential determinants of PA (Ferreira et al., 2007). The results show that students, as well as teachers, lack a higher level of motivation for more dedicated work in active sports life. It seems that adolescents are not aware that being active is first and foremost their responsibility. The institutional environmental correlates (teachers, officials, sports policies) have to find a suitable model to makes adolescents more motivated and committed to leading an active lifestyle.

In general, sport communication strategies might play a prominent role in persuading potential participants of the benefits of sports activity and frequency for adolescents.

Identifying and understanding factors that can improve childhood and adolescent physical activity is necessary to design and implement effective interventions. Recent years have witnessed a growing interest in environmental factors that influence physical activity: physical (e.g. physical structures and facilities), social (e.g. support and norms) and institutional (e.g. school rules and policies). In addition to sports activities, one major contribution to childhood physical activity lies in free active play and unstructured physical activities taking place outdoors during their free time. This type of play provides numerous benefits in terms of cognitive, social and physical development (Van Hecke et al., 2016; Farooq et al., 2018; Dobbins et al., 2013; Bauman et al., 2012).

The adolescents in our study are of the opinion that physical environmental factors (facilities, equipment) are not used enough, but they are happy with social support and institutional (city, state) factors. Based on our results, we propose better cooperation between all the factors involved, which can improve the active lifestyle of adolescents.

The specifics of active lifestyle on one hand and connection with structured (school, sport clubs, etc.) and unstructured (outdoor) correlates on other, could be an interesting research topic for the future.

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PHYSICAL ACTIVITY REGULATES THE INTESTINAL MICROBIOTA COMPOSITION

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ABSTRACT

Gut microbiota is the name given today to the bacterial population living in our intestine. It provides nutrients, metabolites and affects the immune system. Recent animals and human studies suggest that regular physical activity increases the presence of beneficial microbial species of gut microbiota and improves the health status of the host. When gut bacteria diversity reduces, there are systemic consequences leading to gastrointestinal, physiological and psychological distress. This review describes the communication pathway of the microbiota-gut-brain axes and other possible mechanisms by which physical activity causes changes in microbiota composition. Furthermore, it provides the latest evidence of the beneficial role of exercise, which in turn can affect health and various disease processes. The results of research studies in this area are increasingly becoming a focus of scientific attention.

Keywords: *Gut microbiota, physical exercise, health.*

TELESNA AKTIVNOST URAVNAVA SESTAVO ČREVESNE MIKROBIOTE

IZVLEČEK

Črevesna mikrobiota je bakterijska združba v črevesju. Zagotavlja hranila, metabolite in vpliva na imunski sistem. Nedavne študije na živalih in ljudeh nakazujejo, da redna telesna aktivnost povečuje prisotnost koristnih bakterijskih vrst, ki so del črevesne mikrobiote in na ta način izboljšuje zdravstveno stanje gostitelja. Upad raznolikosti črevesnih bakterij vodi v sistemske posledice, ki povzročajo gastrointestinalne, fiziološke in psihološke težave. Pregledni članek opisuje komunikacijsko pot, os mikrobiota--črevesje-možgani ter druge možne mehanizme, s katerimi telesna aktivnost povzroča spremembe v sestavi mikrobiote. Poleg tega ponuja najnovejše dokaze o koristni vlogi telesne aktivnosti, kar lahko vpliva na zdravje in različne bolezenske procese. Rezultati raziskav na tem področju so vse bolj v središču pozornosti znanstvenikov.

***Ključne besede**: črevesna mikrobiota, telesna aktivnost, zdravje.*

INTRODUCTION

Microbiota in Gastrointestinal Tract

The human gastrointestinal tract (GIT) is inhabited by trillions of microbial cells whose coordinated actions are important in human life, having crucial roles in several physiological and pathological processes (Clemente, Ursell, Parfrey & Knight, 2012). These microorganisms are known as gut microbiota and are sometimes referred to as a »forgotten organ« (O'Hara & Shanahan, 2006). The gut microbiota is mostly made up of two bacterial phyla. More than 90% of them belong to *Bacteroidetes* and *Firmicutes*, including species of *Ruminococcus*, *Lactobacillus* and *Clostridium* genera, whereas the minority of species belong to phyla such as *Actinobacteria* and *Proteobacteria*. *Firmicutes* phyla mainly includes *Ruminococcus*, *Clostridium*, *Lactobacillus*, *Eubacterium*, *Faecalibacterium* and *Roseburia*, while in *Bacteroides* mainly *Prevotella* and *Xylanibacter* are represented (Eckburg et al., 2005).

The number, type and function of microbiota along the entire GIT have a great variability. Its density and diversity increase steadily along the GIT. The highest concentration is reached in large bowel where a complex group of microorganisms ferment different non-digestable food components (Bäckhed, Ley, Sonnenburg, Peterson & Gordon, 2005). The gut microbiota functions are highly preserved between individuals, whereas each individual's gut microbiota is characterized by a specific combination of bacterial species due to inter-individual and intra-individual variations throughout human life. Its composition is influenced by different factors like microbial species acquired at birth, host genetics, immunological factors, drugs like antibiotics and nutrition (Bokulich et al., 2016; Yatsunenko et al., 2012; Kashtanova, Popenko, Tkacheva, Tyakht, Alexeev & Boytsov, 2016). Recent studies indicated that physical activity is also one of the main positive modulators of gut microbiota biodiversity. Beneficial effects of exercise on gut microbiota has been supported by investigations performed in animals and confirmed in human studies (Ticinesi, Lauretani, Tana, Nouvenne, Ridolo & Meschi, 2019).

The development and maturation of gut microbiota start in early life. Colonization of the infant gut should begin already during the antenatal period before the delivery (Aagaard, Ma, Antony, Ganu, Petrosino & Versalovic, 2014). After the birth, the infant gut is exposed to complex surrounding environmental and maternal microbiota which begins to colonize the GIT. The development and maturation of gut microbiota are influenced by several intrinsic and extrinsic factors, like mode of delivery, mother's age, diet and metabolic status, type of feeding, family genetics and lifestyle (Rodriguez et al., 2015; Milani et al., 2017). The introduction of solid food to an infant diet changes the microbiota and by the age of three it resembles a relatively stable adult-like profile with a dense microbial population (Milani et al., 2017). In general, changes occur in the elderly population showing a significant decrease in bacterial diversity, especially a decrease in *Bacteroidetes* and an increase in *Firmicutes* (Claesson et al., 2012). Although these may be related to physiological alterations there is now evidence that diet also plays an important role. Dietary factors, particularly carbohydrate and protein intake, are generally considered as the main determinants of gut microbiota composition (Milani et al., 2016).

The preservation of a normal and healthy gut microbiota plays a critical role in maintaining good health, with possible effects on the motility of GIT, conversion of food into useful nutrients, fortification of mucosal barrier, the homeostasis of the immune system, and protection against invasion of pathogenic microorganisms. Microbiota ferments non-digestible dietary residues producing short-chain fatty acids (SCFAs, such as n-butyrate, acetate, and propionate) which modulate the host energy balance increasing the nutrients availability (Samuel et al., 2008). Fermented SCFAs, secreted into the gut lumen, exceed the epithelial barrier and are released into the bloodstream. In this way they reach different organs and are used as substrates for energy metabolism. Hepatocyte cells, in particular, use propionate for gluconeogenesis. SCFAs are involved in the gut-brain axis, stimulating the release of peptide YY (PYY) and 5-hydroxytryptamine (5-HT). They act as signaling molecules to regulate immune and inflammatory responses (Evans, Morris & Marchesi, 2013). N-butyrate regulates neutrophil function and migration, increases the expression of tight junction proteins in colon epithelia, reduces mucosal permeability and inhibits inflammatory cytokines (Nicholson et al., 2012). Beside producing SCFAs, bacterial species of the intestinal microbiota synthesize glycan, amino acids, and vitamins (K, B12, biotin, folate and thiamine), thus participating in the host metabolism (Flint, Scott, Louis & Duncan, 2012).

The recognition of commensal bacteria by toll-like receptors (TLRs) is necessary to stimulate the epithelial cell proliferation, protecting the epithelial surface against gut injury (Akira & Hemmi, 2003). Paneth cells, the secretory cells of the small intestine epithelium, perceive enteric bacteria through TLRs activation and trigger the expression of various antimicrobial factors. This prevents the penetration of pathogenic bacteria over the intestinal barrier (Vaishnava, Behrendt, Ismail, Eckmann & Hooper, 2008). The microbiota is also related to the development of the gut associated lymphoid tissue (GALT), the host immune system stimulating IgA secretion and inhibiting colonization of the GIT by pathogens. Protective functions are performed also by the microbiota through competition with pathogens for nutrients and receptors and the production of antimicrobial molecules to avoid colonization by pathogens (Akira & Hemmi, 2003). Through ligands from commensal bacteria (as lipopolysaccharide, LPS), the gut microbiota influences the mucosal immune system development and function (Rakoff-Nahoum, Paglino, Eslami-Varzaneh, Edberg & Medzhitov, 2004). Furthermore, the innate immune system can also recognize potentially pathogenic microbes through TLRs identification of particular molecules called pathogen associated molecular patterns (PAMP). This leads to an increase in cytokine levels and T-cell activation which are necessary for appropriate immune response to pathogens (Rakoff-Nahoum et al., 2004).

In the present review, we summarize different experimental evidences about the potential mechanisms by which the physical activity might influence the gut microbiota. Besides, we discuss the health benefits of exercise and microbiota diversity.

METHODS

Electronic databases MEDLINE, Science direct and PubMed including the original science articles and reviews, mainly published in the last two years were used to search the literature. Based on the keywords: microbiota, moderate exercise, intensive exercise, gut and health; the role of exercise on microbial composition and benefits to health were described. The search was not restricted to the type of study (i.e., species, meta-analysis, case-control, prospective cohort studies, reviews), sample size, year of publication, publication status or follow-up; however, we only included articles published in English and did not take into account other publications (i.e. conference presentations, abstracts, seminars, doctorate thesis).

RESULTS

Microbiota and Diseases

Physiological gut microbiota variations have huge implications on human health. Alteration of gut microbiota composition, often defined as dysbiosis, is a cause or a consequence of different acute and chronic diseases not limited only to the GIT (Marchesi et al., 2016; Schmidt, Raes & Bork, 2018). Dysbiosis is characterized by reduced bacterial biodiversity, loss of commensals with beneficial metabolic activities and overgrowth of pathogen bacteria (Kriss, Hazleton, Nusbacher, Martin & Lozupone, 2018). This implies a disruption of the mutual equilibrium between gut bacteria and human physiology resulting in the increased intestinal permeability allowing bacteria or bacterial toxins and metabolites to enter into the host circulation and promote subclinical inflammation (Levy, Kolodziejczyk, Thaiss & Elinav, 2017). Dysbiosis reduces the microbial metabolism and the formation of nutrients that the body needs for its proper functioning. Recent studies have linked gut microbiota with different gastrointestinal disorders like inflammatory bowel disease, ulcerative colitis, Crohn’s disease and irritable bowel syndrome (Dieterich, Schink & Zopf, 2018), as well as with metabolic diseases like obesity, diabetes, cardiovascular diseases (Arora & Bäckhed, 2016) and cancer (Garrett, 2015). Alterations in microbiota composition are associated with the onset of autoimmune and allergic diseases including multiple sclerosis, rheumatoid arthritis, systemic lupus erythematosus, psoriasis, atopic dermatitis and food allergies (Tanaka & Nakayama, 2017; McKenzie, Tan, Macia & Mackay, 2017). Gut microbiota dysbiosis may be involved in the pathophysiology of neuropsychiatric disorders (depression, schizophrenia, autism spectrum disorder, dementia, Alzheimer’s and Parkinson’s disease (Ghaisas, Maher & Kanthasamy, 2016; Kim & Shin, 2018), kidney diseases (Knauf, Brewer & Flavell, 2019), osteoporosis (Ohlsson & Sjogren, 2015) and liver cirrhosis (Qin et al., 2014).

Microbiota gut-brain-axis communication mechanism
The role of aerobic exercise

A sedentary lifestyle is associated with a greater incidence of many diseases: cardiovascular, type 2 diabetes, cancer, obesity, and metabolic syndrome. Recently, it has been demonstrated that exercise-induced beneficial modification of the gut microbiota composition is involved in modulation of disease states and modifies host physiology (Choi et al., 2013).

