DOI 10.2478/afepuc-2021-0011
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 122-132

RETURN TO EXERCISE AFTER COVID-19: WHICH ONE IS THE BEST STRATEGY?

Murat Erdoğan[1], Sevgi Sökülmez-Yildirim[2], Nasuh Evrim Acar[3], Okan Kamiş[4]*

[1]Başkent University-Faculty of Health Sciences Department of Exercise and Sport Science, Turkey;

[2]Infectious Diseases and Clinical Microbiology, Gülhane Training and Research Hospital, Ankara, Turkey;

[3]Faculty of Sport Sciences, Mersin University, Mersin, Turkey;

[4]Department of Sports and Health, Aksaray University, Aksaray, Turkey

Summary: Coronavirus (Covid-19), which began in China as of 2019 and spread to almost all over the world in a short time; has shown that we need to plan our life with new strategies as well as changing our current lifestyle today. While we must implement new ways to prevent against Covid-19 and maintaining our healthy lives, we must also design new strategies for returning to sports and physical activities. Therefore, the purpose of this study was to reveal the return strategies for professional and recreational athletes during the quarantine periods in light of evidences. In this regard, firstly we examined the existing literature regarding return strategies to sports. As a result, individual performance and personal hygiene conditions should be considered, and athletic performance should be preserved while keeping a physical distance from teammates and others. The use of masks in sports should be encouraged, but new techniques should be developed by investigating the effect on performance. Consequently, for healthy individuals, low to moderate intensity (not high-intensity) exercise may be beneficial and recommend. However, due to the risk of spreading (person-to-person or contaminated surfaces), exercise is recommended in special places with good ventilation and the use of personal types of equipment.

Key Words: Covid19, Coronavirus, Exercise, Sports, Performance

Introduction

COVID-19, which was caused by a coronavirus that originated regionally in China but quickly expanded over the world, was declared a pandemic by the World Health Organization on March 11, 2020 (World Health Organization 2020). Covid-19 is caused by a virus from the corona viridae family, which belongs to the same subfamily as SARS-CoV-2, which first appeared in China in November 2002. SARS-CoV-2 is a positive-polarity enveloped RNA

virus. The virus's sickness was initially recognized as non-fatal pneumonia, but by the time the study was completed (on July 20, 2020), the disease had been detected in 14.507.491 instances worldwide and had already killed 606.173 people (Wikipedia 2020).

Common symptoms of COVID-19 disease are fever (88 %), continuous dry cough (68 %), fatigue (38 %), phlegm (33 %), difficulty breathing (19 %), sore throat (14 %), headache (14 %) and muscle and joint pains (15 %) (Buruk and Özlü 2020). The disease's progression evolved with time, and it became fatal especially in the elderly and those with chronic illnesses (heart diseases, diabetes, hypertension, respiratory disorders, cancer, etc.) (American College of Sports Medicine 2020; Graziano, Giovanni & Silvio 2020).

Covid-19 is commonly spread through respiratory droplets. Furthermore, non-sick people come into contact with contaminated respiratory droplets on objects left by sick persons coughing, sneezing, or touching, and these non-sick people develop mycosis of the mouth, nose, or eyes. This intense transmission method has a detrimental impact on life and makes physical exercise a tough way of life (American College of Sports Medicine 2020). Personal isolation is the best technique of disease prevention, but exercising is required to make this lifestyle more meaningful and to maintain a certain level of physical activity (PA) and a satisfactory level of health (Lavie et.al. 2019; Fletcher et. al. 2018). In light of scientific findings, this review investigated into the return strategies of both professional and recreational athletes to exercise during and after the quarantine period.

Methods

Exercises and immune system interaction

All living organisms are born with a defense system that protects them against external tissues, cells, and chemicals. In humans, this system, known as the immune system, responds to exercise in a variety of ways. The severity and duration of the immune system's reactions to exercises are linked to a person's health. Exercises also have both acute and long-term effects on the human body and mind. According to several studies, exercising on a regular basis has a good impact on people's immune systems (Barrett et. al. 2012; Niemann and Wentz 2019) while some other studies report that a single bout of exercise (acute exercise) can also produce positive effects upon the immune system (Dimitrov, Hulteng & Hong 2018). During and immediately after exercise, the number of total white blood cells (leukocytes) in circulation generally increases. These leukocytes are related to the intensity and duration of activity, and peak near the end of short-term, high-intensity workouts (McCarthy and Dale 1998).

The increase in the number of leucocytes may be higher during exercises done in hot settings. In the post-exercise period, the number of lymphocytes and monocytes in circulation is observed to characteristically be lower than the number of lymphocytes and monocytes in rest (Gabriel et.al. 1992; Moyna et.al. 1996; Nieman, Nehlsen-Cannarella & Donohue 1991). This causes an increase in the number of neutrophils in circulation to continue for a while after exercise (Fry et. al. 1992).

After acute exercises, the effect of natural killer (NK) cells –a kind of lymphocytes measured in this manner- upon cell function is quite steady. An increase in NK cell function due to intensity is commonly reported during or just after exercises. As a result of running with moderate intensity for 45 minutes (50 % VO2max) (Nieman et.al. 1993a); NK cell function may go up by 50 % whereas NK cell function may be elevated by 100 % in exercises like running and cycling done with high intensity (70 – 80 % VO2max) (Pedersen, Tvede, &Klarlund 1990; Shek et. al. 1995).

Within one hour -at the latest- after exercises, NK cells decrease below the level of the pre-exercise period. If the length of high-intensity exercises is longer, NK cells main defense system of the body are suppressed (Tvede 1989); which makes the body vulnerable to infections in the post-exercise period. This period in which the immune system weakens is known as the "open window" theory that enables infections to enter organisms (Nieman et.al. 1993a; Nieman 1994).

American College of Sports Medicine (ACSM) reports that physically active groups contract infectious diseases more as compared to sedentary groups (Keast et.al. 1995; Nieman et al. 1993b; Nieman et al. 2006), assessed upper respiratory disorders in 155 marathon runners who run 160 km and 24 % of the athletes suffered from upper respiratory disorders. Peters & Bateman (1983) found that the incidence of upper respiratory disorders in 141 south African marathon runners was twofold higher than the control group after a race of 56 km (33.3 % vs. 15.3 %).

Australian Exercise and Sports Science Association advises about the fact that the immune system is supported with exercises and encourages not only the young but also the elderly to do exercises and to move more. According to a study conducted at Birmingham University and King's College London in 2018, it was identified that 125 amateur cyclists who did not smoke and were aged between 55 and 79 still had immune systems similar to the young. Australian Exercise and Sports Science Association CEO Anita Hobson-Powell made a statement about the potential effects of COVID-19 and indicated that studies are emphasizing

that exercises can support our immune system and exercises should be done because they support our mental health (Exercise and Sports Science Australia 2020).

Immune system response in exercises is directly correlated with severity and length of training. High-intensity exercises elevate upper respiratory infection risks whereas moderate-intensity exercises reduce upper respiratory infection risk (Şenışık 2015).

Return strategies to exercise

Maintaining or returning to physical activity during or after infectious disorders is one of the issues exercise physiologists often asked. If the symptoms of an upper respiratory infection are restricted to coughing, sneezing, and a sore throat, the person should jog for 10 minutes. If a person's general health and symptoms worsen, they are advised to refrain from physical activity until they have fully recovered. If an individual's condition does not change after a 10-minute run, he or she is allowed to engage in low to moderate physical activities with a VO2max of less than 80 %. If the symptoms are severe, such as myalgia, fever, or gastrointestinal complaints, physical activity should be discouraged until the patient is fully recovered (Eichner 1993; Harris 2011).

The current treatment appears to be to stop exercising until the athlete heals. At this time, the most serious risk of contracting COVID-19 is being exposed to the virus. We need to come up with new strategies to exercise while maintaining physical distance and maintaining proper hygiene. For example, we can keep a certain distance from friends while running, shoot and pass the ball from a distance in football, or keep a social distance while cycling. Even if exercise does not prevent us from becoming infected, staying active can reduce the harmful effects of viruses, heal symptoms, shorten recovery times, and strengthen our immune system, reducing the possibility of infection.

Recreational athletes

If social distance is maintained, moderate-intensity aerobic exercises (such as brisk walking) can be appropriate alternatives for those who participate in outdoor sports for health reasons. However, high-intensity exercises performed in public indoor facilities and crowded areas can cause more harm than good. Even if necessary hygiene precautions are taken, the presence of an excessive number of athletes in these locations at the same time should be avoided in order to maintain social distance.

An exercise program consisting of easy workouts at home might also be recommended as an option to prevent the coronavirus in the air and maintain fitness levels. This program can include aerobics (at-home walking), resistance exercise, stretching, flexibility, and balance exercises, or a mix of this type of exercises (Chen et.al. 2020). However, when conducted at a moderate intensity during the quarantine period, these activities are said to be suitable (40 – 60 % heart rate reserve or 65 – 75 % of max heart rate) (Jiménez-Pavón et.al. 2020).

Exercises that will terminate a lack of physical activity should start with low-intensity activities. Especially, first training should consist of exercises done in a short distance and in a short time. Individuals should avoid high-intensity activities during the early stages of training. The heartbeat can be used to determine the intensity of a workout for persons who are exercising. If your heart rate is too high, you should lessen the intensity of your workout. Furthermore, taking a day off can be useful in some situations (Erdoğan 2019). Moreover, people should pay attention to feedbacks to be delivered by their bodies and give enough rest pauses between exercises. A sufficient level of sleep is critically important. Each day after each exercise unit, a sufficient level of rest is essential and positive thinking should be a principle (Wingenfeld 2020).

In this subject, ACSM recommends that as long as one stays in the open air and keeps a social distance of 2 meters (with the assent of the authorities); walking or running activities, being physically active in parks, cycling, and gardening such as grassing should be done. Besides; people should abstain from sitting in front of the TV at home and instead; they should perform physical activities by downloading exercise applications to smartphones such as doing yoga, squatting or sitting exercises with a strong chair, lunge exercises with stairs or push up exercises against a wall (American College of Sports Medicine 2020).

Performance athletes

In addition to those doing sports for health, the situation of this group doing sports professionally is more serious because professional athletes do as much as they can to preserve physical performance. Professional athletes may believe that their performances have decreased during the sickness days, but with coaches pressuring them to return to training as quickly as possible, players return to exercises and training before fully recovering. It is the athletes' obligation to understand that the virus has entirely lost its efficacy and to feel well.

Athletes should be conscious of their current recovery status, and while coaches may encourage them, they should not be rushed. If athletes still experience a fever and cough from occasionally, they cannot be considered to be free of Covid-19 symptoms. Once these

symptoms occur, you will be unable to continue training and activities. In order to return to sports, athletes must have confidence in themselves. They should postpone off training and exercise for a while if they are unsure about themselves. At this level, a negative Covid-19 test is necessary. You must be assured that your disease has completely passed. It takes longer for an athlete to return to his prior level of performance the longer he is sick.

Getting a satisfactory rest and sleep between training is crucial. Each day after training, the rest should be taken. Athlete's age, gender and training experience plays a key role in returning to trainings (Wingenfeld 2020). Blocken et al. (2020), argued that to protect the athletes coming behind, the distance should be 4-5 meters for walking, 10 meters for running and 20 meters for cycling since the virus hangs in the air.

