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TABLE OF CONTENTS

Francesca D'Elia, Felice Di Domenico, Giovanni Esposito, Gaetano Altavilla and Gaetano Raiola (Original Scientific Paper) Improvement of Repeated Sprint Ability for a Male Amateur Football Team through the Cometti Concatenations Method	3-7
Suncica Rogic, Milica Vukcevic, Milica Muhadinovic and Julija Cerovic Smolovic (Original Scientific Paper) Montenegrin Sport Associations on Social Media - Quality of Performance Assessment	9-14
Luca Ferrucci, Fabio Forlani and Antonio Picciotti (Original Scientific Paper) Passion as a Determinant in Sport Consumption: the Case of Amateur Cyclists	15-20
Nikola Foretic, Vladimir Pavlinovic and Sime Versic (Original Scientific Paper) Shooting Speed Differences between Playing Positions in Top Level Handball	21-24
Dmitry Butko, Vladislav Kuznetsov, Dmitry Kolesov and Sergey Kondrashev (Original Scientific Paper) Bobath Therapy for Cerebral Palsy: An Efficacy Study	25-29
Uğur Ödek, Kürşat Özcan, Gonca Özyurt and Selcuk Akpınar (Original Scientific Paper) Psychological Benefits of Equine-Facilitated Activities for Children Diagnosed with Cerebral Palsy	31-37
Juel Jarani, Andi Spahi, Klotilda Vrenjo and Keida Ushtelenca (Original Scientific Paper) Comparison of Body Weight between Albanian Children and European Peers in Primary Schools	39-43
Stefan Kolimechkov, Lubomir Petrov, Deyana Vankova and Deidre Douglas (Original Scientific Paper) Nutritional Assessment of Female Yoga Practitioners with Different Levels of Experience	45-49
Iancu Vasilica, Rui Silva, Paulo Costa, Bruno Figueira and Luís Vaz (Original Scientific Paper) Games Based Learning Influence in Portuguese Referees Motivation to study Laws of the Game and Competition Rules: A Longitudinal Study	51-57
Ron Mor, Eyal Weissbluth and Izhar Ben Shlomo (Original Scientific Paper) High Load few Repetitions Exercise is better for the Cardiovascular System than low Load Many Repetitions Exercise	59-64

Nihan Ozunlu Pekyavas, Ewan Thomas, Antonino Bianco and Fatma Nese Sahin (Original Scientific Paper) Effects of Different Sports Shoes and Bare Feet on Static and Dynamic Balance In Healthy Females: A Randomized Clinical Trial	65-69
Alexander Bolotin and Vladislav Bakayev (Original Scientific Paper) The Method for Enhancing Statokinetic Stability in Alpine Skiers Based on the Use of Normobaric Hypoxia in Combination with Cervical Spine Muscle Exercises	71-75
Barbara Gilic, Goran Gabrilo and Vlade Bendic (Original Scientific Paper) Test-Retest Reliability and Validity of the Velocity-Based Training Device for Measuring Kinetics and Kinematics Variables in Youth Soccer Players	77-82
Kyongmin Lee and Sungjung Kim (Original Scientific Paper) Structural Relationship between Technological Characteristics, Perceived Usefulness, Trust, and Continuous Intention to Use Mobile Payment Services: Sports Consumers in MZ Generations	83-88
Sime Versic, Ognjen Uljevic and Katarina Pelivan (Original Scientific Paper) Factors Associated with Potential Doping Behaviour in Windsurfing	89-92
Izet Bajramovic, Ensar Abazovic, Denis Causevic, Ivor Doder, Haris Alic, Erol Kovacevic, Nedim Babic and Slavenko Likic (Original Scientific Paper) Relationship between Muscle Strength of Knee Stabilizers and Quality of Vertical Jump Performance in Physically Active Female Population	93-96
Mirela Sunda, Barbara Gilic and Alen Bascevan (Original Scientific Paper) Association between Enjoyment in Physical Education Online Classes and Physical Activity Levels in Adolescents during the COVID-19 Pandemic	97-101
Besnik Morina, Florian Miftari, Georgi Georgiev and Seryozha Gontarev (Original Scientific Paper) Total and Abdominal Adiposity are Lower in Overweight and Obese Children with High Cardiorespiratory Fitness	103-107
Nikola Foretic, Vladimir Pavlinovic and Miodrag Spasic (Original Scientific Paper) Differences in Specific Power Performance among Playing Positions in Top Level Female Handball	109-113
Megan Bigler, Dale R. Wagner and R. Stephan Lowry (Short Report) Interdevice Reliability of A-Mode Ultrasound to Measure Body Composition	115-118
Guidelines for the Authors	119-129

ORIGINAL SCIENTIFIC PAPER

Improvement of Repeated Sprint Ability for a Male Amateur Football Team through the Cometti Concatenations Method

Francesca D'Elia¹, Felice Di Domenico¹, Giovanni Esposito¹, Gaetano Altavilla² and Gaetano Raiola²

¹University of Salerno, Department of Human, Philosophical and Education Sciences, Salerno, Italy, ²University of Salerno, Department of Political and Social Studies, Salerno, Italy

Abstract

The aim of this study was to examine the improvement of the Repeat Sprints Ability (RSA), during a competitive season in amateur football players (Italian 4th Division, 2020-2021). Specifically, we intend to demonstrate whether through the use of the Cometti concatenations method, a significant increase in RSA can occur during twelve-week training mesocycle. Twenty ($n=20$) amateur footballers, participated in this study (age: 23 ± 0.3 ; height: 184.4 ± 5.5 ; body weight: 80.92 ± 3.4 ; training experience: 8 ± 0.3 yrs), without goalkeepers. In the pre-season (4 weeks, from July to August), the players performed Capanna test, to evaluate the RSA before the start of the season. Every player has been analysed with a K-GPS Live device 50Hz (K-Sport Universal STATS, Italy). After 12 weeks of training (in-season), based on specific workouts of Cometti method, the same players repeated Capanna test to check performance improvements and verify whether the training programme is effective. The aim was to determine whether the improvement in distance covered during the test is better, the same, or worse with respect to the pre-season. After 12 weeks of training, the difference between the first trial (pre-season) and the second one (in-season) is statistically significant ($p<0.05$). The results obtained suggest that the strength work is optimized as well as work times, and the RSA is improved. In addition, thanks to better physical shape which resulted in better performances of individual players, the team in the last period of the championship achieved more positive results in the matches played.

Keywords: *sprint performance, physical preparation, capanna test, aerobic evaluation*

Introduction

In recent years, numerous studies conducted on Repeated Sprint Ability (RSA) in team sports (football, rugby, hockey) have highlighted the key role played by this ability in performance. The training of RSA in football is well documented, since the performance of the competition is characterized not only by intermittent efforts often carried out at high intensity, but also by the presence of accelerations and decelerations that are determined in the frequent changes of direction and sense. The latter made by the players to determine useful disturbances to the game's economy (J. C. Barbero-Álvarez, Coutts, Granda, V. Barbero-Álvarez, & Castagna, 2010). RSA is considered the

ability to produce the best average performance over a series of short sprints (≤ 10 seconds), separated by short recovery periods (≤ 60 seconds), with a minimum decrease in maximum performance (Bravo et al., 2008; Castagna, D'Ottavio, Gabrielli, & Póvoas, 2020). Some benefits of RSA include improved VO_2 max, maximum aerobic speed and improved distance on the football specific yo-yo intermittent recovery test (YYIRT). A recent meta-analysis indicated that a repeated sprint training (RST) is useful for improving high intensity intermittent running and sprint performance (Martin, Sanchez-Sanchez, Ramírez-Campillo, Nakamura, & Gonzalo-Skok, 2018; Faude, Koch, & Meyer, 2012). These training modes usually include



Correspondence:

G. Esposito
University of Salerno, Department of Human, Philosophical and Education Sciences, Fisciano, 84084 Salerno, Italy
E-mail: g.esposito198@studenti.unisa.it

continuous aerobic training, aerobic interval training, or explosive leg training (Izzo et al., 2020a). The scientific literature in relation to the conditional preparation of the player, has produced descriptive training studies in various forms, reporting extremely interesting results for the training practice. In addition, the game analysis (time-motion analysis) has shown that the presence of attack and counterattack actions, supported by high intensity phases produced without interruption, are increasingly frequent and decisive for the outcome of the matches (Carling, Le Gall, & Dupont, 2012). In the topic relating to the RSA, two implementation arguments are distinguished, that of production and maintenance, which are characterized by continuity of exercise and recovery between exercises. Specifically, we talk about maintenance RSA, when the work and recovery ratio is less than 1: 5; while it refers to production RSA, when the ratio is equal or higher ($> 1: 5$). The experimentation both on the field and in the laboratory, has identified in the production mode the most effective method for the physiological development of the player's anaerobic capacity. In football, therefore, aerobic capacity is an essential skill, and the RSA methodology plays a decisive role, as it not only promotes metabolic improvement, but also neuromuscular development (D'Isanto, D'Elia, Raiola, & Altavilla, 2019). The player must improve the same muscle groups as the sprinter and add the football training to the ball which consists of a throw of the free leg. In the case of football, and especially during the competitive season, it is necessary to improve maximum strength with caution; it is therefore necessary to create combinations that match pre-fatigue and isometry. Cometti concatenations method is a widely used method in football for strengthening the lower limbs (Spencer, Pyne, Santisteban, & Mujika, 2011). This method of work is based on the combination of the various contraction regimes (eccentric, concentric, plyometric, isometric, and gesture-specific work). These contractions, in this case, may not even be analyzed separately. According to Cometti, the concatenations make it possible to couple situations very close to the competition needs with strength exercises, with the aim of transferring the new muscular stresses into the technical gesture, working on technical and conditional aspects (Cometti, Maffiuletti, Pousson, Chatard, & Maffulli, 2001). The same author suggests several examples of concatenations carried out with general and specific exercises and even gesture-specific exercises. This working principle can be applied during the training session by alternating series of different contraction regimes or performing repetitions with different contractions within the same series (Raiola, 2017). Concatenations are therefore combined exercises to work both on technical aspects and on conditional aspects which, if well designed, allow to optimize the work of force and optimize the working times. It is certainly a very particular exercise methodology, as indeed all strength exercises with or without overloads, but above all, it must be proposed to athletes suitable to withstand such loads (Impellizzeri, Rampinini, Castagna, Bishop, & Wisloff, 2007). To improve the synchronization of the drive units, it is necessary to work with heavy loads close to the maximum, indeed higher than the maximum, as in the case of eccentric work. The ability to repeat the sprint (RSA), can be evaluated through various types of field tests. However, the main field tests are the Capanna - Sassi test and the 5x30 m test. The Capanna-Sassi test consists of repeating a 20+20-meter shuttle line sprint 6 times, with a change of direction after 20 m and a recovery of 20 seconds between one sprint and the next. In a recent study, all players in a Scandinavian

National League were tested with both the Yo-Yo Intermittent recovery Test level 1 (Yo-Yo IR1) and with the RSA 7x30 m 30 "recovery test (Intermittent Endurance and Repeated Sprint Ability in Soccer Players). The study showed that intermittent high intensity endurance and the ability to repeat sprints should be considered semi-independent physical abilities. The group that achieved the highest Yo-Yo IR1 test values showed a decrease in the lowest RSA test. In addition, the group with the lowest results on the Yo-Yo IR1 test had the fastest decreases on the RSA test. In fact, a good strategy could be to train these two physical skills with two different and specific protocols. The purpose of this study is to verify whether a training mesocycle based on the Cometti concatenations method, carried out for twelve weeks, produces a significant improvement of the RSA.

Methods

Subjects

Twenty ($n=20$) amateur football players participated in this study (age: 23 ± 0.3 ; height: 184.4 ± 5.5 ; body weight: 80.92 ± 3.4 ; training experience: 8 ± 0.3 yrs) without goalkeepers. All athletes are free from musculoskeletal injuries, participated in $\geq 95\%$ of training sessions per year. All athletes are amateur players by Italian football championship. To be included in the study, subjects had to 1) ensure regular participation in all the training sessions, 2) have competed regularly during the previous competitive season, and 3) possess medical clearance. Before entering the study, participants were fully informed about the study aims and procedures, and they provided written informed consent before the testing procedure. The study protocol was conformed to the code of Ethics of the World Medical Association (Declaration of Helsinki). The football team trained for approximately 1h three times per week (always on Monday, Wednesday, and Friday) plus the official match played on Saturday or Sunday. The study was conducted during the 2020–2021 competitive season (i.e., from July to October). Before and after 12 weeks, each player completed Capanna test on the same grass surface.

Design

In the pre-season, after anthropometric measurements, all 20 players performed the Capanna field test. This test is one of the most popular in football for investigating the lactic acid characteristics of players. The test consists in repeating a shuttle sprint of 20+20 m six times, with a change of direction after the first 20 m and recovery of 20 seconds between one sprint and the next. The test is preceded by a 15-minute warm-up and a single maximum sprint that provides a reference data (criterion). It allows to measure the travel times of each individual sprint using a stopwatch connected to a system of photocells. From the data it was then obtained the time of the best test expressed in seconds (RSAbest), the average time related to all the tests (RSAmmean) and the decrease in performance percentage (RSAddec) obtained from the ratio between the average time related to all the tests (RSAmmean) and the best time of the test (RSAbest). The tests carried out followed the original test protocols present in the literature. Multiple athletes cannot be tested simultaneously. After that, specific workouts based on the Cometti concatenations method were carried out over a period of twelve weeks. These workouts after a general activation of about 25 minutes with the ball, initially involved a shuttle run performed at maximum speed on 4 sections of 20 meters each. Three sets were performed with a four-minute recovery time between them. The

second exercise consisted of running pace at an active recovery for a 30-meter stretch. Running pace at active recovery speed is approximately 65% of Maximum Aerobic Speed; for a mid-level player (with a VAM of 17 km/h) it is a question of covering 30 meters in about 10 seconds. Also, in this case, the same series number of the previous exercise were provided, with a similar recovery time between one series and another. The third exercise involved the execution of five to six semi-squat jumps for each of the four series, with a load equal to 30-35% of the maximum load. The fall could be performed in two ways: either by keeping the legs straight (without causing stiffening of the muscles of the lower limbs), with minimal angular variations (approximately 170° of the knee angle in the cushioning-inversion of movement) and short contact; or where the position of departure and arrival on the ground must always take place with the lower limbs in a semi-short stance (90-110° knee angle). With this exercise, the extensor muscles of the foot are stressed more. Finally, the final part of the session was dedicated to shooting on goal. Each player had six shots available to be executed at maximum executive power, compatible with the request to direct the ball at a specific target. In this case the distance of the shot was variable and at the discretion of the coach. Some variants included a series of sprints with stop and instant change of direction (20 m+10 m+20 m), or even the execution of a narrow slalom with the ball, at maximum speed, on a 15 m stretch with the cones spaced 1.5 m apart, or 4 repetitions of ½ squats performed with a load relative to 70% of the maximum, which allowed a maximum of 11 repetition maximum (RM). After 12 weeks of training based on specific workouts based on the Cometti concatenations method

(in season), the same players repeat Capanna test to check performance improvements and verify whether the training programme is correct. The first element was to determine whether the improvement in distance covered during a test is better, the same, or worse with respect to the pre-season.

Statistical analysis

Quantitative variables area presented using their mean and standard deviation and qualitative variables with their absolute frequencies and percentages. Furthermore, the normality of the distributions with the Shapiro Wilk test was determined, and independent sample t-test was conducted to combine the results obtained from the tests before the start of the specific training mesocycle, and at the end of it, after twelve weeks. The analyses were performed with 95% confidence interval and $p \leq 0.05$. The statistical analyses were performed with SPSS Statistics version 23.

Results

In the following tables and graphs, the times of the initial and final Capanna-Sassi test results are presented first, followed by the comparison of the results. Tables 1 and 2 show the times of the results of the Capanna test carried out before and after the training cycle. In addition, the data referring to each individual trials of each player during the execution of the pre and post training test are presented, in particular with regard to the RSA_{mean} (average time related to all trials), the RSA_{best} (best trial time), RSA_{dec} (RSA_{mean} / RSA_{best} ratio), RSA_{dec} and RSA of the six attempts made for the test. In the table the players are divided by role.

Table 1. The results obtained in the first Capanna test (pre-season)

Players	RSA _{best}	RSA _{mean}	RSA _{dec}	RSA _{change}	RSA ₁	RSA ₂	RSA ₃	RSA ₄	RSA ₅	RSA ₆
Defenders	7.27	7.73	6.20%	10.90%	7.32	7.50	7.60	7.83	7.93	8.12
Midfielders	7.29	7.69	5.40%	9.00%	7.35	7.49	7.58	7.87	7.94	8.03
Strikers	7.18	7.65	6.60%	11.90%	7.21	7.39	7.58	7.75	7.91	8.09
Mean±SD	7.24 ±0.05	7.69 ±0.04	6.00 ±0.01	10.60 ±0.01	7.29 ±0.07	7.46 ±0.06	7.58 ±0.01	7.78 ±0.06	7.92 ±0.01	8.08 ±0.04

Note: $RSA_{change} = (RSA_{last} - RSA_{first}) / RSA_{first} \times 100$; $RSA_{mean} = (RSA_1 + RSA_2 + RSA_3 + RSA_4 + RSA_5 + RSA_6) / 6$; $RSA_{dec} = [(RSA_{total} / RSA_{best} \times 6) \times 100] - 100$

Table 2. The results obtained in Capanna test (in-season)

Players	RSA _{best}	RSA _{mean}	RSA _{dec}	RSA _{change}	RSA ₁	RSA ₂	RSA ₃	RSA ₄	RSA ₅	RSA ₆
Defenders	7.24	7.58	4.60%	8.60%	7.27	7.38	7.52	7.64	7.77	7.91
Midfielders	7.11	7.55	4.70%	8.00%	7.24	7.36	7.50	7.63	7.73	7.85
Strikers	7.12	7.51	5.30%	9.40%	7.17	7.28	7.45	7.58	7.72	7.85
Mean±SD	7.19 ±0.07	7.54 ±0.03	5.00% ±0.03	8.70% ±0.07	7.22 ±0.05	7.34 ±0.05	7.49 ±0.03	7.61 ±0.03	7.74 ±0.02	7.87 ±0.03

Table 3 shows the improvements obtained in seconds between the first test (carried out in pre-season) and the second

test (carried out during the season).

Finally, Table 4 compares the values listed above taking into

Table 3. The improvement found, in terms of duration, in the execution of the two tests

Players	RSA _{best}	RSA _{mean}	RSA ₁	RSA ₂	RSA ₃	RSA ₄	RSA ₅	RSA ₆
Defenders	0.03	0.15	0.05	0.12	0.08	0.19	0.16	0.21
Midfielders	0.08	0.13	0.11	0.13	0.08	0.14	0.21	0.18
Strikers	0.06	0.14	0.04	0.11	0.13	0.17	0.19	0.24
Mean±SD	0.05 ±0.02	0.15 ±0.01	0.07 ±0.03	0.12 ±0.01	0.09 ±0.02	0.17 ±0.02	0.18 ±0.02	0.21 ±0.03

account the pre-training test and the post-training test. The values considered for the application of the t-test are those related to the values of the RSAMean, i.e. the average time relating to all the tests carried out pre and post-training with the Capanna test. From here, to understand whether the null hypothesis is to be accepted or not, we take as a reference the Stat t value, which is 8.54, and we correlate it with the two-tailed t-test value. This is because in the alternative hypothesis it was assumed that the averages are different, so we should have a bilateral alterna-

tive hypothesis. For a two-tailed t-test, the critical value of the T-distribution for 20 df and $\alpha = 0.05$, is equal to 2.09. The range for accepting the null hypothesis is between -2.09 and 2.09. The presence of a statistically significant difference between the two evaluation moments was recorded ($p=0.000$). With the results obtained with the t-test, we can reject the null hypothesis, and we can accept the alternative hypothesis.

Figure 1 graphically shows the improvements recorded at the end of the training period in the variables described above.

Table 4. Independent sample t-test results (RSA_{best})

	N	Mean	SD	SE	t	p
Pre-season	20	7.69	0.04	0.46	8.54	0.00
In-season	20	7.54	0.03	0.45		

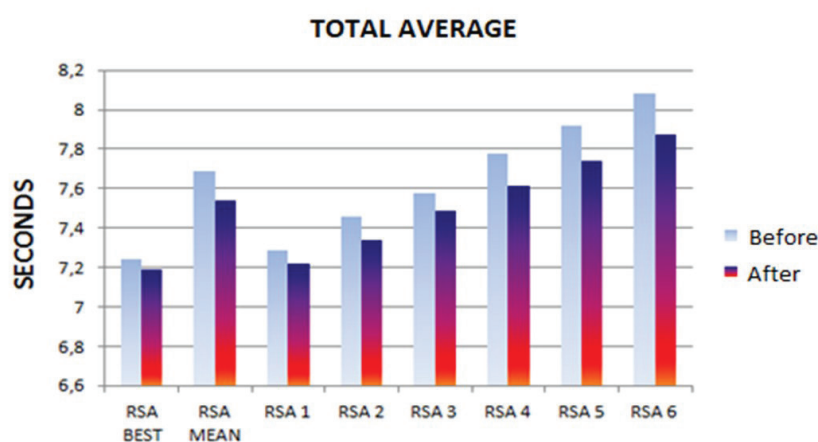


FIGURE 1. Results of Capanna Test pre-season and in-season

Discussion

From the results, the hypothesis of the study regarding the effectiveness of the Cometti method can be confirmed, as it effectively allows to improve the Repeated Sprint Ability by positively influencing motor performance. By observing the results of the group of players, it is possible to understand how to obtain a correct execution of the most important technical gestures, it is necessary to enable the players to respond to the multiple requests that constantly occur in the game. As shown in the tables, the data obtained by the players was grouped by position (7 defenders, 8 midfielders, 5 forwards). The results of these studies demonstrate the possibility of practically applying this operational monitoring tool presented as valid for the individual evaluation of players, since it has a real and significant impact on the result of the game. This study offers itself as a further contribution to strengthen the methodology presented since it produces greater effects than the training process to which the survey group was subjected. Different studies have highlighted repeated-sprint ability as important physical fitness components for soccer players (Rosch et al., 2000; Izzo et al., 2020b). Moreover, similar studies (Helgerud, Engen, Wisloff, & Hoff, 2001; Campa, Semprini, Jùdice, Messina, & Toselli, 2019; Rampinini et al., 2009), reported improved soccer performance, assessed by the number of sprints and the number of involvements with the ball, after the implementation of an 8-week aerobic power training program. As regards the use of the Cometti concatenations method, several authors believe that if well designed, it allows to optimize the working time for competitive athletes, often

engaged in long and daily physical training sessions. In many cases, it also allows to vary the monotony of the exercises and to insert valid metabolic tasks that create the fatigue necessary to optimize individual recovery qualities (Ali, 2011; Altavilla, Riela, Di Tore, & Raiola, 2017). It must be said, however, that this form of training certainly does not contribute to refining the tactical and mental aspects, which are decisive for the leap in football quality, but it can well combine two secondary elements that support the player: conditional qualities and the specific gestures (Buchheit, Mendez-Villanueva, Delhomel, Brughelli, & Ahmaidi, 2010; Padulo et al., 2017). For the athlete not motivated to repeat the same training methods every day, it is preferable, however, to suggest other training solutions, more engaging and with adequate psychophysical commitment (Wragg, Maxwell, & Doust, 2000). Regarding the cognitive aspect, this work acquires a special meaning because it is the essence of a sports game (Chamari et al., 2005; Izzo et al., 2020c). The ability to adapt a learned behaviour quickly and effectively can only be acquired when the player is subjected from the beginning, and up to the high-performance phase, to a systematic development of his mental abilities (Helgerud et al., 2001). These are considered, more than in the past, as the fundamental and essential skills for good performance. Obviously, there is not just one training method that can be recommended to best improve RSA and all the factors believed to be responsible for performance decrements during repeated sprint tasks. This is not surprising, as RSA is a complex fitness component that depends on both metabolic and neural factors, among others (Buchheit et al., 2010; Dellal,

& Wong, 2013). Regarding practical applicability, as many studies to date have used amateur players, we consider that future research will have to recruit highly skilled team sports athletes and be extended to sport-specific test contexts with, in parallel, a high level of standardization and reliability of measures. The results obtained suggest that the strength work is

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Conflict of Interest

The authors declare that there is no conflict of interest.

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ORIGINAL SCIENTIFIC PAPER

Montenegrin Sport Associations on Social Media - Quality of Performance Assessment

Suncica Rogic¹, Milica Vukcevic¹, Milica Muhadinovic¹ and Julija Cerovic Smolovic¹

¹University of Montenegro, Faculty of Economics, Podgorica, Montenegro

Abstract

The aim of this study is to assess the quality of performance of Montenegrin national sport associations on Facebook. As sport is recognized as an activity of public interest, and social media are one of the main sources of information nowadays, given that social media in sport has delivered a new style of communication, authors will try to evaluate the engagement with the fans and the general public. In this paper, Facebook Assessment Index (FAI) methodology will be applied. This methodology involves the analysis of three components: popularity (25%), interactivity (40%) and content (35%). Each of the criteria is evaluated depending on the importance of the indicator on a scale from 0% to 100%. Coefficient value closer to 100% indicates higher quality of performance on Facebook. The results of our paper show the differences between the three categories of Olympic sports in Montenegro, taking into account their performance on Facebook. Social media, as a marketing tool can enhance the positioning of national sport associations by creating a meaningful connection with the fans and the public. Additionally, this connection may strengthen the feeling of devotion to the national team of Montenegro and incentivize younger generations to start training and competing. This study demonstrates which associations use this channel to portray their sport and results, with the aim of promoting sport and healthy lifestyle.

Keywords: social media, sport marketing, FAI methodology

Introduction

The exponential growth of social media users to the detriment of traditional media has also led to a change in the way they seek and collect information. Large commercial brands have recognized and capitalized on this trend, so the annual growth of digital media in the total advertising budget is 8.7%, and in 2020 it is estimated that about 102 billion US dollars have been invested in this way (Zote, 2020). Nearly a third of the world's population, 2.7 billion people are on Facebook (Statista, 2020). And in other spheres of life, whether it is politics, science or sports, social networks are an unavoidable communication channel with the public. Unlike traditional media, they enable interaction and two-way communication with its users.

Due to changes in the consumer behaviour and online communications, it was expected for businesses to turn to

social networks for the marketing and promotion purposes. Social media enable the interaction with consumers, while also allowing the access to their needs, preferences, interests, as well as buying patterns. Additionally, Facebook provided a platform for faster communication and interaction which costs less than traditional advertising media (Ertugan, 2017). Additional marketing benefits include the unique possibility to precisely and accurately target the chosen audience and to customize the content to each defined segment. Therefore, in contemporary marketing literature, Facebook brand pages are recognized as an ideal way to engage with the target market (Logan, 2014).

The benefits of social media are recognized by sport organizations, which are now looking for effective ways of using them as a part of their communication strategies (Coyle, 2010). The popularity of social networks in sports



Correspondence:

S. Rogic

University of Montenegro, Faculty of Economics, Jovana Tomasevica 37, 81000 Podgorica, Montenegro

E-mail: suncica@ucg.ac.me

was first realized by sports clubs, which took the opportunity to increase their influence and make their brands global. For instance, football club Barcelona has over 100 million Facebook followers. There, its sympathizers can find not only information about the club, but also explore the online shop with Barcelona's memorabilia, peek behind the scenes with players, follow live trainings and press conferences, vote for the best players, communicate with them, watching matches in real time, etc. In this way, Barcelona expands its base of followers, connecting with them on a deeper level. From this typical example, it is clear that social networks can be used as a tool to raise brand visibility and awareness.

Similarly, non-commercial sports actors that have the primary mission of popularizing their sport, can use social networks as a medium through which to promote their activities and interact with their followers. Naraine and Parent (2017) conducted semi-structured interviews with representatives from national sport associations from Canada, and explored value, use, and challenges of social media. They concluded that often national associations lack capacities, especially financial and human resources, which would enable them to have a higher quality social media presence.

The aim of social media use for sport organizations is providing team-related information, fostering fandom, and building team reputation (Miranda, Chamorro, Rubio, & Rodriguez, 2014). M. Argan, M. T. Argan, Köse and Gökulp (2013) looked into how Turkish football clubs use Facebook as a marketing instrument and indicated that clubs mostly use Facebook to promote activities and organize campaigns, gifts and discounts, while some used it as a shop by linking the page to their online stores. Additionally, the page was used to distribute news.

One of the ways of analysing the Facebook presence is using the FAI methodology, which will be described in more detail in the following section. In their research, Miranda, Chamorro, Rubio and Morgado (2013) applied the FAI index to evaluate the top 200 most valuable banking brands, based on the Brand Finance Banking 500 report. Their results indicated a low presence of banks on Facebook, as well as significant differences between those who are present, regarding the use of the network, which suggests that there is a possibility to improve the use of Facebook as a marketing tool in this industry.

The FAI methodology was previously applied in some studies in sport. In their study, Miranda et al. (2014) applied this methodology to assess the Facebook pages of European soccer teams and North American professional major leagues - NBA and NFL. Their results showed that only 2.9% of analysed teams (Barcelona, Manchester and Real Madrid) achieved over a half of the maximum score, while 30.39% achieved a score between 30 and 50 points, and the remaining 66.6% have not reached 30 points.

This study will apply the FAI methodology in order to assess and compare the performance of the national sport associations of Montenegro on this social network. Not many studies have treated the problem of analysing and assessing the use of social media networks by the national sport associations.

Methods

There is no universal methodology for measuring the quality of online appearance of subjects on the Internet, but the most common methodologies, are the Facebook

Assessment Index (FAI), the Web Assessment Index (WAI) and Social media influencer index (Miranda, Cortés, & Barriuso, 2006; Miranda et al., 2013; Miranda et al., 2014; Arora, Bansal, Kandpal, Aswani, & Dwivedi, 2019).

According to Mateos, Mera, Gonzalez and Lopez (2001) the WAI evaluates the potential of organizational Web sites, allowing researchers and managers to compare attributes and elements of Internet sites in a particular sector, so as to be able to identify the drawbacks and opportunities. Xanthidis and Nicholas (2009) claim that Web Site Evaluation Index (WSEI) gives the opportunity not only to evaluate if a website is good or not, but also how good it is in comparison with other of similar quality. WSEI can be used to improve the rating system of certain website elements, which are not easily measurable, like attractiveness.

Pegoraro, Scott and Burch (2017) assert that sport associations' interaction with fans on social media can increase a fan's level of identification with the team and their loyalty. Thompson, Martin, Gee and Eagleman (2014) recommended to sports organizations planning to use social media, to be dedicated to a sustainable social media presence across all online profiles, and align those plans with funds able to support it.

In this paper, the performance of Montenegrin national sport associations is assessed. The associations are grouped into three categories, based on the categorization conducted by the Montenegrin Olympic Committee. At the moment of conducting the research, the current categorization was the one published in 2018. Since then, on January 18, 2021, a new categorization was adopted. For this study, authors chose to analyse only the national associations of Olympic sports (19 in total). However, a number of Olympic sports can be considered niche sports, because they do not receive mainstream media coverage on a daily basis.

In order to assess the quality of the performance of sports associations in Montenegro on the social network Facebook, the FAI methodology is applied. The research includes all sports associations that have an appearance on the social network Facebook. Pronschinske, Groza and Walker (2012) tested how are fans affected by Facebook page attributes and found that the number of fans on a Facebook page is determined by authenticity and engagement. They concluded that engaging with fans on Facebook is important for sport organizations, because it positively impacts interaction with a sport brand's content in terms of likes and followers.

In this article, associations are divided into three categories, as previously explained. The research was conducted in December 2020. FAI methodology is based on three components: popularity, interactivity and content (Miranda et al., 2006). Criteria, which construct FAI index, are rated on the scale from 0% to 100%, depending on the importance of criterion. Criterion Popularity accounts for 25%, Interactivity 40% and Content 35% (Miranda et al., 2013). The higher the value of FAI index the better the quality of appearance of sports federations on Facebook. The equation for calculating the FAI index is given below (Miranda et al., 2006):

$$\text{FAI index} = (w_1) \times \text{Popularity Value} + (w_2) \times \text{Interactivity value} + (w_3) \times \text{Content value},$$

where w_1 , w_2 and w_3 are weights (25%, 40% and 35%) for each criteria.

For evaluation of Popularity, the number of followers on Facebook was taken into account. The distribution of points for this criterion is determined according to scale, formulated previously. The sport association with the most followers was given the total weight of this criterion, i.e. 25%, while other points were divided depending on the number of followers.

According to Miranda, Chamorro, Rubio and Morgado (2013), criterion Interactivity includes five indicators: number of wall posts made by the organization in the last 7 days; average number of "likes" per post, calculated from the last 10 posts; average number of comments per post, calculated from the last 10 posts and average number of user's post answered by the association in less than 24 hours, calculated from the last 10 posts that need an answer. In order to distribute points for this criterion it was needed to divide the weight of 40% on five indicators, which means that each indicator got 8%. After that, each sport association is evaluated according to these indicators and the total value of the interactivity indicator for each association was obtained by summing up the values of that association for

each indicator individually.

Last component of the FAI index - Content, was evaluated on the basis of fourteen indicators, in accordance with previous research (Miranda et al., 2014). The weight for this criterion of 35%, was divided by fourteen (number of indicators), i.e. each indicator was assigned 2.5%. Indicators, included in the evaluation of this criteria, are: information about organization, video, photos, marketing message, events, polls, location, e-mail, other Facebook pages, claims and suggestions, website, coupons or specific offers, gamification apps/contests and phone contact (Miranda et al., 2014).

The value of the FAI coefficient was obtained for each sports association, summarizing the values of components, previously explained. The obtained result is given in the next section of the paper.

Results

First component of FAI index is the popularity criterion and it has been rated according to the number of followers on Facebook. The results obtained for this criterion are shown in the Table 1.

Table 1. Results according to criterion popularity

Categories	Link	Number of followers	SUM
First Category			
Water Polo Montenegro	https://www.facebook.com/Vaterpolo-i-pliva%C4%8Dki-savez-Crne-Gore-WPOLO-Montenegro-1539314356307353	3000	20
Volleyball Federation of Montenegro	https://www.facebook.com/OdbojkaskiSavezCG	12092	25
Football Association of Montenegro	https://www.facebook.com/FudbalskiSavez	32507	25
Handball federation of Montenegro	https://www.facebook.com/rscg.me	4234	20
Montenegro Judo Federation	https://www.facebook.com/mnejudo	1239	20
Second Category			
Athletics Federation of Montenegro	https://www.facebook.com/Atletski-Savez-Crne-Gore-Athletics-Federation-of-Montenegro-104934657896698	268	5
Montenegro Sailing Federation	https://www.facebook.com/MontenegroSailingFederation	458	10
Karate Federation of Montenegro	https://www.facebook.com/karatesavezcg	401	10
Tennis Federation of Montenegro	https://www.facebook.com/TeniskiSavezCrneGore	555	10
Third Category			
Shooting Association of Montenegro	https://www.facebook.com/montenegroshooting	284	5
Table Tennis Association of Montenegro	https://www.facebook.com/stscg	555	10
Taekwondo Association of Montenegro	https://www.facebook.com/Tkdmne	291	5

Based on Table 1 it can be concluded that Football and Volleyball associations have the most followers and for this criterion they were given 25 points. Handball, Water Polo and Judo federations have considerably less followers, compared with football and volleyball, but much more than others federations from second and third category. They got 20 points for this criterion. Associations from second and third category have a small number of followers, which is the reason they got 10 or 5 points. This can be explained by the fact that football, volleyball, water polo and handball are the most popular sports in Montenegro and because of that they have the most followers. Associations from second and third category with most followers are Karate, Tennis, Sailing and Table

Tennis and they got 10 points. Athletics and Taekwondo associations have the least followers and thus got 5 points for this criterion.

Criterion Interactivity is the second component of FAI index. It is important to emphasize that although this criterion includes five indicators, this research included only four. Indicator average number of user's post answered by the company in less than 24 hours is not analyzed, because sport is a specific activity, so we cannot expect followers to have special questions as they would have if it was some other activity, such as trade, for example. The results obtained for criterion Interactivity are shown in Table 2.

According to this criteria, the Football Association has the

Table 2. Results according to criterion interactivity

Categories	Number of wall posts	Average number of "likes" per post	Average number of comments per post	Average number of shared posts	SUM
First Category					
Water Polo Montenegro	4	6	4	2	16
Volleyball Federation of Montenegro	8	2	6	0	16
Football Association of Montenegro	2	8	8	8	26
Handball Federation of Montenegro	6	8	4	6	24
Montenegro Judo Federation	0	4	2	6	12
Second Category					
Athletics Federation of Montenegro	2	2	2	6	12
Montenegro Sailing Federation	0	2	2	2	6
Karate Federation of Montenegro	0	4	2	6	12
Tennis Federation of Montenegro	4	4	4	2	14
Third Category					
Shooting Association of Montenegro	2	2	0	0	4
Table Tennis Association of Montenegro	4	2	2	4	12
Taekwondo Association of Montenegro	2	2	4	2	10

highest number of points, which is expected as this association has the most followers on Facebook. The Handball Federation has a slightly lower score, but much more compared to other sports associations. It can be concluded that federations from first and second category have an approximately similar number of points. The exception is the Sailing Federation. Associations from third category have a medium level of interactivity. The Shooting Association has the least points, ac-

cording to this criterion. Although Football and Handball federations have the most points, it is insufficient considering the popularity of these sports.

The last component of the FAI index is the Content criterion, which is estimated on the basis of fourteen indicators, as previously explained, and each indicator is rated with 2.5 points. The results obtained for this criterion are presented in the Table 3.

Table 3. Results according to criterion content

Categories	SUM
First Category	
Water Polo Montenegro	22.5
Volleyball Federation of Montenegro	27.5
Football Association of Montenegro	25
Handball federation of Montenegro	30
Montenegro Judo Federation	22.5
Second Category	
Athletics Federation of Montenegro	22.5
Montenegro Sailing Federation	22.5
Karate Federation of Montenegro	22.5
Tennis Federation of Montenegro	25
Third Category	
Shooting Association of Montenegro	25
Table Tennis Association of Montenegro	27.5
Taekwondo Association of Montenegro	22.5

According to the Content criteria, the Handball Federation ranks first with 30 points. It is followed by Volleyball, Table Tennis and Football Association which scored 27.5, 27.5 and 25 points respectively. All other associations have 22.5 points. Results from this criterion are encouraging

because the federations generally contain all the indicators that form it.

Finally, FAI index is obtained by summing the results from Popularity, Interactivity and Content criterion. The obtained results are given in the Table 4.

Table 4. FAI index

Categories	Popularity	Interactivity	Content	FAI Index
First Category				
Water Polo Montenegro	20	16	22.5	58.5
Volleyball Federation of Montenegro	25	16	27.5	68.5
Football Association of Montenegro	25	26	25	76
Handball federation of Montenegro	20	24	30	74
Montenegro Judo Federation	20	12	22.5	54.5
Second Category				
Athletics Federation of Montenegro	5	12	22.5	39.5
Montenegro Sailing Federation	10	6	22.5	38.5
Karate Federation of Montenegro	10	12	22.5	44.5
Tennis Federation of Montenegro	10	14	25	49
Third Category				
Shooting Association of Montenegro	5	4	25	34
Table Tennis Association of Montenegro	10	12	27.5	49.5
Taekwondo Association of Montenegro	5	10	20	35

Based on the Table 4, it can be concluded that the Football Association and the Handball Federation have the highest value of the FAI coefficient, 76 and 74 respectively, while the Volleyball federation is ranked third. All other federations have a score lower than 60 points, which is at an unsatisfactory level for the modern way of communication and doing business.

Discussion

We can state that federations from the first category scored better in terms of the FAI index, compared to the federations from second and third category. The largest differences among the categories are in popularity and interactivity. This conclusion points out to the need for better performance on social media. The federations should be more active by posting more in order to boost interactivity and gain more points in terms of criteria making up the FAI index. Also, additional reasons for development of comprehensive social media strategy include overcoming the issues of traditional marketing methods, significantly lower costs, creating group of loyal fans, as well as the ability for a cost-effective data analysis available on social media platforms.

When analyzing individual criteria our study showed that first category of sports achieved high results for popularity criterion with all associations achieving 20 points or more. On the other hand, second and third category of sports didn't perform as well. None of the associations reached 50% of the maximum popularity score. In this case, social media managers from the associations can use reach or brand-awareness campaigns which are two of eleven Facebook marketing goals. Brand-awareness campaign can introduce the association page to targeted audience, while reach campaigns allow for the advertisement to be shown to a larger number of Facebook users. It is important to note that these are paid advertisements and it needs to be taken into account when planning the marketing budget. In order to achieve significant results in the segment of interactivity, it is important to focus on building a loyal fan base. One of the most significant advantages of social networks is the possibility of communication with

users, and based on these results, we see that all associations have achieved the lowest results in this segment. Only football and handball achieved over 50% of the maximum interactivity score. This indicates that there are untapped opportunities to strengthen the relationship with the fan base as well as general public and sport lovers. When it comes to the content category, all associations achieved relatively similar results ranging from 20 to 30 points.

It is important to state that some of the associations do not have a Facebook page, such as Basketball and Judo. Having in mind the previously highlighted importance for the engagement with fans, it is recommended that these associations utilize this medium of communication.

Conclusion

As described in the Discussion, alarming shortcomings were observed which, above all, reflect the approach of sports federations to social networks. Namely, it is obvious that sports federations use social networks primarily as a substitute for a website - a bulletin board, where they inform their audience, without using all the benefits and potentials of social networks. These potentials include opportunities to interact and achieve two-way communication with the audience. While large and established organizations like the most popular sports associations have no need to invest in social networks in the short term, to smaller and less well-known sports federations, they represent a great chance to popularize their sports. Research has shown that this potential is completely untapped, and therein lies their chance. Indirectly, it can be concluded that there is a lack of awareness and understanding of the importance of social networks. Given the general lack of funding for sports federations, potential cooperation with commercial sponsors could be achieved if federations on social networks had the value of a segmented, engaged network, making them more attractive to sponsorships. Our results are in line with those obtained by Pegoraro et al. (2017). The authors stated that there is still a significant opportunity to improve the use of social networks as brand management tools, as information posted on Facebook can potentially increase

brand exposure and create positive brand associations for a sport organization.

One of the limitations of this study relates to the choice of organizations to be analyzed. Namely, exclusively national sports federations of Olympic sports were selected. As a recommendation for future research, the inclusion of other

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Conflict of Interest

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ORIGINAL SCIENTIFIC PAPER

Passion as a Determinant in Sport Consumption: the Case of Amateur Cyclists

Luca Ferrucci¹, Fabio Forlani¹ and Antonio Picciotti¹

¹University of Perugia, Department of Economics, Perugia, Italy

Abstract

This paper analyses sport passion as a possible determinant for sport consumption. The purpose of this research, after defining the concept of passion for cycling, is to understand the existing relations between the latter and the costs incurred to practice this sport at an amateur level. This research is exploratory in nature and uses a qualitative mix-method approach. Given the need to isolate individual dynamics of cyclists from socio-cultural influences, the interviewees were selected from a restricted and homogeneous geographical area: the Umbria Region (Italy). The study is structured in two phases: in the first phase 22 in-depth interviews were carried out; in the second phase a group interview was preferred. In order to guarantee transparency e verifiability of the results, the answers were handled with the help of a word processing software (NVIVO). The results of this research suggest that cyclists' consumption models are instrumentally influenced by the passion for cycling, more than other characteristics previously studied in sport management literature. This study provides useful indications on how to develop new forms of market segmentation. It also offers an approach for the operationalization of the level of passion for cycling, which enriches the current equipment of sports management researchers, who can also use the work in other contexts of free time consumption. This work highlights the key role of passion as a determinant for sport consumption and represents an original connection between psychological studies on sport passion and economic studies on sport consumption.

Keywords: *cycling, passion, sport expenses, sport consumption; mix-method approach*

Introduction

Cycling is the fourteenth most popular sport in the world, it ranks in the top ten in Europe and the top five in Italy, France and Spain. Amateur cycling, which is practiced for fun, health and tourism reasons is one of the most popular sports in Europe (Thibaut, Vos, Lagae, Puyenbroeck & Scheerder, 2016; Scheerder, Vos, & Taks, 2011).

In Italy, according to the Italian National Institute of Statistics data (ISTAT, 2017), 8.2% of individuals who practice sports carry out a cycling activity (about 1.935.000 people). In addition to direct consumption, cycling also generates a significant tourist and recreational (events) induced. According to Italian National Tourist Research Institute (ISNART) data, in 2018 bicycle tourism, in its narrow sense, recorded a presence of 21.9 million tourists (2.4% of the Italian tourist movement). On an European level, the European Cycling

Federation (2018) estimates 2.3 billion bicycle touring trips per year.

In the face of a growing industry and a significant economic impact for European economy as a whole, management literature on cycling is still limited. A growing interest for cycle tourism (Perić, Wise, & Dragičević, 2017) and for the analysis of its impact on tourist destinations (Han, Meng, & Kim, 2017) can be observed, while still few studies focus on the spending patterns of cyclists (Thibaut et al., 2016). Specifically, little attention is given to individual passion (Vallerand et al., 2003) as instrumental for sport expenditure.

Given the importance of knowing consumer behavior in practicing sports for both public institutions and businesses and the need to explore these issues with regards to specific behaviours per category of expenditure and per specific sports (Thibaut, Eakins, Vos, & Scheerder, 2017; Wicker,



Correspondence:

F. Forlani
University of Perugia, Department of Economics, Via Pascoli 20, 06123 Perugia, Italy
E-mail: fabio.forlani@unipg.it

Breuer, & Pawlowski, 2010) the purpose of this study is to analyse the dimension of passion for cycling in order to understand if passion is determinant in amateur cyclists' spending patterns.

Individual passion instrumental in sport consumption

The traditional approach used in the analysis of the participation and expenditure models in sports activities has neoclassical roots and its theories are based on: consumer rationality; utility maximisation given the constraints of time and money; stability of preferences; market balance (Thibaut et al., 2016; Pawlowski & Breuer, 2011; Downward & Rasciute, 2011; Downward, 2007). These approaches are based on Becker's (1965) "theory of household production" which stated that the economic decisions of individuals are determined by their available income and the amount of time dedicated to sports (Breuer, Hallmann, & Wicker, 2011; Pawlowski & Breuer, 2011; Wicker et al., 2010).

Some authors (Thibaut et al., 2016; Scheerder et al., 2011; Lera-López & Rapún-Gárate, 2005) have, however, noted how consumers' behavior in sport does not appear to be completely rational. According to these authors, economic agents have limited rationality and, consequently, both psychological and social factors are fundamental in determining consumption behavior (Hallmann & Wicker, 2015; Lera-López & Rapún-Gárate, 2011; Scheerder et al., 2011; Downward & Rasciute, 2011).

In more recent literature (Thibaut et al., 2017; Wicker, Prinz, & Weimar, 2013; Wicker et al., 2010), these perspectives seem to be converging. While keeping the basis of Becker's theory, sport management researchers recognize the importance of "human capital" (Thibaut et al., 2017), characterised by socio-demographic dimensions and "sport-specific consumption capital" (Wicker et al., 2013, 2010).

With regard to the determinants of cyclists' spending, the only available work is Thibaut et al.'s (2016) where, in addition to socio-demographic determinants, the authors have also tested specific determinants related to cycling as: Cycling intensity, Cycling capital and AIOs (Attitudes, Interests, Opinions). Research conducted on about 6.000 cyclists enabled Thibaut et al. (2016) to reach the conclusion that cycling expenditure is more influenced by "sports intensity variables" and "AIOs variables" rather than "classic orthodox socio-economic and socio-demographic variables".

Despite these arguments, there are no studies in sport management literature which specifically analyse sport passion as determinant in sport consumption behaviour, whereas there are a number of works which describe how sport passion holds affective, cognitive and behavioral implications for individuals (Choi, 2019; Wakefield, 2016; Vallerand et al., 2008, 2006; Thomson, MacInnis, & Park, 2005), with references to the passion for cycling (Luth, Flinchbaugh, & Ross, 2017).

Under this perspective, passion is defined "as a strong inclination towards an activity that individuals like (or even love), that they value (and thus find important), and in which they invest time and energy" (Vallerand et al., 2008). In their work, these authors have provided an analysis of the behavioural consequences from leisure activities (including sports), proving that, if internalised in one's personal identity, they tend to grow, thus, generating passion. In some individuals this process is so strong that the object of their

passion becomes a central feature in their personal identity. These authors describe the aforementioned phenomenon as the Dualistic Model of Passion and distinguish between two different ways of experiencing passion: obsessive and harmonious. In obsessive passion the individual feels an uncontrollable impulse to commit wholeheartedly and morbidly to the activity he loves, so much so as to suffer from negative consequences to his other social activities (personal and work-related). On the other hand, in harmonious passion, the strong urge to commit to the sport activity is under full control. Passion experienced in the latter way does not harm social life but improves both social and work performance.