An imbalance diet with high saturated fats, sugar intake, and low fiber consumption in combination with physical inactivity can influence the composition of the microbiota (Proctor, Thiennimitr, Chattipakorn & Chattipakorn, 2017). Poor dietary habits can induce gastrointestinal dysfunction and lead to inflammatory state (Dalton, Mermier & Zuhl, 2019). It has been recently demonstrated that probiotic supplementation improves GI function, many symptoms of inflammatory diseases and psychological and cognition disorders (Dalton et al., 2019).

Regular aerobic physical activity can reduce the risk of several diseases and health conditions and improve the quality of life (Colcombe et al., 2006). Recently, human and animal studies have shown that aerobic exercise increases microbiota diversity altering the bacterial composition and influencing the important metabolites production of gut bacteria, like SCFAs, release and modulation of mucosal neurotransmitters and a brain-derived neurotrophic factor, also known as BDNF (Welly et al., 2016). In this way, aerobic exercise can affect the conditions associated with metabolic diseases, neural and behavioral disorders.

Many evidences suggested an important influence and communication between human gut microbiota and the brain in a bidirectional manner. The brain affects gut microbiota through the autonomic nervous system (the vagus nerve), while gut microbiota influences the brain through neuroendocrine signaling via hypothalamic-pituitary-adrenal axis (HPAA) and neurotransmitter serotonin (5-HT) regulation (Grenham, Clarke, Cryan, & Dinan, 2011; Cryan & Dinan, 2012; Forsythe, Kunze, & Bienenstock, 2016; Dalton et al., 2019).

Disorders in the gut-brain axis functioning are discussed in the pathogenesis of different pathological states (metabolic and inflammatory diseases, psychiatric and depressive disorders, and neurological disorders) (Dieterich et al., 2018).

Vagus nerve activity allows communication between microbiota and brain because it connects the CNS (central nervous system) to ENS (enteric nervous system) and transfers the information from the ENS to CNS that leads to response based on the received information (Forsythe, Kunze, & Bienenstock, 2012). The gut microbiota imbalance can induce CNS inflammatory response. It was demonstrated that a decreased vagus nerve activity is associated with irritable bowel syndrome IBS and many other intestinal inflammations, and depression. This communication is influenced by microbiota metabolites because it has been shown that probiotic supplementation of *Bifidobacterium longum* can modify the functional status of the vagus activity in the gut. (Bercik et al., 2011).

HPA hypothalamic-pituitary-axis regulates physical and mental stressors response and it is influenced by microbiota via a complex of neural immunoregulatory mechanism (Tsigos & Chrousos, 2002). HPA axis is activated by vagus nerve or by metabolites such as LPS from the mucosal layer that promotes the release of inflammatory cytokines that exaggerate HPA activation (Grenham et al., 2011). HPA axis hyperresponsiveness and disturbances in microbiota have been associated with IBS and psychological disorders (Farzi, Fröhlich, & Holzer, 2018).

BDNF acts on neurons of the central nervous system and the peripheral nervous system, promotes the survival of existing neurons, and encourages the growth and differentiation of new neurons and synapses. Recently, it has been shown to be an important regulator of gastrointestinal protein expression and regulation (Dokladny, Zuhl, & Moseley 2015). The probiotic supplements of *Bifidobacterium* improved the HPA response and restored the BDNF levels in rodents (Sudo et al., 2004).

Serotonin (5-HT) is an important neurotransmitter and hormone, it appears to play a key role in maintaining mood and cognition balance, intestinal secretion and motility, and is known as a key signaling molecule in the microbiota-gut-brain axis (O'Mahony, Clarke, Borre, Dinan & Cryan 2015; Jenkins, Nguyen, Polglaze & Bertrand, 2016). Germ free animals' studies demonstrated that microbiota plays a role in serotonin regulation and influences brain and gut function (Clarke et al., 2013; Yano et al., 2015). Other studies showed that *Bacteroides fragilis* supplementation improved control of tryptophan metabolism, the precursor of 5-TH, synthesis and improved GI function (Hsiao et al., 2013).

Exercise and Gut Microbiota

Regular moderate exercise can beneficially affect our body; it can reduce the metabolic and inflammatory disease in both humans and animals. The association between exercise training and alteration in immunity, metabolism and behavior has already been confirmed (Walsh et al., 2011).

Animal Studies

In animals, different forms of exercise, in particular, voluntary and forced, induced different effects on microbiome composition. Many studies with germ-free animals have indicated the relationship between gut microbiota and host function (Choi et al., 2013; Allen et al., 2018). Changes in gut microbiota and its metabolites can affect the structure of the mucus layer and immune system after gut microbiota colonization in germ-free animals. In the study of Allen et al. (2018) it was demonstrated that exercise training induced changes in the gut microbiota community structure of donor mice and caused changes of colon physiology in recipient mice after five weeks of gut microbiota transplant and colonization. Therefore, the gut microbiota composition of recipient mice is dependent of the physical activity level of their respective donor. This indicates that exercise training directly alters the host response by cytokines and gut metabolite production. SCFAs that have been shown to be up regulated after exercise training contribute to enhanced energy harvest and reduce gut inflammation in physically active host (Turnbaugh et al., 2006). The mechanism of this process still needs to be elucidated.

Other studies on animals provided evidence that voluntary exercise training increased the level of host butyrate concentrations and butyrate-producing bacterial genera associated with enhanced early life lean mass (Mika et al., 2015). Since butyrate protects against colon cancer and inflammatory diseases (Monda et al., 2017), it has been proposed that butyrate increase is associated with the colon cancer decrease by exercise (Matsumoto et al., 2008). The mechanism of gut microbiota changes with host increase in SCFAs and butyrate and host decrease in colon inflammation in response to exercise is not fully understood. These data underline the need for future investigation. Although it is certain that voluntary and/or forced exercise altered the gut microbiota composition in animals. It was confirmed that maternal gut microbiota during pregnancy and lactation had effects on offspring gut microbiota in rats. Exercise during pregnancy limited the unfavorable impacts of maternal obesity in offspring, affecting the plasma insulin and glucose concentration (Bhagavata Srinivasan, Raipuria, Bahari, Kaakoush, & Morris, 2018). Others observed that when the exercise started in the juvenile period it modified different bacteria ratio with an increase of *Bacteroidetes* and a decrease in *Firmicutes*. Furthermore, juveniles exercise causes a major change in genera and lead to an increase in lean body mass, suggesting that early life exercise can influence the gut microbiota composition and may favor optimal development of brain function (Mika et al., 2015).

Many authors provide evidence that a routine physical activity is anti-inflammatory and protective against developing the chronic inflammatory disease (Cook et al., 2016).

Human Studies

To date, few studies on humans have indicated a positive influence of exercise on gut microbiota and confirmed the findings of the animal studies.

It has been shown that low-intensity exercise provides a positive effect on the gut by reducing transient stool time and contact time between pathogens and gastrointestinal mucosa layer (Petersen et al., 2017). In this manner, exercise prevents the risk of many diseases such as cancer and other inflammatory diseases. Other possible positive effects of exercise can include an elevated SCFAs and immunoglobulin production, decrease in LPS production and increase in butyrate concentration. The increase of fecal butyrate has anti-carcinogenic and anti-inflammatory properties (Petersen et al., 2017). Exercise-induced changes of microbiota diversity can contribute to reducing obesity and obesity-related complication.

In humans, a major study conducted on 86 elite rugby athletes compared to high and low BMI controls, showed a greater gut microbiota richness/diversity in rugby players (Clark et al., 2014). The increased microbial diversity was positively correlated with protein consumption and creatinine kinase levels, suggesting that both, diet and exercise are drivers of biodiversity in the gut.

In addition, cardiorespiratory fitness (CRF), an indicator of physical fitness has been positively correlated with microbial diversity in 39 healthy individuals, especially in taxa that augmented the production of butyrate, a gut health indicator (Estaki et al., 2016). The authors of this study recommended that exercise could be prescribed in combating dysbiosis-associated diseases.

In the pilot study by Peterson et al. (2017), the microbiota of 22 professional and 11 amateur competitive cyclists was studied. They demonstrated that gut microbiota profiles of professional cyclists differed from amateur control and found a correlation between certain microorganisms in professional cyclists and high exercise load. This study indicates that exercise load alters the bacterial community structure.

Although the human study in this field is still scarce, previous animals and humans study showed the effects of exercise on microbiota regardless of diet. Murtaza and collaborators examined the effects of different dietary programs during intensified training on stool microbiota of elite endurance athletes (race walkers). This study revealed that dietary patterns exert an impact on gut microbiota profiles. In particular, a ketogenic low carbohydrate, high-fat diet was found to induce alterations in abundances of some bacteria species (Murtaza et al., 2019). Other longitudinal studies are needed to examine the effect of diets and gut microbiome on athlete training and performance.

The health benefits of physical activity in older adults have been established in more scientific studies. Recently, data demonstrated the association between physical exercise and gut microbiota diversity in the elderly (Jackson et al., 2016). Authors of many studies reported that gut microbiota composition is less different in some conditions, such as in hypertensive patients and in patients with obesity-associated inflammation and gastrointestinal diseases (Monda et al., 2017; Taniguchi et al., 2018). Exercise can modulate the gut microbiota diversity and could have positive effects on the pathogenesis of mentioned conditions. Since lower inflammation was shown in athletes, it is possible that exercise in older adults could decrease inflammatory markers. Exercise determined changes in microbial composition were correlated with the duration of physical activity. It was recently confirmed that short-term endurance exercise has little effect on gut microbiota composition and diversity in elderly men, but mentioned little changes in the microbiota which were associated with lower cardiometabolic risk factors (Taniguchi et al., 2018). The study suggests that the gut microbiota is influenced by high-intensity interval training and diet and might play a crucial role in modulating CV disease development (Juneau, Hayami, Gayda, Lacroix & Nigam 2014).

Interestingly, a study by Tan et al. (2013) revealed that diet and exercise improved sleep quality and changes in gut microbiota composition in subjects with obesity-related disorders.

All these data highlight the need for future investigation in humans to elucidate how the moderate and rigorous physical activity induces changes in microbiota diversity, composition and function having beneficial effects on human health.

Table 1 summarizes articles that have investigated the role of exercise on gut microbiome in humans.

Table 1: Association between exercise and gut microbiota.

Authors	Subjects	Type of exercise	Results
Clark et al., 2014	Elite athletes and controls	Rugby	Bacterial diversity was higher in athletes than in control.
Estaki et al., 2016	Healthy participants with similar age and BMI	Cardio	Butyrate production
Petersen et al., 2017	Professional and amateur cyclists	Cycling	Exercise load influence the bacterial community
Taniguchi et al., 2018	Patients	Moderate/ vigorous	Decrease inflammation

CONCLUSION

The existing study data indicate that exercise can induce alterations in gut microbiota composition with beneficial effects for the host. Exercise improves microbiota diversity, maintenance of normal gut physiology and contributes to reducing inflammatory markers in different pathological states. Furthermore, exercise stimulates the production of metabolites such as butyrate and SCFAs, protecting us against GI disorders and colon cancer. This may explain why exercise can be a therapeutic strategy during treatment for many disorders in particular psychological and GI diseases. Nevertheless, further studies are needed to understand the mechanisms responsible for these effects. Further exploration is required to understand how physical activity and diet independently influence health. In the future, exercise prescription may hopefully contribute to our health status through the modification of gut microbiota.

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CAN EXERCISE MAKE OUR CHILDREN SMARTER?