Since physical contact is inevitable in sportive branches, infection risk is higher and therefore it is plausible to delay or cancel sportive tournaments and competitions. Yet, when it is impossible to delay or to cancel sportive tournaments for good reasons, matches should be organized without spectators by following protective and hygienic measures in maximum. Therefore; accepted as the world's biggest sports organization, the Tokyo 2020 Olympic and Paralympic Games that will be held in summer 2020 with the participation of 15 000 athletes and 20 million visitors from all over the world have been postponed until 2021 (Gallego et.al. 2020). Professional athletes need to perform high-intensity exercises to maintain their performances. Considering that high-intensity exercises suppress the immune system, professional athletes are advised to go on high-intensity exercises on the condition that they strictly follow isolation regulations (by cutting contacts with others completely) (Aktuğ et.al. 2020).

Infected athletes

There are two different groups in guiding and counselling quarantined and infected athletes' or recreative athletes' activities. The first group is those athletes who have a positive test result with no symptoms whereas the second group is those athletes who have a positive test result and demonstrate positive symptoms. The latter group of athletes should directly receive medical assistance, discontinue exercises and act according to physicians' recommendations. Those in the first group with, no symptoms despite positive test result, can go on moderate-intensity activities but firmly follow quarantine regulations so that virus does not infect other athletes or people. If they later on the present with fever, coughing or short of breath; physical activity should be quitted and a medical care provider or a physician should be contacted (American College of Sports Medicine 2020).

Discussion and conclusion

The main purpose of this brief review was to to reveal the return strategies for both professional and recreational athletes during the quarantine periods in light of evidences. Diseases with high infection rate such as Covid-19 affect all athletes. In particular, necessary measures should be taken to prevent disease spread during organizations like sportive tournaments, competitions and training in which athletes come together. It should be kept in mind that elite athletes are in high-risk groups. Since elite athletes as a part of their lifestyles are popular and get in touch with many people; they should be more careful about personal hygiene. In this respect, disease prevention becomes more important for elite athletes (Mark & Harris 2014). Nowadays, with the Covid-19 pandemic, physical performance should be kept under control at an individual level by following protective measures and keeping social/ physical distance from teammates and other people. Masks should also be a part of sports activities for some time as in every activity. Those athletes testing positive but showing no symptoms should stay away from doing high-intensity exercises and go on low to moderate intensity exercises by taking necessary measures. When symptoms develop, training should be quitted, and medical control should be sought.

After inactivity periods, athletes susceptible to physical injuries (Caterisano et.al. 2019; NCAA's Interassociation Recommendations 2019). Due to the safety-in-place restrictions during the COVID-19, nearly all training by athletes has been limited or interrupted. For this reason, there are some outcomes for coaches and athletes after returning to training. One of the most important outcomes are that increased risks of injury and overtraining as well as adverse weight gain, weight loss and changes to body composition (National Strength and Conditioning Association 2020).

In those athletes who were infected but recovered, it should be confirmed by a medical physician that they have recovered from the disease before they return to exercises and training. After the result of physical examination done by a physician is acceptable; each athlete should receive a detailed test protocol and this test protocol should include aerobic tests, strength and speed tests, neuro-muscular tests, and flexibility tests. In conclusion, low- to moderate-intensity exercise can be beneficial to healthy persons and is thus suggested. However, due to the significant danger of contamination, it is recommended that workouts be performed in private settings (for example, at home) with good air conditioning and personal equipment (from a person or contaminated places to person). If an athlete shows Covid19 symptoms, they should

follow national guidelines, consult a sports medicine doctor, abide to quarantine restrictions, and follow testing and tracking protocols (Elliot et.al. 2020).

Conflict of Interest

The authors declare no conflict of interest and do not have any financial disclosures.

Limitations

The case and death numbers that mentioned in this study can be change during the Covid-19 as of publishing date.

References

1. AKTUĞ, Z.B., R. İRİ & N. A. DEMİR, 2020. COVID-19 Immune System and Exercise. *International Journal of Human Sciences.* **17**(2), pp.513-520. https://doi.org/10.14687/jhs.v17i2.6005
2. AMERICAN COLLEGE OF SPORTS MEDICINE, 2020. Staying Physically Active During the Coronavirus Pandemic. [document on the internet]; Available from: https://www.acsm.org/read-research/newsroom/news-releases/news-detail/2020/03/16/staying-physically-active-during-covid-19-pandemic, https://doi.org/10.1016/j.bbi.2020.04.041
3. BARRETT, B., M. S. HAYNEY, D. MULLER, D. RAKEL, A. WARD & C. N. OBASI, 2012. Meditation or exercise for preventing acute respiratory infection: a randomized controlled trial. *Ann Fam Med*. 10:337–346, https://doi.org/10.1186/1472-6882-12-s1-p92
4. BLOCKEN, B., F. MALIZIA, T. VAN DRUENEN & T. MARCHAL, 2020. Social Distancing v2.0: During Walking, Running and Cycling.[document on the internet]. Available from:https://media.real.gr/filesystem/Multimedia/pdf/Social_Distancing_v20_White_Paper_id38170.pdf
5. BURUK, K. & T. ÖZLÜ, 2020. New Coronavirus SARS-COV-2. *Mukosa.* **3** (1), 1-4.
6. CATERISANO, A., D. DECKER, B. SNYDER, M. FEIGENBAUM, R. GLASS, P. HOUSE, C. SHARP, M. WALLER & Z. WITHERSPOON, 2019. CSCCa and NSCA Joint Consensus Guidelines for Transition Periods. *Strength and Conditioning Journal*. **41**(3), 1-23.

7. CHEN, P., L. MAO, G. P. NASSIS, P. HARMER, BE. AINSWORTH & F. LI, 2020. Wuhan coronavirus (2019-nCoV): The need to maintain regular physical activity while taking precautions. *J Sport Health Sci.* **9** (2):103-4. https://doi.org/10.1016/j.jshs.2020.02.001
8. DIMITROV, S., E. HULTENG & S. HONG, 2017. Inflammation and exercise: inhibition of monocytic intracellular TNF production by acute exercise via β2-adrenergic activation. *Brain Behav Immun.* **61**:60–68, https://doi.org/10.1016/j.bbi.2016.12.017
9. EICHNER, E. R., 1993. Infection, Immunity, and Exercise. *Phys Sportsmed.* **21**(1):125-35.
10. ELLIOTT, N., R. MARTIN, N. HERON, J. ELLIOTT, D. GRIMSTEAD & A. BISWAS, 2020. Infographic. Graduated return to play guidance following COVID-19 infection. *British Journal of Sports Medicine*. ***54***(19), 1174-1175.
11. ERDOĞAN, M., 2019. *40 Yaş Üzeri Egzersiz Rehberi.* Nobel Bookstore.
12. EXERCISE AND SPORTS SCIENCE AUSTRALIA (ESSA), 2020. COVID- 19 Response: Why exercise is more important than ever. Available from: https://www.essa.org.au/Public/News_Room/Media_Releases1/2020/COVID19_Response_Why_exercise_is_more_important_than_ever.aspx, https://doi.org/10.7748/ns.35.4.40.s19
13. FLETCHER G. F., C. LANDOLFO, J. NIEBAUER, C. OZEMEK, R. ARENA & C. J. LAVIE, 2018. Promoting physical activity and exercise: JACC health promotion series. *J am Coll Cardiol*. **72**(14):1622–1639, https://doi.org/10.1016/j.jacc.2018.08.2141
14. FRY, R., A. MORTON, G. CRAWFORD & D. KEAST, 1992. Cell numbers and in vitro responses of leukocytes and lymphocyte subpopulations following maximal exercise and interval training sessions of different intensities. *Eur. J. Appl. Physiol. Occup. Physiol*. **64**:218–227, https://doi.org/10.1007/bf00626284
15. GABRIEL, H., L. SCHWARZ, P. BORN & W. KINDERMANN, 1992. Differential mobilization of leukocyte and lymphocyte subpopulations into the circulation during endurance exercise. *Eur. J. Appl. Physiol. Occup. Physiol.* **65**:529–534.
16. GALLEGO, V., H. NISHIURA, R. SAH, & A. J. RODRIGUEZ-MORALES, 2020. The COVID-19 outbreak and implications for the Tokyo 2020 Summer Olympic Games. *Travel Med Infect Dis.* 101604, https://doi.org/10.1016/j.tmaid.2020.101604
17. GRAZIANO, O., R. GIOVANNI & B. SILVIO, 2020. Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy. *JAMA.* **323** (18), 1775-6, https://doi.org/10.1001/jama.2020.4683
18. HARRIS, M. D., 2011. Infectious disease in athletes. *Curr Sports Med Rep.* **10**(2):84-9.

19. JIMÉNEZ-PAVÓN, D., A. CARBONELL-BAEZA & C. J. LAVIE, 2020. Physical exercise as therapy to fight against the mental and physical consequences of COVID-19 quarantine: Special focus in older people. *Prog Cardiovasc Dis.*[Epub ahead of print], https://doi.org/10.1016/j.pcad.2020.03.009
20. KEAST, D., D. ARSTEIN, W. HARPER, R. FRY & A. MORTON, 1995. Depression of plasma glutamine concentration after exercise stress and its possible influence on the immune system. *Med. J. Aust.* 162:15–18, https://doi.org/10.5694/j.1326-5377.1995.tb138403.x
21. LAVIE, C. J., C. OZEMEK, S. CARBONE, P. T. KATZMARZYK & S. N. BLAIR, 2019. Sedentary behavior, exercise, and cardiovascular health. *Circ Res.* **124**(5):799–815, https://doi.org/10.1161/circresaha.118.312669
22. MARK, D. & M. D. HARRIS, 2011. Infectious Disease in Athletes Current Sports Medicine Reports. *The American College of Sports Medicine*. **10**(2). https://doi.org/10.1249/jsr.0b013e3182142381
23. MCCARTHY, D. & M. DALE, 1988. The leucocytosis of exercise. *Sports Med.* **6**:333–363.
24. MOYNA, N. M., G. R. ACKER, K. M. WEBER, J. R. FULTON, F. L. GOSS, R. J. ROBERTSON & B. S. RABIN, 1996. The effects of incremental submaximal exercise on circulating leukocytes in physically active and sedentary males and females. *Eur. J. Appl. Physiol. Occup. Physiol*. **74**:211–218, https://doi.org/10.1007/bf00377443
25. NATIONAL STRENGTH AND CONDITIONING ASSOCIATION, 2020 COVID-19 Return to Training Task Force. COVID-19, [document on the internet]; *NSCA Guidance on Safe Return to Training for Athletes*.
26. NCAA'S INTERASSOCIATION RECOMMENDATIONS, 2019. Preventing Catastrophic Injury and Death in Collegiate Athletics; Accessed April 13, 2020. Available at: https://ncaaorg.s3.amazonaws.com/ssi/injury_prev/SSI_PreventingCatastrophicInjuryBooklet.pdf
27. NIEMAN, D. C., S. L. NEHLSEN-CANNARELLA & K, M. DONOHUE, 1991. The effects of acute moderate exercise on leukocyte and lymphocyte subpopulations. *Med. Sci. Sports Exerc.* **23**:578–585, https://doi.org/10.1249/00005768-199105000-00010
28. NIEMAN, D. C., A. R. MILLER, D. A. HENSON, B. J. WARREN, G. GUSEWITCH & R. L. JOHNSON, 1993a. Effects of high- versus moderate- intensity exercise on natural

killer cell activity. *Med Sci Sports Exerc.* **25**:1126-34, https://doi.org/10.1249/00005768-199310000-00008