By analyzing the scale used by Vallerand et al. (2003) to differentiate between harmonious and obsessive passion on one hand, and Thibaut et al. (2016) entries in the Cycling intensity and AIOs categories on the other, it is possible to notice several similar elements so as to consider the latter ones as possible proxy variables of passion, rather than determinants in their own rights. Therefore, it is deemed useful to explore this connection, since also consumer models and job satisfaction (Luth et al., 2017) could vary depending on the type of passion for cycling. Accordingly, the first proposition to be proven is the following:

PR1: passion is a relevant phenomenon of amateur sport activities which manifests itself with different levels of intensity and must be measured using multiple dimensions.

The different types of expenses in sport consumption

In sport management literature, there are different scientific contributions which define behavior and types of sport expenditure. Wicker et al. (2010, 2013), have identified different types of expenditure which are directly linked to sport activities, whereas Lera-López and Rapún-Gárate (2011) have widened their approach to indirect expenditures, suggesting the sub-division in two macro-groups: participation-related sport consumption and attendance-related sport consumption. The latter approach has also been used by Thibaut et al. (2017) who, in a transversal work on different types of sports, have subdivided the total expenditures in nine categories of direct expenditures and three indirect ones.

The only study available with regards to cycling is Thibaut et al. (2016), where the authors considered both direct and indirect expenditures, deeming more reasonable to classify them in costs incurred for the purchase of non-durable and durable goods. This approach is considered especially suitable for the current work, under a management point of view, both for the sport discipline analysed and for the resulting implications on consumers' spending patterns.

Experiential expenses (Pencarelli & Forlani, 2018; Chanavat & Bodet, 2014), such as bicycle tourism events and bicycle tourism experiences (Han et al., 2017) are of a different nature (more emotional) and are usually not carried out in the place of residence, and therefore they were separated from the other types of expenditure.

For the purposes of this paper, expenditures for amateur cycling activities are divided into four categories: consumption expenditures, long-term or multiannual expenditures, participation in cycling events expenditures, holiday or tourist experience expenditures.

All of the contributions above, despite being detailed and thorough, do not, however, consider the role that passion plays in determining the amount and type of sport expen-

diture. For this reason, our second proposition is as follows:

PR2: passion is a determinant element which positively influences costs incurred for amateur cycling activities.

Method

Given that the purpose of this work is to explore the existing relationship between passion and costs incurred for cycling, isolating the former from possible local behavioural and cultural influences, it was decided to study amateur cyclists coming from the same geographical and cultural context. Thus, the Umbria Region was chosen for its limited dimension (880,285 people on 01/01/2020), for its geographical position (the Centre of Italy) and for its high number of cycling enthusiasts and cycling clubs (75).

From a methodological point of view, taking into account the explorative nature of this work, a qualitative-type of research design was chosen (McGinley, Wei, Zhang, & Zheng, 2021) and, in order to explore both the results of a personal reflection and the ones resulting from the social interaction of the studied subjects, a mixed method approach (QUAL+QUAL) was used. Studies on mix method approaches argue that the combination of different approaches allows for a triangulation of data and a better understanding of research issues and complex phenomena (Molina-Azorín & Font, 2016; Creswell & Plano Clark, 2007).

This research was conducted in two phases, using two qualitative instruments: a semi-structured qualitative interview and a group interview. During the first phase (May 2019), 22 face-to-face in-depth interviews were carried out on 22 amateur cyclists residing in different municipalities of the Umbria Region who practice different cycling specialties (road and mountain bike), with different age, sex, studies background and employment, who belong or not to an amateur cycling club. The same 18 open-ended questions were asked to each of the 22 interviewees.

The number of interviews was widely within the standards of qualitative studies (12-15), reaching, after the twentieth interview, a saturation of the obtainable information (McGinley et al., 2021). Each interview was 75 minutes long.

All interviews were recorded and, subsequently, transcribed in full.

During the second phase, in order to evaluate the information obtained from the in-depth interviews, and on the basis of the dynamics which emerge from the interactions between amateur cyclists, a group interview was organised with the participation of 8 randomly selected individuals from the 22 interviewed ones. The group interview was 90 minutes long, it was duly recorded and subsequently transcribed.

The information obtain was treated according to the “credibility, transferability, dependability, and confirmability” principles which, as highlighted by McGinley et al. (2021), are requisites to define rigour in a qualitative research. In the first stage, two of the authors conducted, separately, an analysis of the texts by using the Nvivo (Release 1.3) software. The results were then discussed, both in terms of the numbers and types of nodes identified and in terms of existing relationships, with a high rate of agreement (over 80%).

Following to the discussion above, the results were submitted to the third author who has a personal knowledge of the studied phenomenon (being a practicing amateur cyclist) in order to highlight any inconsistencies or lack of data. At the end of this process an unanimous view on the soundness and completeness of the information set was reached by the authors. Lastly, associations for a cross-referenced check of the data were made, identifying the main existing relationships.

Results

The dimensions of sport passion

Using the Vallerand et al. (2003) metrics, it is possible to identify the nature of sport passion as an individual emotional commitment. The survey identified two groups of individuals: 1) those who declare to practice cycling in a balanced manner with regards to other leisure activities, in search of physical wellbeing, being outdoors and socialising and having fun (10/22); 2) those who experience a totalising passion for cycling, regarding this sport as a crucial experience in their existence (12/22).

Table 1. Definition and types of passion

N.	Balanced passion								Totalizing passion						Verbatim	Type
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1										X					It is result-driven	TOT
2									X						If I could, I would go 8 days a week	TOT
3										X					I could define my passion for cycling with a number: 100%	TOT
4									X						It's an ardent passion, from the heart	TOT
5					X										It allows me to keep in touch with nature and it helps me to relax	BAL
6													X		I've been without a bicycle for a while but I was less profitable	TOT
7												X			A sort of reason for living	TOT
8		X													For me it is just for fun	BAL
9										X					I have a bit of an addiction to this passion	TOT
10					X										I give it a fair amount of free time, it allows me to do other things too	BAL
11									X						It has become more serious and more continuous.	TOT

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N.	Balanced passion							Totalizing passion							Verbatim	Type
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
12					X										It is thought-out and not all-encompassing	BAL
13	X														It allows me to combine nature and sport.	BAL
14	X														It's fun and helps me relieve everyday stress.	BAL
15									X						Now it's indispensable, I couldn't do without it.	TOT
16					X										Practising it, even if sometimes it is hard, makes me feel good.	BAL
17	X														I enjoy being among other people or out in the nature.	BAL
18					X										It's a healthy activity and it makes me feel good.	BAL
19	X														For me it's fun, being with people and taking my mind off things.	BAL
20									X						Forces you to go to the limit and not give up	TOT
21									X						For me it is a rejuvenating passion because I feel the need to do it.	TOT
22									X						It's extreme but it makes me feel good.	TOT

With regards to the characteristics of passion for cycling and its measuring metrics (proposition 1), amateur cyclists are almost unanimous (21/22) in regarding free time spent cycling

as the most representative element of sport passion. Free time spent can, in turn, be expressed as a percentage of the available free time and/or the number of outings per week.

Table 2. Dimensions of passion

Dimensions	Balanced passion	Totalizing passion
Free time	Free time as the most representative aspect of passion Free time dedicated to cycling as a minor (less than 30% 5/10) or proportionate (between 30% and 60% 5/10) part of available free time	Free time as the most representative aspect of passion A lot of free time dedicated to cycling, in many cases (7/12) over 70% of available free time
Weekly outings	Small number (once or twice weekly) or medium number (three or four times a week) of weekly outings (5/10 and 4/10)	In the majority of cases (7/12), a high number of weekly outings (5 times and more)
Km per year	In the majority of cases (7/10), low number of km per year (up to 5 thousand)	In the majority of cases (10/12), high number of km per year (over 10 thousand)
Spent income	Low percentage (up to 20%) of income spent on sport activity	For some (6/12) low percentage of income spent on sport activity (up to 20%) while for others (3/12) spent resources make up more than 50% of available income
Type of cyclist	Amateur who defines himself in most cases (6/10) as cycle-sportive	Amateur who defines himself as cycle-professional (10/12)
Competitive nature	Competitiveness in most cases with oneself (6/10) and, in a few cases (2/10) lack of competitive nature at all	Competitiveness in some cases with the others (4/12) and in other cases both with oneself and the others (4/12)
Type of outings	Coexistence of individual and group outings with preference given to the latter for socializing purposes	Complementarity between individual training outings and group outings of a recreational and competitive nature.

A further significant variable to measure the level of passion is the total number of kilometres covered yearly, calibrated, however, with the characteristics of the various cycling disciplines (e.g. road vs. mountain bike) and the physical aspects of the individual (age, physical fitness, etc.)

The competitive dimension is also significant, not necessarily with regards to official competitions but expressed during habitual outings in relation to one's own personal best or in relation to peers' performance. Individuals with a more totalizing passion define themselves as bicycle-professionals and are characterized by a higher level of competitiveness

(with others and with themselves) as opposed to cyclists with a more balanced passion who tend to define themselves as bicycle-sportive.

For the definition of the level of passion, economic resources for cycling activities and the outing methods, seem to be less significant.

The evidence gathered from the individual interviews was confirmed by the group interview. After being asked again, the interviewees confirmed the importance of free time spent as an expression of passion and the need for a multidimensional measurement.

The impact of passion on sport expenditure

The spending and consumer behaviour of amateur cyclists differs according to the type of passion.

With regards to long-term expenditure, cyclists who have a totalising passion for this sport are the ones who invest the

most: they have a higher number of bicycles and higher annual long-term costs. On the other hand, cyclists with a balanced passion show, on average, a lower level of expenditure.

The second type of the expenditure, the consumption one, is also strongly associated to the concept of passion, as the

Table 3. Sport consumption

Type of expenditure	Balanced passion	Totalizing passion
Bicycles	In the majority of cases (7/10), ownership of a single bike with low expenditure (up to three thousand euros)	Ownership of more bicycles (6/12 have two bicycles and 4/12 have three and more bicycles) with a rather high expenditure (4/12 spent between three and six thousand euros and 5/12 spent more than ten thousand euros)
Long-term expenditure	Expenditure generally on an annual basis and with a lower average value (€ 550 per year). Purchasing behaviour predominantly collectivistic, with support (7/10) or total delegation (3/10) to relational networks.	Expenditure generally on an annual basis and with a higher average value (about € 900 per year). Heterogeneous purchasing behaviour, either individualistic (5/12) or attributed, in some cases (5/12), to relational networks
Consumption expenditure	Extremely low expenditure (just over €300 per year). For clothing products, heterogeneity of behaviour based on personal ideas (2/10), affordability of products (2/10), image conveyed (2/10) and suggestions from friends (4/10). For food products, existence of a balance between personal evaluations (4/10) and the influence of relational networks (2/10).	Higher expenses (about € 1.00 per year). For clothing products, more attention to the image conveyed (8/12). For food products, predominantly individualistic purchasing behaviour (7/12), based on personal research and consumer testing.
Event expenditure	Very low average expenses (less than € 200 per year) for participation in non-competitive events (rallies) that often take place in the local context	Higher average expenditure (more than € 1,000 per year) for participation in competitive events (Gran Fondo) considered important in the national context (7/12).
Tourist expenditure	Reduced tourist experiences (2/10) with a significant propensity to carry them out in the future (5/10)	A large proportion have already had tourist experiences (5/12) or attempts to carve out sporting space within traditional holidays (2/12). Some show no inclination to do so in the future (3/12).

greater the involvement and intensity of practice, the greater the wear on certain technical components (tires, brakes, etc.), on clothing products and a greater consumption of dedicated food and beverages (supplements, energy bars, etc.).

As to the third category of expenditures, referring to participation in sporting events, two distinct behaviors have been observed. Amateur cyclists with a totalizing passion favor events with a competitive nature which take place on a national level and require a rather significant economic commitment. Balanced amateur cyclists, on the other hand, have a tendency to participate in non-competitive events (rallies) which often take place in a local context with the purpose of a gathering and which require a lower level of expense.

Lastly, expenditures for tourist cycling experiences that are not linked to any sporting event, follow a different dynamic. This type of expenditure does not seem to be important for the interviewed individuals. Only 7 cyclists stated to have had this type of experience in the past and, only 3 out of these 7 have actually stayed in places outside of the region. The difference in behavior between the two groups does not seem as evident as in the previous categories. It can be, in fact, underlined that for this method of bicycle use, the social dimension represents an instrumental factor, since, besides sharing the passion, an intimacy of a relationship, friendship which goes beyond cycling, must necessarily exist.

The group interview confirmed the results of the in-depth interviews, also with regards to the expenditure patterns and

the influence of the level of passion on sport expenses and has underlined how passion is contaminated by the social dimension.

Discussion

According to the classical models (Becker, 1965) those who practice sports allocate their free time and their income on the basis of a trade-off between these two dimensions (Thibaut et al., 2016; Downward & Rasciute, 2011). If, however, we assume that consumption is guided by passion, both rational and irrational, hedonistic and experiential, important aspects emerge on sport consumption which have been overlooked in previous literature. Under this perspective, free time and available income represent necessary but not sufficient conditions (one may have high resources that are not necessarily used for sport activities). Passion, therefore, represents and is the activator of sport practice and, consequently, sport spending patterns. The results of this research confirm this approach and state: 1) the role of passion as determinant for amateur cycling; 2) the existence of the dynamics of activity, expenditure and consumption which grow as the passion for sports increases.

Incurred cost does not saturate itself, as increased sporting activity and improved performance produce a desire for new activity to achieve ever new goals with regards to one self (competing with one self) and with regards to other members of the community (competing with the others).

This cycle, with different intensity as the passion varies,

was encountered in three of the four categories: greater long-term expenditures (periodic up-grading of technical equipment with a tendency to accumulate them), current expenditure (greater consumption due to wear connected to greater activity), cycling events (participating in increasingly challenging competitive events).

A different dynamic seems to take place with regards to consumption connected with cycle-tourist experiences which are more related to a social dimension.

From a theoretical point of view this study offers distinct implications: 1) it represents, from a marketing perspective, the link between scientific literature on sporting passion which takes a predominantly psychological value, and scientific literature on sports consumption with an economic intake and with the aim of adopting appropriate policies; 2) it provides useful indications on how to develop new forms of segmen-

tation of the market for businesses in the sector; 3) it offers indications for the operationalization of the level of passion in amateur cycling by identifying a number of variables: percentage of free time spent; number of weekly outings; Km completed per year; performance level (km per outing, average speed, altitude level covered, etc.); level of competitiveness; economic resources used.

Due to its explorative nature, this study does not allow any generalizations. The variables can be verified in different socio-cultural dimensions and further tested with qualitative or quantitative techniques in order to identify and measure cause-and-effect relationships in representative samples of the targeted universe.

Lastly, this research lays out considerable scope for development to test the role and influence of passion in other sports and consumer contexts (e.g. cinema, museums, theatres, etc.).

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Shooting Speed Differences between Playing Positions in Top Level Handball

Nikola Foretic¹, Vladimir Pavlinovic¹ and Sime Versic¹

¹University of Split, Faculty of Kinesiology, Split, Croatia

Abstract

Scoring the goal in handball is performed by shooting action. Shooting speed is one of the most important attacking elements that influences successful performance in handball. Anyhow, there is a lack of scientific data considering shooting speed between different playing positions. The main aim of this study was to determine differences in shooting speed between playing positions in top level male handball players. Data used in this study was collected from official match reports of European handball championship held in Austria, Norway and Sweden 2020. Seven hundred and eighty-four (784) shoots were analyzed and variables included were shooting speed and playing position. Shooting speed was collected with iBall (SELECT, Denmark), with a built-in chip that tracks and distributes data in real time (Kinexon, Germany). Differences between playing positions were calculated with Kruskal-Wallis test. Significant difference in shooting speed was noticed between playing positions (Chi-Square=67.34). Post-hoc analysis revealed that line positions (wings and pivots) shoot significantly slower than outfield positions. No differences were noticed between wings and pivots, nor between left, right and center back. On the first sight, results of the study are biomechanically contradictable since faster shoots are from longer distances. Anyway, results could be easily explained if game dynamic is analyzed. Namely, line shoots are executed from narrow angle situations which more often require creative and wise, than strong shooting performance.

Keywords: team handball, shooting velocity, throwing, over-arm throw

Introduction

Handball is team sport game with high physical, technical and tactical demands (Karcher & Buchheit, 2014). Seven players compete for each team, and the game is played on a 40x20-m court. Games are divided into two halves of 30 min each. Main aim is to score more goals than the opponent. Demands of the handball game is seen through its dynamics. Specifically, it is one of the fastest team sport games in which players applicate specific movements in extremely fast and explosive manner (Michalsik & Aagaard, 2015).

Shoot on goal is one of the most frequent technique elements and have several modes of performance. It is divided in 2 bigger groups: shots from the ground and jump shots. Shot from the ground is executed with one leg extended forward although some players perform it with both legs parallel. Although slower, jump

shot is most usual shot in handball and is physically and technically more demanding than ground shot (Rousanoglou, Noutsos, Bayios, & Boudolos, 2014). Approximately one half of all shots during a handball match are executed from the backcourt position and in 60% of them by means of the jump shot technique (Šbila, Vuleta, & Pori, 2004). Regardless shot type, shooting velocity is considered as most important facet of shooting efficiency (Fleck et al., 1992; Rivilla-Garcia, Grande, Sampedro, & Van Den Tillaar, 2011). Therefore, shooting velocity is very important factor of successful attacking performance in handball.

Different playing positions have different roles that puts them in different shooting situations (Büchel et al., 2019; Foretić, Rogulj, & Trninić, 2010; Gusic, Popovic, Molnar, Masanovic, & Radakovic, 2017). For example, wing and outfield players use jump shot in attack ending. Wing players have specific jump



Correspondence:

V. Pavlinovic
University of Split, Faculty of Kinesiology, Teslina 6, 21000 Split, Croatia
E-mail: vladimirpavlinovic@gmail.com

shot in which they jump as long as possible before shooting. Contrary, back players' jump shoot is mostly oriented on vertical dimension of jumping (Karcher & Buchheit, 2014). Scientific research reported that shooting velocity is dependable on four major factors; players morphology, strength and power capacity, shooting technique and fatigue. Zapartidis et al. (2009) found that back players achieved the highest values among all players in ball shooting speed and that they were the tallest (Zapartidis et al., 2009). Associations between players' strength, power and shooting velocity were recorded in several studies (Chelly, Hermassi, & Shephard, 2010; Havolli et al., 2020; Saavedra et al., 2018) while Şimşek (2012) reported negative effect of muscle fatigue on shooting accuracy and velocity in young male handball players (Şimşek, 2012). Analysis of playing position morphology lead to opinion that body height is one of the major selection criteria, especially for back position (Marković & Pivač, 2005; Vuckovic & Dopsaj, 2011). Since shooting situations demand from back players to overcome tall defensive blocks and goal-keeper it is expected that taller players would have more advantage in shooting actions. Beside of the game geometry, taller players would also have longer limbs that can produce longer lever and consequently faster shot (van den Tillaar & Ettema, 2004; Zapartidis et al., 2009).

Generally speaking, shooting ability, especially shooting speed, significantly influences selection of playing positions. Therefore, it is logical to say that shooting speed is very important ability in handball. Its' characteristics should be regularly analysed and monitored. The problem of monitoring is lack of instrument that could be used during official matches where players execute shots in real-game situations. Those situations are specific and have pretty much different demands than those created on simulated testing sessions. Lack of feasible and easily available measuring instruments of shooting speed influenced the lack of

scientific researches in the area. As so, the main aim of our study was to determine differences in shooting speed between playing positions in top level handball.

Methods

Subjects in this study were 118 handball players that participated at European handball championship held in Austria, Norway and Sweden 2020. Just for scored goals shooting speed was reported. Total 784 shots/goals during 15 games were analysed. Shooting speed (SS) was collected with iBall (SELECT, Denmark), with a built-in chip that tracks and distributes data in real time (Kinexon, Germany). Values of shooting speed is presented in kilometres per hour (km/h). Except shooting speed, other variables included 6 playing positions; left wing (LW), right wing (RW), pivot (P), centre back (CB), left back (LB) and right back (RB).

Statistical analyses included the calculation of descriptive statistical parameters (arithmetic means and standard deviations, minimum and maximum measurement values and the Kolmogorov-Smirnov test for testing normality of distribution) and non-parametric ANOVA (Kruskal-Wallis test) to determine the differences between the observed variables. For all analyses, Statistica 13.0 (TIBCO Software Inc, USA) was used, and a p-level of 95% was applied.

Results

Table 1 show results of descriptive statistics calculated for shots taken from 6 playing positions. Uneven distribution is noticed in variables for shots taken from left back (LB) position. This result influenced irregularity of overall distribution (ALL) and caused need for applying nonparametric statistical method for determination of differences in shooting speed between playing positions - Kruskal-Wallis test.

Table 1. Descriptive statistics

Positions	N	Mean±SD	MIN	MAX	KS	p
LW	80	85.90±20.30	38.00	127.00	0.07	> .20
RW	149	87.33±20.68	28.00	136.00	0.04	> .20
P	131	91.07±19.98	25.00	130.00	0.07	> .20
LB	127,0	102.28±20.92	26.00	137.00	0.12 *	< .05
RB	136	102.92±20.18	30.00	137.00	0.07	> .20
CB	161	99.35±19.37	37.00	136.00	0.05	> .20
ALL	787	95.41±21.23	25.00	137.00	0.05 *	< .05

Legend: N – number of subjects; Mean – arithmetic mean; SD – standard deviation; MIN – minimum; MAX – maximum; KS – Kolmogorov-Smirnov test; LW – left wing shoot; RW – right wing shoot; P – pivot shoot; CB – center back shoot; LB – left back shoot; RB – right back shoot; * - irregular distribution

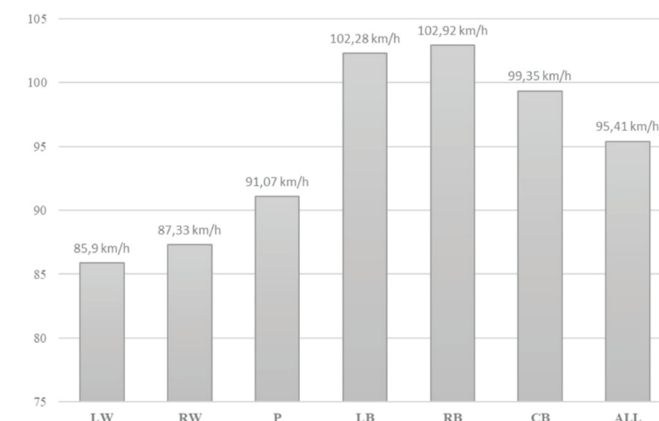


FIGURE 1. Average shooting speed distribution on different playing positions

Figure 1 presents shooting speed distribution on different playing positions. As shown, fastest shots were performed by centre back (CB), left back (LB) and right back (RB) (around 102 km/h), while slowest by left wing (LW) and right wing (RW) (around 86 km/h) playing positions. Pivot (P) players shoot the ball approximately 5 km/h faster than wing players.

Differences between playing positions is shown in table 2.

Significant differences in shooting speed is noticed between: left back (LB) and pivot (P), right wing (RW) and left wing (LW), right back (RB) and pivot (P), right wing (RW) and left wing (LW) and between centre back (CB) and pivot (P), right wing (RW) and left wing (LW). No significant differences were noticed between pivot (P) and wing positions, nor between right back (RB), left back (LB) and centre back (CB), respectively.

Table 2. Differences between playing positions (Kruskal-Wallis test)

Positions	LB R:480.35	P R:340.96	RW R:301.74	RB R:474.49	CB R:432.78	LW R:286.04
LB						
P	4.94 *					
RW	6.53 *	1.45				
RB	0.21	4.82 *	6.43 *			
CB	1.77	3.45 *	5.09 *	1.58		
LW	6.01 *	1.71	0.50	5.91 *	4.74 *	

Discussion

Irregular distribution of left back position shooting speed could be discussed in context of left back player roles in defense and attack transition. Namely, left back players are often players that participate a lot in middle section defensive activities. When opponent loses the ball, and this is happening most frequent in this part of the court, left backs are closest to collect and shoot it on the empty goal. This is happening when opponent is playing 7 vs. 6 or when opponent have excluded player (Korte & Lames, 2019). In both situations there is no goalkeeper on the goal and players that come to the ball possession doesn't have to shoot the ball fast but precise. Obviously, left back players are most of the time in these situations and shoot a lot of "slow shots" on empty goal. These "slow shots" disturbs data distributions and make larger span between minimal and maximal results than in the other playing positions.

Significant difference between outfield and line playing positions should be associated with demands and characteristics of shots taken from different playing positions. When analysing wing players' shots, it can be stated that they have to be more "cunning" than other players. Without question, shots taken from wing positions have smallest angle. Small angle reduces shooting/aiming area (Srhoj, Rogulj, & Katić, 2001). Hence, wing players need to use different shot variations in which they try to trick the goalkeeper (Rogulj, V. Srhoj, & L. Srhoj, 2004). This is most obvious when wing player jumps from "narrow angle" and uses specific shots such as "rotational shot", "dry leave shot" or "lob". All those shots are technically demanding and are very slow in terms of ball speed. Wing players have largest share of "tricky shots" in shooting frequency which influences/decreases overall shooting speed. Slowest shooting speed of wing players was found in some other research. Shalfawi et al. (2014) found that back players had a significant higher ($p < 0.05$) ball shooting velocity of 2.1 ± 1.0 m·s⁻¹ compared to pivots and 4.3 ± 0.7 m·s⁻¹ compared to wing players. Authors concluded that shooting speed in male handball is mostly influenced by playing position, age, shooting type and ball shooting placement (Shalfawi, Seiler, Tønnessen, & Haugen, 2014).

Fastest shooting speed was noticed at outfield players;

left back, right back and centre back, respectively. When observing 9m shots it easy to spot that shooting efficiency is associated with completely different factors than the shoots taken from wing or pivot positions. In outfield shot, back players have to jump as high as possible and perform shot as explosive as possible. Biggest obstacle in 9 m shooting are defenders that constantly interfere shooter, either with physical contact or with blocking actions (Foretić et al., 2010; Karcher & Buchheit, 2014). Opposite to wing player that have small or no defenders' interference, during shooting action, back player needs to shoot the ball as fast as possible to avoid mentioned difficulties. Additionally, 9m shots are geometrically farthest, so "slow" or "tricky shots" are inefficient in these shooting situations. Last factor of difference in shooting speed between outfield and line positions could be players morphology. In particular, outfield playing positions have emphasised longitudinal body dimensions and body weight, in relation to line players (specially to wing players). Several studies showed that those morphological features have strong influence on throwing and shooting performance in various sport activities and games (Fieseler et al., 2017; Srhoj, Rogulj, Papić, Foretić, & Čavala, 2012; van den Tillaar & Ettema, 2004). Although, in our study we didn't consider morphological characteristics, it is logical to assume that back players analysed are highest and heaviest and that those features influence significantly on shooting speed.

Conclusion

Study bring interesting insight shooting speed differences between playing positions in top level handball. Results are in agreement with previous studies coaching intuition in which back players supposed to have faster shooting speed than line players. Authors associate results with specific playing position role and game situation. Wing players use more "tricky shots" than back players and this decreases overall shooting speed of wing players. Future studies should consider and explore some other factors of influence on shooting speed such as detailed players morphology, shooting situations, opponent quality and fatigue. Generally, results could direct handball coaches toward appropriate selection and efficient shooting conditioning on different playing positions.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Bobath Therapy for Cerebral Palsy: An Efficacy Study

Dmitry Butko¹, Vladislav Kuznetsov², Dmitry Kolesov³ and Sergey Kondrashev³

¹Saint Petersburg State Pediatric Medical University, Department of Medical Rehabilitation and Sports Medicine, Saint Petersburg, Russian Federation,

²I. M. Sechenov First Moscow State Medical University (Sechenov University), Department of Physical Culture, Moscow, Russian Federation, ³I. M. Sechenov First Moscow State Medical University (Sechenov University), Department of Chemistry, Moscow, Russian Federation

Abstract

Cerebral palsy is among the most severe perinatal lesions in the central nervous system and a leading cause of childhood disability. Aim to assess how Bobath therapy affects the motor functions and physical development of preschool children with spastic diplegia cerebral palsy. The study includes 42 (46.7%) boys and 48 (53.3%) girls aged four diagnosed with spastic diplegia. All patients were divided into two comparison groups of 45 children based on the method of physical rehabilitation: children enrolled in a conventional rehabilitation program (control group) and children receiving standard rehabilitation together with Bobath therapy (treatment group). After a course of integrated physical rehabilitation, patients demonstrated an improvement in motor skills: 15 (33.3%) children ($p < 0.05$) with GMFCS level 2 improved to level 1, and 16 (35.6%) children ($p < 0.05$) with GMFCS level 3 improved to level 2. In the control group, only 6 (13.3%) children ($p < 0.05$) with GMFCS level 2 improved to level 1, and 11 (24.4%) children ($p < 0.05$) with GMFCS level 3 improved to level 2. The conventional physical rehabilitation combined with Bobath therapy has a positive effect on the motor skills and physical development of children with spastic diplegia cerebral palsy.

Keywords: physical rehabilitation, cerebral palsy (CP), motor dysfunctions, impairment of the nervous system, Bobath therapy

Introduction

At present, perinatal lesions in the central nervous system (CNS) represent an urgent problem in childhood neurology (Bendix, Hadamitzky, Herz, & Felderhoff-Müser, 2019). They are associated with high mortality and disability in children (Novak, Ozen, & Burd, 2018). In general, around 10% of children worldwide experience neuropsychiatric disorders (Bakulski, Halladay, Hu, Mill, & Fallin, 2016; Murden et al., 2019). Brain and spinal cord injuries account for 23% of newborn deaths (Murden et al., 2019).

The most severe perinatal damage to CNS is associated with cerebral palsy (Vitrikas, Dalton, & Breish, 2020), which occurs in 2-3 per 1000 newborns (Stavsky et al., 2017; Maitre et al., 2020). Cerebral palsy (CP) is the leading cause of childhood disability: out of all cases of newly diagnosed childhood disabilities, about 57% are linked to CP (Horber et al., 2020).

The primary etiopathogenetic factors of cerebral palsy are hypoxia and cerebral ischemia, which lead to destructive processes in the central nervous system and cause the development

of irreversible changes (MacLennan, Thompson, & Gecz, 2015). The key mechanisms of rapid damage to the CNS in cerebral palsy encompass the intensifying lipid peroxidation with inhibition of the antioxidant defense system, decompensated oxidative stress, endotoxemia, mitochondrial dysfunction, and activation of cytokines and caspases, resulting in the death of neurons (Panfoli et al., 2018; Magalhaes et al., 2019; Singh-Mallah, Nair, Sandberg, Mallard, & Hagberg, 2019).

The clinical manifestations of cerebral palsy range from subtle to extremely severe symptoms (Michael-Asalu, Taylor, Campbell, Lelea, & Kirby, 2019). Depending on the neurological symptoms, there can be dyskinetic, ataxic and spastic (mono-, hemi-, di- and tetraplegia) forms of CP (Glader, Barkoudah, & Armsby, 2018; Vitrikas, Dalton, & Breish, 2020). Patients with CP can also have epilepsy (41% of the cases), mental retardation (45% of the cases), and autistic disorders (6.9% of the cases); sometimes, such patients experience problems with hearing, vision, speech, etc. (Jonsson, Eek, Sunnerhagen, & Himmelmann, 2019). CP causes impaired movement associated with patho-



Correspondence:

D. Butko

Saint Petersburg State Pediatric Medical University, Department of Medical Rehabilitation and Sports Medicine, 2 Litovskaya str., 194100, Saint Petersburg, Russian Federation

E-mail: butkodmitry@rambler.ru

logical movements and postures, rising (or decreasing) muscle tone, psychomotor issues, and decreased spatial sensation. Almost 30% of children with CP cannot maintain their body in an upright position independently (Michael-Asalu, Taylor, Campbell, Lelea, & Kirby, 2019). Very often, such children experience physical fatigue, pain, and abnormal functioning of organs and systems. Hence, they are at high risk of developing associated conditions and need lifelong medical care (Glader, Barkoudah, & Armsby, 2018; Vitrikas, Dalton, & Breish, 2020).

Until now, the treatment of cerebral palsy has been among the most difficult and unresolved problems in medical rehabilitation (Sadowska, Sarecka-Hujar, & Kopyta, 2020). It calls for an integrated interdisciplinary approach, including pediatric care, physical and occupational therapy, speech and language therapy, neurorehabilitation, assistance of narrow specialists (e.g., psychiatrist, gastroenterologist, nutritionist, orthopedist, audiologist, ophthalmologist, and a surgeon) and social assistance (Stavsky et al., 2017; Ryan, Wright, & Levac, 2020).

Non-drug therapies occupy a central place in the treatment of cerebral palsy (Das, & Ganesh, 2019). In the United States, the most common choice is physiotherapy, accounting for 37.1% of cases, followed by exercise therapy in 29.9% (Pulgar et al., 2019).

The effectiveness of CP treatments and rehabilitation depends on the age of a patient: the most effective scenarios are with patients aged three, owing to greater neuroplasticity at this age (Das, & Ganesh, 2019; Ryan, Wright, & Levac, 2020). A timely non-drug rehabilitation increases the level of functional and psychological independence of a disabled child and significantly improves the quality of patient's life (Das, & Ganesh, 2019). That is why there is an urgent need to develop new, efficient, and cost-effective non-drug therapeutic measures for the treatment and rehabilitation of children with cerebral palsy and other perinatal lesions in the CNS.

In recent years, scientists have drawn their attention to Bobath therapy, which is aimed at restoring systems that are most affected by the damage to the CNS (Kavlak, Ünal, Tekin, & Altuğ, 2018; Zanon et al., 2019). According to the Bobath concepts, a child is a passive recipient, and the Bobath approach itself focuses on the mechanisms of postural control, motor memory, sensorimotor control of muscles, and normalization of muscle tone (Farjoun, Mayston, Florencio, Fernández-De-Las-Peñas, & Palacios-Ceña, 2020). Today, one can find many works devoted to the effectiveness of Bobath therapy (Besios et al., 2018; Kavlak, Ünal, Tekin, & Altuğ, 2018; Zanon et al., 2019), but they cannot boast large samples and do not investigate the possibility of using this technique to treat children with different severities of CP. The aim of the study is to assess how Bobath therapy affects the motor functions and physical development of preschool children with spastic diplegia cerebral palsy.

Methods

The study includes 90 children (48 (53.3%) girls and 42 (46.7%) boys aged four) with spastic diplegia, a form of cerebral palsy (ICP). The patients were divided into two groups: a control group (n=45) and a treatment (study) group (n=45). Children in the control group were assigned to traditional physical rehabilitation, whilst children in the treatment group underwent neuro-developmental treatment. The rehabilitation period in both groups was 6 months (3 courses of 10 days). During the neuro-developmental treatment, anatomical and physiological characteristics of children, the levels of motor disorders, and the type of general nonspecific adaptive response were consid-

ered. The physical rehabilitation program of the control group included treatment with physiotherapy equipment, kinesio taping, sensory integration, and exercises. The program of the treatment group included treatment with physiotherapy equipment, kinesio taping, sensory integration, remedial gymnastics with two motor modes according to Bobath (training, gentle training). The means of Bobath therapy were applied differentially depending on the level of motor disorders (according to the GMFCS system): a gentle training mode was used for children of 1st-3rd GMFCS levels during the first course of physical rehabilitation, further a training mode was used for 1st-2nd levels, while children of 3rd level continued gentle training.

Inclusion criteria: spastic diplegia as a form of cerebral palsy; 1st-3rd level of motor disorders by GMFCS; age of 4 years; examination by a neuropathologist and permission to be included into the child in the study; an informed consent signed by the parents to participate in the study.

Exclusion criteria: other (except for spastic diplegia) forms of cerebral palsy; 4th-5th levels motor disorders by GMFCS; severe congenital malformations; somatic symptom disorder or chronic somatic illnesses.

All children included in the study underwent physical examination by a neurologist and anthropometry (body weight, height, head and chest circumference). Anthropometric indices were assessed using centile tables with regard to gender and age. The data obtained was compared with the average statistical indices. The motor function was evaluated with the help of "Card-test assessment of children's motor abilities" according to B. and K. Bobath. Each of the test points was set up on a 5-point scale: 5 points - normal movements, 4 points - independent-imperfect movements, 3 points - independent-abnormal movements, 2 points - independent but supported in spine position, 1 point - passive movements with the help of a rehabilitation specialist, 0 points - complete inability to take a specific position. The levels of motor disorders were determined according to the GMFCS (Gross Motor Functional Classification System). These levels can be described as follows. Level 1: Children are able to sit on the floor with both hands free to manipulate objects. Children can sit up from lying down and walk without support. Level 2: Children floor sit but may have difficulty with balance when both hands are free to manipulate objects. Children crawl on hands and knees and move around the house holding onto furniture. Level 3: Children can floor sit but may require assistance to maintain sitting. Children crawl on hands and knees and can walk short distances holding onto furniture and using adult assistance. Level 4: Children need additional equipment and assistance for sitting and standing. Children can walk small distances within a room and perform non-reciprocal crawling. Level 5: Complete physical disability restricts volitional control of movement and the ability to maintain head posture. Children are not able to move independently (National Guideline Alliance, 2017).

Statistical data processing was performed with Student's t-test, Fisher's F-test using the SPSS 13.0 software package and Microsoft Excel 2013 (Microsoft, USA). The differences were considered statistically significant at $p < 0.05$. To compare qualitative indicators between the groups, the Fisher's test 2×2 was used.

Results

As regards physical development, the analysis revealed an increase in the following parameters: the average body weight in control group increased by 3.58% ($p > 0.05$), in treatment group

- by 4.86% ($p>0.05$), height - by 1.88% ($p>0.05$) and 1.94% ($p>0.05$), head circumference - by 0.95% ($p>0.05$) and 1.97% ($p>0.05$), chest circumference - by 0.83% ($p>0.05$) and 2.24% ($p>0.05$). There were no statistically significant intergroup differences ($p>0.05$).

Changes in the motor function are shown in Table 1. Children in the control and treatment groups had significant

improvements in the sitting function (improved by 9.1% and 15.5%, respectively, $p<0.05$). Furthermore, improvements were recorded in all parameters, such as motor performance in prone position (6.0% vs 14.7%, $p<0.05$), motor performance in supine position (6.7% vs 13.2%, $p<0.05$), kneeling (13.78% vs 16.3%, $p<0.05$), half-kneeling (13% vs 23.6%, $p<0.05$), and standing (7.8% vs 21%, $p<0.05$) for both groups.

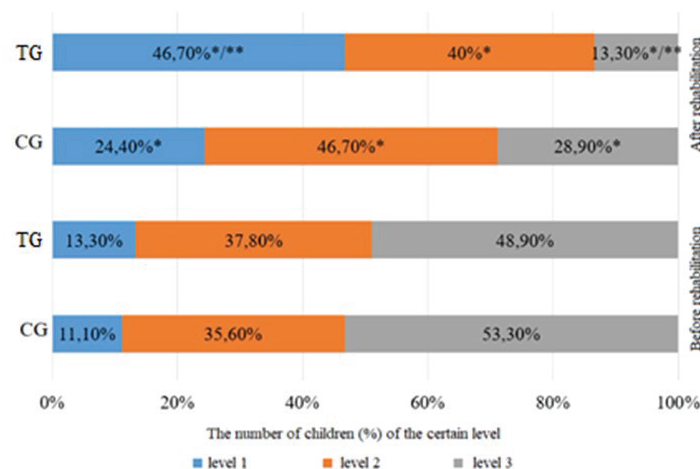
Table 1. Changes over time in the motor function of children with spastic diplegia

Indicators	Group	Before rehabilitation	After rehabilitation
		M \pm SD	M \pm SD
Sitting position, points	CG (n=45)	3.52 \pm 0.08	3.84 \pm 0.03*
	TG (n=45)	3.61 \pm 0.07	4.17 \pm 0.05*/**
Prone position, points	CG (n=45)	4.02 \pm 0.07	4.26 \pm 0.063*
	TG (n=45)	4.15 \pm 0.06	4.76 \pm 0.07*/**
Spine position, points	CG (n=45)	4.03 \pm 0.085	4.30 \pm 0.04*
	TG (n=45)	4.17 \pm 0.09	4.72 \pm 0.036*/**
Turns on the abdomen, points	CG (n=45)	3.75 \pm 0.08	4.08 \pm 0.09
	TG (n=45)	3.83 \pm 0.095	4.16 \pm 0.07
Turns on the side, points	CG (n=45)	3.85 \pm 0.09	4.15 \pm 0.068
	TG (n=45)	3.90 \pm 0.07	4.37 \pm 0.18
Kneeling, points	CG (n=45)	3.34 \pm 0.04	3.80 \pm 0.04*
	TG (n=45)	3.54 \pm 0.068	4.15 \pm 0.05*/**
Half-kneeling, points	CG (n=45)	3.22 \pm 0.057	3.64 \pm 0.05*
	TG (n=45)	3.31 \pm 0.072	4.09 \pm 0.043*/**
Standing, points	CG (n=45)	2.95 \pm 0.03	3.18 \pm 0.03*
	TG (n=45)	3.14 \pm 0.04	3.80 \pm 0.05*/**

Legend: *-the difference is statistically significant comparing to the indicator before treatment ($p<0.05$); **-the difference is statistically significant comparing to the indicator after treatment in the control group ($p<0.05$); CG - control group; TG - the treatment group

The study of motor function (according to the GMFCS system) showed an improvement in motor skills in both groups at the end of rehabilitation (Figure 1). Before rehabilitation, there were 5 (11.1%) children with GMFCS level 1 in the control group, 16 (35.6%) with level 2, and 24 (53.3%) with level 3. The treatment group consisted of 6 (13.3%) children with level 1, 17 (37.8%) with level 2, and 22 (48.9%) with level 3. At the end

of treatment, there were 11 (24.4%) children with level 1, 21 (46.7%) with level 2, and 13 (28.9%) with level 3 in the control group. The treatment group included 21 (46.7%) children with level 1, 18 (40%) with level 2, and 6 (13.3%) with level 3. Hence, with a traditional rehabilitation program, 6 (13.3%) children improved from level 2 to level 1 ($p<0.05$), and 11 (24.4%) children improved from level 3 to level 2 ($p<0.05$). Changes in



Legend: CG-control group; TG-the treatment group; *-the differences are statistically significant comparing to the indicator before treatment ($p<0.05$); **-the differences are statistically significant comparing to the indicator after treatment in the control group ($p<0.05$)

FIGURE 1. Changes over time in GMFCS levels of children with spastic diplegia

the treatment group were more significant comparing to the control group ($p < 0.05$). For instance, there were 15 (33.3%) children in the treatment group ($p < 0.05$) who improved from level 2 to level 1, and 16 (35.6%) children who improved from level 3 to level 2 ($p < 0.05$). There were no statistically significant differences ($p > 0.05$) in GMFCS levels between groups before rehabilitation. After rehabilitation, however, the number of children with level 1 was statistically higher ($p < 0.05$) in treatment group than in the control group. On the other hand, the number of children with level 3 in treatment group was significantly lower than in the control group ($p < 0.05$). There were no statistically significant differences in level 2 between groups ($p > 0.05$), since only 6 children in the control group improved from level 2 to level 1, whereas in the treatment group, the amount of children who improved their GMFCS level was nearly 3 times larger.

Discussion

This study examined two types of physical rehabilitation strategies for children with spastic diplegia cerebral palsy: a conventional strategy and an improved program integrating the Bobath therapy. A positive tendency was observed among children of both groups at the end of physical rehabilitation. However, changes in anthropometric parameters (height, body weight, head and chest circumference) were not significant for both groups. There were no statistically significant differences ($p > 0.05$) in the initial and intergroup indicators ($p > 0.05$), due to a relatively short follow-up period (only 6 months). The significant changes may occur with a longer rehabilitation period.

The rehabilitation programs of both comparison groups were effective, as evidenced by a statistically significant ($p < 0.05$) difference in motor activity before and at the end of rehabilitation. The motor performance of children in the treatment group significantly improved comparing to that in control group ($p < 0.05$, Table 1). At the end of rehabilitation, 13.3% of children in treatment group belonged to GMFCS level 3 compared to 28.9% in control group ($p < 0.05$). Thus, the Bobath concept was proven effective. Meanwhile, the number of children of the 1st level by GMFCS significantly increased ($p < 0.05$) (46.7% in treatment group vs 24.4% in control group). Such a positive effect on the motor skills is due to the influence on 'key points of control': head, shoulders, palms, trunk, pelvis, and feet (Grazziotin dos Santos et al., 2015; Kavlak, Ünal, Tekin, & Altuğ, 2018).

The study results are comparable with data of other studies in the field (Besios et al., 2018; Tekin, Kavlak, Cavlak, & Altuğ, 2018; Zanon et al., 2019). For example, the study of a 8-week Bobath therapy among 5-15-years old children with cerebral palsy, showed a statistically significant improvements in general motor function ($p < 0.05$), functional independence ($p < 0.05$), postural control ($p < 0.05$) (Tekin et al., 2018). A research carried out among 70 children aged 3-18 years with

spastic diplegia. The study evaluated the influence of Bobath therapy on the activity of neck and trunk muscles. At the end of rehabilitation, there was a significant increase in electromyography of neck and trunk muscles ($p = 0.017$). Thus, Bobath therapy increases their activity, improves their functioning in children with cerebral palsy (Grazziotin dos Santos et al., 2015). Another similar study also confirmed a significantly greater ($p < 0.05$) effectiveness of the 8-week Bobath therapy in comparison with traditional physical rehabilitation, while exercises aimed at strengthening the muscles of the trunk were the most effective ($p < 0.05$) (Keser, Kirdi, Meric, Kurne, & Karabudak, 2013). The systematic review of three randomized trials indicated that there is no statistically significant difference ($p > 0.05$) between Bobath therapy and traditional rehabilitation. However, two of these studies had methodological limitations for the use of Bobath therapy, and only one study provided data on the effect of this method on gross motor skills in children with cerebral palsy (Zanon et al., 2019). Most studies of Bobath therapy involved a small number of children. The method has not been sufficiently studied yet and requires further, detailed and in-depth study involving large research samples.

The results of the study suggest that the examined physical rehabilitation technique realizes the basic principles of physical rehabilitation for children with spastic diplegic cerebral palsy (i.e., comprehensiveness, effectiveness, staging, load adequacy, social orientation, emotionality, accessibility, and purposefulness). The proposed rehabilitation program integrating the Bobath therapy also aligns with the basic principles of correctional pedagogy (i.e., individualization, consciousness, consistency, cyclicity, novelty, diversity, moderation of exposure). The Bobath approach allows to improving the physical development, motor functions, and motor skills of children who suffer from spastic diplegia cerebral palsy.

Conclusion

Using Bobath therapy as part of a complex physical rehabilitation program for children with spastic diplegia cerebral palsy is more effective compared with traditional treatment. Children treated according to the Bobath approach showed greater improvement in motor abilities in a sitting position (15.5 versus 9.1% under conventional program), kneeling (16.3 versus 13.8%), standing (21.0 versus 7.8%), when lying on the stomach (14.7 versus 6.0%) and back (13.2 versus 6.7%), and in a half-kneeling position (23.6 versus 13.0%, $p < 0.05$). Improvements were also noticed in motor skills and physical development. Therefore, Bobath therapy can be recommended for spastic diplegia cerebral palsy.

Prospects for further research

The future research can focus on the effect of Bobath therapy on cerebral circulation in children with spastic diplegia, a form of cerebral palsy.

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There are no acknowledgements.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Psychological Benefits of Equine-Facilitated Activities for Children Diagnosed with Cerebral Palsy

Uğur Ödek¹, Kürşat Özcan¹, Gonca Özyurt² and Selcuk Akpinar¹

¹Nevşehir Hacı Bektaş Veli University, Faculty of Education, Department of Physical Education and Sport, Nevşehir, Turkey, ²İzmir Katip Çelebi University, Faculty of Medicine, Child and Adolescent Psychiatry Department, İzmir, Turkey

Abstract

Equine-facilitated activities (EFA) are generally considered to be an alternative treatment method by using the natural body form, gait and behavior of horses. EFA have been used for many years to treat and to improve the living conditions of people with disorders or disabilities such as autism, cerebral palsy (CP), arthritis, multiple sclerosis, stroke, spinal cord injury, behavioral and psychiatric disorders. This study aims to examine the effects of adaptive riding (AR), which is a subdiscipline under EFA, on anxiety, empathy, aggression, and emotional regulation of children diagnosed with cerebral palsy. Maternal depression and anxiety level measurements were also included in the study. Twenty children with CP, between 7 and 10 years old and their mothers participated in the study. They were randomly assigned to one of two groups (intervention and control) consisting of 10 participants. Pre and post measurements were implemented at the beginning and at the end of 8 weeks of AR intervention. The Screen for Anxiety Related Emotional Disorders, Bryant Index of Empathy Measurement for Children and Adolescents, Buss-Perry Aggression Questionnaire, Beck Depression Inventory, The State-Trait Anxiety Inventory were used to measure the psychological and emotional status of the participants and depression, anxiety levels of mothers. Aggression, anxiety, and maternal depression decreased; empathy and emotional regulation improved in the intervention group. No significant differences found in the control group. This study provides strong evidence that an 8-week AR intervention has positive effects on children with cerebral palsy. Significant improvements regarding both maternal and children's psychological and emotional aspects showed how an alternative therapy with animals can be constructive.