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ABSTRACT

Purpose. *The aim of this study is to reveal the effects of exercise on the brain structure and function in children, and to analyze methodological approach applied in the researches of this topic.*

Methods. *This literature review provides an overview of important findings in this fast-growing research domain. Results from cross-sectional, longitudinal, and interventional studies of the influence of exercise on the brain structure and function of healthy children are reviewed and discussed.*

Results. *The majority of researches are done as cross-sectional studies based on the exploring correlation between the level of physical activity and characteristics of brain structure and function. Results of the studies indicate that exercise has positive correlation with improved cognition and beneficial changes to brain function in children. Physically active children have greater white matter integrity in several white matter tracts (corpus callosum, corona radiata, and superior longitudinal fasciculus), have greater volume of gray matter in the hippocampus and basal ganglia than their physically inactive counterparts. The longitudinal/interventional studies also showed that exercise (mainly aerobic) improve cognitive performance of children and causes changes observed on functional magnetic resonance imaging scans (fMRI) located in prefrontal and parietal regions.*

Conclusion. *Previous researches undoubtable proved that exercise can make positive changes of the brain structures in children, specifically the volume of the hippocampus which is the center of learning and memory. Finally, the researchers agree that* *the most influential type of exercise on changes of brain structure and functions are the aerobic exercises.*

Keywords: *physical activity, cognition, brain, children.*

LAHKO OTROCI Z VADBO POSTANEJO PAMETNEJŠI?

IZVLEČEK

Namen: *Namen te študije je razkriti učinke telesne vadbe na možgansko strukturo in delovanje pri otrocih ter analizirati metodološki pristop, uporabljen v raziskavah s tega področja.*

Metode: *S pregledom literature smo izpostavili pomembne ugotovitve na tem hitro rastočem področju raziskav. Obravnavali smo rezultate intersekcionalnih, longitudinalnih in intervencijskih študij vpliva vadbe na možgansko strukturo in delovanje zdravih otrok.*

Rezultati: *Večina raziskav je izvedenih kot intersekcionalne študije, ki temeljijo na raziskovanju povezanosti med telesno aktivnostjo in značilnostmi možganske strukture in funkcije. Rezultati študij kažejo, da je telesna vadba pozitivno povezana z izboljšano kognicijo in koristno vpliva na spremembe delovanja možganov pri otrocih. Fizično aktivni otroci imajo povečano aktivnost bele snovi v več traktih bele snovi (corpus callosum, corona radiata in zgornji vzdolžni fascikul), imajo tudi več sive snovi v hipokampusu in bazalnih ganglijih kot otroci, ki so fizično neaktivni. Longitudinalne / intervencijske študije so pokazale tudi, da vadba (predvsem aerobna) izboljša kognitivno delovanje otrok in povzroči spremembe v prefrontalnem in parietalnem področju, ki se jih opazi pri slikanju z magnetno resonanco (fMRI).*

Zaključki: *Predhodne raziskave so nesporno dokazale, da lahko telesna vadba pozitivno spremeni možganske strukture pri otrocih, zlasti volumen hipokampusa, ki je središče učenja in spomina. Raziskovalci se strinjajo, da imajo aerobne vaje največji vpliv na spremembe možganskih struktur in funkcij.*

Ključne besede: *gibalna/športna aktivnost, kognicija, možgani, otroci*

INTRODUCTION

Physical activity of children has benefits not only to physical health and fitness but to cognitive and brain health as well. Many studies suggest that exercise can increase the brain volume of the children, make positive changes in structure and function of brain, improve their cognitive abilities and academic achievements (Hillman et al., 2009). Further research of relation between physical activity and brain is a very prospective area that could give one a new dimension in the studies of exercise and training. Having acquired strong scientific evidences of the influences of exercise and physical activities on the brain of children we can envisage a new approach in creating physical education curriculums aimed to develop not only physical abilities but also their cognitive side. The greatest influence of physical exercise has been observed in the domain of executive functions, which are of the great importance for performing daily activities, for the ability to adapt behavior in children, their intellectual functioning and success in performing tasks at school (Tomporowski, McCullick, Pendleton, & Pesce, 2015). Exercise has beneficial effects for the mind, it increases attention and cognitive control, it improves emotional responsivity, it enhances short and long-term memory (Chaddock, Pontifex, Hillman, & Kramer, 2011; Hillman, Erickson, & Kramer, 2008). These functional improvements have a strong neurophysiological foundation based on the process of neuronal growth or neurogenesis (Kobilo et al., 2011). It is obvious that the brain is not a static but a very dynamic organ designed to change in response to experience. This ability of the brain to change his structure and function across the lifespan is known as neuroplasticity. Neuroplasticity of brain as the characteristic of adaptation and modification of brain structures in accordance to requirements of environment and some physical activities is very important (Myer et al., 2015). Brain cortex is especially susceptible to such requirements and responsible for the neuroplastic adaptations. The process of neuroplasticity can be explained by the rule that “neurons that fire together wire together” which means that frequent joined firing of neighboring neural cells leads to strengthening and preserving the synapses (Mundkur, 2005).

The major effects of exercise occur within two regions of brain: subventricular zone of the lateral ventricle and dentate gyrus in the hippocampus, but also some research suggest that exercise can affect prefrontal cortex (Verburgh, Königs, Scherder, & Oosterlaan, 2014). The subventricular zone is one of two regions where neurogenesis persists in the postnatal brain. The subventricular zone, located along the lateral ventricle, is the largest neurogenic zone in the brain that contains multiple cell populations including astrocyte-like cells and neuroblasts (Lacar, Young, Platel, & Bordey, 2010). Hippocampal dentate gyrus is another location where neurogenesis induced by physical exercise can occur. Studies carried out on animals shown that exercise causes specific granule cells in the dentate gyrus with longer and more complex dendritic arborizations in comparison to control animals which were not subject to exercise (Arida, Scorza, da Silva, Scorza, & Cavalheiro, 2004). The third part of the brain that can be affected by exercising is the prefrontal cortex. Prefrontal cortex is the part of the brain located in the most frontal part of the brain lobe and makes about 10 percent of the total brain volume (Murray, Wise, & Graham, 2017). The functions of the prefrontal cortex are numerous, but the executive function of this part is the most dominant (Koechlin, Basso, Pietrini, Panzer, & Grafman, 1999; Wharton, & Grafman, 1998). Different authors define executive function in a different way but generally all definitions emphasize control of short-sighted, reflexive behaviors in decision making, planning, solving some problems, dealing with some long-term aims, self-control, and attributes this functions to the region of prefrontal cortex (Koechlin, Basso, Pietrini, Panzer, & Grafman, 1999). Prefrontal cortex is considered as the part of the brain important for the ability to learn. Each new input will be processed in prefrontal cortex before making the final decision (Spitzer, & Hollmann, 2013).

The first studies of changes in brain structure and its function were performed on animals, mainly rodents, but in the last decade there have been plenty of researches carried out on humans proving the positive effects of exercise on the human brain too. The interest of scientists about the relation of exercise and brain functions date back to the second half of 20th century but the application of contemporary diagnostic methods of structural and functional changes in brain gave new quality to the research of this relationship. The pioneer researches were inspired by a strong desire to preserve the brain functions of elderly, aiming to find the most effective tool in fight against the brain diseases related to the loss of memory such as Alzheimer and sclerosis (Radak et al., 2010). Their findings confirm that exercise can reduce the risk of various neurological diseases and protect the brain from detrimental factors of aging and cognitive decline (Bherer, 2015). Studies that compare the cognitive performance between younger and older participants observed reduced cognitive capacities in older, but the difference were lesser if the older participants were fitter, especially if they possess higher level of cardiorespiratory fitness (Hillman, Weiss, Hagberg, & Hatfield, 2002; Renaud, Bherer, & Maquestiaux, 2010). Longitudinal studies carried out on the older participants reported that persons who participated in any type of regular exercise showed less cognitive decline especially when they exercise vigorously more than once a week (Barnes, Yaffe, Satariano, & Tager, 2003; Aichberger et al., 2010).

The aim of this study is to reveal the effects of exercise on the brain structure and function in children, and to analyze methodological approach applied in the researches of this topic. There is an increasing number of researches that prove positive effects of exercise on the cognition of children and their academic achievements and a need for a comprehensive review of published scientific literature is necessary to support this relatively new line of studies.

DISCUSSION

Exercise and White Matter

The majority of researches are performed as cross-sectional studies based on the exploring correlation between the level of physical activity and the characteristics of brain structure and function. The study results indicate that exercise has positive correlation with improved cognition and beneficial changes to brain function in children (Lees & Hopkins, 2013). Physically active children have greater white matter integrity in several white matter tracts (corpus callosum, corona radiata, and superior longitudinal fasciculus), they have greater volume of gray matter in the hippocampus and basal ganglia than their physically inactive counterparts (Erickson, Hillman, & Kramer, 2015; Chaddock et al., 2010b). Corpus callosum is the primary connection between the hemispheres and with more than 190 million axons is the largest white matter tract (Muetzel et al., 2008). The role of corpus callosum is integration of sensory, motor and cognitive processes between hemispheres (Hinkley et al., 2012). Underdeveloped corpus callosum is related to low cognitive function and intelligence, processing speed and problem-solving abilities, even to autism and similar syndromes (van Eimeren, Niogi, McCandliss, Holloway, & Ansari, 2008). Physical activity and exercise lead to increased white matter microstructure of corpus callosum in children (Chaddock-Heyman et al., 2018). Scientists explain that this increase is caused by the exercise which causes more tightly bundled and structurally compact fibers, and increased myelination (Chaddock-Heyman et al., 2018). These results have been obtained from a study including 7- to 9-year-old children who were involved in after-school physical activity programme based on moderate to vigorous physical activities 5 days per week for 9 months.

Importance of Duration and Intensity of Exercise for Changes in Brain Structure and Function

The longitudinal/interventional studies also showed that exercise, mainly aerobic, improves cognitive performance of children and causes changes observed on functional magnetic resonance imaging scans (fMRI) located in prefrontal and parietal regions (Li et al., 2014). Positive changes in brain structure and function are highly dependent on the intensity and duration of exercise. Some studies support the fact that cognitive functioning can be improved with short periods of physical exercise (Hancock & McNaughton, 1986) but many other studies did not find such effects (Cian, Barraud, Melin, & Raphel, 2001; Isaacs & Pohlman, 1991). Short and very intensive exercise with duration not longer than 10 minutes cannot initiate any change in perception, sensory integration or visual discrimination (Fleury, Bard, Jobin, & Carrière, 1981), but physical exercise of moderate intensity and duration can improve significantly brain functions of children. The recommendations of researchers for exercise that can have the highest positive effects on the structure and function of brain are 20 to 40 minutes with sub-maximal intensity i.e. heart rate of about 60 to 70 % of maximum (Ellemberg & St-Louis-Deschênes, 2010). A study from 1979 (Gabbard & Barton, 1979) found that children improved their mathematical skills on test only after 50 minutes of physical activity and not after 20, 30 or 40 minutes. However, one of the newer studies shows benefits of cognitive functions even after 30 minutes of activities (Ellemberg & St-Louis-Deschênes, 2010).

Influence of Exercise on Brain Blood Supply and Angiogenesis

Some of the oldest explanations regarding the improvement of brain functions and structure as a consequence of exercise were based on the improvement of brain blood supply through improved blood circulation. Exercise stimulates the process of angiogenesis and the development of vascular network within the brain. This development leads to a significant improvement of oxygen concentration and a better supply of other important neurochemical substances that improve cognition. Physical activity increases perfusion, and angiogenesis directly increases the perfusion of the brain which is a good foundation for facilitating neuroplasticity and branching neural networks and synaptic connections (Konopka, 2015). This completely rational explanation is based on augmentation of the level of serotonin, dopamine and norepinephrine after the exercise (Querido & Sheel, 2007; Vaynman & Gomez-Pinilla, 2005). Serotonin is associated with memory storage and retrieval, and dopamine and norepinephrine with attention. The stated increase of the level of the cathecholamines that improve cognitive performances can be initiated by exercise.

Influence of Age and Maturity on the Brain Changes Caused by Exercise

Researches considering the difference of effects of exercise on brain structure and function dependent on the age and maturity of children show that the greatest influence can be achieved in the age ranges of 4-7 and 11-13 years, compared with the age ranges of 8-10 and 14-18 years (Sibley & Etnier, 2003). Those are the periods of the intensive growth and development of children and are considered as sensitive periods that “open the gates” for a greater influence of exercise on brain, even the possibility of positive effects of exercise across the whole lifespan are absolutely confirmed (Hillman et al., 2008).