29. NIEMAN, D. C., D. A. HENSON, G. GUSEWITCH, B. J. WARREN, R. C. DOTSON, D. E. BUTTERWORTH & S. L. NEHLSEN-CANNERELLA, 1993b. Physical activity and immune function in elderly women. *Med. Sci. Sports Exerc.* **25**:823–831.
30. NIEMAN, D. C., 1994. Exercise, infection, and immunity. *Int J Sports Med.* **15**(3):131-41.
31. NIEMAN, D. C., D. A. HENSON, C. L. DUMKE & R. H. LIND, 2006. Relationship between salivary IgA secretion and upper respiratory tract infection following a 160-km race. *Journal of Sports Medicine and Physical Fitness.* **46** (1), 158-62.
32. NIEMAN, D. C. & L. M. WENTZ, 2019. The compelling link between physical activity and the body's defense system. *J Sport Health Sci.* **8**:201–217, https://doi.org/10.1016/j.jshs.2018.09.009
33. PEDERSEN, B.K., N. TVEDE & K. KLARLUND, 1990. Indomethacin in vitro and in vivo abolishes post-exercise suppression of natural killer cell activity in peripheral blood. *Int. J. Sports Med.* **11**:127–131, https://doi.org/10.1055/s-2007-1024776
34. PETERS, M. & E. D. BATEMAN, 1983. Ultramarathon running and upper respiratory tract infections an epidemiological survey. *SA Medical Journal.***64** (1).
35. ŞENIŞIK, S. Ç., 2015. Exercise and immune system. *Turk J Sports Med.* **50**, 11-20.
36. SHEK, P. N., B. H. SABISTON, A. BUGUET & M. W. RADOMSKI, 1995. Strenuous exercise and immunological changes: a multiple-time-point analysis of leukocyte subsets, CD4/CD8 ratio, immunoglobulin production and NK cell response. *Int. J. Sports Med.* 16:466–474, https://doi.org/10.1055/s-2007-973039
37. TVEDE, N., C. HEILMANN, J. HALKJAER-KRISTENSEN & B. K. PEDERSEN, 1989. Mechanisms of B-lymphocyte suppression induced by acute physical exercise. *J Clin Lab Immunol.* **30**:169-73.
38. WIKIPEDIA, 2020. COVID-19. Available from https://en.wikipedia.org/wiki/COVID 19_pandemic
39. WINGENFELD, S., 2020. Running after a cold? This Training plan will help you get back to running. Available from: https://www.runtastic.com/blog/en/running-after-a-cold/ 12.02.2020.
40. WORLD HEALTH ORGANISATION, 2020. Coronavirus disease (COVID-19)[document on the internet]. Available from: https://www.who.int/health-topics/coronavirus#tab=tab_

sciendo

DOI 10.2478/afepuc-2021-0012
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 133-146

THE ROLE OF RECREATIONAL SPORTS ACTIVITIES IN REDUCING SOME PSYCHOLOGICAL PROBLEMS CAUSED BY COVID-19 PANDEMIC

Benyoucef Dahou[1], Moussaoui Ala-Eddine[2], *Bnsabeur Mohamed[3]*

[1]University of Abdelhamid Ibn Badis, Mostaganem, Laboratory of the sciences applied to human movement, Algeria
[2]University of Larbi Ben M'hidi ,Oum El Bouaghi, Laboratory of biological and psychological responses in physical and sports activity, Algeria
[3]University of Abdelhamid Ibn Badis , Mostaganem, Laboratory evaluating physical and sports activities programs, Algeria

Summary: This study is aimed at knowing the role of recreational sports activities in decreasing some psychological problems caused by the COVID-19 pandemic among adolescents, and done on a sample of 400 adolescents chosen from the final year of the Intermediate education stage (Hamam bouhjar Middle school - Ain Temouchent state, Sig middle school – Mascara state), the questionnaire was applied as a tool for the study and it consisted of three axes: the axis of aggressive behavior, isolation, and self-confidence, and each axis consists of a group of questions. We used Frequencies, Percentage, and Chi-square goodness of fit test to analyze and interpret the results. In the end, we concluded that recreational sports activities have a role in alleviating some psychological problems resulting from the COVID-19 pandemic in adolescents, and this is based on the results that we have researched which states that recreational sports alleviate the aggressive behavior caused by the COVID-19 and its major role in reducing the weakness of self-confidence caused by COVID-19 among adolescents, as well as mitigating the weakness of self-confidence under the COVID-19 pandemic Finally, the researchers recommend the necessity of practicing recreational sports activities in spare time.

Key words: COVID-19, Psychological problems, Recreational sports activity

Introduction

The new Coronavirus pandemic swept the world quickly and spread calmly, posing a danger to peoples' lives, in addition to their physical and psychological health. Fears,

anxiety, and panic spread, psychological problems and obstacles increased, which led to the aggravation of the damage, Steven Taylor, author of "The Psychology of Pandemics" and a professor of psychology at the University of British Columbia, believes that between 10 and 15 percent of people, will not return their lives to normal, due to the impact of the pandemic on their psychological health, at the same time a group of prominent health specialists recently warned in the British Medical Journal that it is likely to last longer compared to its effects on physical health.

Recreational sports activity has become an integral part of the basic components of daily life for most members of contemporary society, especially adolescents, this is due to the high level of awareness of its importance and psychological, physical, and health benefits (Amarna 2018, p. 450) and its importance in removing some of the diseases and psychological pressures left by the epidemic, such as stress, depression, and behaviors issued towards individuals or the self, whether verbal or material, filled with frustration, anger, self-defense, or the desire for revenge and the consequent psychological and physical harm, and this is called aggressive behavior (Chaachoua 2012, p. 84), with the increase of the number of people isolated as a result of quarantine and social distancing, it leads to the lack of communication of adolescents with others and the lack of comfort between individuals and the tendency to avoid social situations and this is called social isolation (Abd-Al-rahman 2003, p. 03) In addition to the lack of optimism about the future and of the capabilities and self-abilities in facing various matters and thus results in poor self-confidence (Chafika 2015, pp. 111-121), which represents an appearance of the individual's mental health, and while countries of the world adopt measures to restrict the movement of people as part of efforts to reduce the number of people with COVID-19 disease, an increasing number of people are making significant changes to their daily habits, and experts believe that the practice of recreational sports activities in spare times and some hobbies contributed to increasing the feeling of satisfaction and relieved psychological pressure for many people.

And this was covered by several studies related to the subject, the study of Sharef Si-laarbi (2014) named the importance of practicing recreational sports activity in minimizing the phenomenon of aggressive behavior at high school pupils, aimed at knowing the role that recreational sports activity can play within educational institutions in reducing the phenomenon of aggressive behavior among high school students, by proposing an educational recreational program for a period of 12 weeks, and in this context the researcher used references and sources in the field of sports recreation, in addition to personal interviews with experts and specialists to enrich the proposed educational

program, the researcher relied on the experimental approach, using the aggressive behavior scale prepared by Muhammad Hassan Allawi, which was applied in two stages, pre-measurement and post-measurement on the two research samples, a control sample and an experimental one, they were represented in the second year classes, Experimental Sciences 1 and 2, which consisted of 62 students (17 females, 14 males), they were deliberately chosen as the most aggressive after they achieved the highest levels of aggressive behavior in the reconnaissance study, in order to check the hypotheses of the research, the researcher used the appropriate statistical methods and one of the most important results reached is that the proposed recreational program had a positive effect in reducing the phenomenon of aggressive behavior among high school students, and according to this the researcher recommends that all participants in the educational sector need to pay attention to recreational sports activities within educational institutions, and not just stopping at the physical and sports education classes, these activities that have become a successful and meaningful treatment method more than a waste of time and enjoying their spare time, they gain the individual in general and the adolescent in particular experiences that help him enjoy life and get rid of the complex of feelings of inferiority and frustration as well as help him in developing self-confidence (Sharef 2016), meanwhile the study of Arnab, Hamza et al. (2014). It aimed to highlight the role of recreational sports activity in increasing the self-confidence of the physically handicapped has reached important results represented that the disabled self-confidence has improved during the exercise of recreational sports activity which leads to the achievement of good interaction of him in the community and talking with others without feeling inferior. In addition, improving academic performance as well as a sense of positivity and optimism, and it can be said that recreational sports activity increases the self-confidence of the disabled. Among the suggestions that the researcher consider necessary are setting up programs that contain recreational activities that increase the tendency of the physically disabled person towards practicing sports activity, and highlighting the real image that the practice of recreational sporting activity leaves in the psyche of the disabled (Hamza et al. 2014).

On the other hand Mustafa Ayad (2018) in his study aimed to learn about the role of recreational physical activity in the social interaction of high school students and to know the extent of the importance of recreational physical activity in coexistence and respect, knowledge of social values and rules and the preparation of a good citizen by proposing the following hypotheses: Recreational physical activity has a role in providing factors of respect, coexistence, interaction with others, knowledge of and respect for social values and rules, and the preparation of a good citizen. It was in the form of a comparison between

practitioners and non-practitioners. In his study, he followed the descriptive approach and used the questionnaire to reach numerical results. and to analyze these results they came to percentages, standard deviation, and T-test by comparing it with the scheduled T, at the significance level of 0.05, and after analyzing and interpreting the results, he concluded that recreational physical activity has a role in social interaction after finding significant differences between the two groups, the practitioners, and the non- practitioners and in the end, he reached the need for assistance and urged children to engage in recreational physical activity in their spare time (Mustafa Ayad 2018). As for the study of Khaladi Mourad and others (2020)**,** they took the dimension of aggressive behavior, their study aimed at knowing the relationship between the pupils 'attitudes towards practicing physical and sports activity and reducing the aggressive behavior in its various dimensions in the final sections of the high school, and emphasizing the existence of an inverse correlation between the pupils' attitudes towards physical activity and aggressive behavior, where the researchers used the descriptive approach on the research sample, and to collect data and information, the researchers relied on both the measure of attitudes towards physical activity, sport and educational activity and the measure of aggressive behavior. The study found that the degree of aggressive behavior among the sample members is moderate (Mourad & others 2020).

Gouasmia Aissa (2020) says in his study, which aimed to identify the role of practicing educational physical and sports activity by the students in reducing social shyness among adolescents, that practicing educational physical and sports activity can reduce social shyness. According to this the researcher used the social shyness scale, they have distributed it to a random sample of practicing and non-practicing pupils, in the number of 210 students for each of "Colonel Chabani Mohamed High School" and "Khamed Amer" High School, Laghouat State, and after statistical treatment using SPSS, the results showed that the practice of educational physical and sports activity has an effective role in reducing social shyness (Aissa 2020, pp. 485-501).

As a preventive measure against this epidemiological situation of the Coronavirus and home quarantine, we must pay attention to the psychological aspect and develop these aspects in the personality of the teenager, such as self-confidence, self-control, and social integration in a suitable, normal way that gives him happiness and human energy to confront the various challenges of the age, foremost of which are diseases and epidemics, Physical activities in general and recreational sports activities, in particular, are important social behaviors in the daily life of individuals, as they play a major role in preparing the individual, and have a special place among social groups of different genders, levels, and

ages, and are of great importance in developing personality, the recreation of oneself, improving behavior and social relations. Besides other factors, it works to alleviate the tensions and emotions facing the teenager during the quarantine period, and this is what made us ask the following question:

Do recreational sports activities play a role in alleviating some psychological problems caused by the COVID-19 pandemic among adolescents? Under this question, we include three sub-questions which are as follows:

1. Do recreational sports activities play a role in mitigating aggressive behavior among adolescents under the COVID-19 pandemic?
2. Do recreational sports activities play a role in mitigating the isolation among adolescents under the COVID-19 pandemic?
3. Do recreational sports activity play a role in mitigating adolescents' low self-confidence under the COVID-19 pandemic?