Keywords: aggression, cerebral palsy, emotional regulation, empathy, equine-facilitated activities, maternal anxiety, maternal depression

Introduction

Cerebral palsy (CP), with the incidence of 2–3/1000 newborns, is a neurologic disorder, which leads to chronic neurologic and developmental abnormalities, and children diagnosed with CP usually need special education and therapy (Kim et al., 2005). CP may cause severe movement and postural problems. Treatment methods aiming to increase the physical fitness levels and promote the psychological development of individuals with CP include applications that increase sensory input and motor

functions. Equine Facilitated Activities (EFA), which include many physical and cognitive activities and support sensory and emotional development, are widely used today for the treatment of individuals with CP. Adaptive Riding (AR), which is a form of EFA, defined as recreational horseback riding lessons adapted for people with disabilities and it is one of the widely preferred methods for treatment of CP. Physical and functional improvements such as gait speed, rhythm, width, and bilateral symmetry as well as improved gross motor functions and balance parameters are



Correspondence:

S. Akpinar
Nevşehir Hacı Bektaş Veli University, Faculty of Education, Department of Physical Education and Sport, 50300, Nevşehir, Turkey
E-mail: selcukbos@gmail.com

seen after EFA (Manikowska et al., 2013). However, EFA and related treatments lack a scientific basis regarding psychosocial effects. McGibbon et al. (1998) reported EFA treatments twice a week for 8 weeks in children with CP increased social activities and reduced energy expenditure during walking. Casady and Nichols-Larsen (2004) reported that EFA treatments once a week for 10 weeks improve self-esteem and motivation and increase participation in the activities in children with CP. However, their study was not based on objective results but on the participants' verbal expression.

In EFL and AR, horses come into contact with medically or socially disadvantaged humans or those having specific needs. These activities provide new stimulus related to gait and help balance and postural control in children with CP because the pelvic movements of a horse rider are similar to that of the pelvis during gait (Glasow, 1986). EFA is a good strategy to increase functioning in children with CP who need continued, varied, and repetitive treatment.

Children diagnosed with CP usually need long term rehabilitation, which may restrict social interactions with peers and may cause social isolation (Reddihough et al., 2013). Empathy is the capacity to share and understand another's state of mind or emotion. It is often characterized as the ability to put oneself into another's place, or in some way experience the outlook or emotions of another being within oneself. Empathy is a powerful communication skill that is often misunderstood and underestimated. Children can develop their empathy skills through social interaction with each other. In case of a lack of communication, these skills may not be developed at the desired level (Coutinho, Silva, & Decety, 2014). Socially isolated children (such as those with disabilities) are more anxious and aggressive. With the decrease in the social status of children facing social exclusion, these children are deprived of the protective function provided by friendship (Bourke & Burgman, 2010). Children with physical and/or developmental disabilities (like CP) are disproportionately bullied at high rates and that may cause anxiety, aggression, non-empathic attitudes (Asher & Gazelle, 1999). Children with a chronic disorder are almost three times as likely as healthy peers to suffer social exclusion, lower levels of friendship and peer support. For this reason, it is necessary to provide opportunities for disabled children, who are among the disadvantaged groups, to increase their social interactions.

The primary caregivers of children with disabled children have been found to experience increased stress, health problems, and a greater sense of restriction compared to parents who do not have disabled children. Mothers specifically experience a heavy sense of guilt, inferiority and a decrease in their personal well-being, which can lead to depression and anxiety disorder (Ribeiro, Porto, & Vandenbergh, 2013). Maternal anxiety and depression may also cause children's aggression problems, anxiety and empathy deficits. EFA, in which positive psychological effects were shown on disabled children and people who have mental disorders (Brandt, 2013) may improve empathy skills and decrease aggression and anxiety in children diagnosed with CP. Thus, in the present study, we aimed to evaluate the benefits and effectiveness of EFA in the areas of anxiety, aggression, empathy, emotion regulation for children diagnosed with CP. Maternal depression and anxiety levels were also evaluated before and after EFA.

Method

Participants

A total of 20 children and their mothers participated in the

study, and the participants were divided into two groups of 10 by random selection method to be included in the intervention and control groups. The intervention group consisted of three male and seven female children with CP ($M_{age} : 8.2 \pm 0.8$). The control group consisted of the same number of children with CP ($M_{age} : 8.3 \pm 0.5$) with the same gender distribution. Five of the participants in the experimental group had spastic paraplegia, four had spastic hemiplegia, and one had spastic triplegia, while five of the participants in the control group had spastic paraplegia and the remaining six had spastic hemiplegia. Participants were classified between levels 1-4 using Gross Motor Function Classification System. The participants were selected from the children who visited Nevşehir City Hospital Physiotherapy Clinic due to their condition. Children who can sit with limited or no assistance and have no previous EFA experience included in the study. Since EFA have been carried out using AR principles, activities on horseback were mainly used. Therefore, unable to maintain the head position due to gravity and horse movements, feeling unbearable pain, having a limited joint range of motion that prevents riding, having a deformation in the spine and lower extremities that cannot be treated by adaptive riding, having uncontrollable epilepsy, having a fracture risk due to severe osteoporosis were accepted as exclusion criteria.

The mean age of the mothers participating in the study was 33.3 ± 3.6 for the intervention group and 32.6 ± 3.43 for the control group. All mothers were married, the average daily childcare of the mothers time was 18 hours. None of the mothers had a history of using psychotropic drugs such as antidepressants and there were no significant differences in maternal ages, education and working status between the groups. Mothers signed the informed consent forms required for both themselves and their children to participate in the study at the beginning of the study. The study carried on in accordance with the Declaration of Helsinki as amended by the World Medical Association Declaration of Helsinki and the study was approved by the Ethics Committee of Erciyes University.

Measurements

The Screen for Anxiety Related Emotional Disorders (SCARED) instrument: The SCARED is an instrument used to screen for childhood anxiety disorders including, general anxiety disorder, separation anxiety disorder, panic disorder and social phobia. It comes in two versions; one asks questions to parents about their child and the other asks these same questions to the child directly. Respondents may select from the options of "Not True or Hardly Ever True", "Somewhat True or Sometimes True", and "Very True or Often True" (Birmaher et al., 1997). SCARED Turkish forms' validity and reliability were made by Cakmakci (2004). Both child and parent's instruments were used to measure the above-mentioned variables.

Bryant Index of Empathy Scales for Children and Adolescents: The scale was developed by Bryant in 1982 used to measure the empathy skills of children and adolescents aged between 8-14 years. The Turkish validity and reliability study of the scale was done by Görtünca (2013). The original form consisted of 22 items. One item was removed in the Turkish adaptation and validity reliability study, thus the scale included 21 items. The response format was changed from the original two-stage (yes vs. no responses) format that Bryant used, to a scale of one "I strongly agree" to five "I strongly disagree" (Bryant, 1982).

Buss and Perry (1992) Aggression Questionnaire: The scale, adapted from the Buss-Durkee Hostility Inventory, is a 5 point

likert type scale consisting of 29 items. It aims to measure four different dimensions of aggression: physical aggression, verbal aggression, hostility and anger. Physical aggression subscale, 9 questions about physically harming others; verbal aggression subscale, 5 questions about verbally hurting others; anger subscale, 7 questions aiming to measure the emotional dimension of aggression; hostility subscale contains 8 questions aiming to measure the cognitive dimension of aggression (Buss & Perry, 1992). The Turkish adaptation, validity and reliability study of the inventory was carried out by Demirtaş (2012). In this study, only the sub-dimension of the inventory measuring anger was used.

Beck Depression Inventory (BDI): Developed by Beck, Ward, Mendelson and Erbaugh (1961), the scale is used to determine the risk of depression and measure the level of depression symptoms and the change in severity on a 4-point scale ranging from 0 to 3. It is a scale containing 21 self-evaluation sentences. The score range varies between 0 and 63, a high score indicates a high severity of depression. The validity and reliability of the Turkish form were made by Hisli (1989).

The State-Trait Anxiety Inventory (STAI): The scale was developed by Spielberger et al. in 1964 to determine the state and trait anxiety levels of individuals (Spielberger, 1970). Its translation into Turkish, reliability and validity studies were carried out by Öner and Le Compte (1983). The scale, which is a type of self-evaluation, includes 40 items consisting of short expressions. The scale consists of two parts: the "state anxiety form" with 20 items, which was created to determine what is felt at the moment, and the "trait anxiety form" of 20 items, which was created to determine what has been felt for the last seven days (Öner & Le Compte, 1983). In this study, STAI was used only to measure the anxiety levels of mothers.

Adaptive Riding Procedure

The contents in this section have been mentioned in the work previously published by Ozyurt et al. (2020). An occupational therapist, a physical therapist, and a pediatrician were present during all sessions. During the 8-week adaptive riding activities, the participants took a part in the activities for 1 hour each week. A maximum of 2 participants took part in the same session. The content of the sessions was organized in a way that all activities met children's goals and objectives, also their capabilities are taken into consideration. Before the sessions started, the children and their families were given a tour of the equestrian center and informed about the gener-

al layout and rules. Professional Association of Therapeutic Horsemanship International guidelines were administered during all AR sessions. In accordance with the guidelines, there was a trained volunteer leading the horse and two volunteers walking along either side of the horse (side-walkers) to ensure the rider's safety in all sessions. In addition, it was ensured that protective helmets and vests were worn by all participants in all sessions. A certified instructor who specialized in therapeutic horsemanship led all sessions. The certified instructor chose the horses for each rider considering the size and ability of the riders. The sessions included grooming and feeding, walking with the horse, and riding activities (Akpınar, Özcan, Özyurt, & Dinseven, 2016). Additionally, skills such as speech and socialization were also addressed during sessions.

Statistical Analysis

SPSS ver. 19.0 software (IBM, USA) was used for the statistical analyses. Five instruments were used to determine psychological, psychosocial, and emotional parameters. A two-way mixed-model Repeated Measures ANOVA was used for each dependent variable. Prior to each statistical analysis, assumptions for mixed-model Repeated Measures ANOVA were tested. The group (intervention and control) was treated as a between factor, and the test (pre and post-tests) was treated as a within factor. The statistical significance level was set as $p < .05$ for all analyses.

Results

The Screen for Anxiety Related Emotional Disorders (SCARED)

The mean values for the SCARED questionnaires filled by the children and filled by the parents are shown in Figure 1a and Figure 1b. The statistical analysis for the SCARED questionnaire filled by the children displayed a significant two-way interaction (groups*tests), $F_{(1,18)} = 10.66$, $p < .05$, $\eta^2 = .37$. Post-hoc analysis showed that the control group's scores did not change from pre to post-tests ($M = 38.8 \pm 2.56$ and $M = 39.4 \pm 1.84$, $p > .05$, respectively). However, a significant decrease was observed in the intervention group from pre- to post-tests ($M = 37.8 \pm 2.55$ and $M = 30 \pm 1.73$, $p < .05$, respectively). Both group's SCARED scores were not significantly different at the pre-test ($p > .05$). However, the intervention group's score was significantly lesser than the control group at the post-test ($p < .05$).

The statistical analysis for the SCARED questionnaire

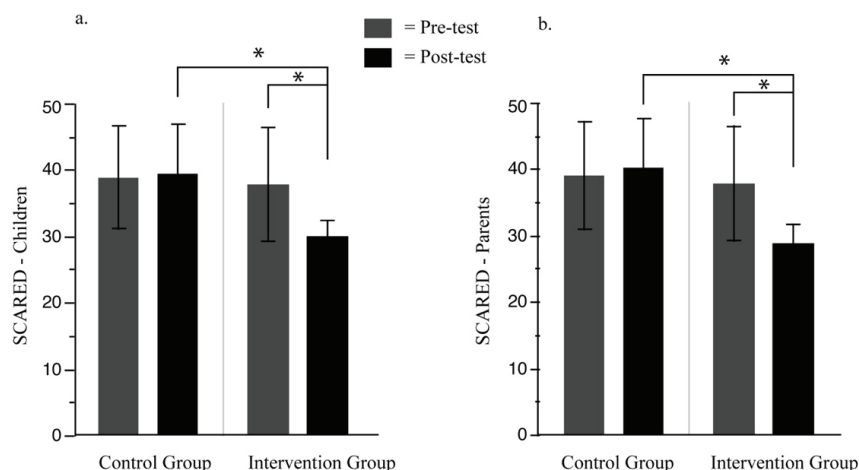


FIGURE 1a and 1b. The average values for the SCARED questionnaires filled by the children (1a) and filled by the parents (1b) for both groups from pre- to post-test

filled by the parents also displayed a significant two-way interaction (groups*tests), $F_{(1,18)}=14.03$, $p<.05$, $\eta^2=.44$. Post-hoc analysis showed that control group's scores did not change from pre to post-tests ($M=39\pm2.66$ and $M=40.2\pm1.75$, $p>.05$, respectively). However, a significant drop was observed in the intervention group from pre- to post-tests ($M=37.8\pm2.66$ and $M=28\pm1.75$, $p<.05$, respectively). Both groups SCARED scores were not statistically significant at the pre-test ($p>.05$). However, the intervention group's SCARED score was significantly lesser than the control group at the post-test ($p<.05$). According to these results, the anxiety levels of the parents and children in the intervention groups significantly decreased after adaptive riding sessions.

Bryant index of empathy

The mean empathy scores for both groups between pre and post-tests are shown in Figure 2. The statistical analysis for Bryant Empathy Scale displayed a significant two-way interaction (groups*tests), $F_{(1,18)}=24.71$, $p<.05$, $\eta^2=.44$. Post-hoc analysis showed that the control group's empathy scores did not change from pre to post-tests ($M=11.5\pm.51$ and $M=11.6\pm.44$, $p>.05$, respectively). However, a significant increase was observed in the intervention group from pre to post-tests ($M=11.3\pm.50$ and $M=13.2\pm.43$, $p<.05$, respectively). Both groups' empathy scores were not significantly different at the pre-test ($p>.05$). We can infer from these results that empathy skills increased in the intervention group after adaptive riding sessions.

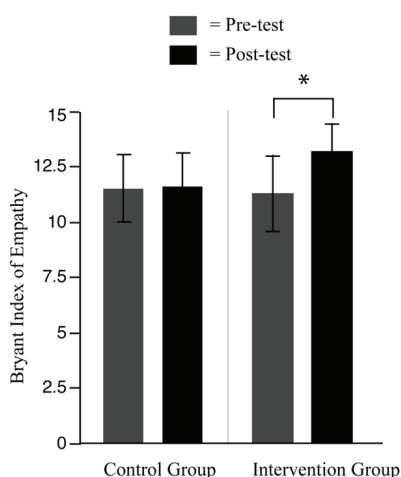


FIGURE 2. The average values for empathy scores for both groups between pre- and post-tests

Buss and Perry Aggression Questionnaire

The mean scores of Buss and Perry Aggression Questionnaire for both groups between pre and post-tests are shown in Figure 3. The statistical analysis for Buss and Perry Aggression Questionnaire displayed a significant two-way interaction (groups*tests), $F_{(1,18)}=34.29$, $p<.05$, $\eta^2=.66$. Post-hoc analysis showed that control group's aggression scores did not change from pre to post-tests ($M=71.5\pm3.5$ and $M=72.9\pm3.6$,

$p>.05$, respectively). However, a significant decrease was observed for the intervention group from pre to post-tests ($M=72\pm3.51$ and $M=56.6\pm3.6$, $p<.05$, respectively). Both groups' aggression scores were not statistically significant at the pre-test ($p>.05$). However, the intervention group's aggression score was significantly lesser than the control group at the post-test ($p<.05$). This result implies that participating in adaptive riding decreased the aggression level in children with CP.

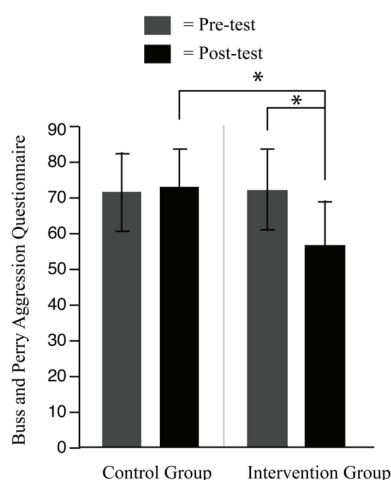


FIGURE 3. The average values for Buss and Perry Aggression Questionnaire for both groups between pre and post-tests

Beck Depression Inventory (BDI)

The mean scores from BDI for both groups between pre and post-tests are shown in Figure 4. The statistical analysis for BDI displayed a significant two-way interac-

tion (groups*tests), $F_{(1,18)}=9.74$, $p<.05$, $\eta^2=.35$. Post-hoc analysis showed that the control group's depression scores did not change from pre to post-tests ($M=13.1\pm1.25$ and $M=14\pm0.84$, $p>.05$, respectively). However, a significant

decrease was observed in the intervention group from pre to post-tests ($M=13.5\pm1.25$ and $M=10.7\pm0.8$, $p<.05$, respectively). Both groups' depression scores were not significantly different at the pre-test ($p>.05$). However, the intervention

group's depression score was significantly lesser than the control group at the post-test ($p<.05$). Similar to aggression level, participating in adaptive riding decreased the depression level in children with CP.

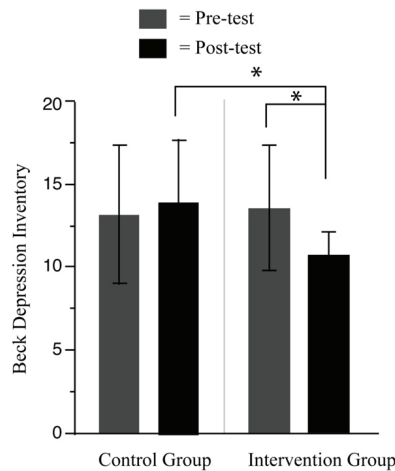


FIGURE 4. The average values for Beck Depression Inventory (BDI) for both groups between pre and post-tests

The State-Trait Anxiety Inventory (STAI)

The mean scores from state and trait anxiety inventory for both groups between pre and post-tests is shown in Figure 5a and Figure 5b. The statistical analysis for state anxiety level among parents displayed a non-significant two-way interaction (group*tests), $F_{(1,18)}=3.32$, $p>.05$, $\eta^2=.15$, a non-significant test main effect, $F_{(1,18)}=.29$, $p>.05$, $\eta^2=.01$, and a non-significant group main effect, $F_{(1,18)}=3.02$, $p>.05$, $\eta^2=.14$.

The statistical analysis for trait anxiety level among parents displayed a significant two-way interaction (group*tests), $F_{(1,18)}=10.27$, $p<.05$, $\eta^2=.36$. Post-hoc analysis showed that the control

group's trait anxiety scores did not change from pre to post-tests ($M=45\pm1.12$ and $M=43.8\pm1.26$, $p>.05$, respectively). However, a significant decrease was observed in the intervention group from pre to post-tests ($M=44.4\pm1.11$ and $M=38.3\pm1.26$, $p<.05$, respectively). Both groups' trait anxiety scores were not significantly different at the pre-test ($p>.05$). However, the intervention group trait anxiety score was significantly less than that of the control group at the post-test ($p<.05$). Unlike state anxiety level, parents of children in the intervention group had a lower level of trait anxiety after adaptive riding sessions, which was not observed in parents of children in the control group.

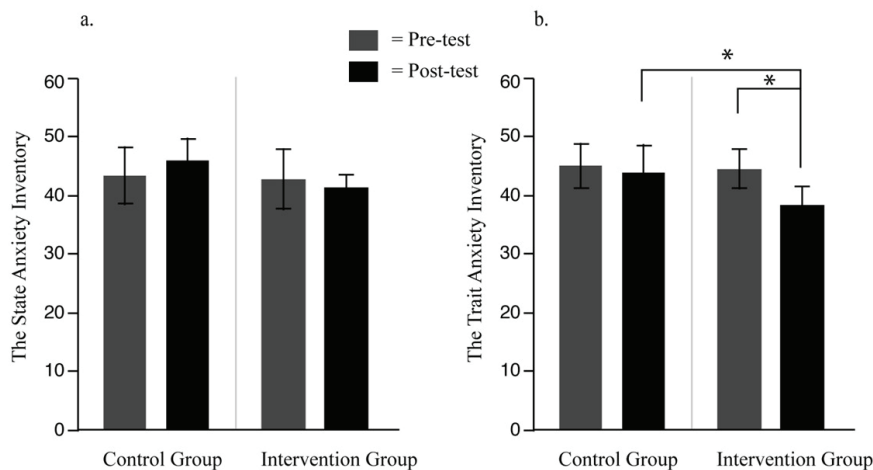


FIGURE 5a and 5b. The average values for the state (5a) and trait anxiety (5b) inventory for both groups from pre- to post-test

Discussion

This study is among the pioneering studies examining how children with cerebral palsy, as well as their mothers, are affected by adaptive riding (AR), one of the equine facilitated activities (EFA). The results of the study showed that the children participants have an increase in their empathy and emotion regulation skills and a decrease in their aggression and anxiety levels. Recent studies on EFA and children with cerebral palsy describe the effects of activities on motor function and balance ability (Shurtleff & Engsberg, 2010). Although

there are several published articles, the psycho-social effects of EFA in children with cerebral palsy have not been fully explained. EFA was found to be beneficial for behavioral and mental health problems among children (Schultz, Remick-Barlow, & Robbins, 2007).

In the present study, we found significant improvements in the psychological parameters; anxiety, empathy, emotional regulation and aggression. Due to these results, it was considered that AR improved emotional regulation and facilitated the ability to overcome emotional difficulties through inter-

actions between the horse and child, the special experience in a natural environment with peers and trainees, entertaining activities, and participation in the sports activity. Pre-tests of the current study showed that children with cerebral palsy experienced difficulties in empathy and emotional regulation skills, aggression, and anxiety. Empathy deficit and aggression may be caused by the lack of friends and social exclusion. After AR, they gained improvement in emotional regulation and empathy. The positive effects of such activities can be related to human-animal interaction theory which posits that many people seek contact with animals due to their calming nature and ability to act as a non-judgmental source of support and facilitator of social interaction (Kruger & Serpell, 2010). Therapeutic riding sessions include the interaction between the horse and child, and during this interaction, children can develop positive social behaviors, empathy skills and improve self-confidence, self-regulation, and self-respect. In particular, the feeling of riding a horse by themselves can positively improve the self-confidence of children diagnosed with CP and aggressive behavior may decrease. As the children accomplish the riding task by themselves, this makes them motivated and less anxious. Increasing empathy skills and decreasing aggression may facilitate emotional regulation. All of those attempts can reduce the anxiety and aggression of children.

Cultural factors were crucial in family relationships and parenting styles (Feldman, Ortega, Koinis-Mitchell, Kuo, & Canino, 2010). Considering the role of women in Turkish culture, taking care of children with CP or any other chronic disease is mostly the responsibility of the mother. Thus, the aggression of a disabled child is usually on his/her mother. Mothers are at the centre of children's lives and therapies (Cho et al., 2008). Previous research indicated that parents who raise children having disabilities reported greater emotional distress than other parents. Most parents of disabled children show depressive symptoms (Smith et al., 1993) and this

is consistently shown in studies targeting children with CP (Ones et al., 2005). Similar to the previous studies, mothers of children with cerebral palsy were found to have higher levels of depression and anxiety in this study. It was very important for this study to see how the psychology of mothers changed during their children's participation in activities.

Improvements in the mental health of children also affect maternal mental health. The results for the maternal depression and anxiety showed positive improvement from the pre- to post-test for the experimental group. Specifically, the anxiety levels of mothers who were in the experimental group decreased from pre- to post-test. However, the control group did not display any enhancement for those variables. Caregiving to a child diagnosed with disabled children and managing problem behaviors, as well as focusing on caregiving rather than working may cause stress (Hastings, 2002; Hauser-Cram et al., 2001) and mental health problems (Morgan, 1988) for parents, especially for mothers.

Stressors that occur with taking care of a family member with CP or any developmental disorder can have a significant negative effect on families, and in some cases may be a reason for burdens in mothers (Weiss & Lunsby, 2011). This may cause maternal anxiety and depression. Participating AR sessions with children and interact with other families and health professionals, sharing some problems together may affect maternal mental health. Therefore, maternal wellbeing must be targeted in the treatment of children with CP. Less is known about which treatments affect parental wellbeing positively. However, the present study investigated the benefits of AR on maternal depression and anxiety and found the beneficial effect of AR on both mothers' and their children's mental health who are diagnosed with CP. Overall, even though we found psychological or emotional improvements in mothers of children with CP after 8 weeks of AR, a more intensive and longer duration of AR could be applied to target continuing effects in children and their mothers.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Comparison of Body Weight between Albanian Children and European Peers in Primary Schools

Juel Jarani¹, Andi Spahi¹, Klotilda Vrenjo¹ and Keida Ushtelenca¹

¹Sports University of Tirana, Faculty of Movement Sciences, Tirana, Albania

Abstract

One of the biggest health challenges today is controlling body weight gain which leads to overweight and obesity. In order to anticipate and monitor the possible problem of overweight/ obesity, this study was undertaken in Albanian children to identify the current status of body weight in primary schools and to compare the children of the same age in Europe for the weight status. A total of 1888 elementary school children (939 boys and 949 girls) aged 6-9 years old) were enrolled in this study. Body mass were measured using a Health O Meter 402 KL professional physician beam scale. The results from this scientific work show that boys in Albania have a higher body weight ($p \leq 0.05$) compared to girls (6-9 years). Comparative data from this study on body weight between Albanian and European children show that Albanian boys and girls in elementary school (ages 6-9) are ranked among the lower body weight children compared to European counterparts. This data would be a great help in creating a clear picture of the trends of body weight growth over the years in Albanian children. These data are very important for the consequences on public health given that overweight children have a tendency to become overweight adults.

Keywords: children, body weight, overweight, obesity, health, school

Introduction

The growth of children is influenced by internal and external factors, such as genetic potential, lifestyle and diet. Some of them can change over time and cause increasing tendencies of body weight and height. According to Kulaga et al., (2010) and Gelander (2006) child well-being is an indicator of health and well-being as well as an overview of the overall socio-economic standard of a society (Tanner, 1987). Over the past two decades in Europe, social changes and lifestyles have influenced the behaviour of children in the unhealthy way of eating and sedentary living (Orsi, Hale, & Lynch, 2011). Kelishadi et al., (2017) in their paper show that high technological progress leads to reduced daily calorie expenditure and consequently to a high sedentary lifestyle. The problem of weight gain poses a threat to public health and further leads to consequences in reducing quality of life (Forhan & Gill, 2013), increasing health care costs (Buchmueller & Johar, 2015) and increasing the morbidity of population (Lenz, Richter, & M^uhlhauser, 2009).

One of the biggest health challenges today is controlling body weight gain which leads to overweight and obesity as one of the major health problems which starts in childhood (Ozden et al., 2011). Studies have emphasized the fact that overweight children have a predisposition to be obese over the years as adults (Franks et al., 2010; Han, Lawlor, & Kimm, 2010). Over the years, treating the problem of overweight and obesity becomes very difficult and the most effective way to curb this major health problem is to prevent it (Zwiauer, 2000). One of the most effective preventions is the early identification of this problem in children (Dietz, 1994; Nader et al., 2006). During childhood, excessive body weight can become an obstacle to the development of motor abilities and further engagement in sports activities (D'Hondt, Deforche, De Bourdeaudhuij, & Lenoir, 2008; Gentier et al., 2013). Also, gross motor coordination represents a peak development phase in this period. Children with excessive weight (overweight/obesity) show poorer motor coordination performance (D'Hondt et al., 2011). Many studies have emphasized the strong positive correla-



Correspondence:

J. Jarani

Sports University of Tirana, Faculty of Movement Sciences, Muhamet Gjollësja Street, Tirana, Albania

E-mail: jjarani@ust.edu.al

tion that exists between motor performance with physical activity and fitness with regard to children (Gattuzzo et al., 2016; Lima, Bugge, Pfeiffer, & Andersen, 2017), which leads to the impact and importance that has excessive weight in motor performance (Lima, Bugge, Ersbøll, Stodden, & Andersen, 2019).

Numerous studies highlight the effect on children being overweight/ obese, with regard participating in physical activity, fitness and motor performance. In order to anticipate and monitor the possible problem of overweight/ obesity, this study was undertaken in Albanian children to identify the current status of body weight in primary schools. Also in Albania there is a lack of data or norms in years, which lead to the problem comparing the performance of anthropometric, motor or health parameters with regards to children. In order to have a clear picture about the current status of body weight in Albanian children, this scientific work was undertaken to compare the children of the same age in Europe for the weight status. This paper reflects data on the body weight of Albanian children and European children obtained from the project COSI (European) 2009/2010 for the age of 6-9 years (Wijnhoven et al., 2014). The Regional Office of the World Health Organization (WHO) for Europe has set up the Childhood Obesity Surveillance Initiative (COSI) to monitor changes in overweight in primary school children. COSI routinely regulates the overweight and obesity of primary school children aged 6-9, in order to monitor progress in curbing excess body weight in this population group and to allow comparisons between countries within the European Region of WHO.

Methods

This study is a cross sectional and is part of a project where children will be monitored in health related variables, fitness components, gross motor coordination and the level of physical activity at baseline (year 2015) followed at intervals over five con-

secutive years (till 2025). Data presented for body weight in this study are from year 2015 (Jarani, 2020).

A total of 1888 elementary school children (939 boys and 949 girls) aged 6-9 years old) were enrolled in this study. The elementary school (N=24) were randomly selected from 192 schools placed Albania. Body height and body mass were measured. Body height and body mass were measured using a Health O Meter 402 KL professional physician beam scale. Values were recorded to the nearest 0.1 cm and 100 g, respectively.

Statistical Analysis

Descriptive statistics (mean and standard deviation) were calculated for the variable assessed in this study. Independent T tests were used for the comparison between boys and girls separately for each age group. Two-Sample T-Test from Means and SD's was used to compare data between Albanian children (Jarani, 2020) and European counterparts (Wijnhoven et al., 2014). This test procedure computes the two-sample t-test and several other two-sample tests directly from the mean, standard deviation, and sample size. Mean difference, and standard deviations were also computed. In this statistical analysis hypothesis tests were included and produced for both one- and two-sided tests as well as equivalence tests. The level of significance was equivalent to the alpha level ($p \leq 0.05$). P-values of ≤ 0.05 were considered statistically significant. All analysis was performed using the statistics software SPSS 26.0.

Results

Data from Table 1 present the mean values and standard deviation for Albanian children 6-9 years old divided by years and gender. The table also shows the statistical comparison by gender for body weight. In all age groups boys have statistically higher values for body weight compared to girls.

Table 1. Body weight in Albanian children by age and gender

Children 6-9 yrs.		Boys		Girls	
Age	Mean \pm SD	Mean \pm SD	N	Mean \pm SD	N
6	24.3 \pm 5.2	*25.1 \pm 5.6	172	23.4 \pm 4	189
7	26.7 \pm 5.5	*27.2 \pm 6	272	26.2 \pm 5.2	236
8	30.1 \pm 6.2	*31.2 \pm 6.5	253	29.2 \pm 6.4	270
9	33.4 \pm 7.8	*34.6 \pm 8.3	242	32.5 \pm 6.8	254

Legend: Statistical analysis for gender differences: * $p \leq 0.005$

Table 2 shows the mean body weight values of children in Albania and other European countries (Wijnhoven et al., 2014) such as Slovenia, Spain and Belgium for boys and girls aged 6 years. Albania has a mean body weight of 25.1 \pm 5.6 kg for boys followed by Slovenia with a lower value of 24.9 \pm 4.6 kg. As for Spain the mean body weight of boys is 24.9 \pm 4.6 kg which turns

out to be the same as Slovenia. Belgium has the lowest mean body weight for boys at 23 \pm 3.7 kg. Spain ranks first as the country with the highest mean body weight with a value of 24.5 \pm 4.6 kg for girls followed by Slovenia which has a value of a mean body weight of 24.4 \pm 4.6 kg for girls aged 6 years old. Albania ranks third in the ranking according to body weight with a value of 23.4 \pm 4 kg

Table 2. Mean body weight values of 6 years' children in Albania and other European countries by gender

Table 2. Mean body weight values of 6 years children in Albania and other European countries, by gender											
Body weight (6 year olds)											
Boys						Girls					
		Mean±SD	N	t	p			Mean±SD	N	t	p
1	Albania	25.1±5.6	172			1	Spain	*24.5±4.6	917	3.35	0.010
2	Slovenia	24.9±4.6	1801	0.45	0.065	2	Slovenia	*24.4±4.6	1834	3.22	0.013
3	Spain	24.9±4.6	901	0.44	0.066	3	Albania	23.4±4	189		
4	Belgium	23±3.7	26542	4.91	0.091	4	Belgium	*22.7±3.9	26105	2.39	0.017

Legend: Statistical analysis for differences between Albania vs each Country: * $p \leq 0.005$

for 6-year-old girls. Belgium presents a mean body weight of 22.7 ± 3.9 kg for girls aged 6 years and which turns out to have the lowest mean compared to other countries listed in the table.

Table 3 gives the mean body weight of 7-year-old boys and girls for different European countries, ranking according to the highest body weight. Greece ranks first with the highest mean body weight at 29.5 ± 5.8 kg for boys and 29.1 ± 6.1 kg for girls. The country that follows Greece is Spain which shows a mean body weight of 28.5 ± 5.7 kg for 7-year-old boys and 27.9 ± 5.8 kg for girls of the same age.

Slovenia presents a mean body weight of 27.8 ± 5.7 kg for boys ranking third and 27.1 ± 5.8 kg is the mean body weight for girls ranking fourth. Lithuania has a mean body weight for boys with a value of 27.6 ± 5.3 kg which is ranked fourth according to the table while for girls this result is 27 ± 5.5 kg being ranked fifth. The boys from Northern Macedonia and Latvia have a mean body weight of 27.6 ± 6.4 kg and 27.4 ± 5.3 kg, ranking fifth and sixth, respectively.

While the girls of Northern Macedonia and Latvia have a mean body weight of 26.5 ± 6.4 kg and 26.3 ± 5.3 kg making them ranked sixth and eighth. Albania has a mean body weight of 27.2 ± 6 kg for boys being in seventh place and 26.2 ± 5.2 kg is the result for girls being ranked ninth. Portugal eighth place and Hungary ninth place represent a mean body weight of 27 ± 5.5 kg and 26.7 ± 5.5 kg for boys aged 7 years while for girls of the same age this mean body weight is 27.2 ± 5.7 kg (Portugal; third place) and 26.4 ± 5.8 kg (Hungary; seventh place).

The Czech Republic and Ireland, concretely ranked 10th and 11th, have a mean body weight of 26 ± 4.8 and 26 ± 4.2 kg for boys, while for girls this ranking varies as the Czech Republic occupies twelfth place with a result of 25.3 ± 5.1 kg and Ireland in eleventh place with a result of 25.6 ± 4.6 kg. The last remaining country is Belgium which ranks last in terms of mean body weight of boys with a value of 25.8 ± 5 kg and for girls this value is 25.7 ± 5.4 kg occupying the tenth place.

The following Table 4 presents the mean body weight of

Table 3. Mean body weight values of 7 years' children in Albania and other European countries by gender

Body weight (7 year olds)											
Boys						Girls					
		Mean \pm SD	N	t	p			Mean \pm SD	N	t	p
1	Greece	*29.5 \pm 5.8	1293	5.779	0.001	1	Greece	*29.1 \pm 6.1	1259	7.638	0.038
2	Spain	*28.5 \pm 5.7	1106	3.232	0.013	2	Spain	*27.9 \pm 5.8	1101	4.462	0.017
3	Slovenia	*27.8 \pm 5.7	2759	1.580	0.011	3	Portugal	*27.2 \pm 5.7	903	2.577	0.010
4	Lithuania	*27.6 \pm 5.3	1648	1.035	0.03	4	Slovenia	*27.1 \pm 5.8	2493	2.514	0.011
5	N. Macedonia	*27.6 \pm 6.4	1429	0.996	0.031	5	Lithuania	*27 \pm 5.5	1794	2.206	0.027
6	Latvia	27.4 \pm 5.3	1381	0.512	0.061	6	N. Macedonia	*26.5 \pm 6.4	1315	0.785	0.043
7	Albania	27.2 \pm 6	272			7	Hungary	26.4 \pm 5.8	682	0.494	0.062
8	Portugal	27 \pm 5.5	910	0.491	0.062	8	Latvia	26.3 \pm 5.3	1457	0.273	0.078
9	Hungary	*26.7 \pm 5.5	553	1.156	0.025	9	Albania	26.2 \pm 5.2	236		
10	Czech Republic	*26 \pm 4.8	638	2.924	0.035	10	Belgium	*25.7 \pm 5.4	6841	1.450	0.014
11	Ireland	*26 \pm 4.2	534	2.951	0.033	11	Ireland	*25.6 \pm 4.6	466	1.500	0.013
12	Belgium	*25.8 \pm 5	7804	3.802	0.014	12	Czech Republic	*25.3 \pm 5.1	633	2.281	0.022

different states being ranked according to the highest value for 8-year-old boys and girls. Italy ranks first for boys and girls in terms of the highest mean body weight with values of 32.3 ± 7.3 kg and 31.6 ± 7.3 kg. Slovenia boys are ranked second for the mean body weight with a value of 31.8 ± 7 kg while girls are ranked third with a value of 31.1 ± 7.1 kg.

The girls of Spain occupy the second place for the mean body weight with the figure of 31.5 ± 6.7 kg and for the boys

this mean is 31.7 ± 6.4 kg occupying the third place. The boys of Albania have a mean body weight of 31.2 ± 6.5 kg, occupying the fourth place. The mean body weight of girls in Albania is 29.2 ± 6.4 kg ranking fifth. Norway (fifth place) and Belgium (sixth place) give a mean body weight of 30.2 ± 5.7 kg and 29.3 ± 5.5 kg for boys aged 8 years. While the girls of Norway and Belgium show a mean body weight of 29.6 ± 5.6 kg being ranked fourth and 29.1 ± 5.9 kg being ranked sixth (last).

Table 4. Mean body weight values of 8 years' children in Albania and other European countries by gender

Body weight (8 year olds)											
Boys						Girls					
		Mean \pm SD	N	t	p			Mean \pm SD	N	t	p
1	Italy	*32.3 \pm 7.3	13197	2.659	0.008	1	Italy	*31.6 \pm 7.3	12812	6.079	0.012
2	Slovenia	*31.8 \pm 7	2690	1.394	0.016	2	Spain	*31.5 \pm 6.7	1047	5.214	0.021
3	Spain	*31.7 \pm 6.4	1083	1.104	0.026	3	Slovenia	*31.1 \pm 7.1	2599	4.593	0.045
4	Albania	31.2 \pm 6.5	253			4	Norway	*29.6 \pm 5.6	1286	0.953	0.034
5	Norway	*30.2 \pm 5.7	1335	2.286	0.022	5	Albania	29.2 \pm 6.4	270		
6	Belgium	*29.3 \pm 5.5	23632	4.647	0.035	6	Belgium	29.1 \pm 5.9	23171	0.255	0.079

Table 5 shows the mean body weight of 9-year-old boys and girls for different countries such as Greece, Spain, Lithuania, Albania, Slovenia, Italy, Ireland and Belgium. Greece presents a mean body weight of 38.4 ± 8.9 kg for 9-year-old boys and 37.6 ± 9.1 kg for girls of the same age, ranking first as the highest mean. Spain ranks second as the country with the highest mean body weight with values of 35.9 ± 7.7 kg for boys and 35.2 ± 7.7 kg for 9-year-old girls.

The boys from Lithuania and Albania have a mean body weight of 34.7 ± 7.5 kg and 34.6 ± 8.3 kg, ranking third and fourth, respectively. Regarding the state of Slovenia (fifth place)

and Italy (sixth place) the mean body weight is 34.2 ± 7.9 kg and 33.9 ± 7.8 kg for boys aged 9 years. The mean body weight of the Irish boys is 33 ± 6.3 kg and for the boys of Belgium the result is 32.8 ± 7.3 kg being the last two places in the ranking.

Slovenia and Lithuania have an mean body weight of girls worth 33.8 ± 8 kg and 33.7 ± 7.3 kg occupying the third and fourth place. For countries like Belgium and Italy a mean body weight of 32.9 ± 7.6 kg and 32.9 ± 7.6 kg is shown ranking in fifth and sixth place. The last two places in the ranking according to the highest body weight of girls are Albania and Ireland with figures of 32.5 ± 6.8 kg and 32.2 ± 6.9 kg.

Table 5. Mean body weight values of 9 years' children in Albania and other European countries by gender

Body weight (9 year olds)											
Boys						Girls					
		Mean \pm SD	N	t	p			Mean \pm SD	N	t	p
1	Greece	*38.4 \pm 8.9	1288	6.458	0.014	1	Greece	*37.6 \pm 9.1	1429	10.41	0.012
2	Spain	*35.9 \pm 7.7	749	2.155	0.031	2	Spain	*35.2 \pm 7.7	752	5.286	0.015
3	Lithuania	34.7 \pm 7.5	1659	0.177	0.085	3	Slovenia	*33.8 \pm 8	810	2.544	0.011
4	Albania	34.6 \pm 8.3	242			4	Lithuania	*33.7 \pm 7.3	1620	2.588	0.012
5	Slovenia	*34.2 \pm 7.9	952	0.675	0.049	5	Belgium	*32.9 \pm 7.6	9256	0.921	0.035
6	Italy	*33.9 \pm 7.8	8280	1.301	0.019	6	Italy	*32.9 \pm 7.6	7383	0.917	0.035
7	Ireland	*33 \pm 6.3	488	2.644	0.003	7	Albania	32.5 \pm 6.8	254		
8	Belgium	*32.8 \pm 7.3	9805	3.341	0.003	8	Ireland	32.2 \pm 6.9	498	0.569	0.056

Discussion

Over the last three decades, a trend of weight gain has been observed (Lobstein, Baur, & Uauy, 2004), explained by the increase in body height as well as the association that reflects the worldwide epidemic of overweight and obesity in children and adolescents. The results from this scientific work show that boys in Albania have a higher body weight ($p \leq 0.05$) compared to girls (6-9 years). The conclusions drawn from this study are in line with studies in European children. At all ages 4-18 in Greek children (Tambalis et al., 2015), boys have higher body weight values compared to girls (all values $p < 0.01$). Boys also have higher body weight compared to girls, and this body weight increases progressively with age in European children (Wijnhoven et al., 2014; Brug et al., 2012) as well as in Polish children (Kulaga et al., 2011). According to a study by Tinggaard et al., (2014) Danish boys (up to 20 years old) have higher body weight than girls in all age groups.

Comparison results from this study show that Albanian 6 years old boys are ranked first with regard to body weight, while the third for 6-year-old girls compared to European children.

Albania has a mean body weight of 27.2 kg for boys (7 years old), being in seventh place and 26.3 kg for girls, ranking ninth. The mean body weight of girls (8 years) in Albania is 29.2 kg, ranking fifth, while boys have a mean body weight of 31.2 kg, ranking fourth. Spain ranks second with the highest body weight with values 35.9 kg for boys and 35.2 kg for girls (9 years old). Albania's boys have a mean body weight of 34.6 kg, ranking fourth.

Comparative data from this study on body weight between Albanian and European children show that Albanian boys and girls in elementary school (ages 6-9) are ranked among the lower body weight children compared to European counterparts.

According to Rockholm et al. (2010) the increase in excess body weight in children and adolescents has spread to high-income countries, but continues in low-income and middle-income countries.

In terms of the progress over the years of the trend of body weight of European children, it is clear that there is a significant increase over the years. Italian children of 2001-2002 compared to children of 1974-1975 (Toselli, Ventrella, Franzaroli, & Brasili, 2006) have an increase in body weight in boys and girls aged 6-9 years. In 6-year-old boys (2001-2002 compared to 1974-1975) the increase in body weight is from 1.8 kg (6 years) to 5 kg (9 years). In girls, the increase in body weight decreases from 9.5% (6 years) to -2.2 kg (9 years). Norwegian school-age children (4-17 years old) weigh more (Júliússon et al., 2009) compared to 1970s children (between 1970-1980 and 2003-2006). The study of Simsek, Ulukol and Gulnar (2005) in children of 1993 and 2003 in Turkey shows an increase in body weight of 2.7-6.3 kg. According to a study by Wikland, Luo, Niklasson, and Karlberg (2002) Swedish children have an increase in body weight by comparing them in years (1955-1958 with those born 1973-1975) respectively; 19-year-old boys with a weight gain of 5.7 kg and girls a 3.4 kg increase.

The presented data and results should be interpreted in the light of the following limitations. We do not possess data to verify and make comparison with the relevant databases of studies undertaken in Europe. Also another limitation is the fact in some of the European countries there are differences in the number of children (sample) taken in the study that leads to decrease the power of statistical comparison analysis.

In Albania there is no systematic valid data to give us the opportunity to compare over the years how has been the trend of body weight in children by comparing it from generation to generation. This data would be a great help in creating a clear

picture of the trends of body weight growth over the years in Albanian children. This is a suggestion for further studies in the field of this study in Albania. These data are very important for the consequences on public health given that overweight children have a tendency to become overweight adults (Deshmukh et al., 2006).

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Nutritional Assessment of Female Yoga Practitioners with Different Levels of Experience

Stefan Kolimechkov¹, Lubomir Petrov², Deyana Vankova³ and Deidre Douglas⁴

¹STK Sport, London, United Kingdom, ²National Sports Academy, Sofia, Bulgaria, ³Medical University Varna, Department of Biochemistry, Molecular Medicine and Nutrigenomics, Varna, Bulgaria, ⁴Iron Philosophy Training, United States of America

Abstract

Yoga includes many components for a healthy lifestyle such as physical exercises, abstaining from tobacco, stress management and a low-fat diet. The aim of this study was to assess the nutrition of yoga practitioners and to compare it with international guidelines for a healthy diet. This study comprised 89 female yoga practitioners from Bulgaria. The nutrient intake was assessed by using a food frequency questionnaire based on the USDA National Nutrient Database. The relative intake of proteins, carbohydrates, fats, energy contribution of each nutrient, and the total daily energy intake and relative energy intake were calculated. The BMI of the yoga practitioners was near the lower normal limit (18.5 kg/m²). Only 3 practitioners were overweight. The yoga practitioners consumed small amounts of pork and beef and ~60% did not consume any meat at all. They consumed an average of 600 g of fruits and vegetables per day, which complies with the 400 g recommended by the WHO. Practising yoga helps to maintain normal weight which is one of the prerequisites for a healthy lifestyle. The nutritional assessment of the yoga participants corresponded with the recommendations of the WHO and the American Cancer Society Guidelines for a healthy diet.

Keywords: *yoga, nutrition, diet, assessment, energy*

Introduction

Yoga has become increasingly popular in many parts of the world as a means of exercise and physical training. It is a comprehensive life discipline which originated in ancient India and has the capacity to harmonize body, mind, and spirit (Prathikanti et al., 2017). Yoga includes many components for a healthy lifestyle, such as physical exercises, abstinence from tobacco, stress management and a low fat diet (Manchanda, 2011).

Several scientific studies have shown that yoga may have beneficial effects on the treatment of various medical conditions such as hypertension (Awdish, Small, & Cajigas, 2015; Murugesan, Govindarajulu, & Bera, 2000; Patil, Dhanakshirur, Aithala, Naregal, & Das, 2014; Selvamurthy et al., 1998), depression (Prathikanti et al., 2017; Streeter et al., 2017), and coronary artery disease (Manchanda, 2011; Manchanda et al., 2000; Sivasankaran et al., 2006).

Nutrition plays a significant role among yoga participants.

A healthy diet is of particular importance in order to prevent diseases and make progress in yoga (Desai, 1990). Yoga practices can be implemented as part of a therapy in the treatment of eating disorders as indicated by Hall, Oftei-Tenkorang, Machan and Gordon (2016). Moreover, improvements in body image, body satisfaction, and alleviating eating disorders were reported in women practising yoga (Dittmann & Freedman, 2009). Yoga-based interventions were also shown to reduce oxidative stress (Bhattacharya, Pandey, & Verma, 2002; Yadav, Ray, Vempati, & Bijlani, 2005).

The aim of this study was to assess the nutrition of yoga practitioners with different levels of experience in yoga, and compare it with international official guidelines for a healthy diet.