Development of the brain imaging techniques (Electroencephalography – EEG, Positron emission tomography – PET, Magnetic resonance imaging – MRI, Functional magnetic resonance imaging – fMRI) ensured the possibility to determine the changes caused by exercise within the specific regions of the brain and to locate the most intensive changes. Researches that follow a positive deflection in a stimulus-locked event-related potential (ERP) that reflects the changes in the neural representation of the stimulus environment and to the amount of attention that is required to encode a given stimulus (amplitude) as well as the speed of stimulus evaluation (latency) has shown changes generated by a network of neural structures in frontal lobe, the anterior cingulate cortex, infero-temporal lobe and the parietal cortex (Hillman et al., 2008). These regions of brain are highly activated in cognitive operations and processing stimulus, as well as in memorizing. Physical activity has a strong influence on spectral frequency activation, especially on P3 component of the event-related potential (ERP). The registered changes in P3 component of ERP could be explained by the changes in network of neural structures within the frontal lobe, anterior cingulate cortex, infero-temporal lobe and the parietal cortex. Larger amplitude and shorter latency of positive deflection in a P3 stimulus-locked event-related potential (ERP) are observed across a variety of intellectual tasks in participants with higher aerobic performances (Li et al., 2014). This research proves the positive relationship between higher level of physical activity or aerobic fitness and cognitive processing (Polich, 2004).Greater amount of physical activity directed towards the aerobic fitness development is beneficial for faster cognitive processing. These evidences could be important for raising smarter children. Researhes that involve MRI as a technique of tracking the changes of brain structures by imaging showed that higher levels of fitness and fitness improvement are related to larger volumes of prefrontal and temporal grey matter, as well as anterior white matter, which are the structures highly related to the intelectual performances (Chaddock-Heyman et al., 2018).

Exercise and Neurogenesis

For decades it has been thought that nerve cells can be produced exclusively during the embryonic period and early childhood, however, it is still unclear whether this is true, even more so, numerous researches have been performed in recent decades that support the hypothesis that neurogenesis is possible even in the adulthood (Cameron & McKay, 2001). The process of neurogenesis produces thousands of new neurons every day (Cameron & McKay, 2001). Most of these new neural cells are produced in the hippocampal formation which is highly responsive to the physical training and exercise (Curlik & Shors, 2013; Chaddock et al., 2010a; Khan & Hillman, 2014). One of the most influential external factors is aerobic exercise because it causes a large increase in the number of cells that are produced. This effect was revealed in the research dating from 1999 (van Praag, Kempermann, & Gage, 1999) when the authors applied two weeks of daily voluntary exercise which caused an increase in the number of new cells by fifty percent with the greater increase in the dentate gyrus. Steiner, Murphy, McClellan, Carmichael, and Davis (2011) reported that just one day of exercise can lead to a significant increase of the number of cells produced.

Meta-analysis of McMorris & Hale (2012) explained the influence of different exercise intensities (low, moderate, heavy) on cognitive performance. The authors of this study also monitored three moderator variables such as the timing of testing (during vs. post exercise), task complexity (central executive task vs. recall and attention/alertness tasks), and protocol issue, the use of counterbalancing/randomization of testing (counterbalanced/random testing vs. pre-exercise testing followed by during or post-exercise testing). The need for monitoring the time of testing is drawn from the hypothesis of catecholamines realization which occurs during, and even immediately before the exercise when hypothalamus and brainstem initiate the reaction of the sympathoadrenal system. This reaction realizes the catecholamines at the postganglionic cells of those neurons that require activating or inhibiting. With an increase of the intensity of exercise there is also epinephrine and norepinephrine are released in lesser quantity. The realized hormones catecholamines, dopamine and norepinephrine have an important role in brain functioning activating primary motor cortex, premotor cortex and supplementary motor area during exercise (McMorris & Hale, 2012). The increases of brain concentrations of catecholamines during and following a moderate intensity exercise should facilitate cognition. With increases of intensity of exercise, the quantity of the realized catecholamines increase and lead to neural noise which could inhibit performance (Arnsten & Goldman-Rakic, 1985).

Exercise and Brain Growth Factors

Another possible influence of exercise on brain is related to the increased concentrations of the brain-derived neurotrophic factor (BDNF) (Ferris, Williams, & Shen, 2007; Goekint et al., 2008; Tang, Chu, Hui, Helmeste, & Law, 2008), insulin-like growth factor 1 (IGF-1) and vascular endothelial-derived growth factor (VEGF). These three growth factors belong to the group of neurotrophins that are important for the development and maintenance of neural cells in the brain. BDNF is the major mediator of the impact of aerobic exercise on hippocampal neuroplasticity and functioning (Cotman, Berchtold, & Christie, 2007). Effects of exercise on learning is mostly regulated by IGF-1 and BDNF. The stimulation of angiogenesis and hippocampal neurogenesis caused by exercise is regulated by IGF-1 and VEGF (Cotman et al., 2007). One of the recent studies shows that BDNF is crucial for hippocampal function, synaptic plasticity, learning and modulation of depression (Kuipers & Bramham, 2006). The level of BDNF in different regions of brain can increase by exercise. The greatest increase of BDNF occurs in the hippocampus, and after a few days of regular exercise BDNF production is increased in all hippocampal subfields. This increase of BDNF can be maintained for weeks with regular exercising (Berchtold, Chinn, Chou, Kesslak, & Cotman, 2005). Similar to the increase of BDNF, exercise can influence the increase of IGF-1 in hippocampal neurons and this level can last several days after the exercise. Exercise induces a rapid increase of peripheral circulating levels of IGF-1 which is the key factor of exercise-induced neurogenesis and improved memory (Trejo, Carro, & Torres-Aleman, 2001; Ding, Vaynman, Akhavan, Ying, & Gomez-Pinilla, 2006). Some studies consider BDNF and IGF-1 as exercise-induced mediator that has the main impact on behavioral improvements, while the exercise-induced neurogenesis and angiogenesis are regulated predominantly by mutual influence of IGF-1 and vascular endothelial-derived growth factor (VEGF). These two growth factors increase their levels by exercise in the periphery and cross the blood-brain barrier to enter the brain (Trejo et al., 2001; Fabel et al., 2003; Lopez-Lopez, LeRoith, & Torres-Aleman, 2004).

CONCLUSION

The examined researches undoubtedly proved that exercise can make positive changes of the brain structures in children, specifically the volume of the hippocampus which is the center of learning and memory. Changes are also associated with greater dorsal striatum volumes and these changes lead to a better cognitive control. Comprehensively observed, the influence of exercise on brain can be described on molecular, cellular, behavioral and systems level. The researches conducted to date do not give a completely clear picture of the necessary volume and intensity of exercise, as well as the type of exercise that can induce the greatest effect on the brain in children. The researchers could agree that the most influential type of exercise on the changes of brain structure and functions are aerobic exercises, especially if performing they require some cognitive deliberation and a higher level of attention. Such exercises can lead to a greater volume of parts of the brain responsible for memory and process of thinking in children which all together leads to a successful raising of smarter children. Also, the recommended duration of such aerobic exercise is between 20 and 40 minutes. Further randomized control studies are necessary to discover the influences of different types of exercise and different intensities and volumes of exercise on brain structure and function.

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NUTRITIONAL INTAKE OF SLOVENIAN SEMI-PROFESSIONAL HANDBALL PLAYERS

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ABSTRACT

Aim: *Handball is a highly popular team sport, both in Slovenia and globally. The performance during team sport matches is influenced by numerous factors, amongst others there is nutrition whose influence is lesser known, particularly since diet is often uncontrolled. The purpose of this paper is to investigate whether Slovenian handball players, on basis of their anthropometric data and nutritional recommendations, have adequate nutritional intakes of energy and macronutrients.*

Methods: *Two Slovenian handball teams with male and female players (17 males and 9 females) who are part of the 1A national league, were assessed through a 7-day food diary to define their nutritional intake in three different conditions for males (on their training days, match days and days off) and in two conditions for females (on their training days and days off). Basal anthropometric data were measured by standard methods and the body composition by a bioelectrical impedance scale. The results were statistically analysed with IBM SPSS programme, using the repeated measures ANOVA model.*

Results: *Both female and male handball players show insufficient amounts of energy intake, based on the most recent nutritional intake recommendations for team sports. Moreover, the intake of carbohydrates is too low for both female and male handball players, and the intake of fat is too high.*

Conclusion: *The analysis of the initial nutritional intake and the comparison with the recommendation shows that the male handball players do not have an optimal diet with proper intake of both energy and macronutrients. The energy intake is insufficient* *also in female players. Adjusting the nutritional intake in a way to make it more balanced and tuned to the training schedule, would support a better health and performance.*

Keywords: *energy intake, macronutrients, nutrition, body composition, handball, team sport.*

PREHRANSKI VNOS ENERGIJE PRI SLOVENSKIH POLPROFESIONALNIH ROKOMETAŠIH IN ROKOMETAŠICAH

IZVLEČEK

Namen: *Rokomet je eden od bolj razširjenih ekipnih športov v Sloveniji in svetu. Tako kot na vse druge športe, tudi na rokomet vplivajo številni dejavniki. Eden izmed njih je tudi prehrana. Namen raziskave je ugotoviti ali imajo slovenski rokometaši ustrezen vnos energije in makrohranil.*

Metode: *V raziskavi sta sodelovali 2 rokometni ekipi 1.a slovenske lige, sodelovalo je 26 rokometašev in rokometašic (17 moških in 9 žensk). Podatke o prehranskem vnosu pri rokometaših in rokometašicah smo v treh različnih okoliščinah (na dan treninga, na dan tekme in na prost dan) zbirali 1 teden. Prehranski vnos smo ocenili z metodo prehranskega dnevnika, telesno sestavo smo izmerili z bioimpedančno tehtnico. Podatke smo obdelali v računalniškem programu IBM SPSS, uporabili smo model ANOVA.*

Rezultati: *Tako rokometaši kot tudi rokometašice nimajo zadostnega energijskega vnosa. Nadalje, oboji imajo prenizek vnos ogljikovih hidratov ter previsok vnos maščob.*

Zaključki: *Ugotovili smo, da rokometaši, ki so sodelovali v raziskavi, nimajo optimalne prehrane z ustreznim vnosom energije in makrohranil, ki bi podpirala njihovo zdravje in zmogljivost. Tudi energijski vnos pri rokometašicah je prenizek. S prilagoditvijo prehrane svojim potrebam, bi lahko rokometaši dosegali boljše rezultate na treningu in tekmah.*

Ključne besede: *energijski vnos, makrohranila, prehrana, telesna sestava, rokomet, moštveni šport.*

INTRODUCTION

An athlete's performance is dependent on many different factors, one of them is nutrition (Thomas, Erdman, & Burke, 2016). Nutritional habits are not permanent and athletes generally adapt their intake to the training periodization (Thomas et al., 2016), with specific athletes adopting specific nutritional strategies. The benefits of adequate nutrition are multiple and lead to better training and performance and quicker recovery, while having lower risk of illness or injury (International Olympic Committee, 2011; Kreider et al., 2010; Rodriquez, DiMarco, & Langley, 2009).

On the other hand, athletes might adhere to diets that do not always meet their energy and nutrient requirements (Spronk, Heaney, Prvan, & O'Connor, 2015). A recent systematic literature review, showed that especially team sport athletes do not meet the dietary recommendations (Jenner, Buckley, Belski, Devlin, & Forsyth, 2019). This review emphasizes the need for sport-specific dietary recommendations for both professional and semi-professional players. Further, it was observed that the recommendations were fulfilled or exceeded for protein and or fat intake, but that the recommendations for both energy and carbohydrates, generally, were not met (Jenner et al., 2019).

Handball is a highly popular team sport in Slovenia and widely practiced on both professional and semi-professional levels, but it is not known whether Slovenian handball players meet the recommendations for nutritional intake. The aim of this paper was to evaluate whether the nutritional intakes in Slovenian handball players meet the recommendations. Thus, we did a literature search to establish the current sport-specific recommendations, and to make a comparison with the actual food intake, we measured the anthropometric and body index parameters and recorded the food intakes for one week of two semi-professional handball teams, both males and females.

METHODS

Participants

The survey was conducted in Koper, Slovenia among two semi-professional national handball clubs (a male team of the Rokometno društvo Koper 2013, and a female team of the Žensko rokometno društvo Koper), which included 26 players in total (17 males and 9 females).

Data Collection

The anthropometric properties of the handball players were measured through standard methods at the University Kinesiology Centre in Koper. Body weight and body composition were measured with a Tanita MC-980 bioimpedance scale (Tanita Corporation Co., USA) and body height with a standardized meter. All anthropometric measurements were made in the morning.