Material & methods

1. The method followed in the study: The researcher used the descriptive approach in a survey method due to its suitability for the nature of the current study, the descriptive approach depends on the study of the reality or the phenomenon as it is actually as a precise description and it is interested in describing it accurately and expressing it qualitatively and quantitatively, and since the content of the research revolves around a social phenomenon, namely, recreational sports activities in and its relationship with the psychological problems caused by the COVID-19 pandemic, by collecting various information on it, revealing its various aspects, determining the relationships between its elements, analyzing and interpreting it, we considered it necessary to use the descriptive approach to match the specifications, objectives, and requirements of the study with this approach. If the researcher wants to study a phenomenon, the first step he takes is describing and presenting the phenomenon he wants to study and collecting accurate descriptions and information about it and its form.
2. Research Community: Male adolescents who are in the final year of middle school (Hamam bouhjar Middle school - Ain Temouchent state, Sig middle school – Mascara state)
3. Research sample: Our research was applied to an intentional (intended) sample because it contained characteristics that are not available in other samples, and it was represented in males (14 – 16 years) practicing recreational sports activity only and in leisure time, and the number was 400 teenagers from the research community. As for the reason for

our selection for male teenagers only without female teenagers is that males are more engaged in sports than females.

4. Data collection tools:

Our research included the Psychological Problems Scale and it contained:

- A Scale of aggressive behavior and low self-confidence of Amal Abdel Sami Abaza, 2001.
- The Social Interactions Scale (Isolation), prepared by Prof. Dr. Adel Abdel Hamid Mohamed in 2003.
- Self-confidence scale, by Amal Abdel Samie Abaza, 2001.
- Benefiting from some previous studies as a source and reference.

psychometric properties of the data collection tools

- Reliability: to calculate the reliability of the scale, the researcher used the Guttman Split Half Reliability Coefficient, and the table below shows the results.

Table 1

Show the results of the K-S normality test and the Guttman Split Half Reliability Coefficient results

	questions	variance	pearson correlation	Guttman Coefficient	Kolmogorov-Smirnov Normality Test	
1st half	12	49.7	0.94	0.959	K-S statistical value	0.119
2nd half	11	47.3			Statistical significance	0.200
All questions	23	238.2			significance level	0.05

Since the statistical significance of 0.2 is higher than the significance level of 0.05 we can say that the null hypothesis (H_0) is validated and that the normality of the data distribution condition is also validated.

From the table, it is clear that the value of Gutman's reliability coefficient amounted to 0.959 with a high degree of correlation between the two halves of the questionnaire, where the value of the Pearson correlation coefficient reached 0.94, which indicates that the questionnaire has a high degree of reliability and we can adopt it in the applied study with confidence.

Validity: To confirm the validity of the study tool, we used the arbitrators' validity as a tool to ensure that the questionnaire measures what is to be measured. Where we distributed the questionnaire to a group of professors from the University of Mostaganem, relying on the observations and directions made by the arbitrators, we made the amendments agreed upon by most of the arbitrators, as some of the phrases were deleted and the wording of others changed.

Subjective validity: To find out the subjective validity of the questionnaire used in our study, we calculated the square root of the reliability coefficient, and the table below shows the results:

Table 2

Show the results of the subjective validity

	reliability coefficient	Subjective validity
1st half	0.86	0.93
2nd half	0.81	0.90
All questionnaire	0.84	0.92

Through the aforementioned measures, the previous studies that we touched upon, the pilot study that we carried out on the sample and the arbitration carried out by a committee of the Institute's doctors, our tool has become codified and contains three axes and each axis consists of nine expressions. Except for the first axis, as it contains 5 expressions, so that the answer to the axes is yes or no.

Table 3

Show the axes of the questionnaire and number of the questions

Number	Axes	Number of questions
1	The first axis: Aggressive behavior which contains some manifestations of abnormal behavior	5
2	The second axis: isolation which included phrases referring to the loneliness and introversion that the teenager is exposed to 2	9
3	The third axis: Low self-confidence which included expressions of adolescent self-confidence	9

Statistical Tools: The researcher used statistical methods like the SPSS Program to calculate: Frequencies, Percentage, and Chi-square goodness of fit test.

Goodness of fit chi-square test:

$k^2 = \sum_{i=1}^{k} \frac{(x_i - m_i)^2}{m_i}$ x_i: observed frequencies / m_i: expected frequencies. (Akkab, 2015, p. 216)

Guttman Split Half Reliability Coefficient:

$\boldsymbol{\gamma = 2\left(1 - \frac{\sigma 1^2 + \sigma 2^2}{\sigma^2}\right)}$ $\sigma 1^2$: 1st half variance/ $\sigma 2^2$: 2nd half variance/ σ^2 : overall variance. (Tighza, 2009)

Results

Presentation and discussion of the results of the first hypothesis: This stipulates the role of recreational sports in alleviating the aggressive behavior caused by the COVID-19 pandemic among adolescents.

Table 4

Shows the significance of the differences in the subjects' answers about the role of recreational sports in alleviating aggressive behavior

N	The question	Frequencies (The ratio)		K^2	K^2 Scheduled	Difference significances
		yes	no			
1	Do you drop your colleague when announcing a recreational game and ignore the imposition of the spacing?	158	242	17.64	3.84	Significant
		39٪	61٪			
2	Do you assault your teammate after losing a game and ignore the imposition of the spacing?	148	252	27.04		
		37٪	63٪			
3	Do you make a mess in stressful sporting activities due to the pressure of spacing ?	172	228	7.84		
		43٪	57٪			
4	Do you destroy the pedagogic tools because of your enthusiasm in a recreational sport game?	158	242	17.64		
		39٪	61٪			
5	Do you say bad words after each sport activity under the pretext of imposing spacing?	159	241	16.81		
		40٪	60٪			
Total		400				
		100				

Scheduled K^2 = 3.84 - degree of freedom **1 -** significance level **0.05**

Through Table 4 we note that the largest percentage of adolescents representing 61 % do not drop their colleagues when announcing a recreation game and respect the imposition of spacing, and 63 % of the number of adolescents do not assault their colleagues after the loss in a game or ignore the spacing, we note that 57 % of them do not make chaos in a sports activity due to pressure of impose spacing, 61 % do not destroy the pedagogic tools due to their enthusiasm in a recreational sports game, and 60 % do not say bad words after each sports activity under the pretext of imposing the spacing, the Chi square goodness of fit test (k2) was also ranged from 7.84 and 27.04, which is greater than the scheduled (k2), witch was 3.84 and these values are statistically significant ,which means there are statistically significant differences in adolescent answers to those who practice recreational activity and do not drop their colleagues or assault their colleagues and make chaos because of quarantine pressure and do not say bad words and respect the imposition of health spacing, from which we conclude that there are statistically significant

differences in reducing the aggressive behavior in favor of practitioners of recreational sports activity,

In the light of these results, most of the teenagers decrease their aggressive behavior immediately after they practice recreational sports, and they avoid the harassment of their colleagues and do not rush to attack them, their discussions are quietly not nervously, and a high percentage of them can control their behavior and their language, and this by not assaulting their colleagues in case of anger, and these are all indicators of the adolescent's capability of controlling his emotions in front of difficult attitudes such as anger and aggression.

Presentation and discussion of the results of the second hypothesis: Which stipulates the role of recreational sports in alleviating isolation caused by COVID-19 among adolescents

Table 5

This shows the significance of the differences for examinations on the role of recreational sports in alleviating isolation

N	The question	Frequencies (The ratio)		K^2 Scheduled	Difference significances
		yes	no		
1	Are you comfortable with your own in recreational sport?	192 48٪	208 52٪	0.64	Significant
2	Can you consolidate relationships in a recreational sport game despite your fellow spacing?	227 57٪	173 43٪	7.29	
3	Do you like recreational sports despite the pressure of COVID-19?	242 60٪	158 40٪	17.64	
4	Do you feel harassed from isolating your colleagues from you despite an enjoyable game in sport activity?	198 49٪	201 51٪	0.04	
5	Do recreational sports games make you forget about isolating yourself from your colleagues?	190 47٪	210 53٪	1	
6	Is it difficult for you to make eye contact with your colleague in a competitive game?	188 47٪	212 53٪	1.44	
7	Do you feel enjoyment in a sport game despite the distance between you?	231 58٪	169 42٪	9.61	
8	Does your preoccupation with playing a sport make you forget your colleagues' alienation in the shadow of COVID-19?	209 52٪	191 48٪	0.81	
9	Are you pleased that there are games in a sporting activity, even if the interaction between you and your colleagues is from afar?	220 55٪	180 45٪	04	
Total		400 100			

Scheduled K^2 = 3.84 - degree of freedom **1 -** and significance level **0.05**

Through Table 5, we note that the largest percentage of adolescents, which represents 52 % , do not feel comfortable on their own in a recreational sport, while the rest, who represent 48 % feel so. In addition, 57 % can consolidate relationships in a sport game despite the distance with their colleagues, We note that 60 % love sports despite the pressure of COVID-19, and 53 % do not forget a recreational sporting activity that isolates them from communicating with their colleagues, whereas, 53 % of the total number of subjects do not have difficulty communicating visually with their colleagues in a competitive game, and 58 % of them enjoy a sports game despite the spacing between them, and that 52 % believe that being busy playing a sports game makes them forget that their colleagues are away from them in shadow of COVID-19. We also note that the largest percentage of adolescents, which represents 55 % are pleased with the presence of games in a sporting activity, even if the interaction between them was from afar. Also, the Chi square goodness of fit test results are all statistically significant, which means that there are statistically significant differences in the responses of adolescents in favor of those who engage in recreational activity, which leads us to conclude that there are statistically significant differences in the relief of isolation demotion in favor of recreational sports practitioners. In light of these results, most adolescents feel enjoyment, enabling them to consolidate relationships in recreational sports activity despite the spacing between them, nor it is difficult for them to make eye contact from afar because they keep in touch with each other in the recreational sporting activity. Also, most of them love sports despite the pressure of COVID 19 - and are not bothered by the isolation of their colleagues on the presence of sports games in the activity, they also see that their preoccupation with practicing recreational sports make them forget about being apart from their colleagues, They feel happy that there are games in sports activity, even if the interaction between them is from afar. Presentation and discussion of the results of the third hypothesis: This stipulates the role of recreational sports in reducing the weakness of self-confidence caused by COVID-19 among adolescents.

Through Table 6 we note that the largest percentage of adolescents, which represents 59 % do not get afraid of COVID-19 pressure in a sports game against a colleague, and that 56 % of them are not afraid to risk friction with their colleagues in a competitive game, We also note that 56 % of them can resist COVID -19 pressure when announcing a recreational game. A percentage of 53 % represents that the practitioners don't have any difficulties communicating from far away with their colleagues in a competitive game, and that 51 % do not accept the criticism of the responsible if they ignore the spacing imposed, and 52 % do not hesitate to express their opinion of a stressful

sports activity despite the health protocol, we counted 52 % of the practitioners can accept the loss in a sports game despite the imposition of spacing, and 59 % of them forget about the COVID-19 pressure in a recreational sports game, the percentage of those who do not feel confused when they touch a colleague's hand by mistake in a game and he sneezes after that 56 % .