Methods

The study was performed in accordance with the Declaration of Helsinki for Human Research (WMA, 2013).



Correspondence:

S. Kolimechkov
STK Sport, 1 Hallsville Road, the Sphere, E16 1BE, London, United Kingdom
E-mail: dr.stefan.kolimechkov@gmail.com

Institutional ethics approval was granted by the National Sports Academy, Sofia, Bulgaria, and informed consent was obtained from all participants.

Participants

This study consisted of 89 female yoga practitioners from Bulgaria, who were divided into 2 groups: Intermediate Yoga with 2 to 5 years of experience ($n=31$) with a mean age of 39.4 ± 7.57 years and a mean sports experience of 45.7 ± 13.67 months, and Advanced Yoga greater than 5 years of experience ($n=58$) with a mean age of 41.3 ± 8.15 years and a mean sports experience of 139.3 ± 88.03 months.

The participants were enrolled in a postgraduate education course, consisting of 646 hours in duration between the period of January 2018 - June 2019. The participants achieved the qualification of "Yoga Teacher," organized by the Bulgarian Yoga Federation (BYF) and the National Sports Academy (NSA), Sofia, Bulgaria. All participants had a minimum of 2 years of yoga practice prior to the teaching yoga course.

The participants were taught integrated hatha yoga following the Sivananda system. The hatha yoga practices included asanas (poses), pranayama (breathing exercises), meditation techniques, relaxation mantras, a calm and concentrated mind, contentment and inner harmony.

Anthropometry

The height of the participants was measured to the nearest 0.1 cm, body weight was recorded to within an accuracy of 0.1 kg, and body mass index (BMI) was calculated as: body weight (kg) divided by height in metres squared (m^2).

Nutritional assessment

The nutrient intake of the participants was assessed by using a food frequency questionnaire (FFQ), as applied in previous nutritional surveys (Kolimechkov, Petrov, Alexandrova, & Atanasov, 2016; Kolimechkov et al., 2019; Miteva et al., 2020). The FFQ queried the weekly consumption of 25 basic groups of food, sports experience and the number of yoga sessions per week. The composition and energy value of different groups of food were calculated based on the USDA National Nutrient Database - Release 28 (US Department of Agriculture, 2015). The FFQ and the data

tables utilized for calculations are available on the internet (STK-SPORT, 2020).

Based on the results from the FFQ, the relative intake (per kg body weight) of proteins (RPI), carbohydrates (RCI), and fats (RFI), the energy contribution of each nutrient (E%), the total daily energy intake (DEI) and relative energy intake (REN), were calculated. The percentages of proteins and fats, which come from animal sources, were also calculated.

The Harris-Benedict equation (Harris & Benedict, 1919) was used to calculate the basal metabolic rate (BMR kcal/24h) and the estimated daily energy needs (kcal/24h) for the yoga practitioners were derived by the formula based on Harris-Benedict (Harris & Benedict, 1919): $BMR \text{ kcal/24h} \times (1.2 + 0.03 \times \text{number of yoga sessions})$.

The international guidelines for a healthy diet as indicated by the World Health Organisation (WHO, 2018) and the American Cancer Society (Kushi et al., 2012) were applied to assess the nutrition of the yoga practitioners in this study.

Statistical analyses

The statistical analyses were conducted with GraphPad Prism 7.04 software, using descriptive statistics and the Shapiro-Wilk test of normality. The data with normal distribution for both groups was compared with unpaired t-test, and data without normal distribution were compared with the non-parametric Mann-Whitney U test. The differences in the frequency of food consumption by participants within the different groups who did not consume certain foods were determined by using Fisher's Exact Test. The data in the text and the tables are presented as mean \pm SD.

Results

The anthropometric parameters of the practitioners in this study are presented in Table 1. The yoga experience of the Intermediate Yoga group was 45.7 ± 13.67 months on average, and was significantly lower than the Advanced Yoga group (139.3 ± 88.03 months on average). The age and the anthropometric parameters did not differ significantly between the two yoga groups (Table 1). Fifteen yoga practitioners had a BMI value of 16.6 kg/m^2 (lower than the normal limit) and three had BMI values of 26.2 kg/m^2 , 26.4 kg/m^2 and 26.7 kg/m^2 (higher than $>25 \text{ kg/m}^2$) which is overweight.

Table 1. Anthropometric parameters of the yoga practitioners (mean \pm SD)

	Intermediate Yoga (n=31)	Advanced Yoga (n=58)
Age (years)	39.4 \pm 7.57	41.3 \pm 8.15
Yoga experience (months)	45.7 \pm 13.67	139.3 \pm 88.03 ***
Height (cm)	165.4 \pm 5.85	167.2 \pm 6.24
Weight (kg)	56.9 \pm 6.74	57.2 \pm 8.12
BMI (kg/m ²)	20.9 \pm 2.62	20.4 \pm 2.09

Legend: *** – $p < 0.001$ vs Intermediate Yoga

The data from the nutritional survey for all yoga practitioners are presented in Table 2. Based on nutritional intake, it was calculated that a single yoga session increased the daily energy consumption by only 3%, in contrast with the 8% originally suggested by Harris Benedict for one average sports session. No significant differences were found in the daily intake of macronutrients and energy contribution of each nutrient

between the two yoga groups.

The calculated energy intake responded to the energy needs of the yoga practitioners, and this ratio was almost nearly 1 (Table 2). The energy contribution from proteins (16%), fats (29%) and carbohydrates (55%) towards the daily energy intake was within the recommended 15%, 30% and 55%, respectively (WHO, 2003).

Table 2. Daily intake of macronutrients and energy contribution of each nutrient (E%) in the diet of the yoga practitioners (mean \pm SD)

	Intermediate Yoga (n=31)	Advanced Yoga (n=58)
Energy needs (kcal/24h)	1786.0 \pm 149.7	1801.0 \pm 172.6
Relative energy needs ^T (REN) (kcal/kg/24h)	31.6 \pm 2.80	31.7 \pm 2.60
Energy intake (kcal/24h)	1797.0 \pm 631.7	1782.0 \pm 542.4
Relative energy intake (REI) (kcal/kg/24h)	31.8 \pm 11.40	31.6 \pm 9.91
Energy needs/Energy intake	1.01 \pm 0.35	0.99 \pm 0.30
Relative protein intake (RPI) (g/kg/24h)	1.25 \pm 0.41	1.23 \pm 0.42
Protein (E%)	16.4 \pm 2.42	16.0 \pm 2.78
Relative fat intake (RFI) (g/kg/24h)	1.01 \pm 0.43	1.01 \pm 0.43
Fat (E%)	28.8 \pm 6.04	28.9 \pm 7.57
Relative carbohydrates intake (RCI), (g/kg/24h)	4.26 \pm 1.67	4.24 \pm 1.44
Carbohydrates ^T (E%)	54.8 \pm 6.82	55.2 \pm 9.23
Animal Protein ^T (%)	45.4 \pm 12.96	41.7 \pm 17.62
Animal Fat (%) ^T	59.9 \pm 14.47	57.1 \pm 16.00

Legend: ^T – variables with normal distribution for both groups, compared with unpaired t-test

The mean amounts of food groups consumed by the yoga practitioners are presented in Table 3. There were no statistically significant differences between the two yoga groups. On a weekly basis, the mean amount of beef, pork and chicken

consumed was considerably low. Weekly milk consumption was only about 1 cup (150-200 ml), but other dairy products, yogurt and cheese, were more widely consumed.

Table 4 presents the percentage frequency and the num-

Table 3. Weekly consumption of the types of food included in the FFQ, reported by the yoga practitioners (mean \pm SD)

	Intermediate Yoga (n=31)	Advanced Yoga (n=58)
Fruits [g]	2380.6 \pm 1487.82	2394.8 \pm 1657.03
Vegetables [g]	1851.6 \pm 1061.41	2027.6 \pm 1312.00
Beans [g]	250.0 \pm 226.94	287.5 \pm 195.97
Nuts [g]	185.5 \pm 171.00	186.6 \pm 114.44
Fish [g]	155.4 \pm 120.27	133.2 \pm 126.28
Chicken [g]	90.7 \pm 131.97	75.0 \pm 166.23
Pork [g]	49.6 \pm 178.90	42.0 \pm 92.14
Beef [g]	15.6 \pm 48.13	22.6 \pm 59.58
Eggs [g]	226.5 \pm 222.19	243.1 \pm 201.03
Milk [ml]	206.5 \pm 295.45	153.3 \pm 338.77
Yogurt [g]	767.7 \pm 570.61	854.1 \pm 835.96
Cheese [g]	296.8 \pm 199.56	268.0 \pm 252.39
Curd Cheese [g]	61.0 \pm 115.15	51.7 \pm 100.42
Yellow Cheese [g]	165.3 \pm 149.54	157.7 \pm 191.22
Butter [g]	62.3 \pm 65.51	64.7 \pm 49.92
Bread [g/24h]	258.3 \pm 248.09	330.5 \pm 312.05
Rice [g]	240.3 \pm 240.98	238.8 \pm 162.77
Potatoes ^T [g]	435.5 \pm 255.01	531.0 \pm 283.74
Pasta [g]	400.0 \pm 280.48	305.2 \pm 266.34
Baked Products [g]	60.5 \pm 84.60	68.5 \pm 115.90
Muesli & Cereals [g]	268.5 \pm 208.56	200.0 \pm 191.26
Sweets [g]	84.7 \pm 71.50	103.0 \pm 136.38
Chocolates [g]	91.5 \pm 87.32	110.8 \pm 96.61
Juice & Drinks [L]	3.9 \pm 6.18	3.1 \pm 5.12

ber of participants who do not consume foods from animal origin. About 60% of the yoga practitioners in the Advanced

and Intermediate groups did not consume any meat. In the Intermediate Yoga group, 50% did not consume milk, and in

the Advanced Yoga group the percentage was 60%. There were no statistically significant differences in the participants who

were vegans and those who did not consume eggs, milk, fish or meat (Table 4).

Table 4. Percentage of vegans and different types of vegetarians, who do not consume specific foods from animal origin, in the yoga practitioners

	Intermediate Yoga (n=31)	Advanced Yoga (n=58)
Vegans	0.0% (n=0)	6.9% (n=4)
Fish	12.9% (n=4)	29.3% (n=17)
Meat	58.1% (n=18)	60.3% (n=35)
Eggs	16.1% (n=5)	6.9% (n=4)
Milk	51.6% (n=16)	60.3% (n=35)

Discussion

A healthy weight depends on a person's height, and, therefore, the recommendations for this weight are often expressed in terms of BMI (Kushi et al., 2012). BMI is normally expected to rise with age, however both yoga groups in our study showed a mean BMI, which was near the lower normal limit for healthy adults (18.5 kg/m²), with a slightly lower BMI for the Advanced Yoga group (Table 1). Moreover, none of the yoga practitioners in our study showed a BMI > 30 kg/m² (obese), and only three of 89 practitioners had a BMI > 25 kg/m² (overweight). The results indicate that practising yoga helps to maintain normal weight as one prerequisite for a healthy life. Taking into consideration the low energy expenditure during yoga practice, it can be observed that diet plays a crucial role in maintaining a healthy weight.

According to the WHO, a healthy diet helps to protect against the development of non-communicable diseases, such as diabetes, heart disease, stroke and cancer. Energy intake of calories should balance with energy expenditure. In order to avoid unhealthy weight gain, total fat should not exceed 30% of total energy intake (WHO, 2003, 2018). In our study, the total fat for both yoga groups did not exceed the recommended limit of 30% (28.8% for the Intermediate Yoga and 28.9% for the Advanced Yoga group). WHO recommends that saturated fat intake should be less than 10% of total energy intake (WHO, 2018). Saturated fats are mainly those fats derived from animal sources. Based on the data for animal fat consumption, it was calculated that 16.5% of the total energy intake was from saturated fat for the Advanced Yoga group, and 17.3% for the Intermediate Yoga group. These values were higher than the WHO recommendation.

According to the WHO, people should consume at least 400 g of fruit and vegetables daily (WHO, 2003). It is recommended to include fruits, vegetables, legumes, nuts and whole grains (unprocessed oats, wheat and brown rice) as part of a healthy diet (WHO, 2018). Dietary intervention studies have suggested that fruit and vegetable intake may be an effective strategy for maintaining a healthy body weight, especially when consumption replaces more calorie-dense foods (Smiciklas-Wright, Mitchell, Mickle, Goldman, & Cook, 2003). Moreover, there is ongoing research on the potential cancer chemo-preventive properties of fruits and vegetables, such as dark green and orange vegetables, cruciferous vegetables (cabbage, broccoli, cauliflower, brussels sprouts), soy products, legumes, allium vegetables (onions and garlic), and tomato products (Kushi et al., 2012). The

yoga practitioners from our study consumed an average of 600 g of fruits and vegetables per day, which complies with the minimum recommendation of 400 g.

A body of research supports the importance for consuming whole-grain foods in reducing cancer of the gastrointestinal tract (Chan & Giovannucci, 2010; Schatzkin et al., 2007; Schatzkin, Park, Leitzmann, Hollenbeck, & Cross, 2008). The yoga practitioners in our study consumed sufficient amounts of nuts and beans as outlined in Table 3. This consumption is in line with the American Cancer Society Guidelines on nutrition and physical activity for cancer prevention, which states that fish, poultry, or beans should be consumed as an alternative to red meat (beef, pork, and lamb) (Kushi et al., 2012). Moreover, the yoga practitioners in our study consumed significantly smaller amounts of pork and 60% did not consume any meat (Table 4).

The reduced consumption of meat is in accordance with the conceptions of yoga practitioners following the Sivananda yoga system (International Sivananda Yoga Vedanta Centres, 2020). The weekly consumption of some dairy products, such as yogurt and cheese, were more widely consumed. However, it was not clear why milk intake was low considering that Swami Sivananda described milk as a 'perfect food which contains all nutritious principles in proper well-balanced proportions' (The Divine Life Society, 2020). Additionally, interviews with the yoga practitioners in our study revealed that lower milk consumption was most likely due to recommendations received from other health information sources promoting a whole food, plant-based diet.

The yoga practitioners from both groups consumed on average 28.5 g/day of sweets and/or chocolates, which contributed to only 6.35% of their total energy intake. This is in line with the WHO recommendations for limiting the intake of free sugars to less than 10% of the total energy intake as part of a healthy diet (WHO, 2003).

Conclusions

The nutritional assessment of the yoga participants in both groups corresponded with the recommendations of the WHO and the American Cancer Society Guidelines for a healthy diet. This is due to the positive contribution of yoga, which is associated with multiple beneficial health outcomes. Therefore, participation in yoga should be widely recommended as a practice for an even greater number of people. More detailed research with a larger number of participants is needed in order to reveal the effects of practising yoga on body composition and nutritional habits.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Games Based Learning Influence in Portuguese Referees Motivation to study Laws of the Game and Competition Rules: A Longitudinal Study

Iancu Vasilica¹, Rui Silva², Paulo Costa³, Bruno Figueira⁴ and Luís Vaz⁴

¹University of Trás-os-Montes e Alto Douro, Sport Sciences Department, Vila Real, Portugal, ²University of Trás-os-Montes e Alto Douro, Centre for Transdisciplinary Development, CETRAD, Vila Real, Portugal, ³University of Beira Interior, Research Center in Sports Sciences, Health Sciences and Human Development, CIDESD, CreativeLab Research Community, Covilhã, Portugal, ⁴University of Trás-os-Montes e Alto Douro, Research Center in Sports Sciences, Health Sciences and Human Development, CIDESD, CreativeLab Research Community, Vila Real, Portugal

Abstract

The present study aimed to measure Portuguese referees' motivation to study the Laws of the Game and Competition Rules (LGCR). This longitudinal empirical study measured the evolution of referees' motivation, whose study needs are essential for their preparation, evolution and career progression. The study was carried out in two different periods, in the beginning and during the 2017/2018 sports season. 179 referees completed a questionnaire, in order to assess the motivation. The same scale was replicated in the middle of the season, after the referees had used a game called RefereeGame, to evaluate the evolution in motivation over the time. The data were processed using longitudinal Structural Equation Models, estimated in the SPSS/AMOS 27 software. The referees used a Game-Based Learning (GBL) tool to study and test their knowledge. The results showed that Intrinsic Motivation to Know increased between Moment 1 and Moment 2. Intrinsic and extrinsic motivation also presented considerable differences between both moments, showing that GBL can be considered as valid tool, to regulate technical and regulatory preparation of referees. This research may help sports researchers to understand the use of games as strategic tools to involve referees in learning the LGCR.

Keywords: football referees, motivation; GBL, laws of the game, competition rules

Introduction

Football Refereeing is one of the most critical positions concerning all those involved in the game. Its decisions have become increasingly important as team members and spectators' expectations and satisfaction are dependent on them (Wühr, Fasold, & Memmert, 2015).

Guillén and Feltz (2011), showed that football referees realize that mastering the game laws and arbitration technique as well as the understanding the game strategy are key examples about game knowledge to achieve a successful performance. Similarly, e Pina, Passos, Carvalho, and Travis Maynard (2019) through the collection of testimonies of 24

specialists in elite refereeing, showed that three distinct dimensions shape the excellence referee: individual preparation, preparation of the game and game management, with the variable "understand the game", where the theoretical knowledge of laws and regulations may be included.

Decision-making process is mediated by the identification and processing information provided by their visual field promoted by any event (stimulus) produced by the players. Then, the perceived situation must be categorized according to game laws and competition rules (LGCR), integrating all this information in order to make the final decision (Plessner & Haar, 2006). The lack of knowledge and



Correspondence:

B. Figueira

University of Trás-os-Montes e Alto Douro, Research Center in Sports Sciences, Health Sciences and Human Development, CIDESD, CreativeLab Research Community, Avenida João Paulo II, Lote 8, 4º Esq. 5000-198 Vila Real, Portugal

E-mail: benfigueira@hotmail.com

negligence of LGCR as well as the regulations can produce wrong decision making and in extreme cases lead to technical errors, which violate the letter and spirit of the law (FIFA, 2020). Thus, and according to the Disciplinary Regulations of the Portuguese Football Federation 2019-2020, may resulting in a game repetition and a disciplinary process to the referee, this outcome being of enormous harm to his career, running the risk of being demoted (FPF, 2020). On the other hand, according evaluation rules and performance of the national refereeing categories (those that give access to the arbitration of professional competitions) of the Portuguese Football Federation 2018-2019, there is a percentage of 2% in the final score, reserved for the media of the three compulsory written tests on Laws of the Game and Competition Rules (LGCR). Thereby, and according to the 2018-2019 Portuguese Football Federation soccer referee rankings, it can mean the difference of several places and in some cases put in risk the promotion or relegation of the respective table, because on a scale from 0 to 10 of the final score, the difference of places is ranked in the thousandths (0.001) (FPF Standards, 2020). As a concrete example and knowing that 2% of 10 values will be 0.2, the difference between a referee who obtains 100% average in the three regular tests and a referee who records only 85% in that same sum will be 0.03, which would thus allow the referee of the C2 board (antechamber of professional soccer) ranked 58th (score 7.734), move to 56th place (score 7.760) and consequently move from a situation of relegation to maintenance in that Portuguese National Division (FPF Standards, 2020).

Therefore, we can consider that one of the most relevant factors, integral to the performance of the referees in the decision making, as well as of real importance in the classification process, will be the domain of the theoretical foundations (LGCR), which should not be neglected in order not to stagnate in the career. Thus, referees must remain motivated for the constant recycling of theoretical knowledge, understanding that motivation is showed by the choice of an individual to get involved in an activity, as well as the intensity and effort that they invest in it (Garris & Ahlers, 2002). This way, motivation ends up being one of the most critical indicators for an individual to succeed in his learning process (Hattie, 2008) because theoretically unprepared referees will be more likely to make mistakes on the field (e Pina, Passos, Araújo, & Maynard, 2018).

The traditional method of referees in the learning of LGCR consists of reading the International Football Federation (FIFA) game laws book. However, this learning process can become dull and tedious (Yeager et al., 2014). Therefore, referees may not improve enough regarding LGCR if they choose this book as their primary study tool. Consequently, decision-making skills may be insufficient, which leads to debatable decisions during the game. From the year 2010, a new trend emerged, called gamification or Games Based Learning, whose objective was, through the use of game design elements in non-game contexts, increase involvement, motivation and attitude (Deterding, 2012). GBL has had a significant increase in its use in several areas, from the business world to the education systems, and is considered a persuasive technological form (Barr, 2018) capable of creating beneficial attitude changes in its users, essentially at the motivational level (Westera, 2019). Some research has emerged showing the importance of games in teaching, highlighting their potential for promotion and impact on learning supporting the use of GBL

(Anastasiadis, Lampropoulos, & Siakas, 2018).

Several research have addressed the improvement of the referees decision making process in the most varied sports, using computer technology, for example in rugby (Mascarenhas, Collins, Mortimer, & Morris, 2005), in football (Catteeuw et al., 2010) or volleyball (Yang, 2011). Gulec and Yilmaz (2016) applied their study to 54 early career Turkish football referees, based on a board game with questions about the sport's rules. Using a control group (N=27) that could only use LGCR book to study and an experimental group (N=27) authorized to use the game for the same purpose. Then, after a written test about LGCR after and before this tool, they reached very encouraging and positive results, in both groups in the post use of the tool and in the biggest increase of success cases in the experimental group in relation to the control group. These values have shown that the digital teaching platform is more beneficial in learning than LGCR traditional book.

However, no studies have been found that allows us to understand the levels of motivation of soccer referees for the study of LGCR using technological resources, and what impact this process in official written tests, in final classification and consequently in decision making process.

In this sense, we created a GBL tool called RefereeGame, based on textual questions that evaluate participants' knowledge about the rules of football, available at www.refereegame.pt. This tool was developed to make the method of study of referees more interesting and motivating, proposing to be able to change their attitude, engagement and concentration to this area of theoretical knowledge, and facilitate their flow in learning. Thus, the learning provided through playful activities becomes more intense, following the referee/player during his study and recycling process about LGCR, since the knowledge acquired is internalized and, when necessary, expressed interactively.

Obtaining robust information on soccer referees' motivation will allow the sports institutions responsible for their technical and theoretical training to make informed decisions on the strategies they should use to involve these sports agents in learning this area of knowledge. Therefore, this work aims to understand the levels of motivation of the Portuguese referees who perform in the national championships (antechamber of professional soccer) for the study of LGCR before and after using technological resources to support the study.

According to the aforementioned literature, to understand these phenomena and consequently this research gap, we defined the research hypotheses that enable the testing of the model presented in Figure 1 to compare the prevalent motivation levels among Portuguese Referees with and without using GBL alongside the dimensions shaping and producing such motivation. In order to respond to the objectives defined, we set out the following two research question for answering:

(RQ1) What is the motivation of Portuguese referees to study LGCR before and after technological tools to support the study?

(RQ2) What are motivation dimensions that have direct influences on the referees in both moments?

(RQ3) Can technology help referees in the study of LGCR to increase their performance in theoretical tests and consequently in the field?

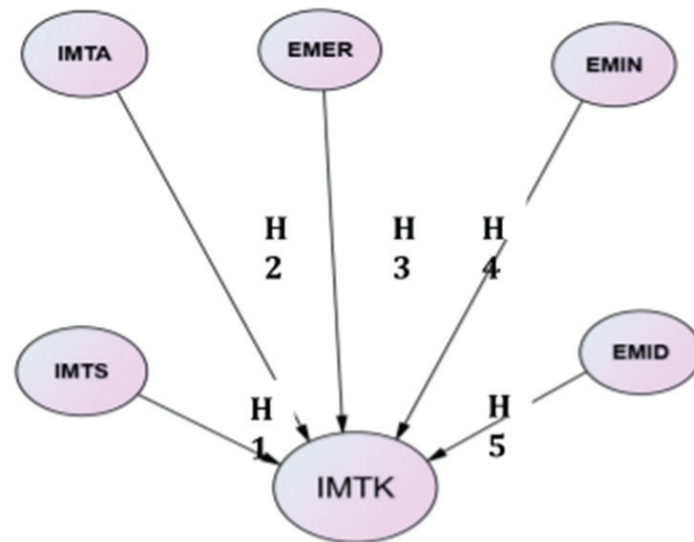


FIGURE 1. Research Model

Methods

Participants

One hundred and seventy-nine referees aged between 20 and 44 years old (72% males/28% females) took part in this study during two different moments. In the Moment 1 referees filled the AMS scale at the beginning of the season during the recycling and evaluation actions, performed every year at the beginning of the season, aiming to evaluate referees' technical and physical performance. After completing the motivation scale, they played the game for six consecutive months. Hereupon, during the second recycling and evaluation action, they filled the AMS again, basing their response on the motivation obtained through the use game RefereeGame to study. Additionally, referees receive information about the guidelines procedure in order to standardize performance criteria. Informed and written consent was provided to the referees before the beginning of the study. All participants were notified that they could withdraw from the study at any time. The study protocol followed the guidelines and was approved by the Local Institutional Research Ethics Committee and conformed to the Declaration of Helsinki's recommendations.

Procedures

This investigation was carried out using a quantitative type study, gathering data through a questionnaire survey that applied the AMS scale by Vallerand et al. (1992), adapted for referees (Vasilica, Silva, Costa, Figueira, & Vaz, 2020) (Appendix 1). The proposed research model deployed Confirmatory Factor Analysis (CFA) alongside a structural equations model (SEM), which enabled multi-group analysis through the utilization of the SPSS/AMOS 27 software (Ringle, Wende, & Becker, 2015). We tested the measurement model (validity and reliability of the measures) following the literature, evaluating the meaning of each respective path's weightings and coefficients (Marôco, 2010).

Validity and Reliability of the Measurement Models

We tested a model with all of the variables to undertake CFA before removing all of those with factorial weightings of below 0.5 (Brown, 2006; Marôco, 2010). The final models tested returned the following statistical findings (Table 1) displaying an adequate suitability level across practically all evaluation indicators (Hair, Black, Babin, Anderson, & Tatham, 2010). Relative to the items and factors' reliability, we verified an excellent level of total internal consistency for the 179 referees participated in this study.

Table 1. Validity and Reliability of the Measurement Models

Adjustment indexes	Moment 1	Moment 2
χ^2 Satorra Bentler	625.444	658.780
df	215	225
p-value	p<0.001	p<0.001
$\frac{\chi^2}{df}$ Satorra Bentler	2.909	2.928
RMSEA	0.014	0.035
SRMR	0.0495	0.0521
NFI	0.805	0.846
GFI	0.819	0.902
AGFI	0.815	0.827
CFI	0.901	0.894

Legend: χ^2/df - Chi-Squared; Degrees of Freedom; p-value - Probability of obtaining test results; RMSEA - Root Mean Square Error of Approximation; SRMR - Standardized Root Mean Squared Residual; NFI - Normed Fit Index | GFI: Goodness-of-Fit Index; AGFI - Adjusted Goodness of Fit Index; CFI - Comparative Fit Index

As regards the convergent validity of the model (Table 2), we evaluated an additional three metrics: Average Variance Extracted (AVE), Composite Reliability (CR) and Cronbach's Alpha (α). All of the convergent validity metrics exceeded the benchmarks established in the literature for relevance, with the AVE needing to be over 0.5, CR over 0.7 and α over 0.8 (Hair et al., 2010; Marôco, 2010). The internal consistency for all items that make up the model is

demonstrated by Cronbach's Alpha (α) higher than 0.9, revealing validity and internal and explanatory reliability. Alfa de Cronbach (α) is a statistical technique widely used and cited by several authors to demonstrate that the tests and scales that were built or adopted are relevant to explain the investigation results (Taber, 2018). Thus, we may conclude that the model meets both the validity and convergent reliability requirements.

Table 2. Validity and Reliability

Constructs	Items	Loadings	CR	AVE	α	Constructs	Items	Loadings	CR	AVE	α
IMTK	IMTK1	0.706	0.782	0.47	0.850	IMTK	IMTK1	0.510	0.742	0.423	0.812
	IMTK2	0.729					IMTK2	0.654			
	IMTK3	0.691					IMTK3	0.721			
	IMTK4	0.626					IMTK4	0.697			
IMTA	IMTA1	0.845	0.812	0.523	0.808	IMTA	IMTA1	0.741	0.850	0.590	0.842
	IMTA2	0.597					IMTA2	0.828			
	IMTA3	0.757					IMTA3	0.628			
	IMTA4	0.671					IMTA4	0.857			
IMTS	IMTS1	0.703	0.834	0.557	0.833	IMTS	IMTS1	0.691	0.800	0.500	0.799
	IMTS2	0.756					IMTS2	0.740			
	IMTS3	0.811					IMTS3	0.715			
	IMTS4	0.713					IMTS4	0.683			
EMER	EMER1	0.330	0.723	0.419	0.710	EMER	EMER1	0.351	0.690	0.372	0.670
	EMER2	0.543					EMER2	0.693			
	EMER3	0.849					EMER3	0.743			
	EMER4	0.744					EMER4	0.578			
EMIN	EMIN1	0.635	0.791	0.488	0.787	EMIN	EMIN1	0.639	0.791	0.491	0.787
	EMIN2	0.701					EMIN2	0.595			
	EMIN3	0.710					EMIN3	0.818			
	EMIN4	0.744					EMIN4	0.731			
EMID	EMID1	0.809	0.864	0.615	0.863	EMID	EMID1	0.825	0.861	0.610	0.857
	EMID2	0.787					EMID2	0.813			
	EMID3	0.749					EMID3	0.623			
	EMID4	0.792					EMID4	0.845			

Legend: EMER-Extrinsic Motivation External Regulation; EMIN-Extrinsic Motivation introjection; EMID-Extrinsic Motivation Identification; IMTS-Intrinsic Motivation to Stimulate; IMTA-Intrinsic Motivation to Accomplish; IMTK-Intrinsic Motivation to Know; CR-Composite Reliability; AVE-Average Extracted; α -Cronbach Alpha

Results

Tested research model – Multi-group Analysis

In Table 3, we may observe the summary of the hypotheses tested in accordance with the best research model for each stage of the multi-group analysis carried out (moment 1 and moment 2) as well as the results obtained conclude that the variation that occurred in IMTK differs in both of the tested models (Figure 2 and Figure 3). The structural results point to the dimensions of IMTS, IMTA, EMIN and EMID as holding direct statistically significant influences over the IMTK of Portuguese referees' motivation in Moment 1 and the same dimensions in Moment 2, validating the formulated research hypotheses H1, H2, H4 and H5 in both models after and before the use of the RefereeGame. Thus, for H3, Portuguese referees do not attribute statistical significance ($p>0.05$) and thus failing to back the hypothesis of EMER influencing the IMTK in both motivation measure moments.

Models present below (Figure 2 and Figure 3) represents the motivation dimension influence in Intrinsic Motivation of Portuguese Referees before using RefereeGame like a learning tool (Moment1) and after using RefereeGame

(Moment 2) to know Laws of the Game and Competition Rules during football seasons. Following analysis of the structural model in Moment 1, we may report that the Extrinsic Motivation (EMOT) dimension with EMID ($\beta=0.220$; $p<0.001$) and EMIN ($\beta=-0.103$; $p<0.05$) held a greater impact in Intrinsic Motivation to Know LGCR. The same impact was obtained in Intrinsic Motivation (IMOT) dimension with IMTA ($\beta=0.296$; $p<0.001$) and IMTS ($\beta=0.615$; $p<0.001$). Regarding the structural model, we may state that the EMOT dimensions like EMER ($\beta=-0.029$; $p>0.05$) did not achieve statistical significance.

Following analysis of the structural model in Moment 2, we may report that the Extrinsic Motivation (EMOT) dimension with EMID ($\beta=0.321$; $p<0.001$) and EMIN ($\beta=-0.098$; $p<0.05$) held a greater impact in Intrinsic Motivation to Know LGCR. The same impact was obtained in Intrinsic Motivation (IMOT) dimension with IMTA ($\beta=0.249$; $p<0.001$) and IMTS ($\beta=0.339$; $p<0.001$). Regarding the structural model, we may state that the EMOT dimensions like EMER ($\beta=-0.124$; $p>0.05$) did not achieve statistical significance.

Table 3. Research hypotheses and statistical results – Moment 1 and Moment 2

Hypotheses	Relationship	Regression Coefficient	Standard Error	t	p-value	Result
H1	IMTS \rightarrow IMTK	.615	.070	8.731	<0.001	Supported
H2	IMTA \rightarrow IMTK	.296	.041	7.270	<0.001	Supported
H3	EMER \rightarrow IMTK	-.029	.054	-.534	>0.05	Non Supported
H4	EMIN \rightarrow IMTK	-.103	.037	-2.812	<0.05	Supported
H5	EMID \rightarrow IMTK	.220	.041	5.321	<0.001	Supported
Portuguese Referees Motivation (Moment 1)						
H1	IMTS \rightarrow IMTK	.339	.080	4.211	<0.001	Supported
H2	IMTA \rightarrow IMTK	.249	.059	4.233	<0.001	Supported
H3	EMER \rightarrow IMTK	-.124	.055	-2.256	>0.05	Non Supported
H4	EMIN \rightarrow IMTK	.098	.043	2.250	<0.05	Supported
H5	EMID \rightarrow IMTK	.321	.076	4.213	<0.001	Supported
Portuguese Referees Motivation (Moment 2)						

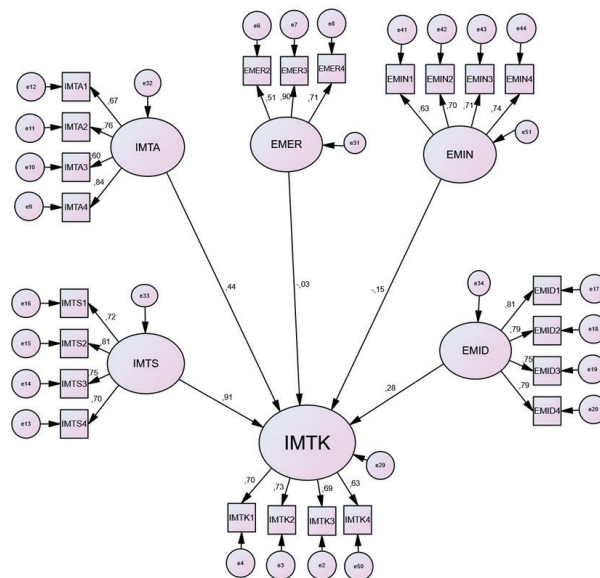


FIGURE 2. Structural Model – Moment 1

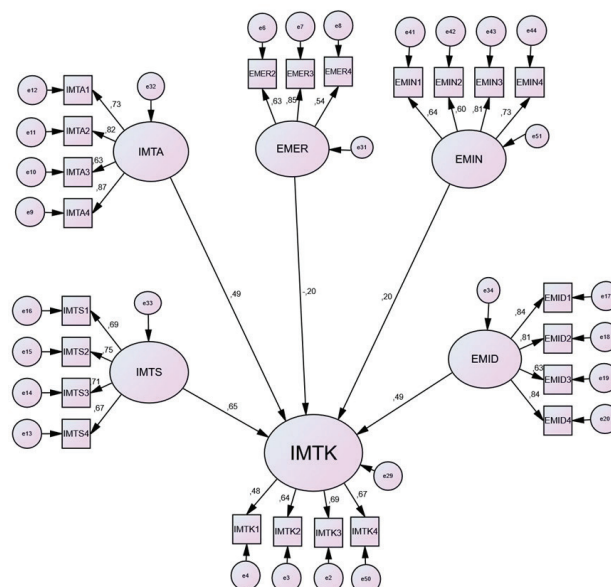


FIGURE 3. Structural Model – Moment 2

Both models reported that Portuguese referees are both intrinsically and extrinsically motivated to study LGCR even while the results identify a greater motivation level using GBL RefereeGame like a learning tool.

Discussion

This research study brought some interesting insights about Portuguese Referees motivation to study Laws of the Game and Competition Rules and the motivation dimensions that influence their will to study. The study incorporated a total of 179 referees who participated in the recycling and training actions throughout a sports season. The referees filled out a questionnaire, adapted of the AMS proposed by Vallerand et al. (1992), to assess the two dimensions that are part of motivation (EMOT and IMOT, which, in turn, subdivided into various constructs that enable the evaluation of motivation according to SDT). The application of these theoretical constructs to students provided evidence that original research applying the Self Determination Theory (SDT) is eligible for application to analyzing the motivational aspects interrelated with learning this field of knowledge (Taylor et al., 2014). In a general way, in both moments, with and without Games Based Learning tools, like RefereeGame, showed positive indices for extrinsic and intrinsic motivation, however, we also found an EMOT dimension that was not statistically significant and, for that reason, it was not possible to measure the Extrinsic Motivation External Regulation (EMER) of the referees at both times. In this sense, it was verified that this type of motivation did not influence the Intrinsic Motivation to Know (IMTK) of the referees before and after using RefereeGame as a Learning Tool. We found that from Moment 1 to Moment 2 the referees felt less intrinsically motivated, however, their extrinsic motivation was superior. Probably, these results were due the interest that RefereeGame has aroused them. In fact, we may report that Moment 2 hold greater study related motivations than Moment 1. Thus, referees showed higher values of intrinsic and extrinsic motivation after using this tool, demonstrating a greater capacity to be self-motivated, and in addition to simultaneously experiencing influences from games using. These results revealed how extrinsic motivation does not affect the need for personal or intrinsic motivation (Ryan & Deci, 2000a). The study's results demonstrate a higher rating for EMOT than for IMOT; previous corroborating studies applying AMS to evaluate motivations for studying (Ratelle, Guay, Vallerand, Larose, & Sen  cal, 2007; Stover, de la Iglesia, Boubeta, & Liporace, 2012). On the other hand, we verify how the levels of motivation increase along the Self-Determination Continuum course proposed by Ryan and Deci (2000b), with the EMOT and IMOT dimensions of referees in Moment 2 higher than in Moment 1. At the individual level, we verify that in both moments, EMOT is higher than IMOT, which reflects higher levels of extrinsic motivation when compared to intrinsic motivation (Vansteenkiste, Lens, & Deci,

2006). Also, we verified that Extrinsic Motivation Introjection that was negative in the first moment, and after RefereeGame use by the referees, became positive. In other words, the use of Games Based Learning given rise positive influences, increasing the Intrinsic Motivation to Know (Anastasiadis et al., 2018; Guill  n-Nieto & Aleson-Carbonell, 2012).

The multi-group analysis carried out (Hair et al., 2010; Mar  co, 2010) enabled the estimation of the construction of IMTK for both groups and immediately identifying how some of the variables in the initial model do not attain statistical significance and correspondingly removing all variables with factorial weightings of below 0.5 (Brown, 2006) to result in a more robust and significant model able to explain a right percentage proportion of IMTK.

The results obtained are in line with the theoretical basis of SDT, regarding its position that whenever meeting the basic psychological needs, intrinsic and extrinsic motivations are susceptible to enhancement while reducing demotivation (Black & Deci, 2000).

This study also demonstrated the existence of motivational differences over the study of LGCR between two different referees study moments and identifying the need to design measures able to nurture the motivations of this kind of athletes and, whenever possible, maintaining and/or boosting the motivations of those expressing a desire to study. The introduction of new forms of studying that move on from traditional methods might contribute to developing a significant increase in the future results of learning for this type of sports group. Therefore, when seeking to increase the motivations in effect to facilitate learning, we might need to consider the deployment of new tools within the near future as the best means of enhancing the referees from all categories learning process.

Limitations and future research proposals

The present research incurs certain limitations. From the outset, students evaluate their motivations and, given this self-reporting facet, there is the scope for them to evaluate their realities incorrectly due to the scope for lack of self-awareness about the content studied. As in this case, we evaluated motivation, different aspect, whether of a personal or professional nature, might eventually have interfered and influenced the results obtained.

Concerning future research proposals, we would recommend replicating this study in other countries to understand the difference in motivation between distinctive groups. Other crucial future research is to evaluate referees' motivations with personal interviews to make a better evaluation without lack of self-awareness. Another proposal would be to assess motivation levels but differentiating the results by gender, age and referee category to evaluate whether socio-demographic differences bias over the motivations for studying Laws of the Game and Competition Rules.

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Conflict of interests

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

High Load few Repetitions Exercise is better for the Cardiovascular System than low Load Many Repetitions Exercise

Ron Mor¹, Eyal Weissblueth¹ and Izhar Ben Shlomo²

¹Tel Hai Academic College, School of Physical Education, Upper Galilee, Israel, ²Zefat Academic College, Faculty of Health Sciences, Zefat, Israel

Abstract

Blood pressure, pulse rate, and blood lactate concentration in response to resistance training are of critical significance for people, who could benefit from performing it, but to whom extreme blood pressure levels may be harmful. Traditionally high load training was held to cause an exaggerated blood pressure response but few recent studies challenged this. Since the published data is not unanimous, we examined whether longer duration with low load or high load in shorter duration would be favorable to heart rate, blood pressure, double product, and lactate levels in a group of healthy young people. Twenty-three young students performed twice, a week apart, a sequence of four sets of an exercise, once with 20 repetitions of 50% of maximal resistance of 1 Repetition Maximum and once with 10 repetitions of 75% of 1 Repetition Maximum. Heart rate was measured continuously while blood pressure and blood lactate levels were measured before exercise and after the conclusion of each set. Heart rate, blood pressure, and blood lactate levels increased significantly more following the 20, lower load repetition sets compared to the higher load 10 repetition sets. We conclude that high load low repetition exercise is less demanding on the cardiovascular system compared to lower load high repetition exercise, which should be considered in prescribing physical activity to older beginners and cardiac rehabilitation patients.

Keywords: resistance training, cardiac rehabilitation, blood pressure, blood lactate

Introduction

Blood pressure (BP), heart rate (HR) and lactate (La) concentration in peripheral blood in response to resistance training (RT) are of critical significance in certain people, such as older beginners and cardiac rehabilitation patients, who could benefit from performing it, but to whom extreme BP levels may be harmful.

RT improves strength and power of action (Garcia et al., 2016; Haskell et al., 2007) and is recommended to the general population as a preventive measure against cardiovascular disease (CVD). It is recommended also to the group of people already diagnosed with CVD as an adjunct to pharmacological treatment (Bjarnason-Wehrens et al., 2004; Sharman, La Gerche, & Coombes, 2015) and to aerobic training in patients

with high BP (Carpio-Rivera, Moncada-Jiménez, Salazar-Rojas, & Solera-Herrera, 2016; Pescatello et al., 2004). Beyond these, RT is known to slow age-related deterioration on both muscular and neuronal levels (Rubenstein, 2006; Chen et al., 2015).

The efficacy of RT for the achievement of different goals depends on the selection and combination of various elements of RT (Bird, Tarpenning, & Marino, 2005) and the consequences of the various clinical conditions in which one should apply each combination (Garber et al., 2011). The balance between high-load low-repetition and low-load high-repetition RT depends on the condition of the subject in question, i.e. whether it is a young athlete who begins a training program or a person after myocardial infarction who seeks rehabilitation



Correspondence:

E. Weissblueth
Tel Hai Academic College, School of Physical Education, Upper Galilee, 1220800, Israel
E-mail: eyalwei@telhai.ac.il

(Sardeli et al., 2017; American College of Sports Medicine, 2009). Related issues to the subject of load vs repetition are post-exercise hypotension and the cumulative effect on arterial stiffness (Cavalcante et al., 2015; Li et al., 2015).

RT with high repetitions and low load affects the cardiovascular system, and muscle endurance (Campos et al., 2002) whereas high load low repetition increases muscle power (Willardson, 2006). A prime concern in people with a cardiac deficit is the elevation of BP (de Vos et al., 2008; MacDougall, Tuxen, Sale, Moroz, & Sutton, 1985; Pedersen & Saltin, 2006; Perk et al., 2012), thus the recommendations for healthy old adults was to use low load high repetition sets of exercises (American College of Sports Medicine, 2009; Pescatello, MacDonald, Lamberti, & Johnson, 2015), in order to refrain from the Valsalva maneuver, known to be taken during high load exercise, which elevates BP (Narloch & Brandstater, 1995). Quite to the contrary, some more recent studies indicated that longer duration of effort, rather than its intensity elevates BP more pronounced (Borde, Hortobágyi, & Granacher, 2015; Gjovaag, Hjelmeland, Oygard, Vikne, & Mirtaheri, 2016; Lamotte, Niset, & van de Borne, 2005; Palatini et al., 1989), which is critical to

cardiac patients (Wise & Patrick, 2011). Additionally, others found higher blood La levels after long-duration exercise (Aguar et al., 2018). Whereas for young and healthy individuals this is immaterial, for cardiac patients it may become detrimental.

Since the published data is not unanimous, we aimed at examining whether a longer duration with low load would be favorable to HR, BP, double product, and La levels in a group of 23 healthy young people.

Methods

Participants

All participants were students for physical education, ages 20-32, who were thoroughly interviewed to verify the lack of any health problems of the cardiovascular and musculoskeletal systems. All participants signed a form of informed consent and health declaration. Table 1 depicts the details of background data on the participants. The Ethics Committee for Studies in Human Subjects of the Academic College (7-2020) approved the study in advance. Each participant voluntarily provided written informed consent before participating.

Table 1. Physical characteristics of the participants in the study (N=23)

	Mean±SD
Age	24.9±3.3
Hight (cm)	172.4±9.9
Weight (kg)	69.6±10.9
Fat percentage	20.8±7.0
Fat mass (kg)	28.8±5.0
Lean Body Weight (kg)	55.2±10.4
BMI (kg/m ²)	23.3±2.6

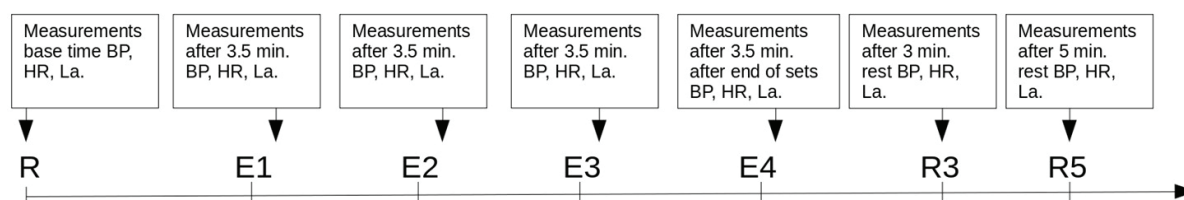
Measures

The test was done on a training device for knee-push (RS-1401 Leg Extension, HOIST® Fitness, San Diego, California, USA), leaving the arms to be crossed over the chest as was done in previous studies (Gjovaag et al., 2016). One Repetition Maximum (RM1) was determined for each subject during 10 repetitions with maximum weight (Desgorces, Berthelot, Dietrich, & Testa, 2010). To scale a participant's personal test load, RM10 (low repetitions, high load) was assumed to be 75% of their RM1 load while RM20 (high repetitions, low load) was 50%. Blood La was measured from capillary blood with EKF Diagnostic Mobile quick lactate-meter. Systolic and diastolic BP (SBP & DBP, respectively) was measured using a non-invasive continuous meter PROBP 3400 WSUREBP made by Welch Allyn. HR was measured using an electronic

HR monitor (Polar H7 watch/strap with Polar Beat application). Weight was measured by a scale endowed with a body composition analyzer (Tanita DC-360 – Tanita Corporation).

Design and Procedures

The RM10 test and RM20 tests were conducted a week apart. In each test, 4 sets of exercises were carried out. For RM10 and RM20, at the onset of each set, participants performed a 10-times leg-push against 75% of RM1 load or 20 leg-push against 50% of RM1 load respectively. The resting interval between sets was 3.5 min. The order of the two events was defined randomly. Measurements were taken before the start (R), immediately after each set (E1, E2, E3 and E4) and at 3 (except La to provide for ethical limitations) and 5 minutes after the conclusion of the total test (R3, R5 respective-



Legend: BP=blood pressure; HR=heart rate; La=serum lactate level. Conditions: R-Rest, E1-1st set, E2-2nd set, E3-3rd set, E4-4th set, R3, R5-3 and 5 min into recovery respectively

FIGURE 1. Exercise and testing schedule as applied to participants.

Once with RM20 for four times 20 repetitions and once with RM10 for four times 10 repetitions.

ly). Figure 1 depicts the order of events. Mean arterial blood pressure (MBP) was calculated as $MBP = DBP + [SBP - DBP] / 3$. Rate-pressure product (RPP) was calculated as $RPP = HR \times SBP$. After each testing event, participants reported their subjective fatigue on a traditional Borg scale.