After receiving the ethical committee approval, the subjects recorded their food and fluid intake for 7 days, one microcycle (a week of training). The food intake data were collected for both male (on training days, match days and days off) and female (training, days off) handball players from March 29 to April 4, 2016.

The individual dietary logs provided detailed information on food intake. For male players we collected information on food intake for 4 days of training, 1 match day and 2 days off. For female players we collected information on food intake for 5 days of training and 2 days off. For all specific days (training, match or days off) we calculated average values (where that was possible). Food diaries were processed using the online tool for monitoring eating habits: Open Platform for Clinical Nutrition (abbreviated as OPKP in Slovenia). At the training and preparatory match days, the researchers were present to ask the participants to promptly submit their written diaries.

The trainers of the teams provided the training schedule. Hence, it was possible for the researcher to record the time of active participation during the match and also during the training. This information was used to accurately estimate the energy requirements of each individual player.

The total energy expenditure requirements (TEEs) were calculated as the sum of the energy needs arising from the resting metabolism, the energy requirements for off-training physical activity level (PAL), and the energy training requirements.

The resting energy expenditure (REE) was calculated by the predictive equation given by Cunningham et al. (1980): RMR = 500 + (22 x fat free mass in kg), based on the individual's fat free mass (FFM).

Recommendations for individual's daily energy intake, the recommended daily energy intakes (RDEIs) were calculated from the following formulas (both in kcal):

RDEI for training days and match days = REE × 1.4 + (MET × body mass × h);

RDEI for days off = REE × 1.6,

using the PAL of 1.4 for training days and match days (which covers all daily activities outside the training or match (Debeljak, Debeljak, Hlastan-Ribič, Salobir, & Pokorn, 2004), and 1.6 for days off (Debeljak et al., 2004). On the day of training and match, the value was multiplied by the metabolic equivalent (MET, defined as the metabolic energy expenditure for sitting quietly, Ainsworth et al. 2011), with a value of 8 for training days and 12 for match days, to capture the energy need for 90 minutes of training or match, respectively (Ainsworth et al., 2011).

Statistical Analysis

The food diaries data were statistically processed in Microsoft Office Excel 2013 and IBM SPSS Statistics for Windows, version 22.0 software (IBM Corp, Armonk, New York, USA, 2013). Basic statistical methods (i.e., descriptive statistics) were used to compare the group characteristics. For independent samples, the statistical analysis of variance (ANOVA) for repeated measurements and post-hoc tests (Tukey LSD post-hoc comparison) were used. A p value less than 0.025 was considered statistically significant.

RESULTS

Characteristics of the Subjects

Tables 1 and 2 show the anthropometric values of male and female handball players respectively. The tables show the average data and standard deviations of age, height, body mass (BM), body mass index (BMI), estimated percentage of body fat, fat free mass (FFM), and visceral fat level for both genders, as well as specified for the handball players' playing position.

For men, the left and right backs are the tallest players with an average height of 191.0 centimeters, followed by the line players with an average height of 187.8 centimeters, then goalkeepers with an average height of 187.0 centimeters, centre-back players with an average height of 183.5 cm. While the smallest in height are the wing players with an average of 177.5 cm.

The line players have the highest percentage of fat among the male handball players (18.6%), followed by left and right backs (16.9%), then centre-back players (16.7%), followed by goalkeepers (14.4%), while the left and right wings have the lowest fat percentages (12.4%). In the present male handball players, the largest FMM was observed in the backs (78.2 kg), followed by the line players (76.4 kg). Goalkeepers and wings had similar amounts of FFM (71.6 kg). The centre-back players had the smallest amount of FFM (70.7 kg).

Regarding the height of the female players, the line player was the tallest (178.3 cm), followed by the back players (177.7 cm), then the goalkeepers (174.1 cm), the wing player (167.8 cm), and the shortest was the centre-back player (165.0 cm). Further, the female players reported the largest percentage of body fat among the wing players (32.3 %), followed by the goalkeepers (29.3%), then the line player (23.5%), and the back players (23.1%), while the centre-back player had the lowest percentage of body fat (22.7%).

Table 1: Anthropometric properties of male players by playing position.

Variable	Goalkeeper (n = 4)	Wing left/right (n = 2)	Back left/right (n = 5)	Centre back (n = 2)	Line player (n = 4)	Total (n = 17)
Age (years)	20.8 ± 3.6	25.5 ± 7.8	21.6 ± 5.5	24.0 ± 1.4	21.3 ± 3.3	22.1 ± 4.3
Height (cm)	187.0 ± 6.7	177.5 ± 0.7	191.0 ± 5.0	183.5 ± 2.1	187.8 ± 5.1	186.8 ± 6.1
Body mass (kg)	84.8 ± 6.4	89.0 ± 6.0	96.4 ± 5.8	84.4 ± 5.9	92.2 ± 3.5	90.4 ± 6.9
BMI (kg/cm2)	25.4 ± 3.4	28.2 ± 1.7	26.5 ± 2.0	25.1 ± 2.3	26.2 ± 0.7	25.9 ± 2.3
Body fat (%)	14.4 ± 5.7	12.4 ± 2.6	16.9 ± 1.4	16.7 ± 0.8	18.6 ± 1.8	16.2 ± 3.5
Fat free mass (kg)	71.6 ± 1.0	71.6 ± 1.3	78.2 ± 4.9	70.7 ± 5.1	76.4 ± 5.8	74.9 ± 5.1
Visceral fat (%)	2.5 ± 3.0	2.0 ± 1.4	3.00 ± 1.6	4.0 ± 0.0	3.8 ± 1.3	3.1 ± 1.8

Data are means with their standard deviation.

Table 2: Anthropometric properties of female players by playing position.

Variable	Goalkeeper (n = 3)	Wing left/right (n = 1)	Back left/right (n = 3)	Centre back (n = 1)	Line (n = 1)	Total (n = 9)
Age (years)	20.0 ± 1.0	23	22.0 ± 1	20	28	21.9 ± 2.7
Height (cm)	174.1 ± 8.3	167.8	177.7 ± 7.3	165.0	178.3	174.1 ± 7.2
Body mass (kg)	75.1 ± 4.6	80.1	68.9 ± 9.3	62.5	68.4	71.5 ± 7,.4
BMI (kg/cm^2)	24.9 ± 2.6	28.4	21.8 ± 2.9	22.7	21.6	23.7 ± 3.0
Body fat (%)	29.3 ± 2.5	32.3	23.1 ± 5.4	22.7	23.5	26.2 ± 4.8
Fat free mass (kg)	53.1 ± 3.9	54.2	52.7 ± 3.4	48.3	52.3	52.5 ± 3.1
Visceral fat (%)	2.0 ± 1	4.0	1.3 ± 0.6	1.0	1.0	1.8 ± 1.1

Data are means with their standard deviation.

Energy and Macronutrient Intakes

Recommended Energy and Macronutrient Intakes

For handball players, there are no specific recommendations for energy and macronutrient intake available from the literature. However, we calculated the average RDEIs for training days, match days and days off from the individual FFM of each male player. These amounted to: 4054 ± 248 kcal; 4587 ± 289 kcal; 3413 ± 193 kcal for training days, match days and days off, respectively. These calculated RDEIs showed significant differences between the days (F=1703,75; p <0,025).

For the female handball players included in this study, the RDEI for training days was 3173 ± 176 kcal and for days off 2646 ± 108 kcal, respectively. For match days we calculated: 3602 ± 218 kcal. The calculated RDEIs showed significant differences between training days, match days and days off (F=539,97; p <0,025).

In general, the recommendations for nutrient intake are not specifically listed for various sports activities, and, with the exception of specific micronutrients, do not mention any specific distinctions between the genders (Burke, Hawley, Wong, & Jeukendrup, 2011; Campbell et al., 2007; Rodriquez et al., 2009; Thomas et al., 2016). Thus, the nutritional recommendations for handball stated here, are presumed to be in a similar range as the recommendations that are mentioned for similar team sports activities like football, basketball, volleyball, and others. The fat intake is recommended to amount to 20−35% of the daily energy intake (American Dietetic Association et al., 2009; Rodriquez et al., 2009). For carbohydrates, it is recommended to consume 6-10 g/kg BM/day (Burke et al., 2011; American Dietetic Association et al., 2009; Rodriquez et al., 2009), while for proteins 1.4-1.6 g/kg BM/day (Campbell et al., 2007).

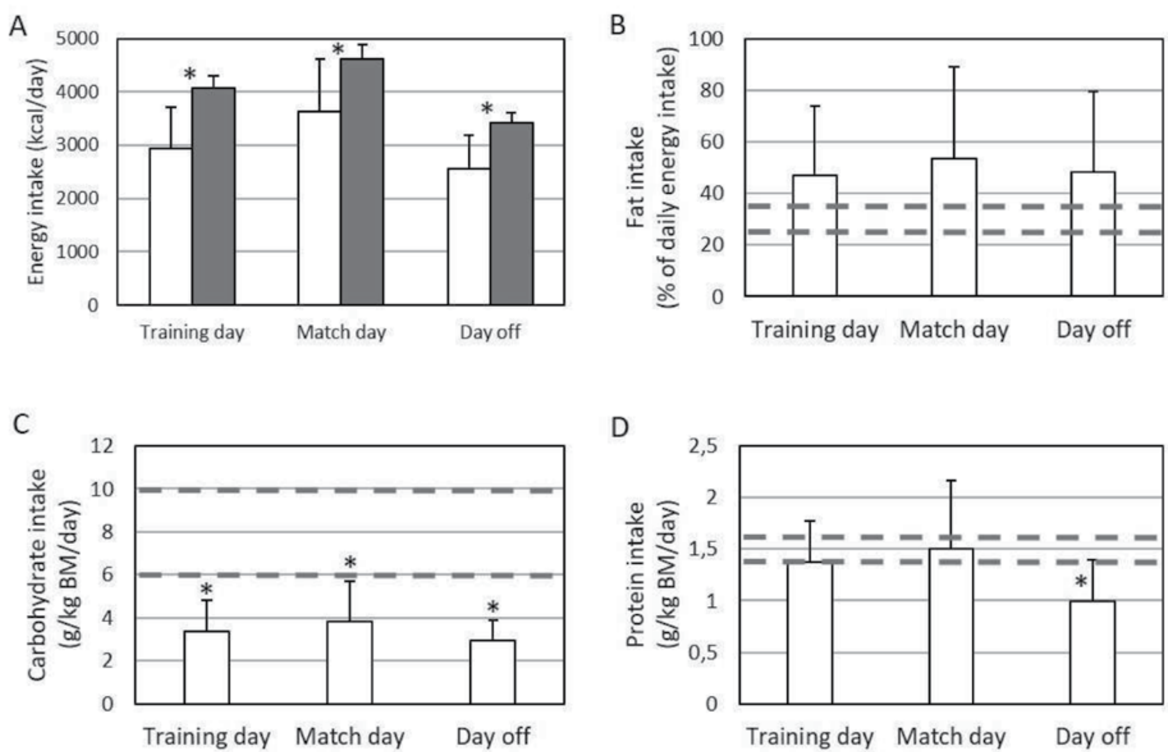
Energy and Macronutrient Intakes in Male Handball Players

Figure 1 shows the average energy and macronutrient intakes for the participating male handball players on the training day, match day and day off, respectively. Fat intake is expressed in percentage of the individual daily energy intake, while the carbohydrates and protein intakes are expressed in gram per kilogram of body mass.

Figure 1A shows the actual recorded and the recommend energy intakes for three days. From the food diaries in this study, it was shown that on average (white bars of Figure 1A), the male handball players had the highest energy intake on a match day (3290 kcal), a somewhat lower on training day (2871 kcal) and the least on a day off (2557 kcal). Repeated ANOVA measures on these actual recorded energy intakes, did not find significant differences between the three days for the included male handball players (F=2.44, p=0.118).