Table 6

The significance of the differences for examinations on the role of recreational sports in reducing the weakness of self-confidence

N	The question	Frequencies (The ratio)		K^2 Scheduled	Difference significances
		yes	no		
1	Are you afraid of COVID-19 pressure in a sports game against a fellow?	164	236	12.9	Significant
		41٪	59٪		
2	Are you afraid of the risk of friction with your colleague in a competitive game?	175	225	6.25	
		44٪	56٪		
3	Do you have the ability to resist COVID-19 pressure when announcing a recreational game?	223	177	5.29	
		56٪	44٪		
4	Do you feel confidence and reassurance under the imposition of spacing knowing that all sports activities are games?	232	168	10.2	
		58٪	42٪		
5	Do you forget the pressure of COVID-19 in a recreational sports game?	236	164	12.9	
		59٪	41٪		
6	Will you feel confused when you touch a colleague's hand and he sneezes after that?	178	222	4.84	
		44٪	56٪		
7	Do you accept the criticism of the responsible if you ignore the spacing imposed?	199	201	0.01	
		49.9٪	501٪		
8	Have you hesitated to express your opinion about a stressful sports activity despite the health protocol?	194	206	0.36	
		48٪	52٪		
9	Can you accept the loss in a sports game despite the imposition of spacing?	210	190	01	
		52٪	48٪		
Total		400			
		100			

Scheduled K^2 = 3.84 - degree of freedom **1 -** and significance level **0.05**

Also, the Chi-square goodness of fit test results are all statistically significant, which means that there are statistically significant differences in the responses of adolescents in favor of those who engage in a recreational activity, which leads us to conclude that there are statistically significant differences in mitigating the weakness of self-confidence in favor of practitioners for recreational sports activity.

In the light of these results, most adolescents are not afraid of the pressure of COVID-19 and do not fear the risk of friction with their colleagues, most of the adolescents can resist COVID-19 pressure through recreational sports activity and are confident and

reassuring despite the spaces between them and do not accept excessive physical stress despite the health protocol and accept the loss in any sports game that makes them forget the pressure on them either from COVID or the pressure of harsh life, they also do not get confused if a colleague sneezes or feels tired, and all this self-confidence is due to the need for recreation through recreational sports activity.

Discussions

Through research, hypotheses, objectives, and what resulted in the results of the analysis of tables and, in the light of discussing these are the results we reached:

1. Most of the adolescents who engage in recreational sports are characterized by low aggressive behavior despite the pressure of the COVID-19 pandemic, this is consistent with the study of Sharef Si-laarbi (2014), which stipulated that the proposed recreational program had a positive impact on minimizing the phenomenon of aggressive behavior at high school pupils, and Mohamad's study adds that recreational sports activities have a role in minimizing aggressive behaviors of the pupils at the final sections of high school. Through the analysis of our tables and from previous studies, we can say that our first hypothesis, which states that recreational sports alleviate the aggressive behavior caused by the COVID-19 pandemic, has been achieved.

2. The adolescents practicing recreational sports activities are characterized by too much social contact and they do not suffer from isolation, this is consistent with the study of Mustafa Ayad (2018), which concluded that recreational physical and sports activity has a role in social interaction, after there are differences between the two groups, practitioners and non-practitioners, for the benefit of practitioners, this is confirmed by the study of Hajaj Saad, Barkat Houssin (2018) which concluded that there are statistically significant differences at the level of significance (0.01) between invasive juveniles practicing recreational sporting activity and non-practitioners, in favor of invasive juveniles practicing recreational sporting activity.

Through the analyzes of our tables and discussion and the results of previous studies, we can say that our first hypothesis which states that recreational sports activities have a role in alleviating the isolation under the COVID-19 pandemic has been achieved.

3. The adolescents practicing recreational sports activities are characterized by high self-confidence and are not affected by the COVID-19 pandemic, This is consistent with a study of Arnab, Hamza, and others (2014), which resulted in the development and positive and notable change in minimizing psychological problems and increasing self-confidence at practitioners for recreational sports activity unlike non-practitioners, and the study of

Abd El-Wahed Hamiid EL- Khabissi (2011), which has reached that recreational activities have an impact on the acquisition of self-confidence pupils, values and different social skills. Through the analyzes of our tables and discussion and the results of previous studies, we can say that our third hypothesis which states that recreational sports activities have a role in mitigating the weakness of self-confidence under the COVID-19 pandemic has been achieved.

Conclusion

The need for self-entertainment is a humanitarian need that has its importance, and usually, we find that we put entertainment and entertainment activity on a side place of our lives and do not give it particular importance, especially at this difficult time of Coronavirus, and to realize how important it is for them and the community, entertainment is a manifestation of human activity characterized by mental, psychological and physical health, the inclusion of recreational sports activity and practicing its all different types and forms is a very useful activity of all segments of society. Finally, we found that the practice of recreational sports activity alleviates the psychological problems (aggressive behavior, social isolation, and low self-confidence) caused by quarantine measures in adolescents.

Acknowledgments

We appreciate all the people especially students who helped us to finalize this work.

Recommendations

- We recommend practicing recreational sports activities in free time to relieve some psychological pressures, especially in these epidemiological conditions of the Coronavirus, while respecting the preventive measures.
- Financial support and sponsorship: No financial support.
- Conflicts of interest: There are no conflicts of interest.

References

1. ABD-AL-RAHMAN, M., 2003. *The effectiveness of social support from comrades and adults in reducing the Isolated behavior of the child*. Egypt: Faculty of Education Zagazig University.

2. AISSA, G., 2020. The role of practicing educational physical and sports activity by the students in reducing social shyness among adolescents. *Journal of Sports Creativity.* 11.
3. AKKAB, S., 2015. *Principles of Statistics in Physical Education*. Oman: Arab Society Library for Publishing and Distribution.
4. AMARNA, S., 2018. *Recreational sports activity as a strategy to achieve job satisfaction for the Algerien policeman*. Algiers.
5. ANGERS, M., 2004. *Scientific research methodology in the humanitarian sciences*. Algiers: Al Qasba Publishing house.
6. CHAACHOUA, A., 2012. *Ladder of needs and aggressive behavior for delinquents and the targeted for delinquency and the normal*. Algiers: phd thesis University of Oran.
7. CHAFIKA, D., 2015. *Factors affecting self-confidence in schooled adolescents*. 111-121.
8. HAMZA, A. et al., 2014. *The role of recreational sports activity in increasing self-confidence in the disabled*. Algiers.
9. MOURAD, K. et al., 2020. Directions of high school students towards physical activity and its relationship with aggressive behavior they have. *Journal of Science and Technology for Physical and Sports Activities.* 17, 314-331.
10. MUSTAFA Ayad et al., 2018. The role of recreational physical activity in the social interaction of hight school students . *Joural el-khabir*, 2.
11. SHAREF, S. A. A., 2016. The importance of practicing recreational sports activity in minimizing the phenomenon of aggressive behavior at high school pupils. *Science and practices of sports and artistic physical activities*. **5**(1), 112-120.
12. TIGHZA, A., 2009. The logical structure of Alpha Cronbach, and its accuracy in reliability in the light of assumptions and measurement models. King Saud University journal - *Educational Sciences and Islamic Studies*. **21**(3), 637-688.

sciendo

DOI 10.2478/afepuc-2021-0013
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 147-155

APPLICATION OF SPORT AND PHYSICAL EDUCATION IN THE PERIOD OF PANDEMIC COVID-19 FROM THE POINT OF VIEW OF TEACHERS

Guezguouz Mohamed[1], Bensemicha Laid[1], Mokrani Djamel[2]

[1]University Center of el- Bayadh, Algeria
[2]Laboratory of Programs Optimization in APS, Institute of Physical Education and Sports, University of Mostaganem, Algeria

Summary: The study aimed to identify the physical education and sports classes implementation in the light of the Corona pandemic, as seen by the teachers. To this end, the researchers used the descriptive approach based on the survey method. The sample included (60) teachers from high schools in the Wilaya of El Bayadh, chosen at random. The results of the study showed that the teachers experienced to a more than average degree, difficulties with the administrative organization, and moderate difficulties during the practice of the lesson of physical education and sports, and therefore the researchers recommended in this regard, the provision of national educational establishments with the material necessary for comprehensive prevention, as well as the need for mutual assistance between the administrative team and teachers.

Keywords: physical education and sports lessons - Corona pandemic.

Introduction

In the light of the current worldwide spread of the Corona pandemic (Covid-19), classified by the World Health Organization as a rapidly spreading and large-scale pandemic disease having affected the lives of human beings, the methods of dealing with this crisis, all over the world, were various and different from a country to another, what has consequently affected the daily way of life of individuals in society, and needs are no more, the same.

Indeed, the world is currently experiencing a momentous event that threatens the educational system with a great crisis that would be the most severe of our modern times. A crisis that comes on top of the one that is beating full force, the education sector where despite their presence in schools, students are not taught the basic skills they need in everyday life. And since physical education is a process of orienting the physical growth and stature of the human being through physical exercise, health measures and other methods which, like educational means, contribute to the development of psychological, social and moral aspects, the course of physical education and sports being one of the practical aspects of education, also allows the achievement of these objectives, and guarantees the overall and balanced growth of the pupils. In addition, the physical education and sports session meets the physical needs of students according to their age groups, and according to the principle of graduating motor capacities, and gives the brilliants among them, the opportunity to take part in the different aspects of competition within and outside the school. In this way, the physical education and sports session not only covers a time space, but also fulfills the educational objectives set out by the educational policy in terms of the physical and health development of pupils at all levels.

West, Butcher 1990 states that the field of physical education and sport has developed considerably over the past two decades, and that the progress and growth of the profession has not only been in the direction of broad knowledge, but has taken expansive forms in terms of programmes and in terms of the quality of the individuals who benefit from them. He defines Physical Education as an "Integral part of total educational process, is a field of endeavor which has its aim — the development of physically, mentally, emotionally and socially fit citizens through the medium of physical activities which have been selected with a view to realize these outcomes."

One of the most important health measures adopted by educational institutions in Algeria in this regard, is the division of classes into groups of students that are taught on an alternate day basis. A system that makes the reduction of the number of students in a class to 20 students instead of 40, possible, and thus makes easier the physical distancing imposed by the exceptional circumstances linked to the Corona virus pandemic. In addition, vigilance units have been set up in all educational establishments with the aim of generalizing the application of the preventive measures provided for this purpose.

And since any educational or teaching work requires a specific method for its execution, and since that method requires appropriate organizational steps, the shape given to this organization by the teacher, depends on the educational objectives, the content of the lesson, and the level of the pupils. Although flowcharts or compositions are not considered in

themselves as a type of motor activity, they are essential for organizing work and facilitating the teaching process. The physical education and sport lesson is the smallest unit of the educational program, but it carries within it the entire mission of physical education and sport with its multiple objectives that it is incumbent on it to achieve, through the time allocated to each lesson including a complete and balanced education at the end of the program. so, achieving the objective of the lesson is only possible through the use of modern teaching methods which guarantee a saving in time and effort necessary to achieve this great target.

The researchers consider that the physical education and sports session is one of the most important sessions that can have an impact on the students, because of its attractiveness. The physical education and sports teacher is also considered one of the most important educators who can influence the behavior of students and their education. They also believe that the educational process must be efficient because it manifests itself in an activity which brings together the teacher and the pupil, and also emphasizes the importance of the environment, which is favored by the physical education and sports class by creating a fertile atmosphere. As part of our monitoring of the health situation linked to the Corona virus pandemic, and for the sake of the safety of students in the school environment, in particular in the physical and sports education session, we sought to reveal the reality of the application of the lesson of physical education and sports in the light of the Corona pandemic (Covid-19), as seen by teachers of middle and secondary education.