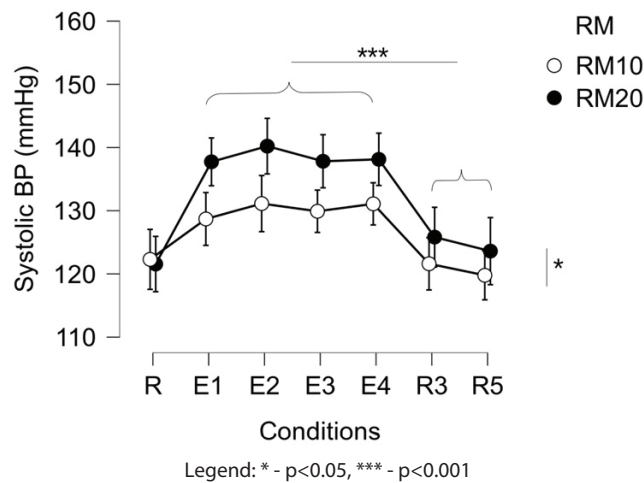
Statistical analysis

All parameters in this study were continuous. To examine the effect of the duration of repetitions on the physiological indices – BP, HR, and La, a two-way analysis of variance was performed with repeated measurements in a $2 \times 2 \times 7$ array. To examine the difference between RM10 and RM20, a paired t-test procedure was employed. Data were imported into JASP statistical software version 0.12.2 for analysis, which was used for all statistical analyses and the significance level was set at 2-tailed, $\alpha \leq 0.05$.

Results

A two-way within-subjects ANOVA was conducted to compare the effect of exercise on SBP for each of 4 sets and

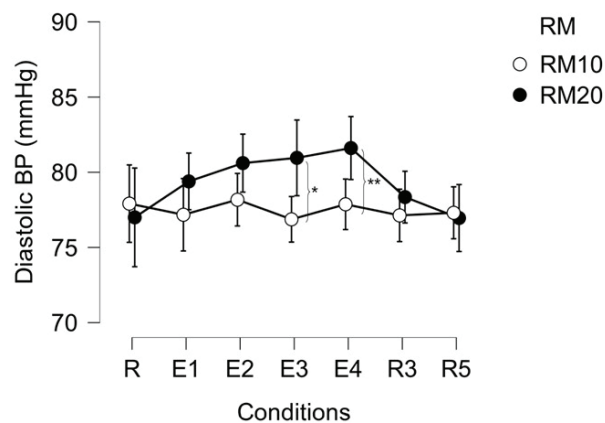
3 and 5 minutes into recovery conditions. Normality checks were carried out on the residuals which were approximately normally distributed thus it was used with a Greenhouse-Geisser correction. Figure 2 shows that there was a significant main effect of exercise sets on SBP ($F(3,28, 72.151) = 27.66$, $p < 0.001$, $\eta^2 = 0.268$). Bonferroni post-hoc tests showed that during RM10 participants raised their SBP significantly more during exercise sets (M range=128.7–131.1 mmHg; SD range=13.6–16.2) compared to that during rest and recovery (M range=119.8–122.3 mmHg; SD range=11.8–15.0). During RM20, participants raised their SBP significantly more during exercise sets (M range=137.7–140.2 mmHg; SD range=14.0–18.1) compared to that during rest and recovery (M range=121.6–125.8 mmHg; SD range=11.0–14.3). Post-hoc comparing SBP levels in RM10 and in RM20 revealed a significant difference ($F(1,22) = 5.119$, $p = 0.034$, $\eta^2 = 0.063$). During RM20 exercises and following it at each set, SBP was significantly ($P < 0.05$) higher than during and following RM10 exercises.



Legend: * - $p < 0.05$, *** - $p < 0.001$
 FIGURE 2. Systolic blood pressure during exercise schedule as applied to participants, once with RM20 for four times 20 repetitions (filled circles) and once with RM10 for four times 10 repetitions (open circles)

The same statistical procedures were carried on DBP together with a paired t-test for individual sets. Figure 3 indicates that DBP followed the same pattern as SBP. However, there was a significant difference in DBP only after E3 in the RM20 exercise (M=81.6

mmHg, SD=4.9) compared to the RM10 exercise (M=76.9 mmHg, SD=5.7), $t(22) = -2.656$, $p = 0.014$ and after the E4 set in the RM20 exercise (M=81.6 mmHg, SD=4.9) compared to that in the RM10 exercise (M=77.9 mmHg, SD=4.8), $t(22) = -3.485$, $p = 0.002$.



Legend: * - $p < 0.05$, ** - $p < 0.01$
 FIGURE 3. Diastolic blood pressure during exercise schedule as applied to participants, once with RM20 for four times 20 repetitions (filled circles) and once with RM10 for four times 10 repetitions (open circles)

Comparing HR levels across various conditions and between RM20 and RM10 with the same statistical procedures revealed statistically significant differences. Figure 4 shows that there was a significant main effect of exercise sets on HR ($F(2,40)=191.5$, $p<0.001$, $\eta^2=0.764$). Bonferroni post-hoc tests showed that during RM10 participants raised their HR significantly more during exercise sets (M range=113-119 beats per minute (bpm); SD range=17.3-20.4) compared to that during rest and recovery (M range=78-83 bpm; SD

range=17.6-19.4). During RM20, participants raised their HR significantly more during exercise sets (M range=130-142 bpm; SD range=16.0-20.4) compared to that during rest and recovery (M range=79-91 bpm; SD range=1.2-19.4). Post-hoc comparing HR levels in RM10 and in RM20 revealed a significant difference ($F(1,20)=41.185$, $p<0.001$, $\eta^2=0.07$). During RM20 exercises and following it at each set, HR was significantly ($P<0.001$) higher than during and following RM10 exercises.

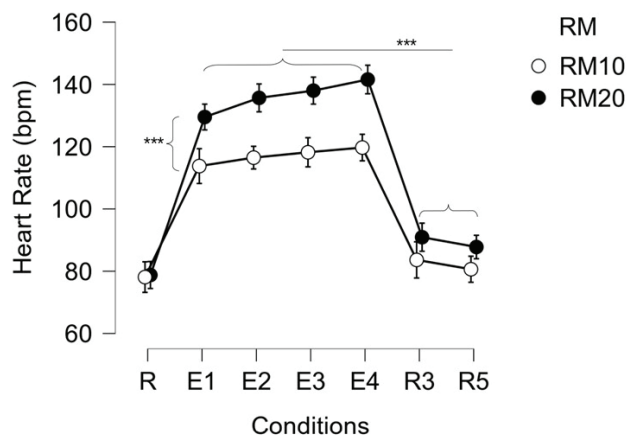


FIGURE 4. Heart rate during exercise schedule as applied to participants, once with RM20 for four times 20 repetitions (filled circles) and once with RM10 for four times 10 repetitions (open circles)

Figure 5 exhibits blood La level during the two exercise schedules. La levels across conditions and between RM20 and RM10 were compared and showed statistically significant differences. There was a significant main effect of exercise sets on La ($F(2.231,49.086)=84.142$, $p<0.001$, $\eta^2=0.501$). Bonferroni post-hoc tests showed that during RM10 and RM20 blood La levels of the participants increased significantly in each set compared with the previous one ($p<0.01$). Post-hoc

comparing blood La levels in RM10 and RM20 revealed that during RM20 exercises at each set, it was significantly ($F(1,22)=29.798$, $p<0.001$, $\eta^2=0.144$) higher than during RM10 exercises. Furthermore, unlike hemodynamic parameters, which returned to initial levels after the sets, blood La continued rising and even after the conclusion of the session remained significantly higher ($t(22)=-10.271$, $p<0.001$) compared to the beginning of the session.

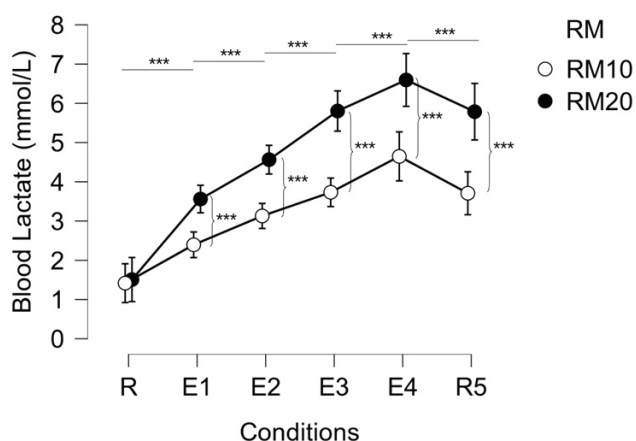


FIGURE 5. Blood lactate levels during exercise schedule as applied to a group of 23 young people, once with RM50 for four times 20 repetitions [full dots] and once with RM75 for four times 10 repetitions [open circles]

Discussion

The current study aimed at comparing the cardiovascular and metabolic responses during exercise between two different protocols in healthy young people, to address the issue of which of the two would be projected to benefit older people with CVD, for whom increased BP and La levels can be detrimental.

It was previously defined that RT with a high number of repetitions (Campos et al., 2002; de Vos et al., 2008; Li et al., 2015; Pedersen & Saltin, 2006; Willardson, 2006) with low to moderate load affects the cardiovascular system, and muscle endurance (Campos et al., 2002) whereas RT with high load and lower number of repetitions (Bird et al., 2005; Chen et al., 2015; Garber et al., 2011; Rubenstein, 2006; Sardeli et

al., 2017) increases muscle power (Willardson, 2006). When planning a training program it is accepted that for improving muscle power, lean body mass and to lower the cardiac load one should aim at 70% of the tested repetition maximum of a person, called RM1 (American College of Sports Medicine, 2009; Garber et al., 2011). A prime concern in this planning process for people with a known cardiac deficit is the elevation of BP during the effort. It is thus advised that performing 15-20 repetitions with 40%-60% of RM1 is expected to elevate BP to a moderate extent (de Vos et al., 2008; Pedersen & Saltin, 2006). Conversely, high load effort of 90%-95% of RM1 (which is defined as RM4) led to systolic pressures up to 320 mmHg (MacDougall et al., 1985). Consequently, the recommendations for improving muscle strength and muscle morphology in healthy old adults was to use low load high repetition sets of exercises (Bird et al., 2005; Chen et al., 2015; Garber et al., 2011; Pescatello et al., 2004; Rubenstein, 2006; Sardeli et al., 2017).

One of the observations underlying this sort of program was that this level of effort does not cause the person to use the Valsalva maneuver, which elevates BP (Narloch & Brandstater, 1995). Quite to the contrary, Borde et al. (2015) on their meta-analysis concluded with a recommendation of “a training volume of 2-3 sets per exercise, 7-9 repetitions per set, a training intensity from 51-69% of the RM1”. They have not addressed the BP and HR issue when recommending sets of 6 sec for each repetition, whereas the previously accepted duration was 2-4 sec.

Furthermore, several studies indicated that a longer duration of effort, rather than its intensity elevates BP more pronounced (Castinheiras-Neto, Costa-Filho, & Farinatti, 2010; Gjovaag et al., 2016; Lamotte et al., 2005; Palatini et al., 1989). The latter concluded that the time under tension, i.e. the dynamic resistance exercise causes occlusion of blood vessels and depending on its intensity and duration, may lead to a compensatory baroreflex response, which is more common in exercises done until fatigue (Castinheiras-Neto et al., 2010). These conclusions are critical to cardiac patients since the current recommendation was to prefer longer exercise with a lighter load (Wise & Patrick, 2011).

The metabolic response to the same volume of exercise (high load short duration to low load long duration) with different durations showed higher blood La levels after long-du-

ration exercise (Aguilar et al., 2018). Whereas for young and healthy individuals this is immaterial for cardiac patients, it may become detrimental.

Resistance training leads to reduced BP after exercise in the long run in both healthy people and those with CVD. Yet, it had to be verified whether the duration of effort or its degree would contribute to the elevation of HR, RPP, BP, and blood La levels during the exercise itself. As the lower load exercise was longer than the high load exercise it had to be tested whether the load is what increases these parameters, or the duration is the major determinant. Our findings, in agreement with several previous observations (Gjovaag et al., 2016), and opposed to others (Palatini et al., 1989), indicate that duration contributes more significantly than load. This conclusion also flies against the recommendations by several medical authorities (Garber et al., 2011).

The traditional view that led to the health organizations' recommendation held that high load effort entails more pronounced elevation of BP, especially through its associated need to perform the Valsalva maneuver. Few more recent studies found that contrary to the traditional view, longer duration exercises, despite involving lower load, led to a higher response of BP (Gjovaag et al., 2016; Lamotte et al., 2005). One study by Aguilar (2018) recorded blood La levels during and after various levels of load and duration and found that the highest levels were recorded following the longest exercise, even though the load was the lowest. This reflects the increased use of glycolytic products rather than ATP-CP, which in turn causes increased HR with its associated shorter diastole and lowered stroke volume, leading to an even more pronounced shift to glycolysis in a form of a “vicious cycle”. Younger people overcome this within a short time of recovery but people with CVD are challenged by this sequence to the level of significant threat of ischemia.

In conclusion, the results of the current study can be projected to indicate that programs of rehabilitation of cardiac patients, as well as programs for older beginners responding to some medical wake-up call, should begin with relatively high load exercise that should be short. Only when these people adjust to the new schedule, the duration can be increased gradually and cautiously, with the same load or lower, to reach a sufficient level that would contribute to their general cardiovascular health.

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Conflict of interest

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ORIGINAL SCIENTIFIC PAPER

Effects of Different Sports Shoes and Bare Feet on Static and Dynamic Balance In Healthy Females: A Randomized Clinical Trial

Nihan Ozunlu Pekiavas¹, Ewan Thomas², Antonino Bianco² and Fatma Nese Sahin³

¹Baskent University, Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Ankara, Turkey, ²University of Palermo, Sport and Exercise Sciences Research Unit, Department of Psychology, Educational Science and Human Movement, Palermo, Italy, ³Ankara University, Department of Sport and Health, Faculty of Sport Sciences, Ankara, Turkey

Abstract

Static and dynamic balance can be influenced by many factors. However, there is limited evidence regarding the effects that shoe sole hardness may have on balance. The aim of our study was to investigate effects of different sports shoes and bare feet on static and dynamic balance in healthy female individuals. Seventeen female participants were included in our study. All participants were assessed with bare feet, hard-support sports shoes and soft-foam sports shoes. The order of the assessment for each participant was randomly determined using an on-line random allocation software. The SportKAT 3000® device was used to assess dynamic double feet, static double feet, dominant foot and non-dominant foot balance. Static balance showed no significant difference between bare feet, hard-support and soft-foam sports shoes ($p_{\text{double feet}}=0.390$, $p_{\text{dominant side}}=0.465$, $p_{\text{non-dominant side}}=0.494$). Difference for dynamic balance was statistically significant between bare foot, soft-foam and hard-support sports shoes ($p=0.003$). When investigating this difference in dynamic balance with dual comparisons, significant differences were confirmed between hard-support and bare foot ($p=0.010$) and between soft-foam and bare foot ($p=0.001$). No difference in static balance is present between the no-shoe and both shoe conditions. Different outcomes regarding dynamic balance were observed between bare feet and both shoe conditions. However, hard surface and soft surface shoes did not differ during the dynamic task condition. Therefore, the purchase of a running shoe may be decided according to the preferred footwear.

Keywords: balance, shoe, static, dynamic

Introduction

Sports shoes have considerably evolved during the last century in terms of features, materials and construction techniques and many different types of sport shoes are present nowadays (Nigg, Baltich, Hoerzer, & Enders, 2015). They differ based on insole material, support or sports type (Fong, Hong, & Li, 2007). Shoe characteristics are important for balance and stability, since these are able to influence the somatosensory feedback to the foot and ankle (Menant, Steele, Menz, Munro, & Lord, 2008b). An example can be

seen when wearing elevated heels which can significantly alter static balance compared to standard low heel shoes (Menant, Steele, Menz, Munro, & Lord, 2008a). Conversely, the type and texture of insoles which has direct contact with the sole of the foot (S. H. Kim, Ahn, Jung, J. H. Kim, & Cho, 2016), can positively influence postural control, static and dynamic balance in either healthy or injured populations, young and old individuals (Menz, Auhl, & Munteanu, 2017; Steinberg, Tirosh, Adams, Karin, & Waddington, 2017). Therefore, depending on the type and structure of the shoe



Correspondence:

E. Thomas
University of Palermo, Sport and Exercise Research Unit, Department of Psychology, Educational Science and Human Movement,
Via Giovanni Pascoli 6 - 90144, Palermo, Italy
E-mail: ewan.thomas@unipa.it

and its components, balance can be both positively or negatively influenced.

Among shoe characteristics also the type of support must be considered. Among these, hard-support and soft-foam soles are commonly employed. Hard-support soles regulate and support the foot structure thanks to their stiffer material (Robbins, Gouw, & McClaran, 1992). Soft-foam soles provide contact with the foot at all points and provide a softer support which harbors the structure of the foot (Nagano & Begg, 2018). However, excessively hard or excessively soft soles have been seen to negatively affect balance and gait, especially in older adults (Menant et al., 2008b).

Evidence also exists regarding the capacity of certain shoes have to absorb shocks and therefore may have the potential effect to prevent from injury occurrence (Peters, Zwerver, Diercks, Elferink-Gemser, & van den Akker-Scheek, 2015). Such shock absorption capacity is guaranteed by the inclusion of synthetic materials and air or gel cells within the sole or the insoles (Nigg, 2001).

Nowadays, there is also increasing interest towards walking and training barefoot or with minimal shoes in order to replicate more natural movements of the feet (Marchena-Rodriguez, Ortega-Avila, Cervera-Garvi, Cabello-Manrique, & Gijon-Nogueron, 2020). Intervention studies have observed that this type of training in runners may be beneficial to increase the strength of the feet or reduce the rate of injuries

(Fuller et al., 2019; Rixe, Gallo, & Silvis, 2012), however no significant differences were seen regarding long term performance or running biomechanics improvements following long periods of bare feet running.

Despite the influence of shoe characteristics has been widely investigated concerning gait or performance in different populations, there is limited evidence regarding the influence of shoe typology on balance. Therefore, the aim of this study was to investigate the effects of different sport shoes or no-shoes on static and dynamic balance in healthy individuals. This question is especially important for athletes or sport professionals which require optimal balance during different motor tasks.

Methods

Participants

Seventeen female participants (mean age 27.0 ± 9.55 years, BMI 23.10 ± 4.15 kg/m², shoe size 38-39) without lower extremity and low back problems were included. The exclusion criteria included: (a) Participants presenting with soft tissue or bone problems affecting the lower extremities, (b) neurologic pathologies or disfunctions, (c) scoliosis, (d) systematic rheumatic pathologies, (f) participants with history of orthopedic problems or surgery affecting lower extremities, and (g) being obese (BMI > 30 kg/m²). A flow chart of participants inclusion and study assessment is presented in Figure 1.

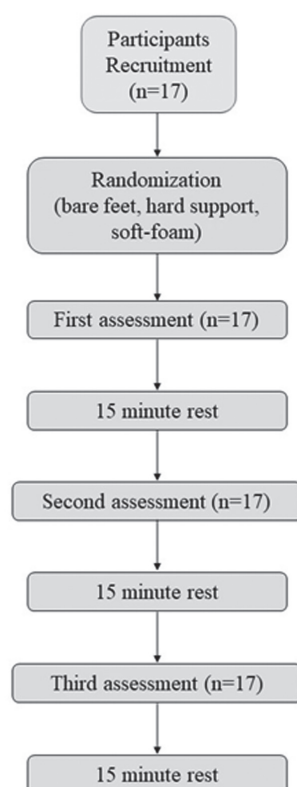


FIGURE 1. Flow-chart of participants inclusion and assessment process

Research design

The study protocol was approved by the University Ethics Committee (n KA16/369; clinical trial n NCT04536948), and a written consent form was obtained from all participants. These were assessed with bare feet, with a hard-support sports shoe and with a soft-foam sports shoe. Nike Air-Max® sports shoes were used as hard-support shoes and Sketchers® sports

shoes with memory-foam were used to provide soft-foam sole support. All participants were assessed by an experienced physiotherapist. The assessment order (bare feet, hard-support shoe and soft-foam shoe) for each participant was randomly assigned using an online random allocation software program (GraphPad Software QuickCalcs, GraphPad Software Inc., La Jolla, CA, USA).

Assessment Procedure

Anthropometric parameters of each participant were first collected. All participants were assessed for three conditions: bare feet, hard-support sports shoes and soft-foam sports shoes.

For each condition, four measures were collected: Dynamic double feet (DDF), static double feet (SDF), static dominant foot (DF) and static non-dominant foot (NF). Dominant foot was determined by asking the participants their preferred kicking leg (van Melick, Meddeler, Hoogeboom, Nijhuis-van der Sanden, & van Cingel, 2017). The Kinesthetic Ability Trainer (SportKAT 3000®) (LLC, Vista, California) device was used to assess balance. The SportKAT 3000® consists of a movable platform supported on a central point by a small pivot. A tilt sensor on the platform is connected to a computer, which registers the deviation of the platform from a reference position with a sampling frequency of 18.2 Hz. The distance from the central point to the reference position is measured at every platform variation. Each subject was allowed to familiarize on

the platform for one-minute before the tests. After the familiarization, the subjects performed the different tasks for every condition. Each measurement was conducted over a 30 second timeframe.

During all the balance tests, the participants kept their eyes open and had to keep sight at a reference point (a red 'X') on a monitor in front of the SportKAT 3000® system at 1.5m distance. The target was constant for static measurements and active for dynamic measurements.

Each subject stood on the force platform in a natural position with arms placed at side. To ensure that the balance measurement was accurate, the SportKAT 3000® device was calibrated, as recommended in its manual, before the tests (Figure 2 and 3 show non-dominant static and static condition without and with shoes, respectively) (Surenkok, Kin-Isler, Aytar, & Gültekin, 2008; Yazicioglu, Taskaynatan, Guzelkucuk, & Tugcu, 2007).

After each condition the participants were asked to sit in a chair for 15 minutes without shoes.



FIGURE 2. Static Balance Assessment with Bare Feet in dominant Side



FIGURE 3. Static Double Feet Balance Assessment with Hard-Support Insole Sports Shoe

Statistical analysis

The power analysis indicated that 17 participants were needed with 80% power and a 5% type 1 error (G*Power 3.1.9.7). The power analysis of our study showed a power of 80% with balance as the primary outcome. The data were analyzed using statistical software (SPSS version 18, Inc., Chicago, IL, USA). All the statistical analyses were set a priori at an alpha level of $p < 0.05$. The tests for homogeneity (Levene's test) and normality (Shapiro-Wilks) were used to determine the appropriate statistical methods to apply for comparison between groups. The differences between groups were analyzed by the Friedman Variance Analysis while paired comparisons

between groups and multiple comparisons between the ranks of each groups with post-analysis Dunn's correction. The level of statistical significance was set at $p < 0.05$.

Results

Dominant foot was calculated in 11.8% the left leg and in 88.2% the right leg. Static balance showed no significant difference between bare feet, hard-support sport shoes and soft-foam sport shoes (SDF $p = 0.390$, DF $p = 0.465$, NF $p = 0.494$). Difference for dynamic balance was statistically significant between bare feet, soft-foam sport shoes and hard-support sport shoes ($p = 0.003$).

Table 1. Comparison of balance outcomes between conditions

	Bare feet Mean±SD	Hard-support shoes Mean±SD	Soft-foam shoes Mean±SD	p
DDF (mm)	2946.88±666.29	2612.59±453.99 ^a	2470.71±502.03 ^a	0.003*
SDF (mm)	472.00±187.28	444.82±129.52	453.59±155.23	0.390
DF (mm)	3160.18±1116.06	3512.41±1308.96	3610.71±1480.41	0.465
NF (mm)	3121.53±1022.08	3212.88±1304.74	3382.24±1497.67	0.494

Legend: DDF-Dynamic double feet; SDF-Static double feet; DF-Static dominant foot; NF-Static non-dominant foot; *- $p < 0.05$, Friedman Variance Analysis, a- $p < 0.05$ compared to bare feet.

When investigating paired differences within the dynamic balance task, there was no significant difference between hard-support sport shoes and soft-foam sport shoes ($p = 0.259$), while a significant difference was present between hard-support sport shoes and bare feet ($p = 0.010$) and soft-foam sport shoes and bare feet ($p = 0.001$) (Table 1).

Discussion

We investigated the effects of sport shoes with different midsole structure on static and dynamic balance and found that different midsoles such as soft-foam and hard-support are equally effective as bare feet in terms of static balance. When considering dynamic balance, sports shoes may be better than bare feet with no differences between the midsoles taken into exam.

There has been an evolutionary change in shoe supports and insoles over time. In addition to fashion, changes in sports shoe insoles have been affected by developing technology and sport needs (Nigg et al., 2015). Different shoe soles can have important implications in maintaining postural control and providing stabilization either in healthy (Corbin, Hart, McKeon, Ingersoll, & Hertel, 2007) and injured individuals (McKeon, Stein, Ingersoll, & Hertel, 2012). Corbin et al. (Corbin et al., 2007) reports that increased afferent information from textured insoles improves postural control in bilateral but not during unilateral stance. Results which seem in line with our findings for both dominant and non-dominant leg and bipodal stance. Regarding possible afferent information, an important consideration which needs to be addressed is that during our evaluations, the participants were for all conditions with their eyes open. As known, balance is the result of different sensory inputs as the visual, vestibular and proprioceptive systems, and the integration between these systems can influence the different balance outcomes (Peterka, 2002). Since dynamic balance was the only outcome which was influenced by the shoe or no-shoe condition, the inhibition of visual inputs could have emphasized the contribution of proprioceptive inputs during the balancing condi-

tions.

Another aspect concerning shoe characteristics addressed by Waddington & Adams (Waddington & Adams, 2003) is that when specific textured insoles were compared to conventional smooth insoles it was possible to observe alterations of the biomechanics of the ankle. Therefore, also the insoles may provide appropriate sensory information needed for correct foot biomechanics. Considering the contribution of the soles and insoles to sensory input for dynamic balance, all shoe components become important factors for balance maintenance (Priplata, Niemi, Harry, Lipsitz, & Collins, 2003).

According to different studies, if there is a defect in the existing foot structure or its biomechanics, when soft-foam insoles are used, the foot will be supported in such direction and poor balance will be maintained (McKay, Goldie, Payne, & Oakes, 2001; Robbins, Waked, & McClaran, 1995). Hard-support sports shoes are expected to provide greater support for dynamic stability (Losa Iglesias, Becerro de Bengoa Vallejo, & Palacios Peña, 2012). Therefore, hard-support insoles are more frequently seen to concerning such aspects to effectively provide tactile sensation for quicker reactions of the foot in order to improve gait and balance (Menant et al., 2008a). However, according to the results of our study both sports shoe soles equally support dynamic equilibrium.

One of the major limitations of this study is that all participants were woman and that these were not using the same shoes used during the evaluation in their daily life.

Conclusions

Our investigation has shown that static balance is not influenced by the typology of shoe support compared to the no-shoe condition. No difference was also present between soft foam shoes and hard support shoes for dynamic balance. However, differences are present between both shoe and the no-shoe condition. These results suggest that wearing a shoe will help dynamic balance tasks. The purchase of a running shoe may be decided according to the preferred footwear.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

The Method for Enhancing Statokinetic Stability in Alpine Skiers Based on the Use of Normobaric Hypoxia in Combination with Cervical Spine Muscle Exercises

Alexander Bolotin¹ and Vladislav Bakayev¹

¹Peter the Great St. Petersburg Polytechnic University, Institute of Physical Education, Sports and Tourism, St. Petersburg, Russia

Abstract

Lately, the improved outfitting and sports alpine skiing equipment have brought about significantly increased speed of their motion on the mountain slope. At the same time, alpine skiers' psychological and physiological reserves remain practically unchanged. In order to enhance the statokinetic stability level of the alpine skiers included in the experimental group, normobaric hypoxia training in combination with cervical spine muscle exercises were used for a month during a preparatory period before competitions. The subjects of the control group used conventional exercises to enhance the statokinetic stability level. The results of the studies showed that the alpine skiers from the experimental group demonstrated a confidently increased tolerance time of continuous cumulation of Coriolis accelerations (versus initial measurements). We also observed the lowered intensity of negative vestibulosensory, vestibulovegetative and vestibuloso-matic reactions. This showed their improved tolerance of continuous cumulation of Coriolis accelerations. Besides that, the alpine skiers of the experimental group showed positive changes in the static stabilometric test in the integrated functional computer stabilography. The open eyes test showed a confidently significant reduction in the rate of increase of the statokinesigram length and area, oscillation amplitude of the projection of the common center of gravity in the frontal and sagittal planes, and also the coefficient of asymmetry in the frontal and sagittal directions. The obtained results can justify recommendation of normobaric hypoxia course to be used in combination with cervical spine muscle exercises as means to improve statokinetic stability in alpine skiers.

Keywords: *alpine skiers, statokinetic stability, normobaric hypoxia, cervical spine muscle exercises*

Introduction

At present, the most important and mandatory conditions for achieving high results in professional sports are the athlete's sufficient psychophysiological capacity, good functional state and high physical performance (Bakayev, 2015; Hébert-Losier, Supej, & Holmberg, 2014; Wrigley, 2015; Bubanja, Milasinovic, & Bojanic, 2016).

The optimum state of the above psychophysiological characteristics is of special importance for alpine skiers whose competitive activities are associated with high tension of the organism psychophysiological functions during the movement along a piste at high speed. The movement speed can exceed 200 km/h along the giant slalom piste during competitions of alpine skiers. Alpine skiers experience intensive



Correspondence:

V. Bakayev
Peter the Great St. Petersburg Polytechnic University, Institute of Physical Education, Sports and Tourism, 29 Polytechnicheskaya st.,
St. Petersburg, 195251, Russia
E-mail: vlad.bakayev@gmail.com

overstresses and simultaneously they should make correct decisions within a minimum interval of time in order to select the right trajectory of going along a piste and at the same time not to allow technical mistakes. Such activity places high demands on alpine skiers' organism psychophysiological systems.

Lately, the considerably improved alpine skiing equipment, betterment of sports equipment technical data result in significantly increased speed of their movement along a piste. At the same time, athletes' psychophysiological reserves remain practically unchanged. This non-compliance resulted, in its turn, in the situation, when during the excessive impact of dynamic factors associated with going along a piste the sportsman's organism is influenced by the forces, which worsen the functional state of his/her vestibular system and have a negative effect on the efficiency of competitive activities (Bakayev, Bolotin, & You, 2018; Nemec, Petric, Babic, & Supej, 2014). This is associated with the fact that the high-speed movement and maneuvering along a piste are accompanied by the influence of angular, linear and centripetal accelerations on the athletes' organisms, which can lead to development of stable vestibulosomatic (vestibular somatic reactions are based on changes in the tone of the striated muscles of the eye, limbs, trunk and neck, which is realized in the form of nystagmus, a motor reaction of the limbs, head and trunk), vestibulovegetative (vestibular-vegetative effects are based on changes in the function of the organs innervated by the vegetative nervous system, which is manifested by haemodynamic, vascular reactions, nausea, vomiting, sweating, changes in the colour of the skin, etc.) and vestibul sensory (vestibul sensory (imaginative) reactions are associated with cortical stimulation and are realised by the appearance of a sense of movement, reflecting its direction and speed, which is characterised as vertigo) reactions. The duration and significant intensity of these reactions have a negative effect not only on alpine skiers' well-being but also on the quality of going along a piste at competitions (Supej, Kugovnik, & Nemec, 2004).

The studies performed by many scientists provide evidence that excessive exposure to dynamic factors negatively influences the bioelectric cerebral cortex activity and conditioned reflexes, memory, attention, emotional responses and also orientation in space. Meanwhile, the time on a piste, as well as the number of mistakes, including gross mistakes, affecting the safety of the athletes' downhill movement, increase. This circumstance dictates the need to search for new effective means and methods for training alpine skiers aimed at improvement of the functional state of their vestibular system and the level of their physical performance (Bakayev et al., 2018; Hadzic, Bjelica, Vujovic, & Popovic, 2015; Mao, Chen, Li, & Huang, 2014; Vaverka, & Vodickova, 2010). This is related to a high degree of manifestation of sensory, vegetative and somatic components of statokinetic reactions in alpine skiers.

The methods currently used for improvement of the functional state and physical performance of athletes, as a rule, directly influence various physiologic systems of alpine skiers. These methods include the method of normobaric hypoxic training as well, which is used to enhance the athletes' organisms resistance to unfavorable influence of several factors associated with going along a piste (Wrigley, 2015; Naeije, 2014; Mekjavic, Amon, Kölegård et.al., 2016;

Gonggalanzi, Labasangzhu, Bjertness, Wu, Stigum & Nafstad, 2017). Besides that, this method is aimed at improvement of adaptive reserves of the alpine skiers' vestibular systems.

Currently, despite the availability of a detailed description of mechanisms of negative impact exerted by hypoxia on organs and tissues, in certain conditions it can also be regarded as a driver for expansion of physiologic ranges of functional systems. This can favor the enhancement of the athletes' organism psychophysiological reserves. The use of normobaric hypoxic training in combination with exercises for certain muscle groups can result in optimization of the athletes' functional state and enhancement of their physical performance (Bakayev, 2015; Bakayev et al., 2018; Gorshova et al., 2017; Vogiatzis et.al., 2007).

The objective of the study was to develop a method for the use of normobaric hypoxia in combination with special cervical muscle exercises of alpine skiers to enhance their statokinetic stability, improve the adaptive resources of the vestibular system for competitive activities.

Methods

The study was performed at the Department of Medical and Valeological Specialties at the Herzen State Pedagogical University of Russia, Institute of Physical Education, Sport and Tourism at the Peter the Great Saint Petersburg Polytechnic University. The alpine skiers aged 18–20 years, whose tolerance time of continuous cumulation test of Coriolis accelerations (hereinafter referred to as CCCA) was less than 2 minutes, performed as the subjects.

At the initial stage of the experiment, all the subjects were presented the plan and protocol of the forthcoming study, and the methods used. All subjects provided voluntary written consent to participate in the experiment (in accordance with the Declaration of Helsinki on Ethical Principles for Medical Research). Next, random sampling was used to form two groups of subjects: the experimental group (n-12) and the control group (n-12). Subsequently, the subjects of the experimental group were engaged in a month course of normobaric hypoxia training (hereinafter referred to as NBHT) in combination with dedicated cervical muscle exercises (hereinafter – DCME). The subjects of the control group received “false” NBHT courses and they did not perform DCME at all.

All subjects underwent a repeated investigation in the initial extent after a month experiment. Then the investigation in the initial extent was repeated 1, 2 and 3 months after the completion of the experiment.

In the course of the experiment, the CCCA test tolerance time was determined using the procedure and evaluation according to the traditional R. Barany chair method (Pearce, 2007; Lewkowicz, & Kowaleczko, 2019). The degree of manifestation of sensory, vegetative and somatic components of statokinetic reactions was also assessed. It was determined using a point rating system developed by us: 0 – absence of sensations; 1 – mildly manifested sensations; 2 – intense sensations.

In the experimental group (EG), we used the “Bionova-Nova-204, AF” system (Russia) for NBHT. NBHT was performed in a course of 14 sessions. The duration of each session was 30 minutes. During the first session, the subjects were administered hypoxic gas mix with 18.0 % oxygen con-

tent. During the following four sessions, oxygen content was reduced by 1.0–1.5 %. Starting from the fifth session to the end of the NBHT course, oxygen content in the hypoxic gas mix was maintained at the level of 11.0–12.0 %.

The DCME method included two exercises in the supine position. In Exercise No. 1, the subject was supine on a gymnastic bench, with the head poised (earphone helmet loaded with 500 g weight prevented engagement of muscles adducting the head to the chest). In Exercise No. 2, a rubber band, secured around the head with the loose end protruding from the back of the head, was fixed 0.8 meters higher than the bench level, preventing engagement of muscles extending the head. In both exercises the subjects of EG evenly tilted the head upward and downward, making one movement in two seconds, with the tilt angle of 30.0°, the duration of each exercise was 5 minutes, and the interval between exercises was also 5 minutes.

Immediately after CCCA, the ST-02 stabilograph was used for the subjects to perform a static stabilometric test in the integrated functional computer stabilography (hereinafter – SST IFCS), consisting of two tests: test No. 1 was performed with the eyes open and the subject's gaze fixed on the remote (5 m) object; test No. 2 was performed with the

eyes closed. The duration of tests amounted to 20 seconds, with the 1-minute interval between them. During the study we recorded the parameters of the mean rate of increase of the statokinesiogram length and area, oscillation amplitude (hereinafter referred to as OA). Besides that, the coefficient of asymmetry (hereinafter referred to as CA) of the projection of the common center of gravity (hereinafter referred to as PCCG) in the sagittal and also frontal planes was also assessed.

Statistical processing of the obtained data was performed using Microsoft Excel software package according to the adopted standards. Numerical distribution characteristics were calculated for each sample of parameters. The statistical significance of difference between the compared samples was evaluated using the parametric Student's t-test.

Results

Results obtained in the course of the studies justify a conclusion that a month of combined use of NBHT and DCME confidently improved CCCA tolerance in the subjects of the experimental group. This was accompanied by a reduced degree of manifestation of sensory, vegetative and somatic components of statokinetic reactions (Table 1).

Table 1. Tested functional parameters for subjects "Before" and "After" a month of NBHT use in combination with DCME (M±SD)

No.	Studied parameters	Experimental group		Control group	
		Before	After	Before	After
1	CCCA tolerance time (sec)	97.1±8.3	190.1±7.1*	98.3±7.6	99.7±7.3
2	Heat sensation (points)	0.57±0.05	0.31±0.04*	0.4±0.06	0.4±0.07
3	Head heaviness sensation (points)	0.53±0.07	0.32±0.05*	0.5±0.06	0.4±0.08
4	Vertigo sensation (points)	0.48±0.04	0.21±0.03*	0.4±0.05	0.5±0.04
5	Stomach discomfort (points)	0.47±0.06	0.23±0.05*	0.4±0.07	0.3±0.08
6	Hypersalivation degree (points)	0.64±0.05	0.32±0.04*	0.5±0.07	0.4±0.08
7	Hyperhidrosis degree (points)	0.43±0.03	0.21±0.04	0.4±0.06	0.5±0.07
8	Protective movements (points)	0.78±0.09	0.43±0.07*	0.6±0.07	0.5±0.08
9	Nystagmus duration (sec)	21.2±3.2	17.1±3.4*	21.1±3.3	20.9±3.8
10	Number of subjects	12	12	12	12

Legend: reliability of differences: * – $p < 0.05$ versus initial parameter values; NBHT - normobaric hypoxia training; DCME - dedicatedcervical muscle exercises; CCCA - continuous cumulation of Coriolis acceleration

The CCCA test tolerance time was improved by 95.8 % in comparison with the initial measurements. Moreover, there was a 47.8 % reduction in parameters descriptive of heat sensation, 48.7 % reduction in head heaviness sensation, 59.3 % reduction in vertigo sensations, and 58.1 % reduction in stomach discomfort. Besides, there was a reduction in hypersalivation by 58.3 %, hyperhidrosis by 59.7 %, manifestation degree of protective movements by 49.3 %, and time of post-rotation nystagmus by 18.1 %.

The open eyes test there was a confident decrease in the parameters descriptive of the rate of increase in the length (by 11.8 %) and area (by 12.7 %) of the statokinesiogram, OA PCCG in the frontal (by 14.7 %) and sagittal (by 12.9 %) planes, CA in the frontal (by 14.8 %) and sagittal (by 12.9 %) directions. At the same time, confident changes between parameter values before and after the course of NBHT and DCME use in the closed eyes test were not revealed.

Overall, the observed positive dynamics in the

above-listed parameters indicates that the experimental group test subjects could tolerate CCCA loads on the R. Barany chair longer and easier.

The obtained dynamics is concordant with the nature of change in parameters obtained during SST IFCS which the subjects underwent after the CCCA test (Table 2).

One of the tasks we intended to solve by the experiment was to determine the duration of the achieved effect from the combined use of NBHT and DCME for a fortnight. To this end, the subjects were investigated repeatedly also in one, two and three months after the NBHT and DCME course.

The analysis of the obtained data shows that the highest value of CCCA tolerance time in the experimental group subjects was reached immediately after the NBHT and DCME course; later its values started to gradually decrease and were back nearly to the initial level by the end of the third month (Figure 1).

Table 2. SST IFCS parameters for subjects "Before" and "After" a fortnight of NBHT use in combination with DCME (M±SD)

No.	Studied parameters	Experimental group		Control group	
		Before	After	Before	After
Open eyes test					
1	Length increase rate (mm/s)	43.2±1.9	37.1±1.7*	42.5±2.3	39.9±2.1
2	Area increase rate (mm ² /s)	63.4±3.9	60.3±3.3*	62.9±4.1	61.8±3.8
3	OA PCCG, frontal plane (mm)	6.7±0.3	5.8±0.3*	6.5±0.4	6.4±0.5
4	OA PCCG, sagittal plane (mm)	7.2±0.4	6.2±0.3*	6.9±0.4	6.7±0.5
5	CA, frontal direction (%)	7.7±0.4	6.4±0.5*	7.6±0.5	6.9±0.8
6	CA, sagittal direction (%)	7.6±0.4	6.7±0.3*	7.5±0.5	7.2±0.7
Closed eyes test					
1	Length increase rate (mm/s)	46.3±4.3	44.1±4.5	46.4±4.1	44.6±4.7
2	Area increase rate (mm ² /s)	69.3±5.3	62.1±4.9	69.8±5.2	62.3±5.0
3	OA PCCG, frontal plane (mm)	8.1±0.8	8.0±0.9	7.8±0.8	7.7±0.7
4	OA PCCG, sagittal plane (mm)	7.4±0.7	7.4±0.8	7.2±0.7	7.3±0.8
5	CA, frontal direction (%)	7.4±0.9	7.3±0.8	7.5±0.8	7.8±0.7
6	CA, saqittal direction (%)	8.2±0.8	7.1±0.9	8.1±0.9	8.0±0.7

Legend: reliability of differences: * – $p < 0.05$ versus initial parameter values; SST IFCS - static stabilometric test in the integrated functional computer stabilography; CA – coefficient of asymmetry; OA - oscillation amplitude; PCCG - projection of the common centre of gravity

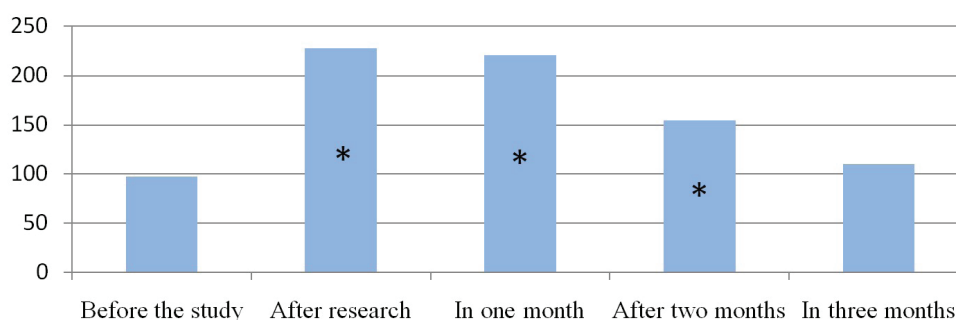


FIGURE 1. The CCCA (continuous cumulation of Coriolis acceleration) test tolerance time in the experimental group subjects "Before", "After", and in 1, 2, 3 months following the course of NBHT (normobaric hypoxia training) use in combination with DCME (dedicated cervical muscle exercises) in seconds

Discussion

It has been found that the effect of any training factor causes a response in a whole range of systems in the alpine skiers' organism. At the same time, it was noted that all homeostasis regulating systems were activated along with exercising an individual functional system enabling increased tolerance to a certain factor. As a result, general tolerance increases not only to the factor of exposure, but also to other stimuli (Hackett, & Rennie, 2016; Luks, Swenson & Bärtsch, 2017). In our study we took into account that in order to improve the stress resistance of the organism it is necessary to use a wide variety of means, methods and their combinations, which can activate the adaptation process and enhance capacity of the stress-limiting systems, both at the level of central regulatory mechanisms and at the tissue level (Gonggalanzi, Labasangzhu, Bjertness, Wu, Stigum & Nafstad, 2017; Hackett, & Rennie, 2016).

It has been found that with the use of normobaric hypoxia training, the process of adaptation to hypoxia caused 53.7 % RNA concentration increase in brain structures. Another response was an increase of the weight of lungs and growth of the quantity of alveoli. There was an increase in the number of red blood cells and hemoglobin, concentra-

tion of myoglobin in myocardium and skeletal muscles. In alpine skiers, we observed improvement in the functional capability of the cardiovascular and muscular systems in the course of preparation to competitive activities. There was a marked increase of the quantity of prostaglandin E and opioid peptides reducing adverse effects of stressors on the athletes' organism, etc. (Luks, Swenson, & Bärtsch, 2017).

On the cellular level, the organism responded by enhancing the capacity of the energy supply system due to the increase of mitochondria count and activation of the respiratory chain ferments. Simultaneously there was a reduction of basic metabolism and more economical use of oxygen by tissues. These changes helped expand reserve capabilities of the organism's functional systems and increase physical performance of athletes.

Therefore, improvement of non-specific resistance of the organism is characterized by a wide range of physiologic changes in alpine skiers' organisms. This results from alpine skiers' adaptation to normobaric hypoxia in combination with cervical muscle exercises. These changes play an important role in correction of the athletes' functional state and optimization of capabilities of organs and systems in athletes (Mao, Chen, Li & Huang, 2014). Finally, this

mechanism plays the role of a critical link in the chain of adaptation changes and facilitates improvement of tolerance to statokinetic exposures and reduction of the manifestation degree of sensory, vegetative and somatic reactions (Gonggalanzi, Labasangzhu, Bjertness, Wu, Stigum & Nafstad, 2017).

In their turn, physical exercises in the form of regular and adequately selected types of loads assist enhancement of the vascular tone, improve the cardiovascular and external respiratory function. They optimize gas exchange, redox and rehabilitation processes, thereby improving bioelectric activity and reinforcing excitatory processes in the structures of the central nervous system, facilitating overall enhancement of the stamina and physical performance of the alpine skiers' organisms.

It has been established that the increase of statokinetic stability under the influence of DCME is caused by the change in the sensitivity threshold of the vestibular, visual,

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Conclusion

1. A month regimen of NBHT in combination with DCME confidently increases the CCCA test tolerance time, simultaneously reducing the degree of manifestation of sensory, vegetative and somatic components of statokinetic reactions in alpine skiers.

2. The highest CCCA tolerance time was registered immediately after a month of NBHT use in combination with DCME. The achieved effect is preserved for 2 months, then it is gradually reduced to the initial level. This shows the need to use such training for alpine skiers at the final stage of preparation to competitive activities.

ORIGINAL SCIENTIFIC PAPER

Test-Retest Reliability and Validity of the Velocity-Based Training Device for Measuring Kinetics and Kinematics Variables in Youth Soccer Players

Barbara Gilic^{1,2}, Goran Gabrilo¹ and Vlade Bendic¹

¹University of Split, Faculty of Kinesiology, Split, Croatia, ²University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia

Abstract

Velocity-based training (VBT) is a popular method for prescribing and monitoring resistance-training load. The aim of this study was to investigate the reliability and validity of the PUSH band for measuring kinetics and kinematics variables during the deadlift exercise at different loads. 16 soccer players (16-18 years) underwent VBT 1 repetition maximum (1RM) protocol over two testing sessions (test-retest). Inertial sensor PUSH Band 2.0 was used for measuring velocity, power, and force during executing hexagonal-bar deadlift at different percentages of 1RM. Test-retest reliability of the VBT-variables was determined by Pearson's correlation coefficients and Bland-Altman plots. Validity was determined by correlating VBT-variables with the Broad jump test (BJ). Average-power, average-, and peak-velocity at 45% 1RM, peak-power at 55% 1RM, average-force and peak-power at 65% 1RM, average- and peak-power at 75% 1RM displayed proper test-retest reliability (>50% of the shared variance), which was confirmed by Bland-Altman plots. Average-power, average- and peak-velocity at 45% 1RM displayed the highest correlations with BJ ($r=0.78$, 0.73 , and 0.76 , respectively), indicating good validity. VBT-variables at moderate loads were more reliable, which could be explained by the low experience in resistance training of studied players. Variables at low-to-moderate intensity displayed the highest correlation/validity with BJ and could be recommended for the development of this jumping performance in youth players.

Keywords: resistance training, feedback, youth athletes, strength and conditioning, inertial sensors

Introduction

Soccer (football) is one of the most popular sports in the world, and therefore a lot of sports professionals are trying to determine the most effective ways to improve soccer-specific performance. Resistance training or training with external loads is one of the most efficient methods for improving general sports performance and is commonly used in soccer (Barjaste & Mirzaei, 2018). The effectiveness of resistance training largely depends on exercise selection and manipulation of training load (Benson, Docherty, & Brandenburg, 2006). The most common way of determining load is based

on prescribing percentages from previously assessed one repetition maximum (1RM), called percentage-based training (PBT). Even though this method has been used for decades, it has some downsides. For example, PBT does not account for athletes' daily strength fluctuations; the level of strength can be decreased due to fatigue or increased due to training adaptation (Eston & Evans, 2009). Simply put, PBT can both overestimate or underestimate optimal daily training load and not provoke intended training adaptations. Therefore, other methods for prescribing training load have recently emerged, with velocity-based training (VBT) being one of the most popular.