However, the theoretical RDEIs show statistical differences between the three days of the training cycle, as explained in section *Recommended Energy and Macronutrient*

*Figure 1: Average daily energy and macronutrient intakes for male handball players. A. Energy intake, with white bars recorded, gray bars recommended. B. Fat intake as percentage of daily energy intake. C. Carbohydrates intake. D. Protein intake. Thick gray hatched lines: upper and lower limit of the range of recommended intakes. BM, body mass. * denotes significant difference between recorded and recommended.*

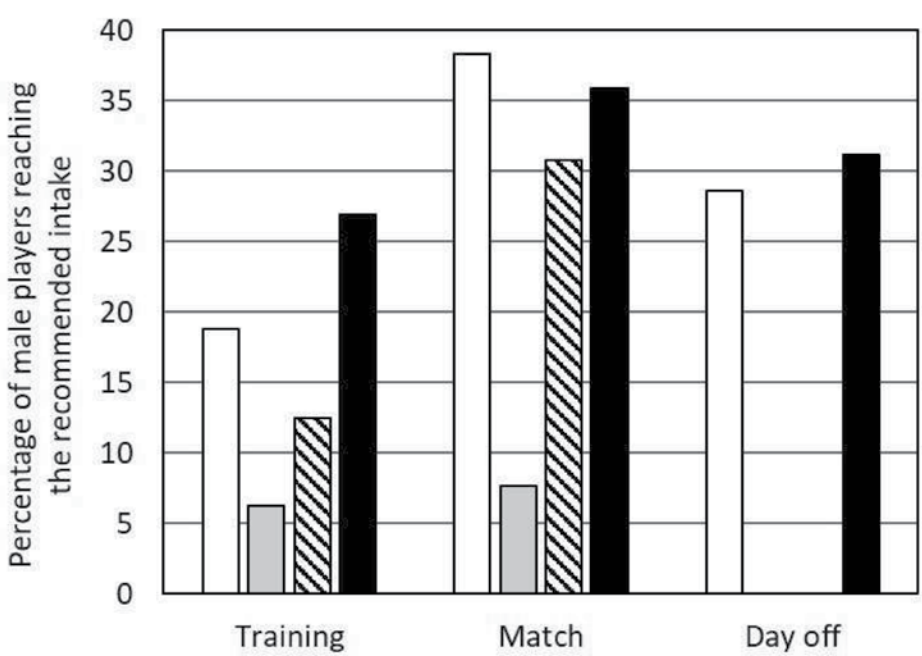


Intakes. Consequently, the actual energy intake (from the food diary) met the theoretical energy recommendation by 72.4 %, 78.7 % and 74.7 %, respectively on a training day, a match day and a day off. For each of the three days separately, the recorded average daily energy intake differed statistically from the RDEI (denoted by the * in Figure 1A).

While the recommendations for the intake of fat were generally fulfilled (Figure 1B), the carbohydrate intake was generally lower than the recommended range (Figure 1C), and the recorded protein intake for male players on the training and match days were within the recommended range, while it was out of the recommended range on a day off (Figure 1D).

For the male handball players, we calculated more in detail the percentage of players that reached the minimal recommendations of energy and macronutrient intakes on the specific days. This is illustrated in Figure 2. Only 38.3% fulfilled the theoretical RDEI on a match day, 18.8 % for the training day, and only 28,6% of the male players obtained enough energy during the day off. In general, carbohydrates and proteins

Figure 2: Percentage of male players reaching the recommended energy and macronutrient levels. White bars: energy, calculated from RDEI as in section 4.2.1; Gray bars: carbohydrates, calculated from lower recommended limit; Hatched bars: protein, calculated from lower recommended limit; Black bars: fat, calculated from upper recommended limit.



recommendations were met poorly for a training day (6.3%; 12.5%, respectively). For days off none of the players fulfilled the recommendations for both carbohydrates and proteins. While on a match day, only 31% of the male players reached the recommended amount of proteins. The percentage of players reaching the minimal recommendation for fat intake was more than 25% during all three days (about 50% was within the recommended range for all days). Moreover, in fact, it was observed that the percentage of players overconsuming fat was more than 38% (based on the upper recommendation limit).

Energy and Macronutrient Intakes in Female Handball Players

During the observational week of this study, the recorded daily energy intakes for the 9 female players on average were 1690 ± 750 kcal for a training day, and 1284 ± 500 for a day off (Figure 3A). As already mentioned in section 4.2.1, the calculated RDEIs showed significant differences between a training day, and a day off (F=539.97; p <0.025), which can also be observed in Figure 3A (gray bars). Consequently, on a training day, 52.3 % of the energy recommendation was met, while on a day off it reached only 47.7 %. To find out whether the differences in the RDEIs and the actual recorded food intake for the female participants were present, a repeated measures analysis was conducted. No significant difference in energy intake between the different days was found (F=1.78, p=0.224). However, for each day separately a statistically significant difference between RDEI and actual recorded energy intake was established (denoted by the asterisks in figure 3A).

In general, the recommended fat intake for both days was reached (Figure 3B). While the actual intakes of both carbohydrates and protein were below the recommendations (Figures 3C and D).

Figure 4 shows the fulfillment of energy and macronutrient recommendations in more detail. The percentage of players that reached the daily energy intake was low (14.3% for both days), while none reached the carbohydrate recommendations, and only 11.1% and 14.3% of the players fulfilled the protein intake on training and resting days respectively. Strikingly, the consumption of fat was high, and reached the upper limit of recommendation among more than 55% of female players (77.8% consume an adequate amount of fat on the training day and 57.1% on the day off).

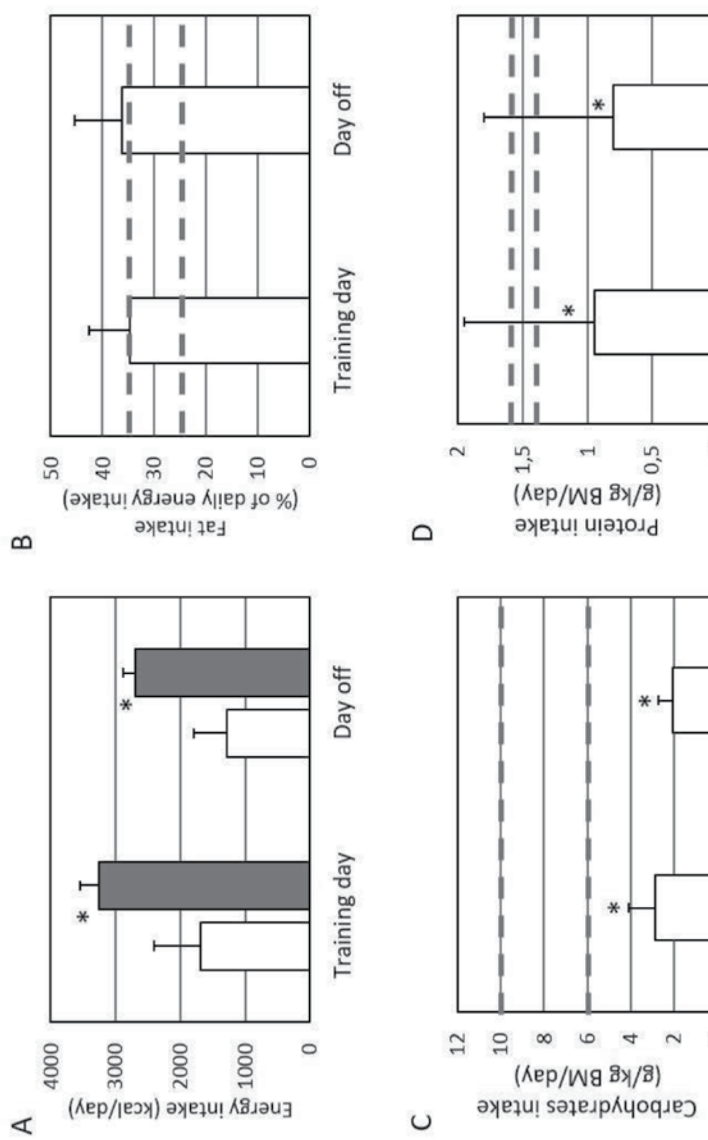
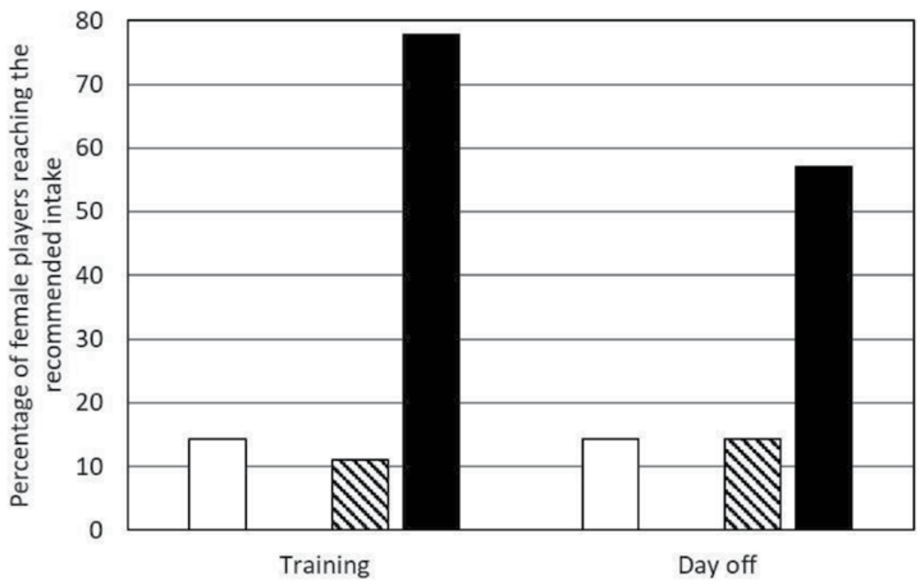


*Figure 3: Average daily energy and macronutrient intakes for female handball players. A. Energy intake, with white bars recorded, gray bars recommended. B. Fat intake as percentage of daily energy intake. C. Carbohydrates intake. D. Protein intake. Thick gray hatched lines: upper and lower limit of the range of recommended intakes. BM, body mass. * denotes significant difference between recorded and recommended.*

Figure 4: Percentage of female players reaching the recommended energy and macronutrient levels. White bars: energy, calculated from RDEI as in section 4.2.1; Gray bars: carbohydrates, calculated from lower recommended limit; Hatched bars: protein, calculated from lower recommended limit; Black bars: fat, calculated from upper recommended limit.



DISCUSSION

The aim of the study was to assess the anthropometric and body composition data in the players of two semi-professional handball teams from the Slovenian national league and to evaluate whether they meet the recommended nutritional intakes of energy and macronutrients. Therefore, players were asked to record, in a detailed way, their daily food intake for the 7 days of a training microcycle.

The heights of the male players, shown in Table 1, are comparable to the heights as previously reported (Chaouachi et al., 2009; Ghobadi, Rajabi, Farzad, Bayati, & Jeffreys, 2013; Molina-López et al., 2013; Massuca, Branco, Miarka, & Fragoso, 2015; Šibila & Pori, 2009; Sporiš, Vuleta, Vuleta, & Milovanović, 2010). In relation to the field position, the current players' heights follow the recent reports from large sets of professional players (n = 406, Ghobadi et al., 2013; n = 161, Massuca et al., 2015). Furthermore, the average of 90.4 kg of body mass falls within the range of 82.2 to 96 kg as reported by previous studies in male handball players (Chaouachi et al., 2009; Ghobadi et al., 2013; Massuca et al., 2015; Molina-López et al., 2013; Šibila & Pori, 2009; Sporiš et al., 2010).

Several studies reported body fat, but only a few specifically related to the field position for male handball players, not differentiating between left, right or centre-backs (n = 21, Chaouachi et al., 2009; n = 78, Šibila & Pori, 2009; n = 92, Sporiš et al., 2010). The averaged percentages of body fat ranged from 11.2 to 15.4% (Chaouachi et al., 2009; Molina-López et al., 2013; Šibila & Pori, 2009; Sporiš et al., 2010), while the male players from the present study have a slightly higher averaged percentage of body fat, amounting to 16.2%. In addition, the average level of visceral fat for the male handball players in the present study was of level 3.1. Unfortunately, other studies do not report the measurement of visceral fat, though up to 12 is considered to be in a healthy physiological range (Tanita Corporation of America Inc., 2013), with athletes most likely falling into the lower levels.