Study methodology and field procedures

1. **The study methodology:** The researchers used the descriptive approach using the survey method.
2. **The study sample:** The research sample, purposely chosen, included (60) teachers of physical education and sports from a number of public secondary schools in the Wilaya of Al-Bayadh, 1st quarter of the school year (2020/2021). A sample of 07 teachers from El Bayadh secondary schools was chosen outside the main experiment, for the pilot experiment.
3. **How to prepare the form:** In order to construct the form, we reviewed references in physical education and sports, teaching methodology, including the books: "Processes and methods of teaching physical education and sports in the educational process analysis element" by Dr. Atallah Ahmed, and "Introduction to the teaching process (analysis of the teaching process)" by Muhammad Al-Dreij, in addition to some other theses and books, as

well as opinions and advice from specialized professors in the field of science education. The axes of the form were collected and modified by the arbitrators who then proceeded to record a number of statements related to the different stages of the teaching process, and submitted them to the assessment of specialized professors with the aim of determining the ways of distributing the said form. We used the five-point Likert scale to analyze and dump the findings as follows (Table 1).

Table 1

The five-points estimated Likert scale (the relative importance index grades) to determine (the teaching performances of secondary school teachers during their teaching under the Corona pandemic).

Likert scale	Relative importance index	General tendency
Exercised to a very high degree**.**	**<00**RII≤0.20	VERY LOW
Exercised to a high degree**.**	**≥0.21**RII≤0.40	LOW
Moderately exercised	**≥0.41**RII≤0.60	MEDIAN
Exercised to a low degree**.**	**≥0.61**RII≤0.80	HIGH
Exercised to a very low degree**.**	**≥0.81**RII≤1	VERY HIGH

Through the above, we were able to reach the final version of the evaluation form for the three stages of the teaching process of physical education and sports classes.

Table 2

The results of the questionnaire's axes relating to (the pedagogical performance of secondary school teachers during their teaching under the Corona pandemic).

Axis	Number of statements	The meaning of expressions
The first axis: facilities and assistance provided by the administration**.**	**15** Positive Closed (Direct Answers)	These are closed-ended questions that are answered directly. They highlight the facilitation provided by the administrative staff to assist in the implementation of the session in Corona virus conditions; For example (the administration provides sufficient teaching resources to enable the teacher to apply the health protocol. The school administration applies group work to enable the teacher to apply the health protocol...etc.)
The second axis: the teacher's organizational and pedagogical work**.**	**15** Positive Closed (Direct Answers)	These are closed expressions to which we respond directly. They indicate whether the teacher is doing his daily task well or not. Example: (The teacher has no difficulty in testing sports activities in the light of Covid. The teacher uses sterilized teaching aids in the course ... etc.)
Method of assessing the degrees on the Lekert scale**:** The formulation of the responses was positive**.** The response was rated on the Lekert scale as follows **:** Practised to a very high degree: '5' degrees. Practised to a high degree: '4' degrees. Practised to a moderate degree: '3' degrees. Practised to a low degree: '2' degrees. Practised to a very low degree: '1' degree**.**		

4. **The main experiment and the analysis method:** We distributed the questionnaire to the research sample (secondary school teachers) in their establishments with the help of a working group and some teachers from the same high schools. A maximum of 10 to 12 minutes were given to retrieve the form, as well as the researchers' answers to questions linked to certain sentences appearing in the questionnaire (which was intended for them) ambiguous.
5. **Statistical methods:** - arithmetic mean - standard deviation - percentage - ka 2.

Presentation, analysis and discussion of the results

1. **Presentation and discussion of the results:** To what extent the administration of national education institutions has helped teachers of physical education and sports during the Corona pandemic, as seen by secondary school teachers?

Table 3

Represents the observed frequency, percentages, and Ka-2 for the first axis of the form submitted to secondary school teachers

Answer sorted by degrees	Levels Determination	Observed frequency	Percentage	Expected frequency	Level of signifi-cance	Degree of free-dom	Tabular Ka 2	computed K2
practiced to a very large degree	63 to 75	00	00	12	**0,01**	**04**	**9،21**	125,17
highly practiced	51 to 62	00	00					
practiced moderately	39 to 50	**09**	15,00					
practiced with a slight degree	27 to 38	46	76,67					
practiced to a very small degree	15 to 26	**05**	8,33					
Total axis		**60**	%100					

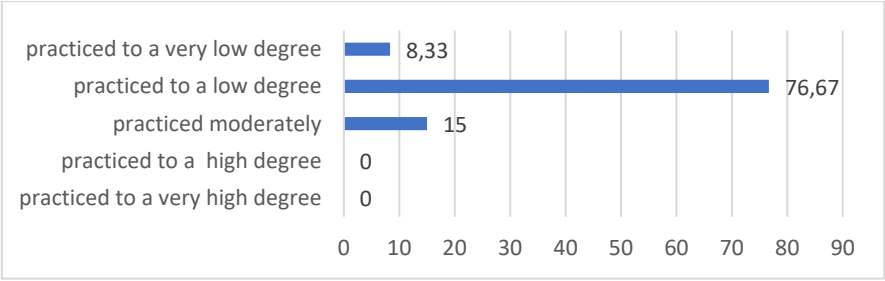

Figure 1

Percentages of the first axis of the form submitted to secondary school teachers.

2. **Presentation and discussion of the results:** Defining the degree of the correct application of the lesson of physical education and sports, in the light of the Corona pandemic, as seen by secondary school teachers.

Table 4

The observed frequencies, percentages, and Ka-2 related to the second axis of the questionnaire submitted to secondary school teachers

Response sorted by degrees	**Level's determination**	**Observed frequency**	**Percentage**	**Expected frequency**	**Level of signifi-cance**	**Degree of freedom**	**Tabular Ka 2**	**computed Ka 2**
Practiced to a very high degree	From63 to 75	05	8,33					
Practiced to a high degree	From51 to 62	23	38,33					
Practiced moderately	From39 to 50	**30**	**50,00**					
Practiced to a low degree	From27 to 38	02	3,33	**12**	**0,01**	**04**	**9،21**	61,50
Practiced to a very low degree	From15 to 26	00	00					
Total axis		**60**	%100					

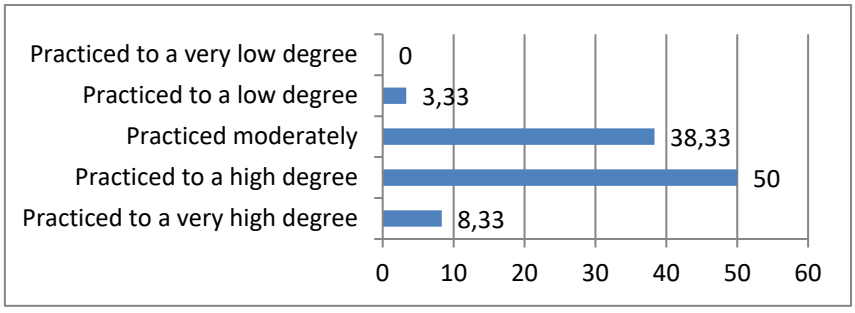

Figure 2

The percentages related to the second axis of the questionnaire submitted to secondary school teachers.

Results

After the dumping of the form addressed to sixty (60) professors from a number of secondary schools in Wilaya of El Bayadh aiming at measuring the extent of the assistance given by the administration of the domestic education institutions to teachers of physical education and sports in light of the Corona pandemic, as seen by secondary school teachers.

The results recorded in the tables and figure above, were as follows: 09 professors answered that they receive aid from the administrative staff for the success of the physical education and sports lesson with a moderate degree, in light of the Corona pandemic, i.e.,

15.00 %. And 46 professors answered that a little degree of assistance was given to them by the administrative staff during Corona pandemic in the success of the physical education and sports lesson by 76.67 %. While 05 teachers answered that they receive a very little degree of assistance from the administrative staff, in the success of the physical education and sports lesson in light of the Corona pandemic by 8,33 %. As for the two dimensions (practiced to a high degree) and (practiced to a very high degree), no answer was given by the teachers. As for the significance of the differences between the answers, the researchers used a k2 good-fit test, where the computed value of k2 was 125.17, i.e., greater than the tabular k2 which was 9.21 at the significance level of 0.01 (99 % confidence level and degree of uncertainty 01 %).

Accordingly, the researchers believe that there are statistically significant differences between the responses of the teachers, in favor of the responses of those who consider that the teachers receive a reduced degree of assistance from the administrative staff for the successful execution of the lesson of physical education and sports, with a rate of 76.67 % which is the highest of all. Thus, we conclude that the teachers of some secondary schools in the Wilaya of Al-Bayadh do not have effective and appropriate assistance and means necessary in the execution of the physical education and sports course, in the light of the Corona pandemic.

On the basis of the results recorded in the tables and the figure above, and after dumping the form addressed to sixty (60) secondary school professors from Wilaya of Al-Bayadh, aiming at measuring and identifying the difficulties that physical education and sports teachers face during the application of the lesson, as seen by the secondary professors, 05 teachers say they apply and practice the lesson of physical education and sports in very good conditions, in the light of the Corona pandemic with a percentage of 8.33 %, and 23 professors answered that they apply the physical education and sports lesson to a high degree, in light of the Corona pandemic, at a rate of 38.33 % . While 30 teachers answered that they are applying the physical education and sports lesson to a moderate degree, in light of the Corona pandemic, by 50.00 %. The last two professors answered to the dimension -a small degree, by 3.33 %. However, no professor has answered to the last dimension. And for the significance of the differences between the answers, the researchers used the good-fit test of Ka 2, where the computed ka2 value was 61.50, which is higher than the tabular ka2, which was 9.21 at the significance level 0.01 (confidence degree 99 % and uncertainty score 01 %). There are statistically significant differences between the answers of the teachers in favor of the answers that say that the teachers apply the physical education and sports course with a medium degree, which is the highest percentage.

In the end, we conclude that the teachers of some secondary schools of Al-Bayadh state are applying the physical education and sports course to a moderate degree in light of the Corona pandemic.

Conclusions

- The administrative staff does not cooperate with the professors of physical education and sports for the good implementation of the lesson in light of the Corona pandemic.
- The administrative staff does not provide the appropriate conditions for physical education and sports professors to properly implement the lesson in light of the Corona pandemic.
- The physical education and sports lesson is being applied at a moderate rate in light of the Corona pandemic.

Recommendations

- The need to provide full protective equipment by the national education institutions.
- The need for cooperation between the administrative team and the physical education and sport teachers (in groups organization, time volume and timetable).
- The need for physical education and sport teachers to make an extra effort for the good running of the class in the light of the Corona pandemic.
- The need for the teacher to choose learning well adapted situations to the health protocol.
- The need for the teacher to organize the groups in the school class to allow students to work while maintaining physical distance.
- The need to choose active methods, and to ensure that the student benefits from them in appropriate health prevention conditions.

References

1. AHMED ATALLAH, 2016. *Processes and methods of teaching physical education and sports* . Algeria: University Publications office.
2. AMIN ANWAR AL-KHOULI, 1996. *The foundations of physical and sports education.* 1st edition, Cairo, Dar Al-Fikr Al-Arabi.
3. CDC, 2020. Symptoms of coronavirus. Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html ,Fleshner, M. (2005). Physical activity and stress resistance: sympathetic nervous system adaptations prevent stress-induced immunosuppression. *Exerc Sport Sci Rev.* **33**(3), 120-126.