Correspondence:

B. Gilic
University of Split, Faculty of Kinesiology, Rudjera Boskovic 31, 21000 Split, Croatia
E-mail: bargil@kifst.hr

The VBT method utilizes real-time velocity data, which enables objective load adjustments during and between training sessions, avoiding muscle failure (Mann, Ivey, & Sayers, 2015). The main applications of VBT is that it provides immediate feedback on movement velocity to the athlete and coach, and this way load could be adjusted (Weakley et al., 2021). Several researches investigated the differences between PBT and VBT methods. Trained men that were included in the VBT group achieved better levels of maximal strength in the back squat, bench press, overhead press, and deadlift exercise after 6 weeks of resistance training, compared to men in the PBT group during the same period (Dorrell, Smith, & Gee, 2020). Similarly, rugby league players in the VBT group had better improvements in strength levels in back squat and vertical jump performance than the PBT group after 7 weeks of resistance training (Orange, Metcalfe, Robinson, Applegarth, & Liefeth, 2020). Besides previously mentioned evidence of increased effectiveness of the VBT method, technological advancement and increased possibilities of acquiring VBT devices led to increased interest for VBT.

Indeed, numerous commercially available devices exist for the direct measurement of kinetic (power, force) and kinematic (velocity) variables during resistance training exercises. Specifically, the VBT devices include linear position transducers, optoelectronic systems, smartphone applications, and inertial measurement units (IMU) (Courel-Ibáñez et al., 2019). The most popular one is linear position transducer GymAware, which is considered a golden standard VBT device, as it showed the highest reliability and validity (Janicijevic et al., 2021; Thompson, Rogerson, Dorrell, Ruddock, & Barnes, 2020). However, the linear position transducers are more expensive than IMU devices (1800\$ and 400\$, respectively), and commonly more complicated to set up due to cable extensions while IMUs are simply attached to the barbell (Mann et al., 2015). Thus, practitioners and scientists use IMUs, and one of the most popular is PUSH Band.

A study on strength-trained men noted that PUSH Band had high correlation with GymAware velocity recordings during a hexagonal-barbell deadlift, indicating good concurrent validity (Jovanovic & Jukic, 2020), and similar was recorded for bench press exercise (McGrath, Flanagan, O'Donovan, Collins, & Kenny, 2018). Furthermore, PUSH Band displayed appropriate reliability during bench press, back squat, and deadlift exercise (Balsalobre-Fernández, Kuzdub, Poveda-Ortiz, & Campo-Vecino, 2016; Chéry & Ruf, 2019; Lake et al., 2019). However, only few studies investigated metric characteristics of VBT devices for hexagonal-barbell deadlift. Deadlift is a strength-training exercise effective for improving strength and is often used in training programs. Mostly used is deadlift with olympic barbell, but since exercise technique is less demanding, hexagonal barbell becomes increasingly popular (Lockie et al., 2018).

However, there is limited number of studies investigating the reliability and validity of the PUSH Band for hexagonal-barbell deadlift exercise. Precisely, previous studies investigated the validity of the PUSH Band by comparing its values with golden standard devices, and not real-life performance variables (Janicijevic et al., 2021). Also, most of the studies have been conducted on older athletes or strength-trained men, and we found only one on youth athletes (Orange et al., 2019). Therefore, the aims of this study are: (i) to determine the reliability of the PUSH Band for measuring velocity, power

and force during hexagonal-barbell deadlift at different loads (percentages of 1RM), and (ii) to determine the validity of the PUSH Band 2.0 by comparing it with jumping performance (horizontal jump) in youth soccer players.

Methods

Participants

Sixteen youth soccer players aged 16-18 years participated in this research. All players practiced soccer for at least eight years and competed at the national rank for juniors. They had at least two years of experience in resistance training and did not have a pause larger than six months before the study initiation. All players were in good health and did not have any injuries during the investigation. Participants were informed about the study's procedures, aims, and purpose and signed informed consent (parents or legal guardians signed the consent for participants under 18 years of age). The study was approved by the Ethical Board of the University of Split, Faculty of Kinesiology, Split, Croatia.

Variables and procedures

This study included anthropometric variables, 1RM assessed with inertial measuring unit used for measuring VBT-variables and Broad jump (BJ).

Anthropometric variables included body height (BH), body mass (BM), and percentage of body fat (% BF), measured by the TANITA measuring scale (model MC780MA, Tokyo, Japan).

VBT-variables included peak and average velocity, relative peak and average power, relative peak and average force, measured during the 1RM protocol using the VBT method. The IMU PUSH Band 2.0 (PUSH Inc., Toronto, ON, Canada) was used for measuring VBT-variables and was placed at the center of the front part of the hexagonal barbell. VBT-variables were recorded at loads at 45, 55, 65, 75, 85, and 95% 1RM. The loads during the VBT assessment of 1RM were chosen based on the previously traditionally assessed 1RM of each player, as suggested previously (Jovanović & Flanagan, 2014). VBT-variables were exported from the PUSH app and were used for further analysis.

The BJ test was used for assessing the horizontal jumping capacity. The participants were asked to jump as far as possible, starting from the marked line on the ground, using an arm swing, and jumping on the standardized measuring mat (ELAN, Begunje, Slovenia). The distance from the start line and the last recorded heel trace of the jump represented the test result (in cm). Players had three attempts, with 30 seconds of rest between the jumps, and the best result (longest jump) was taken for further calculations.

Testing protocol

Players underwent three testing sessions, each separated by 7 days. In the first session, a traditional estimation of 1RM in deadlift was performed. Subjects warmed up with an empty barbell. After that, they performed 6 repetitions with light loads, 3 repetitions with a subsequent heavier load, and a series of one repetition with incrementally increasing load. If the weight was appropriately lifted, players increased the load by 0.5-2.5 kg. The 1RM represented the maximal load (weight) the player managed to lift once. The traditionally estimated 1RM was used for prescribing the load during the 1RM assessment with the VBT method. The second session was the

first/initial VBT 1RM assessment and jumping assessment session, while the third session was the second/final VBT 1RM assessment and followed identical protocol and testing order as the second session. The second and third sessions consisted of a warm-up, VBT 1 RM assessment, SJ, and BJ. Players warmed up at a Keiser stationary bicycle (Keiser Corporation, California, USA) for 5 minutes, followed by 2 minutes of agility drills and 5 minutes of mobility protocol. After a warm-up, players conducted BJ test.

After jumps, the incremental 1RM assessment begun. First, players warmed up with an empty barbell for 10 repetitions, performed 6 repetitions at 20% 1RM, 5 repetitions at 30% 1RM. After that, the PUSH Band was attached to the barbell and players began lifting 45% 1RM for 4 repetitions, 55% 1RM for 3 repetitions, 65% 1RM for 2 repetitions, and 75% 1RM, 85% 1RM, 95% 1RM for single repetition, up until they were not able to lift the load. Players had 3 minutes of rest after each increment of load and were instructed to list the load with maximum concentric velocity and ideal posture. Each repetition from 45 to 95% 1RM was recorded using the PUSH Band, and the fastest repetition during each load increment was further analyzed.

Statistical analyses

The normality of the variables was checked with Kolmogorov-Simonov's test for normality. Test-retest reliability of the VBT-variables was determined by Pearson's correlation coefficients.

Additionally, the reliability was checked by Bland-Altman plots by plotting averaged test-retest results against test-retest differences. Validity of the PUSH Band 2.0 was determined by correlating VBT-variables previously found to be appropriately reliable, with the Broad jump test. A p-value of 0.05 was applied, and the program Statistica ver. 13.5 (Tibco Inc., Palo Alto, CA, USA) was used for all calculations.

Results

Test-retest reliability expressed by Pearson's correlation coefficients among VBT-variables at different percentages of 1RM during hexagonal-barbell deadlift is shown in the Table 1. Results evidenced that average power, average and peak velocity at 45% 1RM, peak power at 55% 1RM, average force and peak power at 65% 1RM, average and peak power at 75% 1RM displayed proper test-retest reliability (>50% of the shared variance).

Bland-Altman plots confirmed the reliability of average

Table 1. Test-Retest Reliability Presented by Pearson's Correlation Coefficients between VBT-Variables at Different Percentages of 1RM during Hexagonal-Barbell Deadlift

VBT-variables	45% 1RM Pearson R	55% 1RM Pearson R	65% 1RM Pearson R	75% 1RM Pearson R	85% 1RM Pearson R	95% 1RM Pearson R
Average force	0.35	0.66**	0.82***	0.58*	0.68**	0.57
Peak force	0.63**	0.4	0.6**	0.54*	0.46	0.01
Average power	0.85***	0.62**	0.67**	0.83***	0.64**	0.3
Peak power	0.69**	0.73***	0.7**	0.82***	0.58*	0.64
Average velocity	0.83***	0.39	0.38	0.69**	0.51	0.01
Peak velocity	0.81***	0.61	0.24	0.66**	0.51	0.3

Legend: * p<0.05; ** p<0.01; *** p<0.001

power, average and peak velocity at 45% 1RM, peak power at 55% 1RM (Figure 1), and average force and peak power at 65%

1RM, average and peak power at 75% 1RM (Figure 2).

Average power, average and peak velocity at 45% 1RM

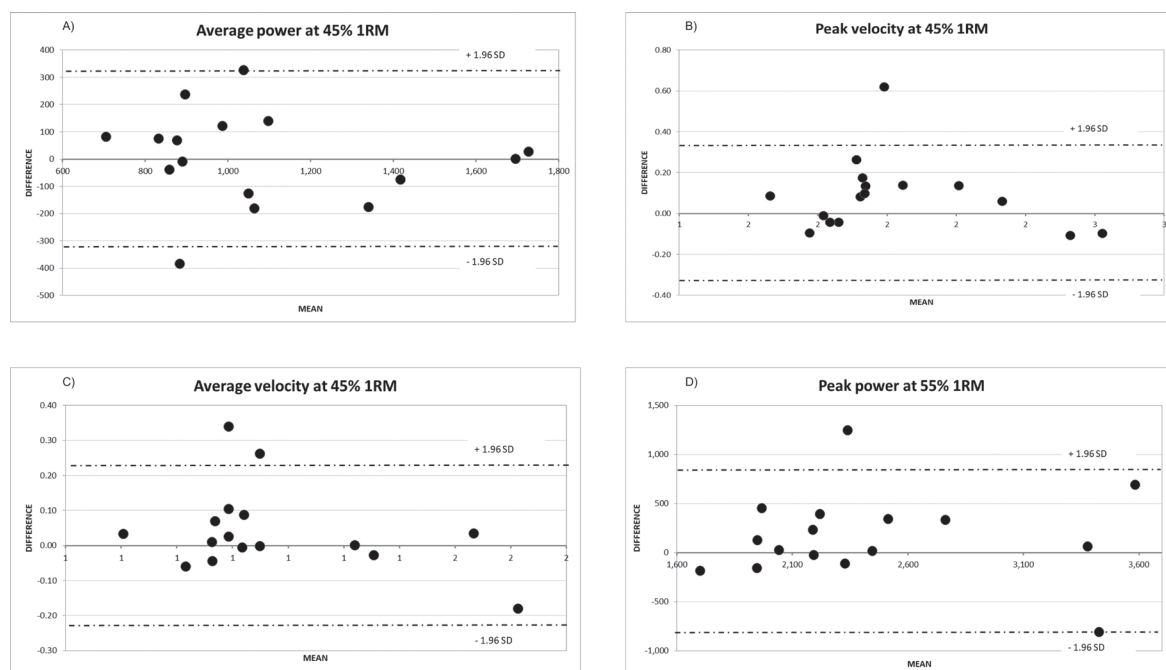


FIGURE 1. Bland-Altman plots for average power (A), peak (B) and average velocity (C) at 45% 1RM, peak power at 55% 1RM (D)

displayed the highest correlations with BJ ($r=0.78$, 0.73 , and 0.76 , respectively), indicating proper validity. Variables at

low-to-moderate intensity displayed the highest correlation/validity with BJ (Table 2).

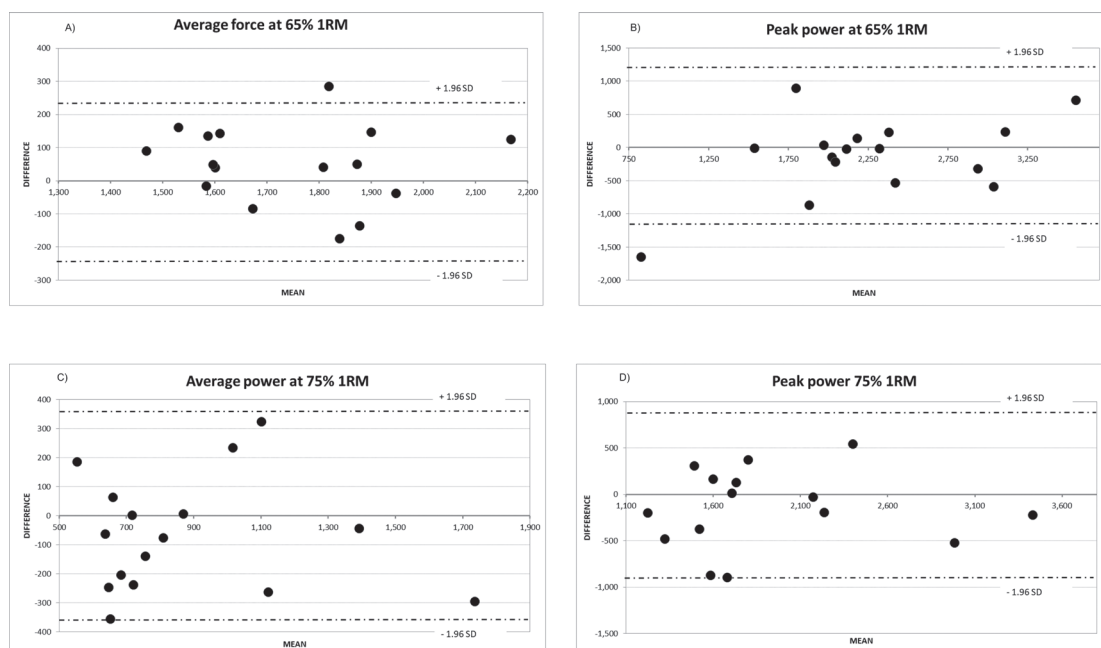


FIGURE 2. Bland-Altman plots for average force (A) and peak power (B) at 65% 1RM, average (C) and peak power (D) at 75% 1RM

Table 2. Pearson's correlation coefficients between VBT-variables and Broad jump

VBT-variables	Broad jump	
	Pearson's R	p
Average power at 45% 1RM	0.78	0.001
Average velocity at 45% 1RM	0.73	0.001
Peak velocity at 45% 1RM	0.76	0.001
Peak power at 55% 1RM	0.70	0.003
Average force at 65% 1RM	0.64	0.008
Peak power at 65% 1RM	0.71	0.002
Average power at 75% 1RM	0.63	0.009
Peak power at 75% 1RM	0.74	0.001

Legend: Only those variables where appropriate reliability was found are included in the analysis

Discussion

This study aimed to investigate the reliability and validity of the PUSH band for measuring velocity, power, and force variables during the deadlift exercise at different loads in youth soccer players. The results evidenced two main findings. First, power and force variables are reliable at the low-to-moderate loads (45-75% 1RM) in the deadlift. Second, power and velocity variables at 45% 1RM were highly correlated with broad jump performance, indicating good validity.

Reliability

The study's first finding is that higher reliability was found at moderate percentages of 1RM (moderate loads). Specifically, at percentages higher than 75% 1RM, the test-retest correlation was relatively low (9-to-46% of the shared variance), and therefore reliability was not satisfactory. There are several possible reasons for the lack of reliability at higher loads in studied players. First, the lack of reliability could be explained by the age of the participants and their experience in resistance training.

Namely, the participants in this study were junior soccer players who did not have much experience in training with high

loads. The low amount of time dedicated to resistance training in youth athletes is widely known and is mainly attributed to time restrictions due to increased technical sport-specific training (McQuilliam, Clark, Erskine, & Brownlee, 2020). Indeed, our players had an average of 2 years of experience in resistance training, which is most likely not enough to develop the exercise's technique fully. As we included the deadlift exercise in our investigation, this explanation is even more logical since the deadlift exercise is one of the most demanding and complex exercises, and it takes time to accomplish good technique. Hence, the stability of the deadlift execution is not to be expected in youth soccer players.

Therefore, the finding that VBT variables at high loads are not reliable can be explained by an underdeveloped technique to repeat the same motion and movement velocity at high loads. Supportively, a study by Ritti-Dias, Avelar, Salvador and Cyrino (2011) reported that individuals who did not have experience in resistance training displayed variations in maximal strength after consecutive repeated testing of 1RM. Those changes most likely occurred due to familiarization and improved technique and no real changes in maximal strength. This most likely occurred

in our players, indicating that measured values do not represent their maximal strength's real state. Consequently, the lack of reliability found at higher loads could be attributed to players' low experience in training with external loads and their insufficiently good technique in deadlift exercise.

The second reason for the lack of reliability at higher loads could be found in the intraindividual variations in exercise execution at high loads, that is, the difficulty to repeatedly perform the movement with sub-maximal or maximal loads in the same way. Similar to our study, a study investigating the reliability of PUSH Band in the deadlift in older participants (22-24 years of age) reported insufficient reliability of velocity and power variables at higher loads (Chéry & Ruf, 2019). The authors explained such findings by the fact that it is challenging to keep the same intent to lift the highest load (close or at 1RM) with maximal velocity. This is especially emphasized in complex exercises/movements such as the deadlift, where individuals try to conduct the lift with the optimum posture to avoid injuries. Thus, it is possible that our players were not able to repeat the same movement at high loads, as it is shown that even older and more experienced individuals do not manage to keep the constant movement at increased loads (Chéry & Ruf, 2019).

Furthermore, it is known that there is a "sticking point" for each individual while trying to lift the maximal load. Briefly, sticking point refers to "the part of the range of motion (ROM) in a resistance exercise in which a disproportionately large increase in the difficulty associated with continuing the lift is experienced" (Kompf & Arandjelović, 2017). Simply put, it is the weakest point of the lift, where individuals tend to slow down while trying to overcome muscular fatigue and failure. It is known that the sticking point is different for each individual and is mainly related to the limb length, torque, and muscle activation (Kompf & Arandjelović, 2016). Therefore, due to large variations in body-built and strength capacities in the studied players, it is reasonable to conclude that each player has a different sticking point which could have affected the reliability of VBT-variables at higher loads in our study.

Validity

Our results showed the association between VBT-variables derived at lower loads and BJ performance. Before explaining this finding, a brief overview of previous studies examining the validity of the PUSH Band will be displayed. Several studies investigated the concurrent validity of the PUSH Band in various strength exercises by comparing it with the "golden standard devices" (i.e., Linear position transducers) and reported mixed findings (Clemente, Akyildiz, Pino-Ortega, & Rico-González, 2021). Precisely, a study by Jovanovic and Jukic (2020) displayed high correlations ($r=0.92-0.95$) between PUSH Band and GymAware mean and peak velocity recordings for executing hexagonal barbell deadlift in twelve strength-trained men. Contrary, a study investigating the validity of the PUSH Band on 10 strength-trained men comparing it to GymAware, displayed that PUSH Band showed low accuracy in measuring velocity at all percentages of 1RM during the Olympic-bar deadlift (Chéry & Ruf, 2019).

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Conflict of Interest

The authors declare that there is no conflict of interest.

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However, to the best of our knowledge, only one study investigated the validity of the PUSH band in young athletes. Orange et al. (2019) investigated the validity of PUSH Band in youth rugby players by comparing it with the GymAware device. The PUSH Band was valid only for mean power and peak power at 20% 1RM in the back squat ($r=0.90-0.91$) and mean power at 40% 1RM in the bench press ($r=0.89$), while it displayed low validity for the velocity variables (Orange et al., 2019). Collectively, PUSH Band displayed appropriate validity mostly for measuring VBT-variables at lower loads (i.e., lower percentages of 1RM).

While previous studies aimed to determine the validity of the PUSH Band by comparing it to other devices, this study investigated the validity by correlating VBT-variables measured by PUSH Band with real-life performances such as jumps. The reason/background for relating the deadlift execution and BJ performance lies in the biomechanical similarity of those two movements. Specifically, the deadlift is a multijoint movement where the most extensive range of motion and the largest muscle activation occurs in the hip joint and then in the lumbar spine, ankle, and knee joint (Brown & Abani, 1985). On the other side, the contribution of the hip joint accounts for 45.9%, for the knee joint 3.9%, and for the ankle joint 50.2% in the BJ performance (Robertson & Fleming, 1987). Thus, we hypothesized that certain VBT-variables derived during the deadlift would be associated with BJ performance.

The results showed the highest associations of power and velocity variables derived at low loads (45% 1RM) with BJ performance (up to 61% of the shared variance), indicating proper validity of these variables. This finding could be observed from the perspective of creating targeted training programs aimed at developing specific performances (i.e., jumps). A well-designed training program aims to develop the wanted performance, which is only possible by knowing exact exercises, modalities, and intensities (i.e., loads) that influence the development of that specific performance (Lesinski, Prieske, & Granacher, 2016). Therefore, according to our results, it could be suggested that incorporating deadlift exercise with low-to-moderate loads in the training program could provoke the best development and adaptations in jumping capacities in youth soccer players.

Conclusion

Results evidenced that VBT-variables at moderate loads are more reliable, which could be explained by the low resistance-training experience of studied players. Variables at low-to-moderate intensity displayed the highest correlation/validity with horizontal jump.

Therefore, this study has some practical implications. First, deadlift exercise with low-to-moderate loads in the resistance-training program could be used for developing jumping capacities in youth players. Also, PUSH Band is not reliable for measuring VBT-variables at higher loads, meaning that its use should be limited for moderate loads. This research investigated only youth soccer players, and the results should be applicable only for this age-group, therefore, future studies should investigate older players.

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ORIGINAL SCIENTIFIC PAPER

Structural Relationship between Technological Characteristics, Perceived Usefulness, Trust, and Continuous Intention to Use Mobile Payment Services: Sports Consumers in MZ Generations

Kyongmin Lee¹ and Sungjung Kim²

¹Dankook University, Department of Sport Management, Cheonan, Korea, ²Sungshin University, Education Research Institute, Seoul, Korea

Abstract

While the mobile payment service market is expanding, few studies have been conducted on sports consumers to promote the continuous use of mobile payment services. The current study empirically analyzed the structural relationship between technological characteristics, perceived usefulness, trust, and continuous intention to use mobile payments services among sports consumers in millennials and Generation Z (MZ Generations). A questionnaire survey was conducted on students majoring in sports in 4-year universities located in Chungcheong and Gangwon Provinces, Korea. The collected data were examined using frequency analysis, correlation analysis, and structural equation modeling. The key results are as follows. First, the technological characteristics of mobile payment services had a positive effect on perceived usefulness of the services. Second, perceived usefulness had a positive effect on trust in the services. Third, perceived usefulness had a positive effect on continuous intention to use the services. Fourth, trust in mobile payment services had a positive effect on continuous intention to use the services. The results are significant as they provide a reference in establishing marketing strategies required to promote the continuous use of mobile payment services among sports consumers in MZ generations.

Keywords: *technological characteristics of mobile payment services, perceived usefulness, trust*

Introduction

Necessity and purpose of the research

With the increasing dependence on online platforms due to accelerating digital transformation, the growing use of smartphones, and increasingly widespread online shopping, the number of users who buy products and services online through mobile payment has been on the rise. Particularly, contactless payment services based on mobile devices are becoming increasingly common due to social distancing measures put in place because of the prolonged coronavirus (COVID-19) pandemic. Mobile payment service refers to an

online payment method that allows users to make a payment after initially registering their card information and then simply verifying their identity with a password or fingerprint (Eun & Kim, 2018). Mobile payment services can lock in consumers once they are successfully attracted to the payment platform by providing basic financial services, including remittance and payment. Further, they can explore new businesses and additional services based on big data related to purchasing patterns among consumers. Given this, it is becoming increasingly competitive to attract loyal customers between mobile payment service providers including banks, fintech firms, and



Correspondence:

S. Kim
Sungshin University, Education Research Institute, 2, 34 da-gil, Bomun-ro, Seongbuk-gu, Seoul, Korea
E-mail: sun_jung_kim@daum.net

retailers (Kim, 2018).

To get ahead in this competitive environment, mobile payment service providers recognize that it is necessary to have a strategy that encourages continuous intention to use, which refers to an individual's intention to continue using the products and services that they are currently using or recommend the products and services to others (Bhattacharjee, 2001). Hence, a user with a high level of continuous intention to use a particular mobile payment service is highly likely to use the service again and communicate its advantages to others through word of mouth (WoM). Thus, it is necessary to examine the factors influencing continuous intention to use mobile payment services to retain the existing user base and attract potential new users (A. Hossain, S. Hossain, & Jahan, 2018).

Trust is a factor that influences mobile payment users' continuous intention to use. Mobile payment refers to a contactless transaction made online. Users may have perceived risk in online transactions due to uncertainty, including personal information leaks or transaction cancellation due to system errors, which have a negative effect on the continuous use of online transactions (Piriyakul et al., 2015). The 2019 Survey on Payment Methods and Mobile Financial Service Use Behaviors conducted by the Payment & Settlement Systems Department, the Bank of Korea (2020) on 2,650 men and women aged 20 or older revealed that lack of trust is the greatest factor discouraging the use of mobile payment services. The survey demonstrated that to expand continuous intention to use, it is necessary to increase the level of trust in such services.

Another predictor variable for continuous intention to use mobile payment services is perceived usefulness, which means how useful it is to use new information technologies as perceived by a user in terms of improving their performance (Lee, Xiong, & Hu, 2012). According to the technology acceptance model (TAM) proposed by Davis (1989), the acceptance of new information technologies is determined by users' attitude, which is affected by perceived usefulness. In other words, when users have a high level of perceived usefulness toward a new information technology, they have a favorable attitude toward the technology, which ultimately leads to their acceptance of it. In this regard, it is necessary to improve users' perceived usefulness for mobile payment to expand their continuous use of such services and the effect of WoM.

Meanwhile, in the TAM, it is important to identify external factors influencing perceived usefulness (Davis, 1989). This is because a certain external factor has an effect on perceived usefulness about a new information technology, which in turn affects the acceptance of the technology (Phonthanukitithaworn, Sellitto, & Fong, 2016). In other words, users who highly perceive the usefulness of a new information technology due to a particular external factor are likely to accept the technology. Research on the acceptance of mobile payment services (Liu & Tai, 2016; Rizkyandy, Setyohadi, & Suyoto, 2018; Schierz, Schilke, & Wirtz, 2010) found that technological characteristics of mobile payment services are one of the determinants affecting the perceived usefulness. In this sense, examining what effect technological characteristics have on perceived usefulness of such services is required to increase the continuous use of mobile payment services.

As seen above, to promote continuous intention to use mobile payment services, it is necessary to examine the causal relationship between the technological characteristics, perceived usefulness, trust, and continuous intention to use. Based on

the TAM model, research in the field of sports identified determinants of sports consumers' acceptance of new information technologies. For instance, Hong (2012) found that for college students who purchased sports products online, perceived usefulness had a positive effect on willingness to purchase such products. Kwag, Cho, and Lee (2014) confirmed that perceived ease of use had a positive effect on perceived usefulness, which in turn positively affects college students' attitude toward buying sports products online. Such studies are significant as they identified a causal relationship between sub-factors in the TAM model and proposed how to improve sports consumers' willingness to pay online. However, there are few studies analyzing sports consumers' continuous intention to use mobile payment services. This study, thus, empirically examines the relationship between the technological characteristics of mobile payment services, perceived usefulness, trust, and continuous intention to use for promoting the use of mobile payment among sports consumers.

This study analyzed sports consumers in MZ generations because they are at the center of the growth of mobile payment services. They are exposed to the digital environment growing up, are familiar with economic activities based on digital devices, and use mobile payment services often as they are more likely to have and use smartphones than other generations (Pew Charitable Trusts, 2016). In addition, as MZ generations are emerging as major consumers, replacing baby boomers and Generation X, mobile payment service providers including banks, fintech firms, and retailers are competing fiercely to attract MZ generation consumers.

Research hypothesis

Previous studies on willingness to accept mobile payment services confirmed technological characteristics as a key determinant of perceived usefulness. Schierz et al. (2009) found that ubiquity and compatibility had a positive effect on perceived usefulness. Liu and Tai (2016) demonstrated that compatibility and ease of use had a positive relationship with perceived usefulness, and the effect of compatibility on perceived usefulness was greater than that of ease of use. Furthermore, Rizkyandy et al. (2018) revealed that responsiveness was a key factor that can affect perceived usefulness. Based on these previous studies, the following hypotheses were established:

Hypothesis 1: The technological characteristics of mobile payment services will have a positive effect on perceived usefulness.

Hypothesis 1-1: Ease of use will have a positive effect on perceived usefulness.

Hypothesis 1-2: Responsiveness will have a positive effect on perceived usefulness.

Hypothesis 1-3: Ubiquity will have a positive effect on perceived usefulness.

Hypothesis 1-4: Compatibility will have a positive effect on perceived usefulness.

Among previous studies on the relationship between perceived usefulness and trust, Chinomona (2013) found that users who perceived mobile social software as useful had a high level of trust toward social software. Amin, Rezaei, and Abolghasemi (2014) reported that perceived usefulness played an important role in improving trust among users regarding mobile e-commerce providers. Herzallah and Mukhtar (2016) suggested that perceived usefulness had a positive effect on trust in e-commerce among managers in small and medi-

um-sized enterprises. Based on these previous studies, the following hypothesis was established:

Hypothesis 2: Perceived usefulness of mobile payment services will have a positive effect on trust in the services.

Among previous studies on the relationship between perceived usefulness and continuous intention to use, Jung (2014) investigated continuous intention to use smartphones and reported that users with high perceived usefulness were highly likely to continue using smartphones. Hamid, Razak, Bakar, and Abdullah (2015) examined the acceptance of e-government services and found that perceived ease of use had a positive effect on the continuous use of e-government services. Tsai, Lee, and Ruangkanjanases (2020) confirmed that perceived ease of use had a direct effect on continuous intention to use social media and an indirect effect via satisfaction. The following hypothesis was thus established:

Hypothesis 3: Perceived usefulness of mobile payment services will have a positive effect on continuous intention to use the services.

According to previous studies on the relationship between trust and continuous intention to use, trust is considered a key

factor in continuous intention to use information technologies and related services. Ramos, Ferreira, Freitas, and Rodrigues (2018) found that trust positively affected continuous intention to use mobile banking services. Abed (2016) proved a positive relationship between trust and continuous intention to use social networking services. The following hypothesis was thus established:

Hypothesis 4: Trust in mobile payment service will have a positive effect on continuous intention to use the services.

Methods

Participants

A questionnaire survey was conducted on the study population, including students majoring in sports in 4-year universities located in Chungcheong and Gangwon Provinces, who had purchased sports products by using mobile payment services. In total, 320 questionnaires were obtained, and 14 with incomplete responses were excluded. Using convenience sampling, 306 copies were included as effective samples for final analysis. Table 1 presents detailed information on the subjects.

Table 1. Demographic Characteristics of the Subjects (N=306)

		Frequency	Percentage
Gender	Male	195	63.7
	Female	111	36.3
University year	Freshman	77	25.2
	Sophomore	95	31.0
	Junior	80	26.1
	Senior	54	17.6
Age	<21	73	23.9
	21 to 22	94	30.7
	23 to 24	85	27.8
	≥25	54	17.6

Measures

The questionnaire was used to measure technological characteristics of mobile payment services, perceived usefulness, trust, and continuous intention to use. All questions were based on a 5-point Likert scale.

Technological characteristics were measured using a questionnaire in Eun and Kim (2018) based on questions used in previous studies in Korea and abroad. Sub-factors in the tool comprised ease of use (4 questions), responsiveness (4 questions), ubiquity (4 questions), and compatibility (4 questions). This study defined ease of use as a perceived level of easily using mobile payment services and responsiveness as fast processing in mobile payment services and responding quickly to inconveniences during the use of the services (Eun & Kim, 2018). Ubiquity was defined as the degree to which mobile payment services are available anywhere anytime, while compatibility was defined as how compatible mobile payment services are with other payment systems (Eun & Kim, 2018).

Perceived usefulness was measured using a questionnaire in Eun and Kim (2018) based on questions used in Davis (1989). Perceived usefulness comprised four questions as a single factor. It was defined as how useful the use of a mobile payment service is compared to traditional payment methods as perceived by users (Eun & Kim, 2018).

Trust was measured by modifying and adapting a questionnaire in Choi and Choi (2011) based on questions in previous studies. The tool comprised of four questions as a single factor. Trust was defined as the level of trust in mobile payment services and their providers (H. Choi & Y. J. Choi, 2011).

Continuous intention to use was measured using a modified and adapted questionnaire from Eun and Kim (2018) based on questions used in previous studies. Continuous intention to use comprised four questions as a single factor. It was defined as a person's intention to use the mobile payment services they are currently using in the future or recommend the services to others (Eun & Kim, 2018).

Data analysis

SPSS 23.0 and AMOS 23.0 were used to statistically process the data. Confirmatory factor and reliability analyses were conducted to test the validity of the tool and the reliability of measured items. Correlation analysis was conducted to examine the correlation between measured variables, and structural equation modeling analysis was conducted to test study hypotheses.

Validity and reliability

The results of confirmatory factor analysis are reported in

Table 2. Goodness of fit for the measurement model was found satisfactory, with $\chi^2=576.093(df=329, p<.001)$, $\chi^2/df=1.751$, TLI=.957, CFI=.963, and RMSEA=.050. In terms of evaluation of the validity of the measurement model, the average variance extracted (AVE) was above .50, and construct reliability was

above .70, confirming convergent validity. In addition, AVE values for all variables were larger than the squared value of all correlation coefficients, and hence, discriminant validity was ensured. Reliability analysis revealed Cronbach's α between .831 and .927, suggesting that each factor had internal consistency.

Table 2. Results of Confirmatory Factor Analysis and Reliability Analysis (N=306)

Factor	Estimate	S.E.	C.R.	CR	AVE	α
Ease of use 4	1					
Ease of use 3	.980	.053	18.458	.922	.748	.921
Ease of use 2	.976	.050	19.366			
Ease of use 1	.980	.049	19.923			
Responsiveness 4	1					
Responsiveness 3	1.023	.054	19.032	.922	.746	.912
Responsiveness 2	.946	.052	18.176			
Responsiveness 1	.933	.053	17.605			
Ubiquity 4	1					
Ubiquity 3	.970	.049	19.916	.941	.799	.927
Ubiquity 2	1.035	.050	20.763			
Ubiquity 1	.986	.048	20.447			
Compatibility 4	1					
Compatibility 3	1.260	.074	17.082	.912	.723	.911
Compatibility 2	1.069	.070	15.164			
Compatibility 1	1.231	.072	17.104			
Perceived usefulness 4	1					
Perceived usefulness 3	.935	.059	15.766	.926	.759	.878
Perceived usefulness 2	.907	.057	15.990			
Perceived usefulness 1	.849	.055	15.450			
Trust 4	1					
Trust 3	1.096	.093	11.759	.910	.717	.831
Trust 2	.981	.084	11.667			
Trust 1	1.085	.087	12.467			
Continuous intention to use 4	1					
Continuous intention to use 3	1.034	.064	16.225	.940	.796	.900
Continuous intention to use 2	.979	.057	17.276			
Continuous intention to use 1	.992	.055	17.874			

Results

Correlations results

The results of correlation analysis between technological characteristics of mobile payment services, perceived useful-

ness, trust, and continuous intention to use are reported in Table 3. A positive correlation between variables was found below the p-value of .01. No multicollinearity was found, as the correlation coefficient between all variables was below .80.

Table 3. Correlation Analysis between Study Variables (N=306)

Variable	1	2	3	4	5	6	7
Ease of use	1 (.748)						
Responsiveness	.603**	1 (.746)					
Ubiquity	.626**	.540**	1 (.799)				
Compatibility	.621**	.536**	.588**	1 (.723)			
Perceived usefulness	.616**	.622**	.597**	.592**	1 (.759)		
Trust	.579**	.600**	.608**	.565**	.763**	1 (.717)	
Continuous intention to use	.659**	.643**	.618**	.681**	.721**	.715**	1 (.796)

Legend: ** - $p<.01$, () - AVE

Hypothesis testing

The results of a hypothesis test are presented in Table 4. Goodness of fit for the structural model was found to be satisfactory, with $\chi^2=647.162$ ($df=337$, $p<.001$), $\chi^2/df=1.920$, $TLI=.947$, $CFI=.953$, and $RMSEA=.055$. As ease of use had a significant positive effect on perceived usefulness ($\beta=.196$, $p<.01$), Hypothesis 1-1 was accepted. As responsiveness had a significant positive effect on perceived usefulness ($\beta=.309$, $p<.001$), Hypothesis 1-2 was accepted. As ubiquity had a significant posi-

tive effect on perceived usefulness ($\beta=.226$, $p<.001$), Hypothesis 1-3 was accepted. As compatibility had a significant positive effect on perceived usefulness ($\beta=.228$, $p<.001$), Hypothesis 1-4 was accepted. As perceived usefulness had a significant positive effect on trust ($\beta=.802$, $p<.001$), Hypothesis 2 was accepted. As perceived usefulness had a significant positive effect on continuous intention to use ($\beta=.588$, $p<.001$), Hypothesis 3 was accepted. As trust had a significant positive effect on continuous intention to use ($\beta=.244$, $p<.05$), Hypothesis 4 was accepted.

Table 4. Results of Structural Equation Modeling (N=306)

Hypothesis test	Estimate		S.E.	C.R.
	B	β		
H1-1 Ease of use \rightarrow Perceived usefulness	.126	.196	.043	2.913**
H1-2 Responsiveness \rightarrow Perceived usefulness	.210	.309	.042	5.034***
H1-3 Ubiquity \rightarrow Perceived usefulness	.161	.226	.044	3.626***
H1-4 Compatibility \rightarrow Perceived usefulness	.171	.228	.047	3.634***
H2 Perceived usefulness \rightarrow Trust	.781	.802	.067	11.640***
H3 Perceived usefulness \rightarrow Continuous intention to use	.651	.588	.108	6.056***
H4 Trust \rightarrow Continuous intention to use	.277	.244	.107	2.590*

Legend: * - $p<.05$; ** - $p<.01$; *** - $p<.001$

Discussion

This study was conducted on university students who purchased sports products with mobile payment services to examine factors influencing continuous intention to use mobile payment services. From previous studies on intention to accept mobile payment services based on the TAM model, this study identified technological characteristics, perceived usefulness, and trust as key factors that may have an effect on continuous intention to use and analyzed the causal relationship between the factors. Key implications from the results of this study are outlined below.

First, there was a positive relationship between ease of use, responsiveness, ubiquity, compatibility; that is, technological characteristics, and perceived usefulness. This finding is consistent with the results of previous studies, which argue that technological characteristics have a positive effect on perceived usefulness (Eun & Kim, 2018; Liu & Tai, 2016; Rizkyandy et al., 2018; Schierz et al., 2009). Based on the results, it is necessary for mobile payment service providers to use technological characteristics in their services and provide usefulness differentiated from traditional payment methods to improve perceived usefulness of their mobile payment services. Particularly, this study found that responsiveness and compatibility among other technological characteristics had a greater effect on university student users' perceived usefulness about the services than ubiquity and ease of use. Hence, to improve perceived usefulness, mobile payment service providers need to consider improving the compatibility of their services with other payment systems, increasing service processing speed, and quickly responding to complaints from users, provide an environment where users can make a payment with their mobile devices anywhere anytime, and improve ease of use of the services (Eun & Kim, 2018).

Second, users' perceived usefulness of mobile payment services had a positive effect on trust in the services. This finding is consistent with the results of previous TAM-related studies by Chinomona (2013) and Amin et al. (2014), who argue that the more useful users perceive new information tech-

nologies and related services to be, the more trust they show about such information systems and services. A higher level of trust in mobile payment services and their providers will increase users' continuous intention to use the services. Thus, it is important for mobile payment service providers to make their customers aware that their mobile payment services are more useful than traditional payment methods. As previously mentioned, mobile payment service providers need to consider that users' perceived usefulness may be higher when the ease of use, compatibility, responsiveness, and ubiquity are higher.

Third, perceived usefulness had a positive effect on continuous intention to use the services. The relationship between perceived usefulness and continuous intention to use was reported to be positive by various other studies on the acceptance of information technologies (Hamid et al., 2015; Tsai et al., 2020). Hence, mobile payment service providers need to use the aforementioned technological characteristics in their services and make users aware of the advantages of their services. This would help improve users' continuous intention to use mobile payment services.

Fourth, users' trust in mobile payment services had a positive effect on continuous intention to use. This finding is consistent with the results of previous studies that argue a higher level of trust leads to a higher level of users' continuous intention to use mobile payment services (Cho, 2018; Choi & Choi, 2016). Since mobile payment services provide contactless transactions online, the level of trust that users have built while using the services can potentially have a significant effect on their continuous intention to use (Pal, Funilkul, & Papasratorn, 2019). Trust can play an important role in alleviating perceived risk that may occur during mobile payment (Choi & Choi, 2016). In other words, the more users trust mobile payment services and their providers, the more it alleviates their anxiety about uncertainty, including personal information leaks or abuse that may occur during their use of mobile payment, and it will have a positive effect on continuous intention to use such services (Malaquias & Hwang, 2016).

This study is significant in that it expanded the underlying TAM for sports consumers in MZ generations, identified preceding variables for perceived usefulness, and found the determinants that had a positive effect on continuous intention to use mobile payment services. Furthermore, the results may be used as a reference to establish marketing strategies to promote the use of mobile payment services among sports consumers in MZ generations.

Despite its implications, this study has the following limitations. First, respondents were mostly university students in their 20s. Thus, it is difficult to generalize the results across all

age groups. Future research would need to investigate whether a similar significant relationship exists in other age groups as well. Second, only technological characteristics of mobile payment services are selected as variables influencing perceived usefulness. Previous studies on continuous intention to use mobile payment services, which apply the expanded TAM (Schierz et al., 2010), used not only technological characteristics but also personal and social characteristics as preceding variables influencing perceived usefulness. An additional study may be needed to expand these variables and verify the relationship between them.

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Conflict of Interest

The authors declare that there is no conflict of interest

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ORIGINAL SCIENTIFIC PAPER

Factors Associated with Potential Doping Behaviour in Windsurfing

Sime Versic¹, Ognjen Uljevic¹ and Katarina Pelivan¹

¹University of Split, Faculty of Kinesiology, Split, Croatia

Abstract

Windsurfing is dynamic water Olympic sport in which surfer is using wind force to generate forward motion on the water while maintaining balance on the board. Although is fast-raising and popular sport, previous studies have not addressed the issue of doping in this sport. The main aim of this study was to identify predictors of potential doping behaviour in windsurfing. The sample of participants included 48 senior windsurfers (40 males, 8 females, average age 31.1) in slalom class. The testing occurred during European Championship 2014. The participants filled previously validated questionnaires that included socio-demographics and doping-related factors variables. Descriptive statistic parameters were calculated and binary logistic regression was used to determine association between predictors and criterion (potential doping behaviour). Only 60% participants showed negative attitude towards potential usage of doping, while the rest of them were positive or neutral. Logistic regression identified only opinion about penalties for doping offenders as a predictor of potential doping behaviour in windsurfers (OR: 2.99, 95% CI: 1.44-6.2). The results of this study showed that windsurfers who advocate higher penalties for doping offenders are less likely to use doping. The lack of association of other variables with the criterion can probably be attributed to the heterogeneous sample of windsurfers since most of them are recreational sailors. In future studies windsurfers for other disciplines and additional predictor variables should be included.

Keywords: windsurfing, doping, slalom, doping knowledge

Introduction

One of the burning problems of modern sport is the use of prohibited substances, commonly known as doping (Baron et al., 2007). Doping violations include the consumption of performance-enhancing substances that are on the list, annually revised by the World Anti-Doping Agency (WADA), or the use of prohibited techniques such as covering up traces of doping in the body (Mazzeo & Di Onofrio, 2019; Mazzeo, Santamaria, & Montesano, 2019). WADA conducts regular testing of athletes, either during training period or during competition, and in case that traces of drugs are found in an athlete's blood or urine sample, the athlete bears certain consequences. They are most often of a sports nature, in terms of deleting the results achieved with the help of doping and exclusion from competi-

tion for a certain period of time (Petroczi, 2016; Zvan, Zenic, Sekulic, Cubela, & Lesnik, 2017). Recently, another, preventive approach has been used in the fight against doping. The basis of this way of combating the use of doping is in researching and analysing the factors related to potential doping behaviour (PDB). In numerous studies, the connection between various socio-demographic, sports, doping and many other groups of factors that can either prevent or "push" an athlete in the direction of doping consumption has been investigated (Devic et al., 2018; Zvan et al., 2017). In this way, specific anti-doping programs can be created for certain groups of athletes.

Windsurfing is discipline of sailing and is globally very popular at both recreational and competitive levels (Dyson, Buchanan, & Hale, 2006). It was invented in 1960s in Southern



Correspondence:

S. Versic
University of Split, Faculty of Kinesiology, Teslina 6, 21000 Split, Croatia
E-mail: simeversic@gmail.com

California and has six disciplines which can be divided in race boarding and slalom as two major divisions based on differences in equipment and type of activity (Dyson et al., 2006; Nathanson & Reinert, 1999). Windsurfing is physically highly demanding sport as it requires the whole body strength and endurance while maintaining balance position on the board and speed of the movement in line with the wind (Dyson et al., 2006). In general, prevalence of doping in sailing is very low with only 0.4% of positive findings among all sailing disciplines, including windsurfing where there was no any positive finding in windsurfers in RS:X discipline (WADA, 2019). However, since increased popularity and number of competitions worldwide, there is a clear need to investigate doping issues in the population of windsurfers in order to keep it as doping-uncontaminated sport. The analysis of scientific literature showed there are no any studies regarding this topic. Therefore, the main aim of this study was to examine doping factors and attitudes toward doping issues among windsurfers and evaluate correlates of potential doping behaviour.

Methods

Sample of participants in this study consisted of 48 windsurfers (8 females, on average 31.1 years old). There were tested between in Bol, island Brač in Croatia, during the 2014 European championship in windsurfing slalom discipline. Tests were conducted with questionnaires on English in groups of at least five athletes who were informed that the survey was strictly anonymous. Participants could refuse to participate, leave some of the questions or the entire questionnaire unanswered, and submitting a completed questionnaire was considered consent to participate in the survey.

All data were collected with previously validated

Questionnaire of Substance Use (QSU) and Knowledge of Doping and Performance-Enhancing Drugs (KD) (Devic et al., 2018). QSU consisted of (i) sociodemographic characteristics, (ii) sport factors and (iii) doping factors. Sociodemographic part included questions regarding participants age, gender, marital status and level of education. Sport factors were sport status, training experience in windsurfing, the highest competitive result achieved in junior and senior competition. Finally, doping factors included following items: self-assessment of doping knowledge, opinion on the main problem of doping in sports, trust in terms of doping and nutrition, source of knowledge about doping and food supplements, number of tests for banned substances during their career so far, opinion on the presence of banned substances in their sport, opinion on penalties for doping and potential usage of doping, i.e. potential doping behaviour (PDB). KD consisted of two sets of 10 claims about doping and nutrition which participants highlight as true or false. In case of correct answer, participants get 1 point and the final result was on the scale from 1 to 10.

Statistical analysis included descriptive measures, frequencies and percentages or mean and standard deviation, depending on the type of the variable. To evaluate association between predictors (socio-demographic, sport and doping factors) and binomial criterion (positive or negative doping behaviour) binary logistic regression was used. For all analyses, Statistica 13.0 (TIBCO Software Inc, USA) was used, and a p-level of 95% was applied.

Results

Table 1 shows descriptive parameters, showed as frequencies and percentages for non-parametric variables and arithmetic mean and standard deviation for parametric.

Table 1. Doping factors in windsurfers – frequencies and percentages

Personal opinion about knowledge on doping	n	%
I have no knowledge	8	16.67
Poor	19	39.58
Average	12	25.00
Good	8	16.67
Excellent	1	2.08
Trust in doping issues		
Nobody	22	45.83
Doctor	10	20.83
Coach	3	6.25
Doctor and coach	13	27.08
Main problem about doping		
Health	21	43.75
Fair play	7	14.58
I'm not sure doping should be prohibited	17	35.41
Doping should be allowed	2	4.17
Opinion about penalties for doping offenders		
Lifelong suspension	11	22.92
First time milder punishment, than lifelong suspension	16	33.33
Suspension for couple of seasons	13	27.10
Financial punishment	6	12.50

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Personal opinion about knowledge on doping	n	%
Doping should be allowed	2	4.17
Potential doping behaviour		
If assured it will help me	1	2.08
If assured it will help me with no health hazard	3	6.25
Not sure about it	14	29.17
I will not use doping	29	60.42
Doping in windsurfing sport		
I don't think doping is used in sailing	19	39.58
Don't know/Not sure	18	37.5
Used, but rarely	9	18.75
Doping is frequent	2	4.17
	Mean	SD
Age	31.1	9.08
Experience in sailing	9.13	8.36
Doping knowledge	2.23	1.48
Nutrition knowledge	4.08	3.25

Results of binary logistic regression are presents in Table 2. It is clear that only variable of Opinion about penalties for

doping offenders is significantly associated with PDB (OR: 2.99; 95% CI: 1.44-6.22).