Concerning muscle mass, most studies report a detailed recording of muscle mass from body weight measurements (Chaouachi et al., 2009; Ghobadi et al., 2013; Massuca et al., 2015; Šibila & Pori, 2009; Sporiš et al., 2010). The muscle mass in the present study is obtained as the percentage of fat-free mass (FFM), that includes bone mass. Hence, a detailed comparison is not possible. On the other hand, the averaged body mass index for the current sample of players amounts to 25.9 ± 2.3 kg/m2, that is identical to the large set reported by Ghobadi and co-workers (25.5 ± 2.1 kg/m2), as well as to a small sample of 14 Spanish professional male handball players (24.7 ± 1.1 kg/m2, (Molina-López et al., 2013).

Only a few studies report anthropometric data for female handball players (n = 24, Michalsik, Madsen, & Aagaard, 2013; n = 16, Weber, Kehl, & Fonseca Moreira, 2012). The presently reported average values for height and weight (Table 2, 174.1 ± 7.2 cm; 71.5 ± 7.4 kg) are comparable with the Danish data (174.2 cm and 70.3 kg, (Michalsik et al., 2013). While for Brazilian players both height and weight are smaller (164.2 cm and 56.8 kg) with a percentage of body fat of 23.2% (Weber et al., 2012). In contrast, the present sample of female players displayed 26.2% of body fat. In addition, the Brazilian FFM was lower and amounted to 47.9 kg, as compared to 52.5 kg in our study. Thus, overall, the Brazilian female handball players seem to be somewhat smaller and leaner. Additionally, we report average visceral fat amounting to level 1.8 that is within the normal physiological range (Tanita Corporation of America Inc., 2013).

Although the literature is limited in providing the anthropometric and body composition data for professional male and female handball players, we can assume that the data presented in Tables 1 and 2 are representative of semi-professional Slovenian National League handball players, and besides are within the normal range for handball players in general.

The daily energy intake for team sports athletes has recently been found structurally too low (Jenner et al., 2019). In the present study, an energy deficient of about 800 to 1100 kcal per day in males, and even 1500 kcal in females, has been found during the current microcycle. However, the studies specifically focused on the nutritional intake of handball players are limited. Among 6 Portuguese professionals, an average energy intake of 4652 kcal was found (Silva et al., 2017), which is fairly high, but seems to be adequate. On the other hand, a study among 14 professional Spanish male handball players measured 2975 kcal per day (Molina-López et al., 2013), which is comparable to our training day data (2871 kcal/day). 16 Brazilian female players had an energy intake of 1883 per day (comparable with the 1690 kcal per day found here), which was mentioned to be at least 220‒440 kcal less than the recommended range (Weber et al., 2012). Interestingly, when the Spanish study introduced a nutritional education programme, after 8 weeks the intake increased with an additional 380 kcal per day (Molina-López et al., 2013). After finishing the education, a new assessment after 8 weeks showed that the intake remained at 3329 kcal per day. While these studies do not mention the amount of players that meet the recommendations, it seems plausible that specific nutritional training and education, especially with the involvement of an expert sports dietitian, would yield higher percentages of players fulfilling the recommendations. Just like the recent systematic literature review by Jenner et al., (2019), we emphasize the need to prepare and include, sport-specific and player-position nutritional recommendations/education, to enhance performance.

Next to these generally low energy intakes, it became increasingly important to known whether our participants reached the recommended levels of macronutrients. As we suspected, the intake of macronutrients was not adequately assorted. The actual intake of carbohydrates was statistically different from the recommendations on all days, both for males and females. Such a poor carbohydrates intake for team sport athletes has been reported before (Holway & Spriet, 2011), while on the other hand, sufficient carbohydrate intake in male soccer teams is reported in predominantly older literature (Hickson, Johnson, Schrader, & Stockton, 1987; Jacobs, Westlin, Karlaaon, Rasmusson, & Houghton, 1982; Rico-Sanz, 1998). For women, the highest recorded carbohydrates intake was 5.2 g/kg BM/day (Clark, Reed, Crouse, & Armstrong, 2003). This does not reach the most recent minimal recommendation level of 6 g/kg BM/day that is based on soccer players (Burke et al., 2011; American Dietetic Association et al., 2009; Rodriquez et al., 2009). Despite that metabolic demands between football and handball might differ, it is also suggested that recommendations for the intake of carbohydrates in team sports are set too high. Based on football, recommendations have been issued ranging from 5-7 g/kg BM/day (Consensus Statement, 2006; Holway & Spriet, 2011).

The protein intake of the male players was insufficient only on the day off (1,0 ± 0,4 g/kg BM/day), while for female athletes, protein intake was insufficient on training days and days off. It is important to notice that the official recommendations issued by the establish sports institutes (International Society of Sports Nutrition – ISSN; American Academy of Sports Medicine – ACSM; and Medical Commission of the International Olympic Committee - IOC), are of a very general character. Usually recommending a range in the high amounts, facilitating for each individual (handball) player to adjust the intake, according to their personal wishes.

Regarding the fat intake, for all players, both males and females, no statistical significant differences with the literature recommendations were observed. However, while for females the fat intake was within the recommended range, for males an excessive intake was noticed for all days.

High fat intake and inadequate carbohydrate intake (and on certain days, inadequate protein intake), can be linked to the anthropometric characteristics of handball players. A relatively high percentage of body fat may be due to the excess of fat intake. Inadequate macronutrient ratios in combination with low energy intake, can also be interpreted as an excess of body fat, and consequently, a lower percentage of muscle mass. Appropriate food choices, especially less fatty foods or foods rich in monounsaturated and polyunsaturated fatty acids, improve the anthropometric values of both males and females, optimizing their physical performance (Burke & Cox, 2010; Fink & Mikesky, 2015). For both the male and female athletes of this study, the proportion of macronutrients (carbohydrates, proteins and fats) is not in line with the recommendations of global sports institutions (Burke et al., 2011; Campbell et al., 2007; American Dietetic Association et al., 2009; Rodriquez et al., 2009; Thomas et al., 2016). The present study shows that the participating handball players, of both genders, adhere to a high fat intake, and, above all, low carbohydrates and protein intakes.

The present study comes with several limitations. Food diaries do not always reflect the actual food intake, as self-report is subject to recall errors and reporting bias, both general limitations of this method. Some individuals have reported very low energy intake in relation to their actual body composition. Knowing that a high percentage of body fat is due to inadequate nutrition, we assume that their reporting was not reliable. Here we see an opportunity to further explore and verify the reporting of data in athletes who have weight problems. The reporting was only performed during one week. For a more accurate information and a reliable account of the nutritional status of handball players on match days, their nutrition should be recorded preferably over a whole season, especially during multiple matches. Despite the fact that this study reports on a limited number (9 females and 17 males), it adds to previous energy intake studies. The anthropometric data of our study were in fact comparable with those from previous studies. Thus, despite the limitations within the current study, the results bring a relevant addition to the published literature on hand ball players' nutritional intake.

CONCLUSION

In conclusion, the Slovenian male and female handball players evaluated in the current study are not adequately nourished considering the current nutritional recommendations. They do not have optimally distributed macronutrient intake during their whole-day energy intake, and these inadequate macronutrient values could affect their energy metabolism and performance. Both male and female athletes consume especially too little carbohydrates and too much fat. Although the intake of protein for male players is within the recommended limits, the macronutrients introduced are not in the optimal ratio.

Handball, and other team sports, demand different exposure to the efforts in terms of playing positions, and thus, individual consultations. However, the number of scientific studies regarding nutrition and team sports are limited, and often include only a small number of players. Thus, little comparable research is available. It is for these reasons that it is difficult to formulate recommendations that would suit all players and thus optimize their performance. Nevertheless, introducing nutritional instructions and interventions could improve the players' eating habits and thus their psychophysical fitness.

Conflicts of Interest

The authors declare that no conflicts of interest exist.

Funding

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Ethical Aproval

The approval for this study by the Ethics Committee of the Republic of Slovenia is located under 0120-132 / 2016 KME 55/03/16.

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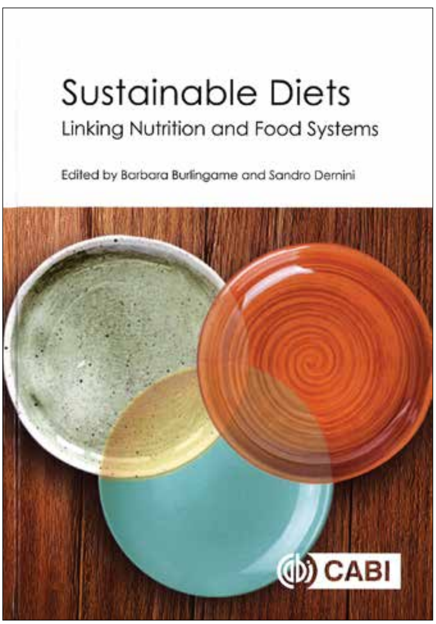
REPORTS AND REVIEWS/POROČILA IN OCENE, 149–154

Book review
Barbara Burlingame and Sandro Dernini (eds): SUSTAINABLE DIETS – LINKING NUTRITION AND FOOD SYSTEMS

CAB International, 2019, 280 pages



In the scope of the nutrition decade that started in 2016, this monograph addresses, in detail, the *United Nations Food and Agriculture Organisation*'s current definition of sustainable diets from the perspective that 'those have low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Besides, are protective and respectful of biodiversity and ecosystems, culturally acceptale, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources'. Throughout 29 expert contributions, the current policy-making process regarding the *sustainable development goals* of the *United Nations General Assembly* supported by the *World Health Organisation* and their implementation are explained in length. A focus is placed on the right to high quality nutritious food, and the incorporation of safe food and food security into sustainable development. More importantly, it is outlined how to qualitatively and quantitatively approach these challenges through sustainable lifestyles, which the monograph names as diets.

The Mediterranean Diet frequently resurfaces to illustrate a sustainable diet according to this definition. However, there are concerns about the decline of the 'traditional' *Mediterranean Diet* throughout the Mediterranean countries due to various economic and sociocultural factors and globalization of food markets. Various chapters describe how to hold on to such lifestyles, which is outlined as a multi-actor responsibility. Other chapters describe how to assess lifestlye adherence, and their subsequent environmental, nutritional and sustainable impacts. Next to various nutritional dimensions, an indicator concerning the prevalance of physical activity and inactivity is outlined, with the notion that the related questionnaires are difficult to compare across cultures, indicating the limitation of population-based data. It is emphasized that personal interviews related to physical activity should be included, and that country-specific sustainable food-based dietary and lifestyle guidelines are needed.

In view of the *sustainable development goals* such as zero hunger, good health and well-being for everyone, with responsible production and consumption, the *Mediterranean Diet* is recognized as a lifestyle with a healthier dietary pattern characterized by a lower environmental impact. The international experts contributing to this monograph recognize the role of physical activity therein. But it is for kinesiology and physiotherapy practitioners to emphasize the role of it, and further develop the indicators and present the proof of effectiveness of nutrition combined with physical activity in the breadth of sustainable diets.

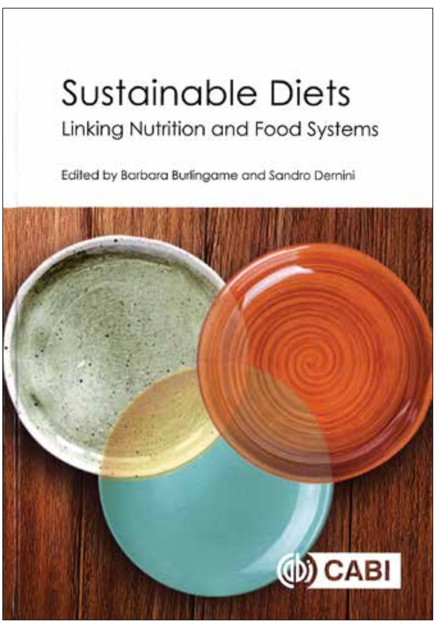
The issues described in *Sustainable Diets* will be of major use in planning effective holistic research as they provide direct links to the existing written policies in order to further intertwine kinesiology and health-related research proposals.

Cécil J. W. Meulenberg

REPORTS AND REVIEWS/POROČILA IN OCENE, 149–154

Recenzija knjige Barbara Burlingame in Sandro Dernini (ur.): SUSTAINABLE DIETS – LINKING NUTRITION AND FOOD SYSTEMS

CAB International, 2019, 280 str.