4. DARWISH AFAF ABDEL MONIIM, 2007. *Means in Physical Education*, Ma'arif Foundation, Alexandria ishing. 1st ed.
5. GUO, Y. R., CAO, Q. D., HONG, Z. S., TAN, Y. Y., CHEN, S. D., JIN, H. J., . . . YAN, Y., 2020. The origin.
6. ISSAM EL-DIN METWALLY ABDULLAH & BADAWY ABDEL-ALI BADAWY, 2006. *Methods of teaching physical education*. Alexandria: Dar Al-Wafa for the World of Printing and Publ.
7. MARWAN ABDEL MAJEED IBRAHIM, 1999. *Tests, measurement and evaluation in physical education and sports.* Jordan: Dar al-fikr Al-Arabi house for Publishing and Distribution.
8. MOHAMMED SAÎD AZMY, 1996. *Methods and Development of Physical Education and Sports Lesson.* Ma'arif foundation, Alexandria.
9. MUHAMMAD AL-DREIJ, 2000. *Introduction to the teaching process* (analysis of the teaching process). Rabat - Morocco: Faculty of Educational Sciences, National Training Center for Education Inspectors.
10. MUHAMMAD TAYYAB, 2013. *The trend towards the teaching profession and its relationship to the teaching performance of a professor of physical education and sports in the secondary education stage*. Algiers University.
11. Transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status. *Mil Med Res.* **7**(1), 11.
12. ZAHRAN LAYLA, 2005. *The Scientific Principles of Building Curricula in Physical Education.* Horus for Printing, Cairo.

DOI 10.2478/afepuc-2021-0014
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 156-171

GENDER DIFFERENCES IN ATTITUDES OF STUDENTS ATTENDING NON-INCLUSIVE SCHOOL TOWARDS INCLUSIVE PHYSICAL EDUCATION

Dagmar Nemček[1], Julie Wittmannová[2]

[1]*Comenius University in Bratislava, Faculty of Physical Education and Sports, Slovakia*
[2]*Palacky University Olomouc, Faculty of Physical Culture, Czech Republic*

Summary: The objective of the study was to determine and compare the attitudes of high school students of the non-inclusive school towards inclusive physical education according to gender. This study deepened the knowledge about the students' attitudes toward the inclusion of students with physical and intellectual disabilities. The research sample comprised a total of 181 able-bodied high school students (56 boys and 125 girls) attending one non-inclusive high school in Bratislava, Slovakia. Modified Czech version of the CAIPE (Children's Attitude toward Inclusive Physical Education) questionnaire was used as a primary research method. Girls presented higher levels of positive attitudes towards inclusive physical education (IPE) in goal achievement, motivation, and motor skills learning. Boys showed a higher level of positive attitudes in the self-confidence of students with disabilities through IPE. In the goal achievement, girls expressed a significantly higher positive attitude towards IPE in students with intellectual disabilities inclusion ($U = 2817$, $p = 0.029$, $r = 0.168$). The highest level of a positive attitude toward IPE declared both genders by society inclusion and the lowest level of positive attitude by motor skills acquisition. Slovak students of a non-inclusive high school showed a positive attitude toward IPE for the inclusion of pupils with physical as well as intellectual disabilities.

Keywords: inclusion, physical education, physical disability, intellectual disability, attitude, boys, girls.

Introduction

Inclusion and inclusive education have become increasingly common in pedagogy and special education, which can be described as international topics because the problem of inclusion is global. International studies (Kudláček et al. 2002; Meegean & MacPhail 2006) tell

us that with a growing number of students with disabilities being included in general physical education (P.E.), more and more P.E. teachers face the reality of teaching these students together with able-bodied students. In inclusive physical education (IPE), a student is attributed a share of the success of the whole class. The student sees that the success of the whole class also depends on him, thus stimulating the learner's motivation to learn and grow interested in the task at hand (Booth & Ainscow 2011). IPE could help to change the attitudes and opinions of able-bodied students (Bailey 2005). In literature focused on the inclusion of students with disabilities toward P.E. classes and attitudes toward inclusion, it played a very important part in what is considered to be one of the key competencies of P.E. teachers (Hutzler 2012; Sherrill 2004). This is an important variable influencing the behaviour and interaction of able-bodied peers in IPE.

Attitudinal research in IPE has focused on the past thirty years in attitudes of P.E. teachers starting with research utilizing the theory of planned behaviour by Terry Rizzo (1984) followed by the inline of research using the theory of reasoned action (Downs & Williams 1994; Rizzo & Kirkendall 1995). Studies of students about IPE focus predominantly on experiences of students with special educational needs including students with different kinds of disabilities (Goodwin 2001; Bertills, Granlund & Augustine 2019). Some studies focused on the impact of inclusion on students without disabilities (Obrusníková, Válková & Block 2003; Ruijs & Peetsma 2009; Kart & Kart 2021). Slininger, Sherrill & Jankowski (2000) declare, if attitudes towards the inclusion of pupils with disabilities are positive, the process of inclusion of the students is easier to achieve and result in it being more successful. Female students show a more positive attitude toward inclusion, and these attitudes are associated with empathy and social dominance (Navarro-Mateu et al. 2020; Průžek et al. 2020).

Inclusive education is a result of an inclusive philosophy in which the acceptance of children with disabilities and their inclusion among able-bodied children is the primary goal (Janoško 2011). However, it is also characterized by a change in the attitudes of both kinds of students and also school. Schools, so-called inclusive schools must be able to help students with disabilities overcome the barriers that arise and help them to adequately develop their skills (UNESCO 2017).

The study aims to determine the attitudes of Slovak students attending non-inclusive school towards inclusive physical education. Furthermore, this study should deepen the knowledge of the students' attitudes about the inclusion of students with physical and intellectual disabilities and compare it between boys and girls high school students.

Material and methods

Participants

The research sample comprised a total of 181 able-bodied high school students attending one non-inclusive high school in Bratislava, Slovakia. 56 male high school students (boys; mean age of 17.3 ± 1.2 years) and 125 female high school students (girls; mean age of 17.1 ± 1.1 years) participated in the questionnaire survey. Participants meeting the following criteria were included: (1) able-bodied (healthy) students; (2) attending non-inclusive high school; (3) without any experience with students with disabilities in P.E. classes. The exclusion criteria for all participants were students with special educational needs. Able-bodied high school students attending non-inclusive high schools were informed of the purpose of the research and the procedure for filling out the questionnaire. The questionnaire was completed in the presence of their headteacher and the researcher. In this study, informed consent was obtained from all participants. The research was approved by the Ethics Committee of the Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia (No. 10/2019).

Research design

We were inspired by a standardized diagnostic tool an attitudinal questionnaire entitled CAIPE-R (Children's Attitude toward Inclusive Physical Education-Revised) developed and validated by American scholar Martin Block (Block 1995). The CAIPE-R is generalizable to more than one disability label and appears to be a valid and reliable instrument measuring attitudes of children without disabilities towards including children with disabilities in P.E. Modified Czech version (CAIPE-CZ) of the questionnaire (Kudláček, Ješina & Wittmannová 2011) was translated in the Slovak language (Nemček & Bumbera 2021). The questionnaire consists of basic questions, where we were informed about each student (gender, age, class, and place of residence). Further, the questionnaire informs us if the student had experience with children with disabilities in physical education. Other information was the description of the student with physical and intellectual disability. The last part of the questionnaire consisted of 5 following statements toward inclusion of students with physical and intellectual disabilities in P.E. classes: (1) The advantage of joint exercise students with disabilities in IPE is in achieving goals together (goals achievement), (2) Exercising with students with disabilities in IPE motivates able-bodied students to joint physical activities increasingly (motivation), (3) Students with disabilities will learn motor skills faster in IPE classes (motor skills acquisition), (4) Self-confidence of students with disabilities in IPE is strengthened (self-confidence) and (5) Integration of students with disabilities in IPE classes is important for their social inclusion

(social inclusion). Each statement was accompanied by a 5-point scale from point 1 (strongly disagree) to point 5 (strongly agree). Overall students' attitudes were calculated by summarizing scores of all 5 statements. A higher mean point score meant a more positive attitude and a lower point score more negative attitude toward the inclusion of students with a physical and intellectual disability through P.E. classes. We considered a positive evaluation of inclusion when the statement reached a mean score of 5.00 – 3.50 points, an indifferent attitude to inclusion when the statement reached a mean score of 3.49 – 2.49 points, and a negative attitude to inclusion when the statement achieved 2.50 – 1.00 points of the mean score.

Statistical analysis

The program IBM SPSS Statistics version 23.0 was used for data processing. The data were described using absolute and relative frequencies, including the mean ($\overline{x}$) and standard deviation (±SD). The Non-parametric Mann-Whitney U-test was used to assess differences in able-bodied students' attitudes between two independent samples according to gender (boys versus girls). Wilcoxon Signed Rank Test was used to assess the differences in attitudes toward inclusion between two related samples of students with physical disability and intellectual disability inside boys' and girls' groups. The significance level was set at $\alpha \leq 0.05$ (*) and $\alpha \leq 0.01$ (**). In the current study, only one measurement has been made and two main groups of able-bodied students according to the gender formed the study.

Results

Analysing the mean scores of expressed attitudes about goal achievement through IPE we found that girls compared to boys expressed a more sympathetic attitude with the statement that "*The advantage of exercising students with disabilities in IPE is in achieving goals together*" (Table 1, 2). Girls more than boys agreed that if students with physical and intellectual disabilities will be integrated into P.E. classes all students (able-bodied and with disabilities) will achieve the same goals together. The application of the Mann Whitney U-test revealed a significantly higher positive attitude to inclusion in girls compared to boys. Girls of the present study were significantly more likely to agree that the advantage of exercising students with intellectual disabilities and able-bodied students in IPE is in achieving goals together ($U = 2817$, $p = 0.029$, $r = 0.168$) (Table 2). No significant differences in attitudes between boys and girls were found on the inclusion of a student with a physical disability neither in the total score of the statements. Both evaluated groups of boys (3.54 ± 1.16 points) and girls (3.82 ± 1.03 points) have taken a positive attitude towards inclusion as they agreed that the advantage of exercising

students with physical/intellectual disabilities and able-bodied students in IPE is in achieving goals together (Figure 1).

In the field of motivation of able-bodied students through IPE, we found that girls more likely than boys agreed that "*Exercising of students with disabilities in IPE motivates able-bodied students to joint physical activities increasingly*". Even the higher mean scores, at the same time a more favourable opinion, were displayed by girls compared to boys, application of Mann Whitney U-test did not reveal significant differences in this statement between assessed groups of students (Table 1, 2). Both, boys (3.74 ± 1.13 points) and girls (3.94 ± 1.06 points) have taken a positive attitude towards inclusion as they agreed that exercising students with physical and intellectual disabilities in IPE motivates able-bodied students to join physical activities (Figure 1).

Table 1

Attitudes towards IPE of student with physical disability

Statement	**Boys (n = 56)**	**Girls (n = 125)**	**Mann-Whitney U Test**	
	(mean ± SD)		***U***	***p***
goals achievement	3.64 ± 1.34	3.81 ± 1.15	3327	0.581
motivation	3.84 ± 1.14	3.99 ± 1.07	3223	0.370
motor skills acquisition	3.63 ± 1.36	3.62 ± 1.17	3380	0.704
self-confidence	3.82 ± 1.06	3.66 ± 1.09	3216	0.363
social inclusion	4.07 ± 1.02	4,16 ± 1.07	3268	0.444

Note: Higher mean score indicates more positive attitude towards IPE; U = Mann-Whitney U Test statistics; *p* = statistical significance (*p*-values *≤.05, **≤.01)

Table 2

Attitudes towards IPE of student with intellectual disability

Statement	**Boys (n = 56)**	**Girls (n = 125)**	**Mann-Whitney U Test**	
	(mean ± SD)		***U***	***p***
goals achievement	3.45 ± 1.19	3.83 ± 1.06	2817*	0.029
motivation	3.64 ± 1.23	3.88 ± 1.15	3095	0.194
motor skills acquisition	3.45 ± 1.29	3.58 ± 1.18	3325	0.580
self-confidence	3.77 ± 0.95	3.54 ± 1.07	3085	0.185
social inclusion	4.18 ± 0.92	4.04 ± 1.07	3308	0.530

Note: Higher mean score indicates more positive attitude towards IPE; U = Mann-Whitney U Test statistics; *p* = statistical significance (*p*-values *≤.05, **≤.01)

Mean scores analyses of the third statement showed the equal score in both genders of expressed opinion that "*Students with physical disabilities will learn motor skills faster in IPE classes*" (Table 1). Even female high school students displayed a more positive attitude in motor skills acquisition of students with intellectual disability in IPE classes, calculation of Mann

Whitney U-test did not reveal significant differences in opinions between boys and girls in the statement (Table 2). Both assessed groups of high school students, boys (3.54 ± 1.21 points) and girls (3.60 ± 1.04 points) have taken in this statement a positive attitude towards the inclusion of students with physical and intellectual disabilities in IPE (Figure 1).