Table 2. Correlates of potential doping behaviour in females and males.

Socio-demographic, sport and doping factors	OR (95% CI)
Age	1.02 (0.95-1.09)
Gender	1.79 (0.39-8.27)
Educational level	1.35 (0.70-2.62)
Sport status	0.93 (0.40-2.17)
Sport achievement junior level	0.69 (0.21-2.30)
Sport achievement senior level	0.88 (0.45-1.75)
Smoking	1.02 (0.61-1.71)
Alcohol consumption	1.20 (0.67-2.11)
Religiousness	1.05 (0.97-1.13)
Subjective nutrition knowledge	0.94 (0.52-1.70)
Subjective doping knowledge	1.02 (0.57-1.80)
Use of supplements	0.90 (0.43-1.87)
Trust in doping issues	1.48 (0.92-2.39)
Trust in nutrition issues	0.97 (0.59-1.62)
Source of knowledge about doping and nutrition	1.18 (0.77-1.81)
Number of doping tests performed	1.98 (0.41-9.68)
Opinion on the presence of doping in wind-surfing	2.08 (0.99-4.38)
Opinion about penalties for doping offenders	2.99 (1.44-6.22) *
Doping knowledge	1.11 (0.75-1.66)
Nutrition knowledge	1.02 (0.85-1.22)

Discussion

There are several major points of this study. First of all, looking at doping attitudes we can conclude that 60% windsurfers have negative attitude toward doping, i.e. negative doping behaviour. Around 29% have neutral opinion while approximately 8% showed inclination to doping consumption

(positive doping behaviour. Also, what is partly unexpected when recent trends are taken into account, most windsurfers view doping as a health threat rather than a violation of fair play. Here observed windsurfers showed extremely low level of doping knowledge with only 2.2 average points on KD. Finally, of all observed predictors, only opinion about penalties for

doping offenders showed to be associated with PDB.

If this results are compared with results of previous similar studies, that used the same measuring instruments, we can say that windsurfing has high tendency in doping. For example smaller possibility of doping behaviour was found in Olympic sailing (81.8% of athletes have a negative doping attitude), swimming (71-82%), dancing (71% women and 90% men) and women in racket sports (64.5-100%) (Devcic et al., 2018; Veršić, 2020; Zenic, 2010; Zvan et al., 2017). A similar probability that athletes will reach for banned substances has been observed in team sports (56.7 - 69.9% for men and 58.2 - 66.7% for women), synchronized swimming (62-63%), rowing (60%) and in men in racket sports (52.4 - 66%) (Zenic, 2010; Zvan et al., 2017). Finally, the only two sports with higher potential doping use are rugby (51.4%) and kickboxing (47.8% men, 42.1% women) (Veršić, 2020). However, large number of neutral PDB should be emphasized, as this clearly "worsen" the whole picture. As stated before, windsurfers in this study achieved very low results on KD so this probably resulted in high number of neutral answers regarding PDB as they probably chose that answer ("Not sure about it") because of their complete ignorance of the whole doping problem. This probably caused them to answer the question about the main problem of doping more conservatively (health related consequences), ie to emphasize the attitude that prevailed in the past but which in recent times has been substituted with a violation of fair play as a major problem.

The only significant predictive factor for PDB in windsurfers is the opinion about penalties for doping offenders. In short, participants who are asking for more rigorous punishments for doping violations are less prone to use doping.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Similar findings were found in the study on Olympic sailors. However, authors of this study have linked that finding and the fact that sailors look at doping as mainly a fair play problem (Veršić, 2020). Author's explanation was that by observing doping in this way, athletes see the ones who consume doping as fraudsters which gain unfair advantage over competitors. For these reasons, it is logical to expect those who are less prone to doping to require heavier penalties for offenders, such as annulment of results and medals to suspension from training and competition for a specified period of time. However, as mentioned before, participants in this study did not put to much emphasize on fair play issues of doping. In light of this, results obtained herein can be explained in the logical context that that windsurfers who do not intend to use doping to improve their performance expect harsher penalties for colleagues who try to gain an advantage by using doping substances.

Conclusion

Results of this study indicated very low levels of doping knowledge among windsurfers and relatively high tendency in doping behaviour. It is clear there is a need of systematic education of windsurfers on all aspects regarding doping, including legal, health and many others.

Although windsurfing, as discipline in sailing, is a sport not contaminated by doping, high physical demands and growing popularity worldwide suggest that all preconditions should be made to keep it that way and prevent a possible increase in the consumption of prohibited drugs. In future studies larger sample of windsurfers should be included and also participants from multiple windsurfing disciplines.

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ORIGINAL SCIENTIFIC PAPER

Relationship between Muscle Strength of Knee Stabilizers and Quality of Vertical Jump Performance in Physically Active Female Population

Izet Bajramovic¹, Ensar Abazovic¹, Denis Causevic¹, Ivor Doder¹, Haris Alic¹, Erol Kovacevic¹, Nedim Babic¹ and Slavenko Likic¹

¹University of Sarajevo, Faculty of Sport and Physical Education, Sarajevo, Bosnia and Herzegovina

Abstract

High relationships between muscle strength and various forms of jumps are usually based on the research samples of professional athletes or students of sports and physical education. However such studies are less known in the case of recreational women. This study aimed to determine the relationship between isokinetic parameters of knee joint muscle strength with the efficiency of performing vertical jumps. The sample represents a group of 16 healthy and physically active women (age=31.04±3.71; height 168.13±8.34; weight 59.80±9.80). Knee extensors and flexors were evaluated by using an isokinetic dynamometer, while the two-foot vertical jump performance was measured using the Opto Jump System. Pearson's correlation coefficient was used to determine correlation magnitude ($p < .05$). The obtained results indicated high correlations of the knee extension peak torque dominant leg (KEPT D), knee extension peak torque non-dominant leg (KEPT ND) and knee flexion peak torque non-dominant leg (KFPT ND) with counter movement jump free arms (CMJFA) ($r = .525$; $r = .511$; $r = .594$; $p < .05$). High correlations was also indicated between KFPT ND with counter movement jump (CMJ) ($r = .514$; $p < .05$). Given that these are recreational women, we can assume that the countermovement free arm jump type was the most natural form of expressing their explosive potential. It is certainly important that future studies further examine the relationships between muscle strength and performance of primary and specific motor tasks in recreational women.

Keywords: knee joint, peak torque, jumps, recreational women

Introduction

As a type of motor ability, the explosive strength represents one of the determinants of success in all the activities which demand the use of great muscle force in the shortest period (Metikoš et al., 1989). Jumping is a complex human movement that requires complex motor coordination between the upper and lower body segments. In particular, the propulsive action of the lower limbs during a vertical jump has been considered particularly suited for evaluating explosive characteristics of elite athletes and sedentary individuals (Genuario & Dolgener, 1980; Bosco & Komi, 1980; Markovic,

Dizdar, Jukic, & Cardinale, 2004). Also, most complex sports movements contain specific movements similar to those used in everyday life (Bjelica, 2013).

The results of various jump tests show a high correlation and are interpreted as a factor of explosive strength of the lower extremities (Bjelica & Fratrić, 2011). The relation between peak torque and maximum jump has been the subject of several previous research (Bosco, Luhtanen, & Komi, 1983; Binet, Lehanç, Vandenbroek, Bury, & Croisier, 2005; Almuzaini & Fleck, 2008; Anderson et al., 1991; Kovačević, Abazović, Bradić, & Vrcić, 2012). However, such research has



Correspondence:

S. Likic

University of Sarajevo, Faculty of Sport and Physical Education, Patriotske lige 41, 71000 Sarajevo, Bosnia and Herzegovina

E-mail: slavenko.likic@fasto.unsa.ba

been conducted on samples of elite athletes and/or students of sports and physical education. Also, no studies have been found to determine the relations between peak torque and vertical jump height in the recreational population. This difference is essential to emphasize since the first listed samples have good movement pattern, and therefore, this correlation is primarily important in the recovery period. In the recreational population, who often have not adopted good and sometimes even correct movement structures, this correlation brings even more significant benefit.

Although it can be assumed that there is a connection between maximum strength and vertical jump height in recreational individuals, the same has not been investigated so far. Therefore, the question arises whether there is a lower correlation between these parameters in recreational individuals, and if so, what is its basis. Accordingly, this research aimed to determine the relationship between the peak torque, measured by an isokinetic dynamometer, and the height of the vertical jump.

Methods

Participants

The sample consisted of women ($n=16$), middle-aged (age 31.04 ± 3.71 ; height 168.13 ± 8.34 ; weight 59.80 ± 9.80), with no lower extremity injuries during the last two years and with active participation in group recreational programs for at least the past year.

Variables and measurement protocol

Isokinetic variables (Biodex System): Knee extension peak torque of dominant leg (KEPT D) (Nm), Knee extension peak torque of non-dominant leg (KEPT ND) (Nm), Knee flexion peak torque of dominant leg (KFPT D) (Nm), and Knee flexion peak torque of non-dominant leg (KFPT ND) (Nm), Hamstring/quadriceps unilateral ratio of dominant leg (H/Q D) (%) and Hamstring/quadriceps unilateral ratio of non-dominant leg H/Q ND (%). CON/CON 60°/s isokinetic protocol was implemented according to Abazovic et al. (2015). Variables for estimating explosive strength - jump type: Squat jump (SJ) (cm), Countermovement jump free arms (CMJFA) (cm) and Countermovement jump (CMJ)

(cm). A standardized warm-up procedure was performed (10-minute of ergometer-cycling followed by 7 minutes of dynamic stretching). Dominant and non-dominant leg were determined based on the statement of the respondents. Each subject was tested through nine jumps: three attempts of SJ, CMJFA and CMJ. The pause between the same jumps lasted 20 seconds, while the pause between different jumps lasted 60 seconds. The highest jump attempt was taken for further analysis.

Statistical analysis of the results

The results were analyzed in the IBM-SPSS 23 statistical program. Descriptive parameters of all variables were calculated: minimum and maximum value, arithmetic mean (Mean), standard deviation (\pm SD), skewness and kurtosis. The correlation of the variables was calculated using the Pearson correlation coefficient (r). Statistical significance was set at the conventional 95%. The magnitude of the correlation was interpreted as follows: small ($r=0.10$ to 0.29); moderate ($r=0.30$ to 0.49); high ($r=0.50$ to 0.69), perfect ($r=1$) (Hopkins, 2002).

Results

Subjects achieved better results in all isokinetic variables with their dominant leg (Table 1). The variable Elevation CMJFA indicates a slightly more pronounced grouping of most results to the left of the arithmetic mean. Other skewness results have fair values. The variables KEPT D, KEPT ND, and KFPT D are closest to the ideal distribution of results. A slightly more pronounced negative value of kurtosis in the variables KEPT D and KFPT D indicates platykurtic curve, which means that part of the result is positioned on the tails of the curve. The variable Elevation CMJ has a leptokurtic roundness of the curve, which indicates the positioning of the results near the center of the distribution. The one-sided strength ratio between legs flexors and extensors, based on the values of the arithmetic means, points to a slightly worse ratio in the case of both H/Q variables. The dominant leg (49.57%) has somewhat more pronounced muscle imbalance than the non-dominant leg (47.55%). The optimal value of the ratio of the front and back of the thigh is 61% (Biodex normative goals).

Table 1. Descriptive parameters of isokinetic strength of legs and explosive strength of jump type

	Min	Max	Mean \pm SD	Skewness	Kurtosis
KEPT D	116.4	216.6	164.36 \pm 33.37	.05	-1.58
KEPT ND	113.1	209.1	155.97 \pm 30.28	.17	-1.00
KFPT D	56.5	112.0	81.35 \pm 18.70	.10	-1.54
KFPT ND	42.1	96.2	74.20 \pm 16.72	-.44	-.92
H/Q D	38.3	60.1	49.58 \pm 5.14	-.24	.85
H/Q ND	34.6	56.3	47.56 \pm 6.17	-.97	.54
SJ	17.5	31.8	23.34 \pm 3.65	.73	.40
CMJFA	21.7	36.8	26.38 \pm 4.16	1.19	1.19
CMJ	16.2	31.9	23.50 \pm 4.16	.41	-.04

Legend: D: dominant; ND: non dominant; KE: knee extension; KF: knee flexion; PT: peak torque; H/Q: hamstring/quadriceps ratio; SJ: squat jump; CMJFA: countermovement jump free arms; CMJ: countermovement jump

High positive direction correlations (Table 2) were found between the variables KEPT D and CMJFA ($r=.525$; $p<.05$); KEPT ND and CMJFA ($r=.511$; $p<.05$); KFPT ND

and CMJFA ($r=.594$; $p<.05$); KFPT ND and CMJ ($r=.514$; $p<.05$). Other treated variables do not correlate with each other ($p>.05$).

Table 2. Relations between isokinetic leg strength and jump-type explosive power

Variables	SJ	CMJFA	CMJ
KEPT D	.393	.525*	.472
KEPT ND	.348	.511*	.460
KFPT D	.308	.424	.413
KFPT ND	.410	.594*	.514*
H/Q D	-.082	-.029	.015
H/Q ND	.188	.291	.222

Legend: * - Correlation is significant at the 0.05 level

Discussion

Considering the research aims to determine the relationship between the peak torque and vertical jump height, it is important to point out the following observations.

Table 2 indicates that the squat jump height did not have a statistically significant correlation with the peak torque of the knee extensors and flexors. On the other hand, CMJ and CMJFA indicated statistically significant correlations with isokinetic parameters. Although both CMJs are related to isokinetic power parameters, it is still noticeable that the free-hand jump result indicates the highest correlation with isokinetic power parameters. Therefore, it can be assumed that this sample did not maximally trigger the active musculature during the other two vertical jumps.

Although the reasons for the weak correlation with SJ and the existence of significant correlation with both forms of CMJ are explained below, it is worth mentioning that the magnitudes of the correlation coefficient differ from some previous studies. Thus, Bosco et al. (1983), Binet et al. (2005), and Tsiokanos, Kellis, Jamurtas and Kellis (2002) recorded correlation coefficients ($r > 0.6$; $p < 0.05$), but it is important to note that in these studies the samples were composed of active athletes. On the other hand, in the study by Blackburn and Morrissey (1998), in the case of physically inactive women who did not have lower extremity injuries, no significant correlations were found at all ($r = 0.097$; $p > 0.05$). Wilson & Murphy (1995) recorded most similar results to this research and the most similar sample of physically active individuals.

Although CMJ and CMJFA do not differ significantly from SJ, the main difference is reflected in the volume of instructions that should be given for the first two variables, and which, although they do not look like that, can represent a significant modification of previously adopted movements in the case of recreational individuals. Due to weakness of the m. gluteus medius (Semciw, Pizzari, Murley, & Green, 2013) a squat jump can cause unwanted valgus or "knee failure" medially in untrained or poorly trained individuals during the stabilization phase (or semi-squat retention), which signifi-

cantly and acutely increases the level of stress that also occurs typically in the knee joint (Joseph et al., 2008). Also, during CMJ the muscles are actively "pre-stretched", absorb force and use the elastic energy stored in muscles and tendons (Komi & Bosco, 1978). This indicates that due to an eccentric-concentric cycle, the total work performed during CMJ is higher than in SJ (Komi & Bosco, 1978).

The performance of motor tasks that have two or more instructions, and that require the simultaneous performance of two and/or more tasks, and which are commonly used to assess the effect of the second task on the performance of the first (Huang & Mercer, 2001) has been investigated several times. Most authors are consistent in stating that trained individuals perform significantly better results when performing complex tasks than untrained ones and even when their results do not differ significantly in some basic motor tasks (Abernethy, 1993; Beilock, Carr, MacMahon, & Starkes, 2002; Gray, 2004).

Following the above, it can be concluded that there is a high correlation between the peak torque and maximum jump height in recreational women. With the complexity of the motor task, the intensity of correlation becomes lower. At the same time, in SJ there is no correlation between these values. Furthermore, the results indicated that it is necessary to determine how the complexity of performing additional motor tasks may affect the level of performance of the primary motor task. In addition to the perceptual and motor performances, investigating athletes' neurophysiological background would be sufficient to make a connection between motor and neural mechanisms (Gardasevic, Akpinar, Popovic, & Bjelica, 2019).

This study showed a strong positive correlation between knee extensors PT and CMJFA height in recreationally trained females. Furthermore, the absence of correlation between SJ, CMJ, and knee extension PT might be due to the low movement mechanics. Given that these are physically active women, we can assume that their countermovement free arm jump type was the most natural form of expressing their explosive potential.

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Conflict of Interest

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ORIGINAL SCIENTIFIC PAPER

Association between Enjoyment in Physical Education Online Classes and Physical Activity Levels in Adolescents during the COVID-19 Pandemic

Mirela Sunda¹, Barbara Gilic^{1,2} and Alen Bascevan¹

¹University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia, ²University of Split, Faculty of Kinesiology, Split, Croatia

Abstract

Motivation, with special emphasis on intrinsic motivation is important factor that influences physical activity levels (PAL). The COVID-19 pandemic forced Physical education (PE) teachers to switch to online classes, which increased the problem of keeping students motivated to be physically active. This study aimed to determine the associations between enjoyment in online PE classes and PAL during the COVID-19 lockdown. 198 high-school students aged 14-19 years participated in this study. Variables included interest and enjoyment in PE classes assessed by the Intrinsic Motivation Inventory questionnaire and PAL assessed by Physical Activity Questionnaire for Adolescents. Pearson's correlation coefficient was calculated to evaluate the associations between variables. Independent samples T-test and χ^2 test were used for determining the gender differences in study variables. Significant correlation between PAL and interest/enjoyment in online PE classes was recorded ($R=0.23$, $p<0.05$). There were no significant differences between girls and boys in the total subset interest/enjoyment of intrinsic motivation. However, the difference was observed in the subset enjoyment ($\chi^2(1, N=198)=9.53$), with boys showing more enjoyment. Because of the evidenced positive association between interest/enjoyment in PE classes and PAL, it is crucial to provide students fun and interesting PE online classes to maintain PAL during the pandemic and similar situations. The special emphasis should be placed on girls.

Keywords: distance learning, health crises, youth, motivation, exercise

Introduction

Physical activity (PA) is defined as any movement of the human body performed by skeletal muscles, which requires energy expenditure (Caspersen, Powell, & Christenson, 1985). Even though regular and adequate PA has numerous benefits for health of children and adolescents, research has shown that 81% of adolescents worldwide do not meet the recommended guidelines of 60 minutes of moderate to high PA (Guthold, Stevens, Riley, & Bull, 2020). Of particular concern is the data from World Health Organization (WHO) from 2018, where it is shown that only 19% of Croatian 15-year-olds (25% of boys and 12% of girls) reach the recommended physical activity levels (PAL) (WHO, 2018). At the same time, 10-20%

of children and adolescents worldwide have mental disorders (WHO, 2020).

Physical Education (PE) classes are considered to be one of the most important factors in promoting lifelong PA and improving the health of young people, both in PE classes (Barkoukis, Chatzisarantis, & Hagger, 2021; Escrivá-Boulley, Tessier, Ntoumanis, & Sarrazin, 2018), and in their free time (Wang & Chen, 2020). In Croatia, PE classes are carried out in a fund of 3 hours per week from the 1st to the 3rd grade of primary school, and 2 hours per week in secondary schools and at faculties. PE enables students to get to know their own body and its functioning, encourages harmonious growth and development of the organism, contributes to greater work abil-



Correspondence:

M. Sunda
University of Zagreb, Faculty of Kinesiology, 10000 Zagreb, Croatia
E-mail: mirela.sunda@kif.hr

ities, learning success, personal and social development and develops awareness of the importance of PA and exercise for maintaining and improving health (Rasberry et al., 2011).

Motivation is an important factor influencing PAL. Motivation is defined as “a psychological construct that explains why people choose to behave in a certain way at a certain moment” (Barić, 2012). Engaging in PA is a consequence of a combination of intrinsic and extrinsic motivation (Ryan, Williams, Patrick, & Deci, 2009). Briefly, intrinsic motivation is one in which the need for activity arose from internal incentives, satisfaction arose from the activity itself and its meaning, and not from external stimuli such as rewards and acknowledgments which determine extrinsic motivation (Ntoumanis, 2001). In research, intrinsic motivation has been recognized as an important factor for exhibiting greater effort in activity and greater satisfaction with exercise during PA classes, and in sports (Brustad, Babkes & Smith 2001; Ntoumanis, 2001). When students are intrinsically motivated, they show interest and intention to participate in PA, experience enjoyment and feelings of competence, and are less likely to feel bored in PE classes (Ntoumanis, 2001).

The pandemic of the new disease COVID-19 was declared in March 2020 (Cucinotta & Vanelli, 2020). The main method for controlling the COVID-19 pandemic was the implementation of social distancing measures that included the closure of schools, universities, cafes, restaurants, sports and recreational facilities and clubs, and other places for social gatherings (Bedford et al., 2020). Research has regularly reported a decrease in PAL worldwide as a result of imposed social distancing measures during a pandemic (Stockwell et al., 2021), and a decrease in PAL has also been reported in adolescents from Croatia and Bosnia and Herzegovina (Sekulić, Blažević, Gilić, Kvesić, & Zenić, 2020; Gilić, Ostojić, Čorluka, Volarić, & Sekulić, 2020; Karuc, Sorić, Radman, & Mišigoj-Duraković, 2020). At the same time, the appearance of COVID-19 disease has significantly changed the usual way and approach of teaching PE and expected teachers to introduce modern technology and implementation of distance PE teaching. This posed a significant challenge for PE teachers to motivate their students to remain active and to create applicable online PE classes.

Regarding the lack of studies that directly examined the relationship between enjoyment in distance learning PE and PAL, the aim of this study was to determine the association of distance learning PE with PAL and to determine whether there are gender differences. We hypothesized that the enjoyment in distance learning PE will be positively associated with PAL, i.e., that students who enjoy distance learning PE will be more physically active. Also, we hypothesized that a significant difference will be found regarding gender; precisely, that boys will enjoy distance learning PE more than girls.

Methods

Participants

This research included 198 high school students (141 female, 57 male) from Osijek - Baranja County (Croatia), aged 14 to 19 years. Students were of good health (i.e., not injured or ill) during the study duration. The informed consent was signed by the parents or legal guardians before the study initiation for students aged less than 18 years. The study was approved by the ethical board University of Zagreb, Faculty of Kinesiology.

Study design and procedures

The data used in this research was collected during April 2021. At the very beginning, the participants were explained the purpose of the research, it was pointed out that there are no correct or incorrect answers and that they answer questions according to personal evaluation of the current situation. Data collection was organized through an online survey system (Survey Monkey, San Mateo, California, USA). Participants were asked to enter their code so that anonymity would be guaranteed and that the data could be linked in case of a repeated measurement.

Variables

The variables in this study included the gender (male, female), age of participants (14-19 years) and questionnaires for assessing the interest/enjoyment in PE classes and PAL.

The Croatian version of the questionnaire of intrinsic motivation (Intrinsic Motivation Inventory - IMI) was used to assess the enjoyment in PE online lessons (McAuley, Duncan, & Tammen, 1989; Barić, CeciĆ-Erpić & Babić, 2002). IMI is a measuring instrument where the total level of intrinsic motivation is estimated as a result of four corresponding dimensions (interest/enjoyment; perceived competence; effort/importance; tension/pressure). The questionnaire consists of 18 items; for the purposes of this research, the interest/enjoyment dimension was used, which consists of 5 items through which it is determined to what extent the assessed activity is considered interesting and enjoyable. The task of the participants when filling out this questionnaire is to indicate the degree of agreement with the 5 offered statements: (1) “I really enjoy distance learning physical education” – IMI 1; (2) “It’s fun to practice distance learning physical education” – IMI 7; (3) “The contents we learn in distance learning physical education are very interesting to me” – IMI 8; (4) “I think it’s great for me while I’m in distance learning physical education classes” – IMI 13; (5) “The contents of distance learning physical education classes can not hold my attention” – IMI 17. The answers were evaluated on a 5-point Likert scale, marked as 1-strongly disagree, 2-mostly disagree, 3-neither agree nor disagree, 4-mostly agree, 5-completely agree. The results of each participant are expressed as the average value of their responses. For this study, the parts of the questionnaire were terminologically adapted to assess the enjoyment in PE distance learning classes, based on the previously tested Croatian version of the questionnaire used to assess the motivation of athletes (Barić et al., 2002).

The Physical Activity Questionnaire for Adolescents (PAQ-A; Janz, Lutuchy, Wenthe, & Levy, 2008) was used to assess PAL. The PAQ-A is a questionnaire about the last seven days of the activity that the participants fill out independently, and it is used to measure the level of PA in adolescents aged 14 to 19 years. The reliability and validity of the PAQ-A questionnaire was proven in a sample of adolescents from Croatia and Bosnia and Herzegovina (Miljanović Damjanović, Obradović Salcin, Zenić, Foretić & Liposek, 2019). This questionnaire consists of 9 items; first 8 items assess PA during leisure-time, during PE classes, during lunch, after school, during evenings, during week-ends, and regular weekly PA, while 9th item assesses whether student was ill or injured during the last 7 days. The first 8 items are scored on a scale from 1 to 5, with 1 representing low level of activity and 5 representing a high level of

activity. The final PAQ-A score was calculated as the arithmetic mean of the scores from all 8 particles (Kowalski, Crocker, & Donen, 2004).

Statistics reporting

The program Statistica 13.5. (Tibco Inc., Palo Alto, CA, USA) was used for statistical data processing. Basic descriptive indicators were calculated for the whole sample and separately for gender. The Shapiro-Wilk W test was used to analyze the normal distribution of the data. Pearson's correlation coefficient was used to check the correlation between the variables. Frequencies were calculated for each individual item. A Chi-

square test was used to determine the differences by gender in each item of interest/enjoyment. An independent sample t-test was used to determine gender differences for PAQ-A and dimension of interest/enjoyment.

Results

Descriptive statistics for total sample and separately for boys and girls are shown in the Table 1. The results of the PAQ-A are 2.53 ± 0.71 for total sample, while boys have higher PAQ-A score (2.74 ± 0.82) than girls (2.45 ± 0.64). Also, boys have higher scores than girls for the interest/enjoyment (3.86 ± 0.79 and 3.77 ± 0.80 , respectively).

Table 1. Descriptive statistics for the results of PAQ-A and subset interest/enjoyment of intrinsic motivation

Variables	Total (N=198)	Boys (N=57)	Girls (N=141)
	Mean \pm St.Dev.	Mean \pm St.Dev.	Mean \pm St.Dev.
PAQ-A	2.53 \pm 0.71	2.74 \pm 0.82	2.45 \pm 0.64
IMI 1	3.96 \pm 0.96	4.26 \pm 0.84	3.84 \pm 0.99
IMI 7	3.95 \pm 0.94	4.02 \pm 0.94	3.93 \pm 0.95
IMI 8	3.74 \pm 1.03	3.66 \pm 1.01	3.77 \pm 1.04
IMI 13	3.66 \pm 1.12	3.86 \pm 1.14	3.59 \pm 1.10
IMI 17	3.67 \pm 1.15	3.53 \pm 1.26	3.7 \pm 1.11
interest/enjoyment	3.80 \pm 0.80	3.86 \pm 0.79	3.77 \pm 0.80

Legend: PAQ-A - Physical Activity Questionnaire for Adolescents; IMI - Intrinsic Motivation Inventory; St.Dev. - Standard deviation

Chi-square independent test showed significant difference between boys and girls in the item IMI 1 ($\chi^2(1, N=198)=9.53$, $p=0.04$) (A), with boys showing higher enjoyment than girls at PE classes. Test did not show significant differences between

boys and girls in the items IMI 7 ($\chi^2(1, N=198)=1.61$ (B), $p=0.81$), IMI 8 ($\chi^2(1, N=198)=1.61$, $p=0.81$) (C), IMI 13 ($\chi^2(1, N=198)=5.01$, $p=0.29$) (D), and IMI 17 ($\chi^2(1, N=198)=2.5$, $p=0.64$) (E) (Figure 1).

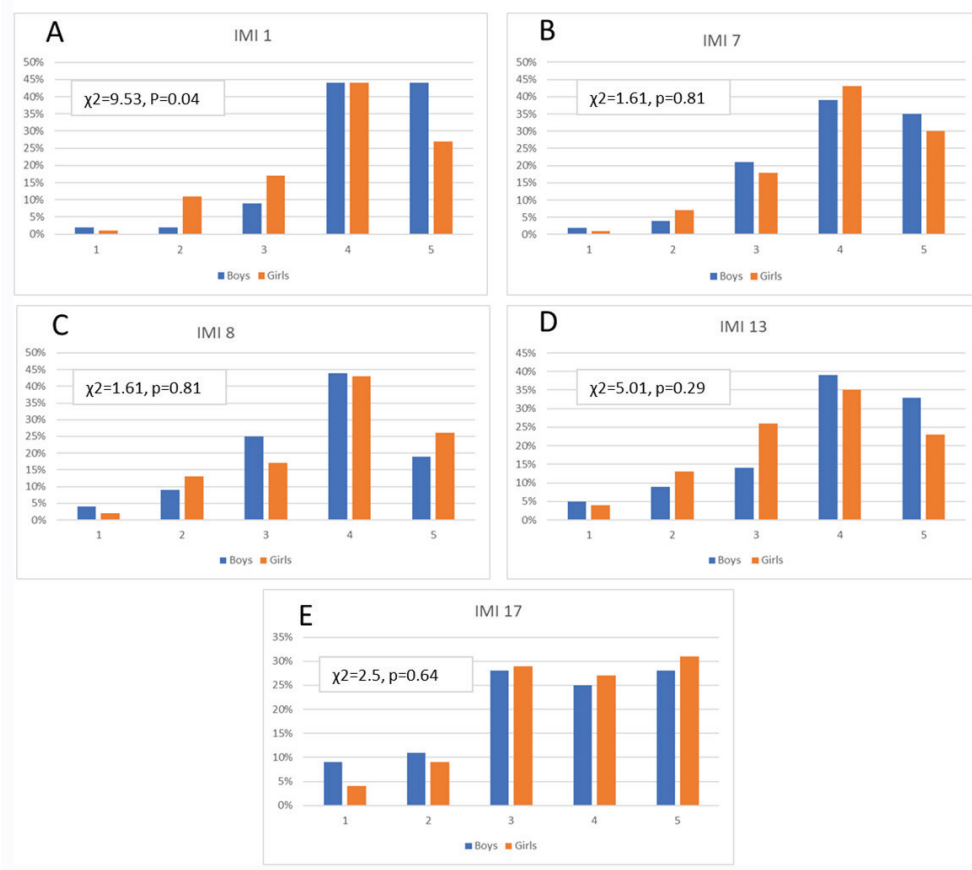


FIGURE 1. Chi-square test for gender differences for items IMI 1 (A), IMI 7 (B), IMI 8 (C), IMI 13 (D), IMI 17 (E)

T-test evidenced a significant difference between boys and girls for PAQ-A ($t=7.70$, $p=0.00$). No significant difference was recorded for the interest/enjoyment of intrinsic motivation.

Pearson's correlation coefficient showed a significant association between PAQ-A and subset interest/enjoyment of intrinsic motivation ($R=0.23$, $p<0.05$) (Table 2).

Table 2. Differences between boys and girls the PAQ-A and subset interest/enjoyment of intrinsic motivation and Pearson's correlation coefficient between PAQ-A and subset interest/enjoyment of intrinsic motivation

Variables	T-test		Pearson's R	
	t	p	PAQ-A	interest/enjoyment
PAQ-A	2.70	0.00	/	0.23
interest/enjoyment	0.76	0.45	0.23	/

Discussion

The primary goal of this study was to determine the association of enjoyment in distance learning PE with students' PA, assuming that students who enjoy PE classes will be more physically active. The obtained results confirm a positive association between PA and the dimension of interest/enjoyment in distance learning PE. Furthermore, the results confirm differences by gender in PA, i.e., male students are more physically active than female students.

The results did not establish differences by gender in the interest and enjoyment dimension of intrinsic motivation between male and female students. Thus, it can be said that male and female students similarly enjoy distance learning PE. However, the analysis of individual items of the interest and enjoyment dimension found that male and female students differ significantly in the IMI item 1 ("I really enjoy distance learning physical education"). Specifically, 88% of boys and 71% of girls state that they enjoy PE classes. This is probably because boys are more physically active in their free time than girls (Guthold et al., 2020), and distance learning PE allows them to practice PE in their free time when and where it suits them best. Unlike the usual PE classes, which are held according to a pre-planned and time-limited schedule, distance PE classes are planned differently, i.e., they offer more freedom to both teachers and students in the implementation and organization of the classes. Namely, during distance learning PE, students would receive assignments and activities from their teachers according to the planned schedule, but they did not always have to do assignments in real-time but could do them at a time that suits them best, respecting the agreed deadlines for sending feedback information on completed tasks and activities.

There were no significant differences by gender in the remaining four items of the interest and enjoyment dimensions (IMI 7, IMI 8, IMI 13, and IMI 17); boys and girls stated that the content and practicing online PE classes was equally fun. However, it is interesting that only 19% of boys and 13% of girls stated that the content of distance PE classes can keep their attention even though it is interesting to them. In the author's opinion, this is especially important because distance learning PE is a new concept and students' attention is extremely important to achieve the goals and objectives of the teaching itself. Attention and concentration are two aspects of cognitive function that have a special importance during development because they are key elements in the learning process (Zervas & Stambulova, 1999). It has been shown that even short periods of exercise can contribute to improved attention and concentration (Budde, Voelcker-Rehage, Pietraßyk-Kendziorra, Ribeiro, & Tidow 2008). Therefore, PE classes can be helpful to children and young people to concentrate while learning and

can improve cognitive capacities (Gallotta et al., 2012).

The reasons for students' lack of attention in the distance teaching PE could be found in the fact that students need to learn more independently during distance learning as they do not have the direct support and contact of the teacher. Particularly, in live and regular teaching, the student can get the teacher's answers to all his questions immediately and get additional encouragement, while in distance teaching, this is much harder to achieve as there is no direct contact (Jeong & So, 2020). If distance-learning is held in real-time, it can be effective in classrooms with a smaller number of students, however, in classrooms with 25 or more students; such teaching is difficult and inefficient. In addition, in distance learning, students need significantly more time to master the subject content on their own, resulting in a lack of attention/concentration and losing motivation.

When we talk about the specifics of distance learning PE, it should be aimed at developing students' awareness and importance of their PA in the future, it should encourage students to learn independently and develop their competencies. Specifically, students' attitude towards independent learning is one of the important factors and prerequisites for the effectiveness of distance learning PE (Jeong & So, 2020). Also, teachers should develop strategies for distance learning through which students will form a positive attitude to independent learning, and the evaluation in such teaching should be more flexible (Jeong & So, 2020).

The value/result of the intensity and enjoyment dimension of high school students in this study is 3.80. This is slightly more than the value of the interest and enjoyment dimension obtained in research by Cvenić and Barić (2015), who researched the student population in which this dimension was 3.64. This is probably because by completing high school education, young people become less physically active, less enjoy exercise, put in less effort, and feel less competent to exercise. A study on 2,000 American adolescent girls found that increased enjoyment resulted in increased PA among adolescent girls (Dishman et al., 2005), and a positive association between enjoyment and PA was confirmed in this study as well. However, it should be said that the relationship between the variables is numerically relatively small, and further research should additionally investigate this issue.

Conclusion

This research found that girls are generally less physically active than boys and that enjoy distance learning PE less than boys. Therefore, the question arises which content or ways of distance teaching PE would meet students' basic needs, make their classes interesting, and motivate them to be more involved in classes and PA in their free time. Thus, PE teachers

and other educational authorities should develop a distance education program that will be acceptable and interesting to students. Indeed, uninteresting teaching of PE can potentially lead to a decrease in intrinsic motivation in students and a decrease in interest and enjoyment of activities which can ultimately result in a decrease in PA of students. The introduc-

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Conflict of Interest

The authors declare that there is no conflict of interest.

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ORIGINAL SCIENTIFIC PAPER

Total and Abdominal Adiposity are Lower in Overweight and Obese Children with High Cardiorespiratory Fitness

Besnik Morina¹, Florian Miftari¹, Georgi Georgiev² and Seryozha Gontarev²

¹University of Pristina "Hasan Pristina", Faculty of Physical Education and Sport, Prishtina, Republic of Kosovo, ²Ss. Cyril and Methodius University, Faculty of Physical Education, Sport and Health, Skopje, Republic of North Macedonia

Abstract

The study goal was to determine the impact of cardiorespiratory fitness on the total and abdominal adiposity in a sample of children aged 6 to 10. It was hypothesised that high cardiorespiratory fitness would result in lower total and abdominal obesity. The research was conducted on a sample of 1432 respondents where 717 (50.1%) are boys, and 715 (49.9%) are girls aged 6 to 10. The average age of the respondents was 8.72 ± 1.4 years. Three anthropometric measures (body height, body weight and waist circumference) were considered and the body composition was determined by BIA. Body mass index sex- and age-specific cut-off points were used for overweight and obesity definition and children were placed in two groups: overweight/obese and non overweight. Cardiorespiratory fitness (CRF) was assessed with the endurance shuttle-run test. Participants were grouped into high and low CRF based on age and sex distributions. The results were statistically analyzed by using t-tests and a χ^2 test, analysis of covariance, Pearson correlation and hierarchical linear regression. On the basis of the obtained results, one can conclude that children who are overweight or obese and have a high level of cardiorespiratory fitness, have lower body mass index values, lower waist circumference, lower body fat percentage and a higher muscle mass percentage compared to children who are classified in the same BMI category, but have low values of cardiorespiratory fitness. The results of this study suggest that an appropriate level of cardiorespiratory fitness can reduce the threats of obesity among the pediatric population.

Keywords: central adiposity, fatness, fitness, obesity, children

Introduction

The prevalence of paediatric obesity has been increased in USA and Europe over the past years (Wang, Monteiro, & Popkin, 2002; Lobstein & Frelut, 2003). It seems, however, that central and abdominal obesity increase at a faster rate than total body obesity in children (McCarthy, Ellis, & Cole, 2003). It has been shown that a lack of physical activity and a low cardiorespiratory fitness are associated with total obesity (Janssen et al., 2005; Katzmarzyk & Tremblay, 2007) and with abdominal obesity (Dencker et al., 2008;

Yoon & So, 2009) in children.

Central adiposity is related to multiple risk factors for cardiovascular diseases in children (Freedman, Srinivasan, Harsha, Webber, & Berenson, 1989; Goran, Kaskoun, & Shuman, 1995) and adults (Bigaard et al., 2003). When it comes to both men and women, there is strong evidence that physical activity and cardiorespiratory fitness (CRF) may protect against the adverse effects of obesity on health. Indeed, Blair et al. (1989) found twice lower relative risk of mortality of all causes in obese adults with moderate to



Correspondence:

F. Miftari

University of Pristina "Hasan Prishtina", Faculty of Physical Education and Sport, Str. "Nëna Terezë", p.n. 10000, Prishtina, Republic of Kosovo

E-mail: florian.miftari@uni-pr.edu

high levels of cardiorespiratory fitness compared to obese adults with low levels of cardiorespiratory fitness. Ross and Katzmarzyk (2003) suggest that high levels of cardiorespiratory fitness are associated with lower levels of total and central obesity for an indicated body mass index (BMI) in 20-59 year-old men and women.

To the authors' best knowledge, there is no information in the literature on the effect of CRF on total and central obesity in children. Therefore, the aim of the present study was to examine the influence of CRF on total body and abdominal adiposity in a sample of young people.

Methods

Sample of respondents

A total of 1432 healthy children (717 boys and 715 girls) aged 6–10 years participated in this study. Subjects were living in Skopje, North Macedonia, and a signed consent was obtained from their parents. The respondents were treated in accordance with the Helsinki Declaration 1961 (revision of Edinburgh 2000). Measurements were realized in March, April and May 2019, in standard school conditions at regular classes of physical and health education. The measurement was realized by experts from the area of kinesiology and medicine, previously trained to perform functional tests and to take anthropometric measures.

Anthropometric measures and body composition

Anthropometric measurements were taken according to standard methodology of International Biological Program (IBP) and according to the recommendations of World Health Organization (WHO) and Weiner and Lurie (1981). Weight was measured in underwear and without shoes with an medical decimal weight scales, to the nearest 0.1 kg, and height was measured barefoot in the Frankfurt horizontal plane with a telescopic height measuring instrument (Martin's anthropometry) to the nearest 0.1 cm. Waist circumference was measured with a anthropometric tape positioned horizontally mid-way between the bottom of the rib cage and the iliac crest. A single measure was taken at the end of a normal expiration and recorded to the nearest 0.1 cm. Body mass index was calculated as bodyweight in kilograms divided by the square of height in meters.

Components of the body composition have been determined by the method of bioelectrical impedance (measuring of the electric conductivity – Bioelectrical Impedance Analysis - BIA). The measuring was realized by a Body Composition Monitor, model "OMRON - BF511", by means of which we have measured the body weight, fat tissue percent and muscular mass percent. Prior to commencing the measurement we had entered the parameters of gender, years and body height of the respondent in the Body Composition Monitor. In order to provide better precision of the results obtained from the estimation of the body composition, prior to each measuring, we ensured that the preconditions recommended by American College of Sports Medicine (2005) and Heyward (2006) had been fulfilled.

Definition of weight status

Three weight status groups were established in this study: underweight/normal weight, overweight and obesity. Participants were categorized according to the interna-

tional gender and age-specific BMI (kg/m^2) cut-off points (Cole, Bellizzi, Flegal, & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007). These points have been particularly established for children and adolescents aged from 2 to 18 years, separately for males and females and for 0.5 year age groups. These cut off values are based on percentiles passing at age 18 years through BMI $18.5 \text{ kg}/\text{m}^2$ for underweight, $25 \text{ kg}/\text{m}^2$ for overweight and $30 \text{ kg}/\text{m}^2$ for obesity (Cole et al., 2000, 2007).

Cardiorespiratory fitness

The 20 meter shuttle run test (Leger & Lambert, 1982) was used to measure fitness. All testing was completed on a firm and level surface (concrete play area at each school). For this test, children were required to run back and forth between two lines placed 20 meters apart. A sound signal was emitted from a pre-recorded tape to dictate running speed. Frequency of the sound signals increased such that running speed increased by $0.5 \text{ km}/\text{hour}$ each minute from the starting speed of $8.5 \text{ km}/\text{hour}$. The test ended when children could no longer keep pace with the sound signal. The last stage that children reached was used to predict maximal oxygen uptake (VO_2max) from the running speed corresponding to that stage ($\text{VO}_2\text{max} = 31.025 + 3.238 X - 3.248 A + 0.1536$, where X = the final speed and A = age). Children were divided into quintiles based on age- and sex-specific distributions for CRF. Participants were classified as unfit (first and second quintile) or fit (fourth and fifth quintile). The middle quintile was not used in the analysis.

Statistical analysis

Descriptive statistical analyses were conducted to explore the characteristics of the data and to assess statistical assumptions. Independent samples t-tests were used to test for gender differences in the study variables. Normality of distribution was checked for all variables. Differences between fit and unfit children within each BMI category were assessed with one-way analysis of covariance with age and gender as covariate. The strength of the associations between variables was determined using Pearson correlation coefficients. Finally, hierarchical linear regression was used to determine the independent contributions of fitness on predicting the obesity measures. All the analyses were performed using the Statistical Package for Social Sciences software (SPSS, v. 22.0 for WINDOWS; SPSS Inc., Chicago, IL, USA), and values of $p < 0.05$ were considered statistically significant.

Results

The research was conducted on a sample of 1432 respondents where 717 (50.1%) are boys, and 715 (49.9%) are girls at the age of 6 to 10 years. The average age of the respondents was 8.72 ± 1.4 years.

The sample characteristics are presented in Table 1. The table overview shows the values of the arithmetic means, the standard deviations and the level of statistical significance, and it is observable that there are statistically significant differences of the variables between male and female respondents: waist circumference, body mass index, body fat percentage, 20-m shuttle run test (shuttles) and 20-m shuttle run test ($\text{VO}_2/\text{kg}/\text{min}$).

The overview of the obtained results shows that the val-

Table 1. Descriptive statistics of each study variable presented separately for boys and girls

Variables	Boys		Girls		T-test	Sig.
	Mean±SD		Mean±SD			
Age (years)	8.74±1.46		8.71±1.42		0.18	0.669
Waist circumference (cm)	61.24±8.63		58.25±7.84		46.82	0.000
Body mass index (kg/m²)	18.76±3.82		17.98±3.29		17.03	0.000
Body fat (%)	23.66±7.99		22.20±8.17		10.94	0.001
20-m shuttle run test (shuttles)	28.21±14.43		21.71±9.61		100.62	0.000
20-m shuttle run test (VO ₂ /kg/min)	49.18±3.63		47.73±3.04		67.16	0.000
Normal§ (% (n))	450	62.8%	476	66.6%	χ ² 8.46	p 0.015
Overweight§ (% (n))	157	21.9%	166	23.2%		
Obese§ (% (n))	110	15.3%	73	10.2%		

Legend: § - Determined through body mass index

ues of waist circumference are higher in boys, they also have higher body mass index, higher percentage of fat tissue, higher percentage of muscle mass, and they achieve better results in the 20 m. Shuttle Run Test and have higher maximum oxygen consumption.

The distribution of the overweight and obesity status in children, estimated by BMI, according to gender, is presented in Table 1. The table analysis and the overview of the χ^2 test ($\chi^2=8.46$, $p=0.015$) suggest that there are statistically significant differences in regard to the degree of nutrition among boys and girls. The percentages show that a higher percentage of the girls have a moderate BMI, while a higher percentage of

the boys have high BMI (obese).

The Pearson coefficients of correlation between cardiorespiratory fitness and obesity measures for the respondents of both genders are displayed in Table 2. The table above shows that all obesity measures for the respondents of both genders show a statistically significant negative correlation (within the range $r=-.53$ to $-.36$) with the cardiorespiratory fitness. The associations between fitness and obesity measures ($r=-.53$ to $-.47$) were stronger in boys compared to girls ($r=-.42$ to $-.36$). The highest correlations in both boys and girls were found in the comparison between fitness and waist circumference.

Waist circumference, body fat percentage, and body

Table 2. Pearson correlations among study variables presented separately for boys and girls.

Variables	Boys		Girls	
	R	p	R	p
Fitness - Waist circumference	-.53	.000	-.42	.000
Fitness - BMI	-.49	.000	-.41	.000
Fitness - Body fat percentage	-.47	.000	-.36	.000

mass index were significantly lower ($p<0.01$) in overweight/obese and fit children compared to unfit children at the same BMI category (Table 3), while the percentage of muscle mass showed statistically significant higher values in overweight/obese and fit children compared with unfit children at the same BMI category. Also, the values of waist circumference,

body fat percentage and body mass index were significantly lower ($p<0.01$) in non overweight and fit children compared with unfit children at the same BMI category (Table 3), while the percentage of muscle mass showed statistically significant higher values in non overweight and fit children compared with unfit children at the same BMI category.

Table 3. Anthropometric, body fat measures and physical characteristics between fit and unfit within the same BMI category

Variables	Non overweighta		Overweight/obesea	
	Unfit	Fit	Unfit	Fit
n	279	497	305	110
Waist circumference (cm)	55.99±5.28	55.05±4.16*	68.78±8.22	65.12±8.00*
Body mass index (kg/m ²)	16.51±1.61	16.13±1.47*	22.78±3.42	20.92±2.54*
Body fat (%)	18.99±5.55	17.26±4.64*	32.66±5.08	28.92±4.50*
Muscle mass (%)	30.17±3.81	30.71±4.02*	29.44±2.38	30.39±2.77*
20-m shuttle run test (shuttles)	16.31±4.76	35.50±12.03*	14.43±4.61	31.34±10.13*
20-m shuttle run test (VO ₂ /kg/min)	45.95±2.30	51.36±2.63*	45.40±2.26	50.44±2.14*

Legend: a - Values are Means±SD; * - $p<0.01$ between fit and unfit within the same BMI category

Finally, hierarchical linear regression was used to determine the independent effects of fitness on the obesity mea-

asures. After controlling for age, gender, fitness accounted for 31% of the variance in waist circumference ($r^2=0.313$, $p<.01$),

32% of the variance in BMI ($r^2=0.315$, $p<.01$), and 34% of the variance in the body fat percentage ($r^2=0.340$, $p<.01$).