V duhu desetletja ukrepov na področju prehrane, ki se je začelo leta 2016, monografija podrobno predstavlja uveljavljene definicije trajnostnih načinov prehranjevanja Organizacije Združenih narodov za prehrano in kmetijstvo (UN FAO). Predstavitev izhaja iz stališča, da so trajnostni tisti prehranski sistemi, »ki imajo nizek vpliv na okolje in zagotavljajo varno in kakovostno hrano, dostopno vsem sedanjim in prihodnjim generacijam. Poleg tega ohranjajo biotsko raznovrstnost vseh ekosistemov, so kulturno sprejemljivi, ekonomsko pošteni ter dostopni vsem v enaki meri. Morajo biti prehrambno ustrezni in s tem zagotavljati zdravje in varnost ter stremeti k optimizaciji naravnih in človeških virov.« V 29 poglavjih zbornika, strokovnjaki poglobljeno predstavijo trenutno stanje na področjih vzpostavljanja ustreznih politik za doseganje ciljev trajnostnega razvoja, ki si jih je zadala Generalna skupščina Združenih narodov (UN GA) in jih podpira Svetovna zdravstvena organizacija (WHO). Avtorji se izrecno posvečajo problematiki pravice do ustrezne prehrane ter povezavi med varno in kakovostno prehrano in trajnostnim razvojem. Posebno pozornost so posvetili kvalitativnim in kvantitativnim pristopom pri soočanju s tovrstnimi izzivi skozi trajnostni življenjski slog oz. trajnostne prehrambne navade, kot jih poimenujejo avtorji posameznih poglavij.

V navezavi na navedene definicije, je kot ilustracija trajnostne prehrane pogosto omenjena Sredozemska prehrana, hkrati pa je prisotna tudi zaskrbljenost zaradi postopnega opuščanja ‹tradicionalnega› sredozemskega načina prehranjevanja v Sredozemlju, kot posledica različnih ekonomskih, socialnih in kulturnih faktorjev ter globalizacije prehrambnih trgov. Več poglavij opisuje aktivnosti, s katerimi bi omogočili nadaljnji obstoj tradicionalnih prehrambnih slogov. Avtorji trdijo, da je za doseganje tega cilja nujna aktivacija številnih različnih akterjev. Spet druga poglavja opisujejo načine, s katerimi bi bilo mogoče vrednotiti privrženost izbranemu življenjskemu slogu ter iz njega izhajajoči učinek na okolje, prehrano in trajnost. Ob mnogih prehranskih indikatorjih, je kot posebej poveden izpostavljen tudi vidik telesne aktivnosti oz. neaktivnosti. Ob tem pa je nujno izpostaviti pomislek glede primernosti uporabe tovrstnih vprašalnikov za medkulturne primerjave, kar nakazuje na določene omejitve pri populacijskih študijah. Avtorji so opozorili še, da je za pridobivanje relevantnih informacij glede telesne aktivnosti primerna metoda osebnih intervjujev ter da je nujno potrebno zagotoviti priporočila za specifične trajnostne prehrambne in tudi sicer življenjske sloge za vsako državo posebej.

V luči nekaterih od ciljev trajnostnega razvoja, kot so odprava lakote, zdravje in dobro počutje za vse ter odgovorna poraba in proizvodnja, je bil prav sredozemski življenjski slog prepoznan kot tisti z bolj zdravim vzorcem prehranjevanja, ki ga hkrati karakterizira nižji vpliv na okolje. Mednarodni strokovnjaki, avtorji prispevkov v zborniku, so v vsem tem prepoznali tudi pomen telesne aktivnosti. Šele kineziologi in fizioterapevti pa so tisti, ki morajo izpostaviti pravo vlogo telesne aktivnosti ter oblikovati primerne indikatorje, s pomočjo katerih bodo lahko nedvoumno dokazali pozitivne učinke ustrezne prehrane v povezavi s telesno aktivnostjo na stopnjo doseganja zastavljenih ciljev v okviru trajnostnih prehrambnih sistemov.

Vsebine, ki jih nagovarjajo avtorji v zborniku »*Sustainable Diets*«, so lahko v veliko pomoč pri načrtovanju učinkovitih in celostnih raziskav, vsebujejo pa tudi neposredno povezavo do številnih obstoječih priporočil za še intenzivnejši preplet kineziologije in z zdravjem povezanih raziskovalnih predlogov.

Cécil J.W. Meulenberg

REPORTS AND REVIEWS/POROČILA IN OCENE, 149–154

REPORT ON A VISIT TO THE RUSSIAN STATE UNIVERSITY OF PHYSICAL EDUCATION, SPORT, YOUTH AND TOURISM

Moscow, Russian Federation, 14th–18th May 2019

Within the framework of the bilateral cooperation between Slovenia and Russian Federation, a few colleagues from the Institute for Kinesiology Research of SRC Koper paid a visit to the Russian State University of Physical Education, Sport, Youth and Tourism was held between 14th and 18th May 2019. Our kind hosts were Elena Komova, PhD, and prof. Sergei Levuskhin, PhD, who showed us the university and the laboratory of the Research Institute for Sports and Sports Medicine, where we got acquainted with the research associates, equipment, different measurements and researches as well as how the institute functions. At the same time, our research work and scientific capacities were presented to our Russian partners in bilateral cooperation.

On 16th May 2019, we were invited to lecture at introductory session at XIII. "Contemporary University Sport Science", a conference dedicated to graduate students and their international experiences. Prof. Boštjan Šimunič, PhD, participated with the lecture "The use of methods of tensiomyography in the study of atrophies" while Saša Pišot, PhD with the lecture titled: "Basic motor patterns and physical (embodied) capital of the child." The following day, on 17th May 2019, we also participated in a round-table discussion held at the conference entitled: World Sports Development Systems and Elite Athletes' Access to Education. The topic of the round table was about the current good practices and shortcomings of the systems in Russia, Egypt and Slovenia, where Prof. Rado Pišot, PhD, presented the results of the project "Double Career (2D4C)", while Prof. Smolianov presented his research of elite sports development systems around the world, currently in the US, UK, Senegal and Qatar. In the afternoon we had a meeting with Prof. Valentin Sonkin, PhD, who explained us their work in detail. We all recognised several common interests in further research, above all in the fields of muscle physiology.

The first visit can be considered a success since we have had an important insight into the work of our partner institutions and have made a new acquaintance for a successful cooperation in research on the field of motor status components of children and adolescents with an emphasis on their assessment and measurement. The next step we are going to pursue is to formulate concrete suggestions of common research or data comparison in the field of children's motor status. Our Russian colleagues visited us in October 2019, when they visited our premises and laboratories as well as participated at the 10th International Scientific and Professional Conference "Child in Motion" in Portorož, Slovenia. This way we continue our collaboration.

Saša Pišot

REPORTS AND REVIEWS/POROČILA IN OCENE, 149–154

POROČILU O OBISKU RUSKE DRŽAVNE UNIVERZE ZA TELESNO VZGOJO, ŠPORT, MLADE IN TURIZEM

Moskva, Ruska federacija, 14.–18. maj 2019

V okviru sodelovanja Bileterala Slovenija - Rusija je od 14. do 18. maja 2019 manjša skupina sodelavcev Inštituta za kineziološke raziskave ZRS Koper obiskala Russian State University of Physical Education, Sport, Youth and Tourism, kjer smo bili gostje prof. Sergeja Levuskhinga in dr. Elene Komove. Ogledali smo si univerzo ter laboratorij raziskovalnega inštituta za šport in medicino športa, kjer smo se seznanili z raziskovalnimi sodelavci, opremo, meritvami, raziskavami in delovanjem inštituta. Ruskim partnerjem v bilateralnem sodelovanju smo ob tem predstavili tudi svoje raziskovalne in znanstvene zmogljivosti.

16. maja 2019 smo sodelovali z uvodnimi predavanji na konferenci XIII. Modern university sport science, namenjeni podiplomskih študentom. Prof. dr. Boštjan Šimunič je sodeloval s predavanjem The use of tensiomiography in athrophy study /Uporaba metode tenziomiografije v študijah atrofij in dr. Saša Pišot s predavanjem Fundamental motor patterns and physical (embodied) capital of a child /Elementarni gibalni vzorci in utelešen gibalni kapital otroka. 17. maja 2019 smo sodelovali na okrogli mizi, ki je potekala v okviru konference Worldwide sport development systems and elite athlete's access to education /Sistemi za razvoj športa in dostop elitnega športnika do izobraževanja. Pogovarjali smo se o trenutnih dobrih praksah in pomanjkljivostih sistemov v Rusiji, Egiptu in Sloveniji. Prof. dr. Rado Pišot je predstavil izsledke projekta Dual career (2D4C), prof. Smolianov pa raziskavo, ki proučuje različne elitne sisteme za razvoj športa po svetu, trenutno v ZDA, Veliki Britaniji, Senegalu in Katarju. V popoldanskem času smo imeli še sestanek s prof. dr. Valentinom Sonkinom, v okviru katerega smo podrobneje spoznali njihovo delo in opredelili precej skupnih interesov pri raziskovanju, predvsem na področju motoričnega razvoja in fiziologije mišice.

Prvi tovrsten obisk je bil uspešen, saj smo dobili pomemben vpogled v delo partnerske institucije ter sklenili nova poznanstva za uspešno prihodnje sodelovanje in raziskovanje na področju komponent gibalnega stanja otrok in mladostnikov s poudarkom na njihovem spremljanju in merjenju. Naslednji korak je namenjen oblikovanju konkretnih predlogov za sodelovanje v raziskavah in morebitno primerjavo podatkov raziskav na področju gibalnega statusa otrok. Obisk ruskih kolegov je potekal oktobra 2019, ko so obiskali naše prostore in laboratorije in se udeležili 10. mednarodne znanstvene in strokovne konference Otrok v gibanju v Portorožu.

Saša Pišot

GUIDELINES FOR AUTHORS

1. **Aim and scope of the journal:**
   Annales Kinesiologiae is an international interdisciplinary journal covering kinesiology and its related areas. It combines fields and topics directed towards the study and research of human movement, physical activity, exercise and sport in the context of human life style and influences of specific environments. The journal publishes original scientific articles, review articles, technical notes and reports.

2. **General policy of Annales Kinesiologiae**
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Journal articles
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Šimunič, B., Koren, K., Rittweger, J., Lazzer, S., Reggiani, C., Rejc, E., … Degens, H. (2019). Tensiomyography detects early hallmarks of bed-rest-induced atrophy before changes in muscle architecture. Journal of applied physiology, 126(4), 815–822. https://doi.org/10.1152/japplphysiol.00880.2018

Book chapters

Šimunič, B., Pišot, R., Mekjavić, I. B., Kounalakis, S. N. & Eiken, O. (2008). Orthostatic intolerance after microgravity exposures. In R. Pišot, I. B. Mekjavić, & B. Šimunič (Eds.), The effects of simulated weightlessness on the human organism (pp. 71–78). Koper: University of Primorska, Scientific and research centre of Koper, Publishing house Annales.

Rossi, T., & Cassidy, T. (in press). Teachers' knowledge and knowledgeable teachers in physical education. In C. Hardy, & M. Mawer (Eds.), Learning and teaching in physical education. London (UK): Falmer Press.

Conference proceeding contributions

Volmut, T., Dolenc, P., Šetina, T., Pišot, R. & Šimunič, B. (2008). Objectively measures physical activity in girls and boys before and after long summer vacations. In V. Štemberger, R. Pišot, & K. Rupret (Eds.) Proceedings of 5th International Symposium A Child in Motion "The physical education related to the qualitative education" (pp. 496–501). Koper: University of Primorska, Faculty of Education Koper, Science and research centre of Koper; Ljubljana: University of Ljubljana, Faculty of Education.

Škof, B., Cecić Erpić, S., Zabukovec, V., & Boben, D. (2002). Pupils' attitudes toward endurance sports activities. In D. Prot, & F. Prot (Eds.), Kinesiology – new perspectives, 3rd International scientific conference (pp. 137–140), Opatija: University of Zagreb, Faculty of Kinesiology.

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5. For additional information regarding article publication, please do not hesitate to contact the secretary of Annales Kinesiologiae.

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