Discussion

On the basis of the obtained results, it can be concluded that cardiorespiratory fitness is negatively related to the measures of total (BMI, body fat percentage) and abdominal (waist circumference) obesity in this sample of 6-10 year-old Macedonian children. The regression model showed that cardiorespiratory fitness is a significant predictor that accounts for 31 to 34% of the variance in the obesity measures.

This is the first study in Macedonia to show the favorable effect of high CRF on body fat distribution in overweight and obese children. Although the respondents were not randomly selected, the prevalence of overweight and obesity was similar to representative samples of Macedonian children (36.4% of overweight children in representative samples; 35.5% in our study; Spiroski, 2016). The prevalence of overweight and obesity in the present study was also within the range reported for the countries surrounding the Mediterranean (27–36% for children aged 7–11 years; Lobstein & Frelut, 2003).

The cardiorespiratory fitness in this study is estimated indirectly. However, past studies suggest that the test is valid for estimating the maximum aerobic capacity in children (Leger & Lambert, 1982; Van Mechelen et al., 1986). Furthermore, our study was limited to the use of anthropometric indices and body composition was determined indirectly by the bio-electrical impedance method. The use of highly sophisticated methods, such as DEXA, computed tomography and magnetic resonance imaging, could provide more information about the role of cardiorespiratory fitness in the intra-abdominal fat in children. However, these methods are not suitable for large population studies.

The results of this study are in line with some previous studies involving adult men and women (Ross & Katzmarzyk, 2003). These authors showed that waist circumference, the sum of trunk skinfolds and the sum of the four skinfolds were lower at a given BMI in individuals with high cardiorespiratory fitness. The lower values of central obesity in the group with high values of cardiorespiratory fitness in this study also correspond to the previous studies which suggest that a reduction in waist circumference and intra-abdominal fat after exercise training, independently of BMI changes (Mourier et al., 1997; Ross et al., 2000).

The results from previous studies indicate that cardiorespiratory fitness is a strong predictor of health given that it is associated with overall obesity and abdominal obesity (Ortega, Ruiz, Castillo, & Sjostrom, 2008), which is consistent with the results obtained in this study. The strongest association observed was that of total adiposity, followed by abdominal adiposity and BMI. Because BMI does not measure fat mass or fat distribution directly, it can misclassify individuals (e.g., a mesomorphic child may be incorrectly classified as obese). Consequently, additional obesity indicators were used in the present study which provided better estimates of adiposity.

The study by McCarthy et al. (2003) suggests that central fat increases faster than total body fat in European children. The increased accumulation of adipose tissue in the abdominal or central region in children and adolescents is associated with adverse lipids and insulin concentrations. Namely, subscapular and truncal skinfold thickness and waist circumference are related to an increased level of fasting insulin, LDL cholesterol,

total cholesterol and triglycerides levels (Freedman, Serdula, Srinivasan, & Berenson, 1999; Savva et al., 2000). These body composition indices are also associated with systolic and diastolic pressure (Savva et al., 2000; Maffei et al., 2003) and a reduction of the HDL cholesterol concentration in children (Freedman et al., 1999).

Hussey, Bell, Bennett, O'Dwyer, and Gormley (2007) in a sample of 244 children from 7 to 10 years of age investigated the relationship between cardiorespiratory fitness and waist circumference, whereby a statistically significant correlation was found. Ekelund et al. (2001) found that fitness, measured by indirect calimetry, is statistically significantly related to body fat estimated through skinfold thickness in 82 adolescents between 14 and 15 years of age. Tell and Vellar (1988) found that cardiorespiratory fitness measured during submaximal bicycle exercise is correlated to BMI and triceps skinfold thickness in a sample of 413 boys and 372 girls, from 10 to 14 years of age. Liao et al. (2013) studies the associations between health-related physical fitness and obesity in the Taiwanese youth. The results of the research showed that cardiorespiratory fitness, lower body muscular fitness is also an important predictor of childhood and adolescent obesity. Wisniewski, Dalimonte-Merckling and Robbins (2019) studied whether CRF mediates the relationship between PA and OW/OB in adolescent girls. The results of the research showed that CRF is improved by increasing MVPA, and the improvement in CRF results in lower BMI and % BF among adolescent girls.

Although it is not possible to assess the impact of the results of this study on future health complications of obesity in children, the studies conducted with adult respondents suggest that fitmen with elevated central adiposity had almost 2.5 times lower mortality rate than unfit men in the same central adiposity category (Lee, Blair, & Jackson, 1999). Furthermore, fit men with high waist circumference had a rate of all-cause mortality similar to unfit men with low waist circumference both in a European sample (H. M. Lakka, T. A. Lakka, Tuomilehto, & Salonen, 2002) and in a USA sample (Lee et al., 1999). In another study, it was found that odds ratios for metabolic diseases were increased in overweight men and women with high abdominal adiposity compared with men and women with normal abdominal adiposity (Janssen, Katzmarzyk, & Ross, 2002). Finally, men and women who are overweight or obese and have high cardiorespiratory fitness, have a 2.5-times lower relative risk of mortality of all causes, compared to people of the same category of BMI who have low cardiorespiratory fitness (Blair et al., 1989).

The mechanism by which the high cardiorespiratory fitness reduces the risk of obesity is not clear. Cardiorespiratory fitness is inversely related to systolic and diastolic pressure, triglycerides, and total cholesterol concentration; it is also positively related to the HDL cholesterol in children (Tell & Vellar, 1988). In adults, regular exercise is associated with improved muscle metabolism, and reduced metabolic risk as a result (Duncan et al., 2003; Goodpaster, Katsiaras, & Kelley, 2003).

Conclusion

On the basis of the obtained results, one can conclude that children who are overweight or obese and have a high level of cardiorespiratory fitness, have lower body mass index values, lower waist circumference, lower body fat percentage and a higher muscle mass percentage compared to children who are

classified in the same BMI category, but have low values of cardiorespiratory fitness. The beneficial impact of high CRF on body composition remained even after the values of body fatness were corrected for different BMI. The results of this study suggest that the appropriate level of cardiorespiratory fitness can reduce the threats of obesity in the pediatric population. They also highlight the limitation in examining health complications of obesity by studying BMI alone and suggest that

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There are no acknowledgements.

Conflict of Interest

The authors declare that there is no conflict of interest.

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ORIGINAL SCIENTIFIC PAPER

Differences in Specific Power Performance among Playing Positions in Top Level Female Handball

Nikola Foretic¹, Vladimir Pavlinovic¹ and Miodrag Spasic¹

¹University of Split, Faculty of Kinesiology, Split, Croatia

Abstract

Since all activities in handball should be performed as fast and as powerful as possible, power is involved in almost all players' movements. There is an evident lack of studies that monitored this ability during matches. The study aimed to determine the situational differences in power among playing positions in top-level female handball. Variables included: body height, average game time, fastest shot, fastest sprint, and highest jump. Subjects were 227 female handball players that participated in the European handball championship 2020. Analysis of variance with the post-hoc Scheffe test was calculated. Results showed significant differences among playing positions in body height, fastest sprint and highest jump performed in real game situations. The largest differences were noticed in anthropometrics, with significant differences between back- and pivot-players on one side, and wing-players on the other. The fastest sprinting was recorded for wingers (26.5 ± 1.12 km/h), who were significantly faster than other players. Jumping performance was most diverse among playing positions, with back-players being superior in this performance (47.24 ± 17.61 cm, 48.44 ± 20.71 cm, and 50.35 ± 16.76 cm for centre-backs, left-backs, and right-backs, respectively). Evidenced differences are explainable knowing the specific positions' roles and typical game situations which players encounter during the match.

Keywords: *jump, sprint, shoot, back player, wing player, pivot player*

Introduction

Handball is a team sports game with specific morphological, technical, tactical and physical demands (Karcher & Buchheit, 2014). In two teams, 14 players play against each other, exchanging offensive and defensive manoeuvres on a 40x20 m court, with the main goal being to outscore the opponent. From a physical point of view, the game is fast and explosive, brimming with high-intensity movements (Barbero, Granda-Vera, Calleja-González, & Del Coso, 2014). Even the performance of the main technical elements is significantly influenced by power abilities (Hespanhol Junior, Girotto, Alencar, & Lopes, 2012; Póvoas, Seabra et al. 2012).

Power is defined as the ability of an athlete to recruit as many motor units as possible in as short a time as possible (van der Kruk, van der Helm, Veeger, & Schwab, 2018). In various sports, it manifests itself in specific explosive movement patterns (Šimonek, Horička, & Hianik, 2017). The most common

manifestations of power in handball are specific jumps, throws, shots, runs and sprints (Karcher & Buchheit, 2014). Jumps can be performed with one or two legs. Two-legged jumps are typically used to defend in block jump actions, while one-legged jumps are a constitutive part of jump shot executions (Srhoj, Rogulj, Papić, Foretić, & Čavala, 2012). Depending on the game situation and playing position, players also perform long or vertical jumps (Davila, Garcia, Montilla, & Ruiz, 2006). Long jumps are performed on individual fastbreaks and on shots from the wing positions, while vertical jumps dominate on shots from the outside positions (Vila et al., 2012). Although throwing is one of the natural forms of movement in handball, it is specifically performed during shots. Shots can be executed from the ground or after jumping. Shooting speed is one of the most important individual characteristics of players (Sarvestan, Riedel, Gonosová, Linduška, & Přidalová, 2019). Research shows that shots from the ground are signifi-



Correspondence:

N. Foretic
University of Split, Faculty of Kinesiology, Teslina 6, 21000 Split, Croatia
E-mail: nikolaforetic@kifst.eu

cantly faster than shots from the jump (Šibila, Pori, & Bon, 2003; Saavedra, Halldórsson, Kristjánsdóttir, Forgeirsson, & Sveinsson, 2019). Handball players run at different intensities. The "handball sprint" is the fastest of them and is usually noticed when a player runs in an individual fastbreak, where he/she has to run over the defender. Although it is called "sprinting", it is not, because "sprinting" is a synonym for maximum speed, which can only be developed after running sixty meters. The handball court is only 40 metres long and does not allow a player to develop maximum speed. Therefore, the term "handball sprint" refers to the power rather than the speed of the player.

As mentioned earlier, the playing positions in handball have different roles that influence the positional differences in morphology and physical fitness (Karcher & Buchheit, 2014; Wagner, Finkenzeller, Würth, & Von Duvillard, 2014). One of the abilities that is most pronounced at the different positions is power. More specifically, the characteristics of shots and jumps differ especially among backcourt, wing and pivot players (Foretić, Veršić, Uljević, Pavlinović, & Modrić, 2021). Specific playing position morphology may also be an important factor for power actions in handball. For example, a review of the literature suggests that body mass or height can significantly improve a player's shooting speed (Massuça & Fragoso, 2013; Gümüş & Gençoğlu 2020; Foretić et al., 2021).

It is obvious that power is of great importance for successful performance in handball. Therefore, a rational and effective conditioning plan in handball should be based on current data on the specific and situational power load that players endure in real game situations at their playing positions. However, a review of the current literature shows that there is a lack of data on situational power activities during a handball game. Most studies were conducted under controlled conditions and evaluated only basic and very rarely specific power performance in handball, mostly in male players.

Therefore, the main aim of this study was to determine the differences in situational power performance between the six playing positions in top female handball.

Methods

The subjects of this study were 227 female handball players participating in the 2020 European Handball Championship in Denmark. Variables included basic anthropometric data: body height (BH) and body weight (BW), fastest shot (FS), fastest sprint (FSP), highest jump (HJ), average playing time (AM). All data was collected from the official championship website.

Shooting speed, sprint and jump performance were collected with iBall (SELECT, Denmark) and Player Tracking System (Kinexon, Germany). PTS is ultra-wideband local positioning system that assess specific movements in handball (Fleureau, Lacome, Buchheit, Couturier, & Rabita, 2020). The system used consisted of 14 antennas positioned around the handball playing field at three different heights. The tag is placed in the centre of the players' upper back using the manufacturer harness. The data were collected at 20 Hz and processed via the specific Kinexon Software. The signals were transmitted to the antennas using UWB technology in a frequency range of 4.25–7.25 GHz. The field position of the tag is calculated by a proprietary algorithm based on a combination of different methods such as Time Difference of Arrival, Two-Way Ranging and Angle of Arrival (Blauberger, Marzilger, & Lames, 2021). A 12-camera Vicon motion analysis system (Vicon Nexus T40,

Vicon Motion Systems, Oxford Metrics, UK) is implemented in the two configurations. Data were collected at 250 Hz. Only one 14 mm reflective marker (B&L Engineering, Santa Ana, USA) is placed on the Kinexon tag. The data obtained from the three-dimensional marker position are used for further analysis. The loss of the marker signal is never longer than 25 successive images (i.e., 0.1 s) and automatically extrapolated with the Vicon 3D software using the marker position immediately before and after the loss. The average Vicon calibration errors (Image and World Error, respectively) are 0.09 and 0.17 mm for data collected in the centre of the field, and 0.08 and 0.16 mm for those collected on the side of the field. The original datasets from Kinexon were oversampled from 20 to 250 Hz for subsequent fine synchronization with Vicon data. Signals from both systems are filtered using a 3rd order zero phase shifting low pass Butterworth filter with a 10 Hz cut-off. Each pair of Kinexon and Vicon data sets for each movement repetition is manually synchronized to determine a common start and end. The distance travelled is then calculated as the sum of the instantaneous positions in the horizontal plane (x, y). Velocity and acceleration data are obtained by successive derivation and low pass filtering (10 Hz, 3rd order zero phase shifting Butterworth filter). Peaks in speed, acceleration and deceleration are calculated from the raw data and utilised for the analysis. They are respectively computed as the maximum mean speed, acceleration and deceleration over a 500 ms window (Aughey 2011, Buchheit & Simpson, 2017).

All players were divided into 6 playing positions: left wing (LW), right wing (RW), pivot (P), centre back (CB), left wing (LB) and right wing (RB). The ethics committee of the author's institution approved the research experiment.

Statistical analyses included calculation of descriptive statistical parameters (arithmetic means and standard deviations) and analysis of variance with post hoc Scheffe test to determine differences between playing positions in the observed variables. Statistica 13.0 (TIBCO Software Inc, USA) was used for all analyses and a p-level of 95% was applied.

Results

Table 1 shows the results of the descriptive statistics and the differences between playing positions calculated with the Scheffe test.

The analysis of variance showed significant differences between the playing positions in the following variables: BH, FSP, and HJ. No statistically significant difference was found in the variables representing fastest shot (FS) and average minutes spent in the game (AM). The range of playing time was from 23.12±16.62 (LB) to 28.53±13.12 (RW) minutes per game. Although there was no statistical difference in playing time, it can be observed that the line players (pivots and wings) play slightly more than the back players (about 3-5 minutes more). Although no statistical difference was found between playing positions in shooting speed, it is noted that P shoots the slowest and RB is the fastest compared to the other positions. It is also very interesting that RW players shoot faster than LB. The biggest differences were found in body height. Obviously, backcourt and pivot players have this morphological characteristic more pronounced than wing players. The best results in sprinting performance were obtained for wing players, with a significant difference between LW and RW and LB playing position. Faster sprinters were wing players who reached almost the same maximum speed (about 26.5 km/h). The analysis of spe-

Table 1. Descriptive statistics and differences between playing positions (post hoc Scheffe test)

VAR	All (N=227)	CB (N=41)	LB (N=49)	RB (N=37)	P (N=41)	LW (N=32)	RW (N=27)
	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD
BH (cm)	175.86±6.51	174.68±4.48 LB, LW, RW, P	179.92±4.73 CB, LW, RW	178.11±6.25 LW, RW	179.76±4.87 CB, LW, RW	169.81±4.20 CB, LB, RB, P	168.44±4.28 CB, LB, RB, P
FS (km/h)	89.29±23.83	92.29±23.57	88.98±35.57	98.89±7.43	82.15±20.16	83.78±23.61	89.48±10.78
FSP (km/h)	24.53±3.57	24.27±1.57	22.92±5.47 LW, RW	24.49±1.45	23.98±1.56	26.41±5.03 LB	26.52±1.12 LB
HJ (cm)	41.84±19.41	47.24±17.62 P	48.45±20.71 LW, P	50.35±16.76 LW, P	30.12±15.57 CB, LB, RB	33.84±19.50 LB, RB	37.26±15.56
AM (min)	25.88±14.44	23.44±13.32	23.12±16.62	25.40±11.32	28.34±15.54	28.41±14.73	28.53±13.12

Legend: All – all players, CB – centre back, LB – left back, RB – right back, P – pivot, LW – left wing, RW – right wing, BH – body height, BW – body weight, FS – fastest shot, FSP – fastest sprint, HJ – highest jump, AM – average minutes

cific jumping performance shows that the back players jump higher than the line players. For example, the highest jumps were performed by RB (50.35±16.76 cm) and the shortest by P (30.12±15.57 cm). Overall, the line players jump on average 14.64 centimetres lower than the back players.

Discussion

Similar playing times for all playing positions, averaging 25.88 minutes per game, point to the high physical demands of modern women's handball at the highest level. Under these conditions, coaches are forced to divide playing time evenly among players and positions. In this way, injuries and poor performance due to fatigue can be more easily avoided.

Although the main aim of this study is to describe situational power performance in handball, the analysis of basic anthropometric characteristics can give a better insight into the differences between playing positions. The results show that wing players have a below average BH (169.12±4.24 cm), LB, RB and P players have an above average BH, while CB has an average BH (174.68±4.48 cm). Such positional differences have been found in previous studies (Granados, Izquierdo, Ibanez, Bonnabau, & Gorostiaga, 2007; Čižmek, Ohnjec, Vučetić, & Grujić, 2010; Bon, Pori, & Šibila, 2015). Overall, BH is one of the most important selection criteria in handball, especially for back and pivot positions. It is very difficult to play effectively in the backcourt position without having an advantage in BH, as the main task of BP is to shoot over big defenders (Urban & Kandrác, 2013). Moreover, P players are constantly fighting for position through various types of phys-

ical contact with opposing defenders (Michalsik, Aagaard, & Madsen, 2013). In these colliding, pulling, checking and blocking activities, BH and body weight are very beneficial for P performance (Bojić-Čačić 2018). On the other hand, shorter BH of wing players is regularly associated with lower body mass (Burger, Foretić, & Čavala, 2015). Lighter players are faster and more agile and these abilities are most important for winger positions (Karcher & Buchheit, 2014). Therefore, the fastest sprinting was found in wing players in our study. This phenomenon is well described in the literature. For example, Haugen, Breitschädel and Seiler (2019) found that wing players differ from the other positions by superior 10-m and 40-m sprint times (Haugen et al., 2019). In a review study, Karcher and Buchheit (2014) found that wing players complete significantly more sprints than backcourt and pivot players (Karcher & Buchheit, 2014). In addition, Luig et al. (2008) reported that pivot players complete sprints over 5-7 m, backcourt players over 8 m, and wing players over 15-18 m (Luig, Manchado-Lopez et al. 2008). A longer running distance gives wing players a greater advantage in speed development. Together with the advantageous somatotype (shorter-lighter), the role of wing players, who are more involved in fast breaks and counterattacks during the game than the other playing positions, logically explains the difference in "handball sprint performance" (Foretic, Rogulj, N., & Papic 2013). Despite the fact that jumping is a very important element of handball, present in the techniques of defensive and offensive players, it has not been investigated in any study in real game situations in women's handball (Figure 1).

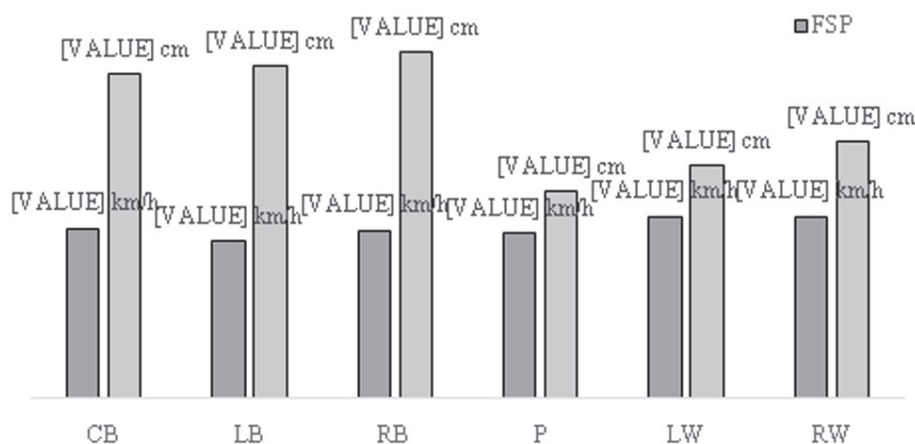


FIGURE 1. Distribution of fastest sprint (FSP) and highest jump (HJ) among playing positions

In our study, jumping shows the greatest diversity between playing positions compared to sprinting and shooting. In general, backcourt players jump 5 to 8 cm higher than P and wing players. Similar results were reported by Foretic et al. (2021), where male handball back players at the highest level jumped 16.76 cm higher than other playing positions (Foretic et al., 2021). On superficial inspection, this could be beneficial as most previous studies characterised wing players as the highest "jumpers" or at least at the same level as back players (Vila et al., 2012; Krüger, Pilat, Ückert, Frech, & Mooren, 2014; Hammami, Gaamouri, Aloui, Shephard, & Chelly, 2019). However, a more thorough analysis of the tasks, roles and technical activities at the back and wing positions could lead to a better understanding of this phenomenon. First, back players are the most involved in defensive and offensive actions of all playing positions and consequently jump the most. Secondly, the main task of back players during attack is to shoot over the defensive centre, where the tallest players are located (Foretic et al., 2013). To overcome these obstacles, they have to jump as high as possible before shooting. In contrast, wing players have to jump as far as possible. This is because they need to have an "open shooting angle" and thus increase the possibility of scoring (Foretic et al., 2013). In summary, backcourt players predominantly shoot with vertical jumps during situational activities, while wing players shoot with a horizontal jump (Póvoas, Seabra et al. 2012; Karcher & Buchheit, 2014). In this study, we only observed and analysed the vertical jump characteristics where backcourt players show dominance during a situational jump performance, while the previously mentioned studies evaluated the overall power performance.

The most interesting finding of this study is the lack of statistically significant differences in shooting speed between playing positions, although BP had a faster shooting speed than the line players (P and wing players). In contrast to our finding, many studies conducted on male and female handball players reported differences in shooting speed between playing positions (Rivilla-Garcia, Grande, Sampedro, & Van Den Tillaar, 2011; Zapartidis, Kororos, Christodoulidis, Skoufas, & Bayios, 2011; Ferragut, Vila, Abalde, & Manchado, 2018; Foretic et al., 2021). Most of these studies reported a positive influence of longitudinal body measurements, such as BH (Gorostiaga, Granados, Ibanez, & Izquierdo, 2005; Sarvestan

et al., 2019). Despite the differences in BH, no differences in shooting speed were found in our study. This may be related to a curious fact that almost certainly affected statistical significance during data analysis: RW players shot faster than LB (RW 89.48 km/h vs LB 88.98 km/h). This is somehow an unexpected result, since in all previous studies BP had the fastest throwing and/or shooting performance (van den Tillaar & Ettema, 2004; Van Den Tillaar & Cabri, 2012; Ferragut et al., 2018). It becomes even more interesting when we see that RW are the shortest (168.44 cm) and BP the tallest (179.92 cm) players in top female handball. Understanding this phenomenon requires a deeper tactical analysis of shooting from the RW position. We can only speculate that RW players were involved in shooting situations that required quicker shots than from other line positions (P and LW). There is a possibility that RW players took shots at empty netters more than other positions, which is a very common result of an unsuccessful 7 vs 6 attack. Shots from these situations allow players to take quicker shots without tactical problem solving. However, as we mentioned earlier, these are only speculations and possible reasons for the observed phenomenon, which should be investigated separately in future studies along with some other influencing variables.

Conclusion

This study is the first study to describe situational power performance and determine the differences between playing positions in situational power performance in women's handball at the highest level. The results show significant differences between playing positions in height, sprinting, and jumping. The greatest differences were observed in jumping performance, where backcourt players jumped significantly higher than line players. The differences observed are related to the roles in the playing positions and the game situations in which the players in each position encounter. A limitation of the study is that only the best performance results in jumping, sprinting and shooting were analysed. Nevertheless, the results of this study may help handball coaches to better identify situational power demands in top female handball. In addition, the reported positional differences and similarities may contribute to more effective explosive power training in women's handball.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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SHORT REPORT

Interdevice Reliability of A-Mode Ultrasound to Measure Body Composition

Megan Bigler¹, Dale R. Wagner² and R. Stephan Lowry³

¹Utah State University, Athletics Department, Logan, UT, USA, ²Utah State University, Kinesiology & Health Science Department, Logan, UT, USA, ³Grantsville High School, Grantsville, UT, USA

Abstract

A-mode ultrasound is a noninvasive, rapid method for measuring subcutaneous fat thickness and estimating body fat percentage (%BF). Validity and reliability of the BodyMetrix BX2000 A-mode ultrasound has been reported; however, this study aimed to compare results from two machines to determine interdevice reliability. Ultrasound measures were repeated with two BX2000 machines at 10 body sites (chest, biceps, triceps, scapula, lower back, hip, waist, thigh, calf, axilla) on 42 males of varying age and leanness (age: 28.6 ± 11.9 y, BMI: 25.4 ± 4.6 kg/m²). The intraclass correlation coefficients ranged from 0.939 to 0.998 with standard errors of measurement from 0.31 to 0.58 mm of fat thickness. The largest mean difference between devices was 0.37 mm at the scapula. The difference between machines in %BF was not significant (0.34%BF; $p=0.09$). The interdevice reliability is similar to the previously reported test-retest reliability with no clinical significance between machines.

Keywords: *subcutaneous adipose tissue, body fat, intermachine variability*

Introduction

Ultrasound as a diagnostic tool to measure subcutaneous fat has recently increased in popularity. This method is fast, cost-effective, portable, and easy to use. A-mode (amplitude modulation) ultrasound provides a graphical

representation of tissue thicknesses in response to reflected sound waves. Each tissue interface elicits a spike in the graph with a large amplitude recorded at the subcutaneous fat-muscle junction. One reads the depth or thickness of the subcutaneous fat layer along the x-axis (Figure 1). For

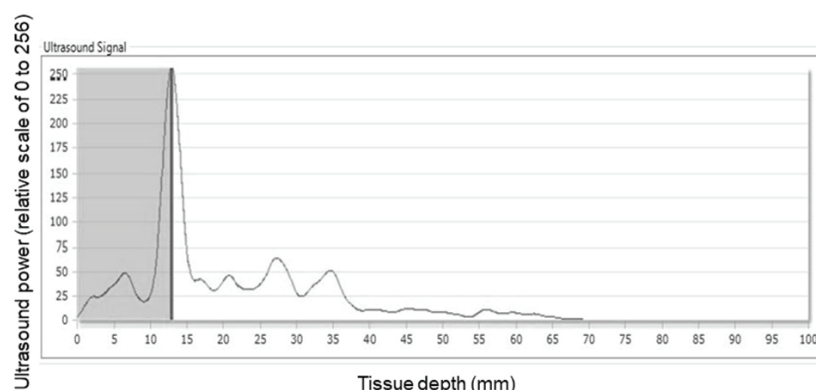


FIGURE 1. Example of A-mode ultrasound with the shaded area indicating the depth of the fat-muscle interface



Correspondence:

D. R. Wagner
Utah State University, Kinesiology & Health Science Department, 7000 Old Main Hill, 84322-7000, Logan, UT, USA
E-mail: dale.wagner@usu.edu

a more complete explanation of this technology, see the review by Wagner (2013).

A commercial A-mode ultrasound device commonly used for body composition assessment is the BodyMetrix BX2000 (IntelaMetrix, Inc., Livermore, CA, USA). Fat thickness measurements obtained from this device were validated against cadaver dissections (Wagner, Thompson, Anderson, & Schwartz, 2019) and high-resolution brightness modulation (B-mode) ultrasound (Wagner, Teramoto, Judd, Gordon, McPherson, & Robison, 2020). In addition to validity, test-retest, day-to-day, and interrater reliability of the BX2000 have also been evaluated (Hendrickson, Davison, Schiller, & Willey, 2019; Loenneke et al., 2014; Miclos-Balica et al., 2021; Smith-Ryan, Fultz, Melvin, Wingfield, & Woessner, 2014; Wagner, Cain, & Clark, 2016; Wagner & Teramoto, 2020). Test-retest reliability for the estimate of body fat percentage (%BF) obtained from the BX2000 was reported to be excellent with a ICCs of 0.979 (Miclos-Balica et al., 2021) to 0.996 (Wagner et al., 2016). Similarly, the day-to-day reliability was nearly as good with ICCs ranging from 0.935 to 0.980 (Loenneke et al., 2014; Smith-Ryan et al., 2014). Additionally, the interrater reliability was excellent (ICC=0.972 to 0.987) for both experienced technicians (Miclos-Balica et al., 2021; Wagner et al., 2016) and novice examiners (ICC=0.969 to 0.990) (Wagner & Teramoto, 2020).

Despite excellent ratings for test-retest, day-to-day, and interrater reliability, the interdevice reliability is unknown. Interdevice or intermachine reliability, although rarely evaluated, serves to further demonstrate that a measurement device is acceptable for intersite and multicenter body composition testing. The purpose of this study was to evaluate the interdevice reliability of A-mode ultrasound by comparing site-specific subcutaneous fat thicknesses and %BF estimates from two BodyMetrix BX2000 machines.

Methods

Participants

This study included 42 male participants, ranging from 18 to 57 years of age and varying in body type (16 elite, 18 athletic, and 8 non-athletic). The BodyView Professional software that accompanies the BodyMetrix BX2000 defines these body types as; elite being those with low body fat and good muscle definition, including “six-pack” abdominal muscles; non-athletic being clearly overweight or obese; and the athletic category includes everyone else. Inclusion of the body type classification aids the software in selecting which A-mode peak corresponds to the fat-muscle interface.

The university's Institutional Review Board approved the study (protocol #9696). Upon arrival on testing day, participants signed a written informed consent before participating.

Procedures

Participants emptied their bladders before testing began. We measured height and weight to the nearest 0.1 cm and 0.1 kg, respectively. Height was measured with a wall-mounted stadiometer (Seca 216, Seca Corp., Ontario, CA), and weight was measured with a digital scale (Seca 869, Seca Corp., Ontario, CA). Participants wore only compression shorts for all measurements. In addition to height

and weight, we entered age and body type, as defined above, into the BodyView Professional software.

Each participant had ten measurement sites (chest, scapula, axilla, triceps, waist, hip, thigh, lower back, biceps, and medial calf) marked with a surgical marker to facilitate accurate placement of the ultrasound transducer head for both devices. Site-point ultrasound measurements were taken with the participant standing, according to the manufacturer's instructions as detailed by Wagner (2013). Participants were measured at all 10 sites with device 1, and then measurements were repeated with device 2. The BodyView Professional software requires multiple measurements at each site to obtain a site-specific fat thickness; thus, 3-5 measurements per site produced an averaged site-specific measurement for each device. The same technician took all measurements with both devices.

Statistical Analyses

Data were analyzed using SPSS version 25.0 (IBM, Inc., Chicago, IL, USA). We calculated means and standard deviations for all variables. The BodyView software uses a proprietary formula to convert the ultrasound fat thicknesses into a %BF estimation using the measurement sites of common skinfold prediction equations. The BodyMetrix conversion of the 7-site Jackson and Pollock (1978) equation was used to estimate %BF. A paired t-test was done to determine if there was a significant difference between the two devices for the estimate of %BF. We assessed interdevice reliability for each of the 10 measurement sites with a single measures intraclass correlation coefficient (ICC) with absolute agreement. Additionally, standard error of measurement (SEM) was calculated [$SEM = SD \times \sqrt{1-ICC}$]. The standard deviation used for SEM calculation was the combined standard deviations of the two ultrasound devices. Subsequently, minimal difference (MD) was calculated as $MD = SEM \times 1.96 \times \sqrt{2}$. The ICC, SEM, and MD are the recommended statistics for quantifying reliability (Weir, 2005).

Results

The sample varied in age (28.6 ± 11.9 y), height (182.4 ± 7.6 cm), weight (84.5 ± 16.9 kg), and body mass index (25.4 ± 4.6 kg/m²). During preliminary screening, one participant was determined to be a statistical outlier (>3 SD) for the chest, hip, and axilla measurements. Consequently, this participant was removed from the site-specific analyses for these three sites and the %BF estimation. See Table 1 for interdevice reliability results. The ICCs were excellent for all 10 sites, ranging from 0.939 to 0.998. Additionally, the SEM were small, ranging from 0.31 mm to 0.58 mm, with MD ranging from 0.86 mm to 1.61 mm. Further, mean differences were <0.4 mm at each site and were smaller than the SEM at each site. The difference in %BF between ultrasound 1 and ultrasound 2 was only $0.34 \pm 1.24\%$ BF and not statistically significant; $t(40) = 1.76$, $p=0.09$.

Discussion

This research represents the first interdevice reliability study of the BodyMetrix BX2000 A-mode ultrasound. The high ICCs and low SEMs at each measurement site indicate excellent agreement between the two machines. Furthermore, the ICCs for interdevice reliability were sim-

Table 1. Interdevice Reliability Results Between Two BodyMetrix BX2000 A-Mode Ultrasound Machines

Measurement site	ICC (95% CI)	SEM (mm)	MD (mm)	Mean difference (mm)
Chest	0.982 (0.927-0.993)	0.40	1.11	0.33
Triceps	0.986 (0.970-0.993)	0.35	0.97	0.20
Biceps	0.939 (0.889-0.966)	0.56	1.55	0.14
Scapula	0.980 (0.936-0.992)	0.47	1.30	0.37
Back	0.998 (0.996-0.999)	0.31	0.86	0.09
Hip	0.991 (0.983-0.995)	0.33	0.91	0.05
Waist	0.998 (0.996-0.999)	0.52	1.44	0.26
Thigh	0.985 (0.971-0.992)	0.35	0.97	0.17
Calf	0.984 (0.970-0.991)	0.34	0.94	0.06
Axilla	0.971 (0.941-0.985)	0.58	1.61	0.30

Legend: ICC - intraclass correlation coefficient; SEM - standard error of measurement; MD - minimal difference

ilar to ICCs reported for intra- and interrater reliability (Hendrickson et al., 2019; Loenneke et al., 2014; Miclos-Balica et al., 2021; Smith-Ryan et al., 2014; Wagner et al., 2016; Wagner & Teramoto, 2020). The mean differences in fat thicknesses between devices at each measurement site were small (<0.4 mm) and less than the SEM, with no statistical or clinically meaningful difference in the estimate of %BF (0.34%). For comparison, Miclos-Balica et al. (2021) recently reported a similar mean difference of 0.50% BF for intertester reliability.

The one statistical outlier in the study happened to be the subject with the largest %BF. In a study of A-mode ultrasound to measure body composition of obese and overweight individuals, Smith-Ryan et al. (2014) reported excellent day-to-day reliability, suggesting that the reliability of the machine was not influenced by high %BF. One limitation of the current study was that only 19% of our sample were in the “non-athlete” BodyMetrix body type classification. More research may be needed on obese individuals to determine if the outlier identified in this study is an aberration or if obese individuals are subject to machine or technician error.

Both devices used were BodyMetrix BX2000 A-mode ultrasound machines. These devices were the same model from the same manufacturer, yet one machine was several years older. Despite the age difference between the devices, the interdevice reliability was excellent, suggesting that results from older devices are still comparable to newer machines.

Acknowledgements

There are no acknowledgements.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Interdevice reliability is an important component in determining the overall usefulness of a measurement tool. High interdevice reliability gives greater confidence for comparing results between labs or testing centers. Other body composition assessment tools have undergone interdevice reliability testing. For example, interdevice reliability of the Bod Pod was carried out by evaluating the reliability of two machines in the same laboratory (Ball, 2005) as well as a multi-site comparison (Collins, Saunders, McCarthy, Williams, & Fuller, 2004). No clinically significant differences in the estimation of %BF were found in these interdevice reliability studies, and these studies helped to further solidify the Bod Pod as a viable assessment method. Similar to the Bod Pod studies, this research yielded strong correlation and agreement between the A-mode ultrasound machines.

It is important to note that there are several A-mode ultrasound machines from various manufacturers commercially available for body composition measurement. This study was limited to the BodyMetrix BX2000 device, which operated at a fixed frequency of 2.5 MHz. Other devices may operate at different frequencies or with different software algorithms. Thus, while our research suggests that the results from various clinics or laboratory settings using the BodyMetrix BX2000 can be compared, we do not recommend comparing the results from different A-mode ultrasound manufacturers. In conclusion, there was no significant difference in the estimate of %BF between the two BodyMetrix BX2000 A-mode ultrasound machines, and the interdevice reliability was high.

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Revised September 2019

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Original Scientific Paper

Elite Soccer Players from Montenegro

Dusko Bjelica¹

¹Univeristy of Montenegro, Faculty for Sport an Physical Education, Niksic, Montenegro

Corresponding author:

Dusko Bjelica

University of Montenegro

Faculty for Sport and Physical Education

Narodne omladine bb, 81400 Niksic, Montenegro

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Word count: 2,946

Abstract word count: 236

Number of Tables: 3

Number of Figures: 0

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Journal article (print):

- Nepocatych, S., Balilionis, G., & O'Neal, E. K. (2017). Analysis of dietary intake and body composition of female athletes over a competitive season. *Montenegrin Journal of Sports Science and Medicine*, 6(2), 57-65. doi: 10.26773/mjssm.2017.09.008
- Duffield, R., & Marino, F. E. (2007). Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. *European Journal of Applied Physiology*, 100(6), 727-735. doi: 10.1007/s00421-007-0468-x
- Krstrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise*, 35(4), 697-705. doi: 10.1249/01.MSS.0000058441.94520.32

Journal article (online; electronic version of print source):

- Williams, R. (2016). Krishna's Neglected Responsibilities: Religious devotion and social critique in eighteenth-century North India [Electronic version]. *Modern Asian Studies*, 50(5), 1403-1440. doi:10.1017/S0026749X14000444

Journal article (online; electronic only):

- Chantavanich, S. (2003, October). Recent research on human trafficking. *Kyoto Review of Southeast Asia*, 4. Retrieved November 15, 2005, from <http://kyotoreview.cseas.kyoto-u.ac.jp/issue/issue3/index.html>

Conference paper:

- Pasadilla, G. O., & Milo, M. (2005, June 27). *Effect of liberalization on banking competition*. Paper presented at the conference on Policies to Strengthen Productivity in the Philippines, Manila, Philippines. Retrieved August 23, 2006, from <http://siteresources.worldbank.org/INTPHILIPPINES/Resources/Pasadilla.pdf>

Encyclopedia entry (print, with author):

- Pittau, J. (1983). Meiji constitution. In *Kodansha encyclopedia of Japan* (Vol. 2, pp. 1-3). Tokyo: Kodansha.

Encyclopedia entry (online, no author):

- Ethnology. (2005, July). In *The Columbia encyclopedia* (6th ed.). New York: Columbia University Press. Retrieved November 21, 2005, from <http://www.bartleby.com/65/et/ethnolog.html>

Thesis and dissertation:

- Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport*. Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:

- Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:

- Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from *Routledge Handbook of Applied Sport Psychology* ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:

- Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

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2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See example:*

- ✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

- ✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. ^{a,b,c}), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^a.

- ✓ ^aOne participant was diagnosed with heat illness and n = 19.^bn = 20.

Probability notes provide the reader with the results of the tests for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

- ✓ *P<0.05, †p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See example:*

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. SM prefers TIFF, EPS and PNG formats.

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Figures and figure legends should be completely intelligible without reference to the text.

The price of printing in color is 50 EUR per page as printed in an issue of SM.

2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written below the figure, in sentence case. *See example:*

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, * $p > 0.01$, † $p > 0.05$.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See example:*

- ✓ Figure 1
- × figure 1
- × Figure 1.
- ✓ ...exhibit greater variance than the year before (Figure 2). Therefore...
- ✓ ...as shown in Figures 1 and 3. (citing more figures at once)
- ✓ ...result has shown (Figures 1-3) that... (citing more figures at once)
- ✓ ...in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See example:*

- ✓ Figure 1a
- ✓ ...in Figures 1a and b we can...
- ✓ ...data represent (Figures 1a-d)...

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

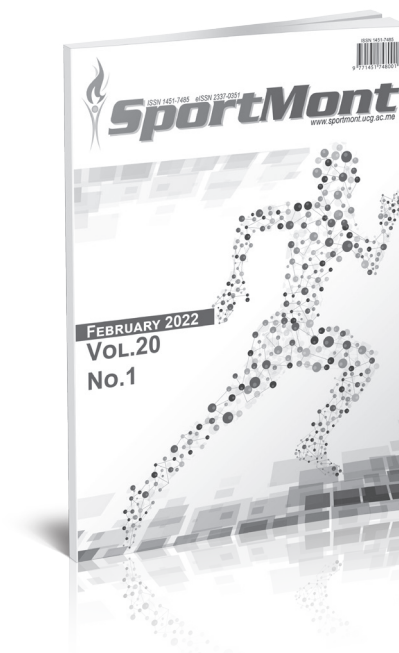
Percentage	Degrees	All other units of measure	Ratios	Decimal numbers
✓ 10%	✓ 10°	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 °	× 10kg	× 12 : 2	× .056
Signs should be placed immediately preceding the relevant number.				
✓ 45±3.4	✓ p<0.01	✓ males >30 years of age		
× 45 ± 3.4	× p < 0.01	× males > 30 years of age		

2.8. Latin Names

Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. See example:

✓ First time appearing: *musculus biceps brachii*

Abbreviated: *m. biceps brachii*



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SM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

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Autumn issue – October 2022
Winter issue – February 2023



MONTENEGRIN SPORTS ACADEMY

Founded in 2003 in Podgorica (Montenegro), the Montenegrin Sports Academy (MSA) is a sports scientific society dedicated to the collection, generation and dissemination of scientific knowledge at the Montenegrin level and beyond.

The Montenegrin Sports Academy (MSA) is the leading association of sports scientists at the Montenegrin level, which maintains extensive co-operation with the corresponding associations from abroad. The purpose of the MSA is the promotion of science and research, with special attention to sports science across Montenegro and beyond. Its topics include motivation, attitudes, values and responses, adaptation, performance and health aspects of people engaged in physical activity and the relation of physical activity and lifestyle to health, prevention and aging. These topics are investigated on an interdisciplinary basis and they bring together scientists from all areas of sports science, such as adapted physical activity, biochemistry, biomechanics, chronic disease and exercise, coaching and performance, doping, education, engineering and technology, environmental physiology, ethics, exercise and health, exercise, lifestyle and fitness, gender in sports, growth and development, human performance and aging, management and sports law, molecular biology and genetics, motor control and learning, muscle mechanics and neuromuscular control, muscle metabolism and hemodynamics, nutrition and exercise, overtraining, physiology, physiotherapy, rehabilitation, sports history, sports medicine, sports pedagogy, sports philosophy, sports psychology, sports sociology, training and testing.

The MSA is a non-profit organization. It supports Montenegrin institutions, such as the Ministry of Education and Sports, the Ministry of Science and the Montenegrin

Olympic Committee, by offering scientific advice and assistance for carrying out coordinated national and European research projects defined by these bodies. In addition, the MSA serves as the most important Montenegrin and regional network of sports scientists from all relevant sub-disciplines.

Over the years the Montenegrin Sports Academy (MSA) has established a productive pool of vital partnerships within the sports science related industry. Apart from two-way visibility, these partnerships provide mutual exchange of scientific research and competence.

Most of the MSA activities and services it provides would not be possible without the continuous support of its partners.

The Montenegrin Sports Academy very much appreciates the support of:

- Ministry of Science of Montenegro
- Ministry of Education of Montenegro
- Ministry of Health of Montenegro
- University of Montenegro
- Montenegrin Olympic Committee
- Institute of Public Health of Montenegro
- European College of Sports Science
- Volleyball Federation of Montenegro
- Faculty for Sport and Physical Education a University of Montenegro
- Athletic Federation of Montenegro
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- Karate Federation of Montenegro
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- Water Polo and Swimming Association of Montenegro

The main scientific event organized by the Montenegrin Sports Academy (MSA) is the annual conference held in the first week of April.

Annual conferences have been organized since the inauguration of the MSA in 2003. Today the MSA conference ranks among the leading sports scientific congresses in the Western Balkans. The conference comprises a range of invited lecturers, oral and poster presentations from multi- and mono-disciplinary areas, as well as various types of workshops. The MSA conference is attended by national, regional and international sports scientists with academic careers. The MSA conference now welcomes up to 200 participants from all over the world.



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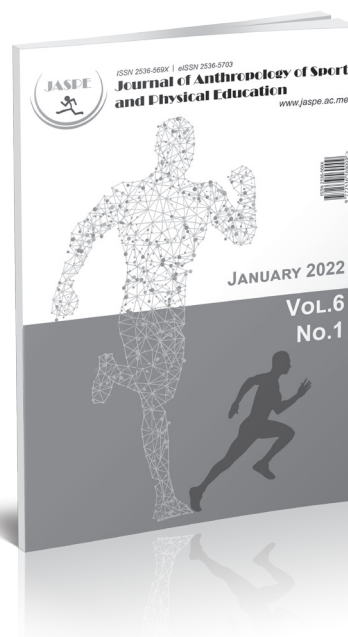
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Publication date:
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Autumn issue – October 2022
Winter issue – January 2023

EAPA-BCH

SCIENTIFIC PROJECT

Efekti autofagije i fizičke aktivnosti na tjelesnu kompoziciju, indeks tjelesne mase, stres, zdravstveno ponašanje, kognitivne sposobnosti i društvenu uključenost starijih osoba

(Projekat finansiran od strane Ministarstva nauke, direktorijata za mlade, a koji sprovodi Fakultet za sport i fizičko vaspitanje Univerziteta Crne Gore)

Glavni cilj projekta je da se primjenom naprednih praksi utvrde efekti autofagije i fizičke aktivnosti na tjelesnu kompoziciju, indeks tjelesne mase, trenutni nivo doživljaja stresa, zdravstveno ponašanje, kognitivne sposobnosti i nivo društvene uključenosti starijih osoba.

Projekat ima i svoj radni dio koji podrazumijeva organizovanje besplatnog vježbanja starijim osobama 3 puta nedeljno u trajanju od 6 mjeseci.

Učesnici mogu biti sve osobe iznad 50 godina a prijave se primaju na mail adresu fakultetzasportnk@ucg.ac.me i telefon fakulteta +38240235207. Svi su koji žele da uzmu aktivno učešće u ovom projektu koji njima može unaprijediti život, a naučnoj zajednici Crne Gore može donijeti značajna teorijska znanja koja će se u budućnosti koristiti u praktične svrhe su dobrodošli.

Svim učesnicim će na početku biti ponuđena najsavremenija dijagnostika, koja će im pružiti uvid u vlastito zdravstveno stanje, kako fizičko tako i kada su neki psihološki parametri u pitanju. Nakon toga će učesnici biti prema sopstvenim interesovanjima podijeljeni u grupe koje će raditi prema različitim programima.

1. Prva grupa će vježbati 3 puta nedeljno 6 mjeseci u prostorijama Fakulteta za sport i fizičko vaspitanje.

2. Druga će samo primjenjivati izmijenjeni način ishrane i voditi tačnu evidenciju o stepenu poštovanja zadatka koji im se postave. Ishrana će biti takva da se napravi pauza u unošenju hrane u trajanju 16 sati između poslednjeg dnevnog obroka i prvoga obroka u sledećem danu, a sve u cilju pokretanja procesa Autofagije koji ima blagotvorno dejstvo na organizma.

3. Treća grupa će kombinovati vježbanje i izmijenjenu ishranu, tj. biće kombinacija prethodno pomenutih zadataka.

4. Četvrta grupa će biti kontrolna. Njeni članovi će proći dijagnostiku i pomoći da se utvrdi kakve su prirodne promjene u organizmu za pomenuti šestomjesečni period, odnosno da li ih ima.

Svim prijavljenim osobama, koje imaju interesovanje za to, će prije početka rada biti održana dva predavanja o pomenutom izmijenjenom načinu ishrane koji danas postaje sve popularniji u svijetu pa ga primjenjuju i vrhunski sportisti poput Novaka Đokovića.

Još jednom treba napomenuti da će svaka od 4 grupe na poklon dobiti najsavremeniju dijagnostiku kompletnog psihofizičkog stanja koja je inače i nedostupna i skupa.

Prijavljivanje može da počne odmah, broj učesnika za grupe koje bi vježbale u prostorijama fakulteta je ograničen.



Fakultet za sport i fizičko vaspitanje Univerziteta Crne Gore

Narodne omladine bb, Niksic, 81400, Montenegro

Mobile: +38267257393; Phone: +38240235207; Fax: +38240235207



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