Analysing the mean scores of expressed students' opinions about self-confidence towards IPE we found that boys compared to girls expressed a more sympathetic attitude that "*Self-confidence of students with physical and intellectual disabilities in IPE is strengthened*" (Table 1, 2). Calculation of Mann-Whitney U-test did not reveal significant differences between boys and girls high school students in this opinion. Both boys (3.79 ± 0.95 points) and girls (3.60 ± 1.04 points) have taken a positive attitude towards inclusion through the statement telling about the self-confidence of students with disabilities by IPE (Figure 1).

In the last statement, telling that "*Integration of students with disabilities in IPE classes is important for their social inclusion*" we see a highly positive attitude expressed by an able-bodied student toward IPE classes (Table 1, 2). Boys together with girls achieved a mean score value higher than 4.0 points in the opinion about the inclusion of students with physical and intellectual disabilities. No significant differences were revealed by Mann-Whitney U-test application between samples in opinions telling that integration of students with disabilities in IPE classes is important for their social inclusion (Figure 1).

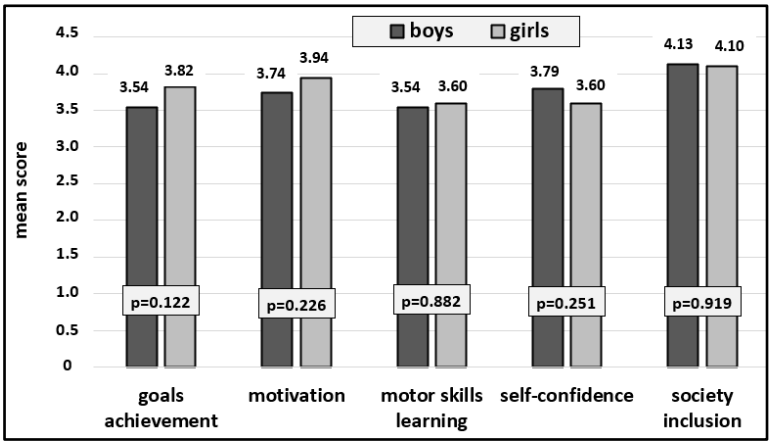

Figure 1
Attitudes' total scores towards IPE

Summarizing attitudes towards IPE, we found that girls presented higher levels of positive attitudes in the statements of goal achievement, motivation, and motor skills acquisition compared to boys. On the other hand, boys showed a higher level of positive attitudes in the statements of self-confidence compared to girls. The same level, as well as the most positive

attitude toward IPE, declared both evaluated samples of high school students by the statement of society inclusion through IPE. No significant differences were found between boys' and girls' attitudes' total scores toward IPE in the case of the inclusion of students with physical and intellectual disabilities in P.E. classes (Figure 1).

Analysing the overall attitude of able-bodied students, we declare by both genders a positive attitude toward inclusion of students with physical as well as intellectual disabilities. Similar overall attitude of both genders was declared also by the total score. No significant differences were found between boys and girls in attitudes toward the inclusion of students with physical/intellectual disabilities in P.E (Figure 2).

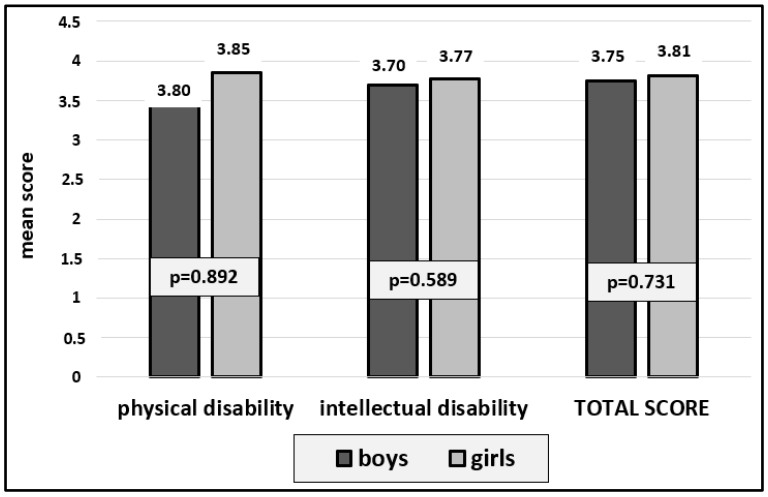

Figure 2
Overall attitude towards IPE

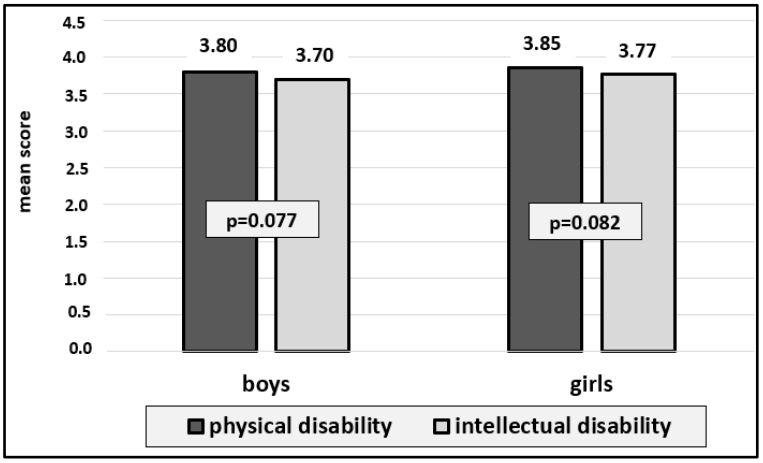

Figure 3
Differences between disabilities towards IPE

In the last comparison, we tried to find out which disability inclusion perceive boys and girls more positively or negatively in P.E. classes. By mean scores evaluation, both genders of

high school students perceived the inclusion of a student with a physical disability in P.E. classes more positively than the inclusion of a student with an intellectual disability. However, the application of Wilcoxon's T-test did not reveal significant differences in the attitudes toward inclusion of students with physical nor intellectual disabilities in the P.E. classes in both groups of high school students according to gender (Figure 3). This establishes approximately the same opinion in both the boys' and girls' groups about the inclusion of both physically and mentally handicapped students in P.E. classes in high schools.

Discussion

The present study aimed to determine the attitudes of Slovak able-bodied high school students towards IPE, especially for the inclusion of students with physical and intellectual disabilities in P.E. classes. Able-bodied high school students presented their attitudes in five main statements towards IPE: goal achievement, motivation, motor skills acquisition, self-confidence, and society inclusion. There were no significant differences found between boys and girls either in attitude towards IPE. Girls of the present study were significantly more likely to agree that the advantage of exercising students with intellectual disabilities and able-bodied students in IPE is in achieving goals together. Our research findings are consistent with the results of Wilhite, Biren & Spencer (2012), who have found that joint exercise of people with intellectual disabilities and able-bodied individuals helps both groups to achieve common goals. People with intellectual and developmental disabilities in the above-mentioned study reported benefits of improved muscle tone, more strength, more energy, improved mood, less stress, healthier eating habits, more health awareness, better sleep patterns, more alertness, greater socialization opportunities, and renewed interest. Their able-bodied caregivers reported that joint exercises allowed them to do something positive to themselves while spending quality time with their adult child or sibling with an intellectual and developmental disability (Wilhite, Biren & Spencer 2012).

In general, students with disabilities enjoy P.E. classes. Kurková (2018) found, that students with visual disabilities have a higher percentage of positive attitudes than students who are deaf or hard of hearing in indicators: popularity, importance, students' efforts, and their feelings towards P.E. classes (Kurková 2019). On one hand, the phenomenon of IPE from the perspective of students with disabilities shows good days in the themes of sense of belonging, skill full participation, and sharing in the benefits. On the other hand, the bad days the students with physical disabilities in IPE feel in the themes of social isolation questioned competence,

and restricted participation (Goodwin 2000). Some other studies show also negative attitudes toward P.E. lessons in students with disabilities. Kurková & Nemček (2016) found significant differences in attitudes expressed by students with disabilities if for some reason a regular P.E. lesson is canceled. The highest degree of happiness was observed in the students with physical disabilities, while the highest degree of pity was declared by students with visual disabilities. Authors also found that the biggest reason for inactivity of students with a physical disability during P.E. lessons is their laziness; for students who are deaf and hard of hearing inconvenient conditions; and for students with visual disability thoughts about their next subjects (Kurková & Nemček 2018). The degree of popularity of P.E. is often related to the level of a pupil's successful gaining of movement skills, the level of intensity of specific exercises, and their degree of difficulty, all of which affect the pupil's ability to display their personality.

We have found that boys and girls have taken a positive attitude towards inclusion as they agreed that exercising students with physical and intellectual disabilities in IPE motivates able-bodied students to join physical activities. Authors Pan et al. (2011) in their study concluded that adolescents with autism spectrum disorders had lower motives toward IPE than adolescents without autism spectrum disorders, and external regulation was important in facilitating physical activity participation in adolescents with autism spectrum disorders. The study of Tristani et al. (2021) confirmed, that participation in inclusive physical activity has a motivating character for children with disabilities in social inclusion, secondary health conditions reduction, optimized physical functioning, and overall well-being improvement. Results of Vogler et al. (2021) study indicate that the IPE class where a child with severe spastic diplegic cerebral palsy was included was highly effective in time engagement and management. The qualitative nature of inclusion was one of widespread social acceptance and successful motor participation. The results of Seymour, Reid & Bloom (2021) study showed four conceptual categories that motivate students with disabilities in IPE, that is the development of friendship, best friend, preferred physical activities and outcomes, and dealing with a disability. The results of the study further demonstrated the key characteristics of best friends and the influential role they play.

Motor skill acquisition is one of the primary goals of P.E. and IPE (Bendíková 2016; Bendíková & Dobay 2017; Bendíková, Marko & Šmída 2018). The results of the present study show a positive attitude of able-bodied students in motor skills learning of students with physical and intellectual disabilities in IPE classes. Results of other studies also confirm that an inclusive physical activity program is an effective method for improving the social skills and motor skills of students with autism spectrum disorder (Sansi, Nalbant & Ozer 2021). The

results of this study also demonstrated that an inclusive physical activity program is an effective method for developing the motor skills in typical development peers and creating positive changes in their attitudes. Strategies of universal design for learning, instructional support, incorporation of student choice, and use of multiple media in instruction (e.g., video, verbal, kinesthetics, and photography) significantly contribute to increased success in motor skills learning in IPE (Gilbert 2019). For students who are deaf and hard of hearing, teachers may need to make some basic modifications to their inclusion strategies, visual instruction, communication styles, peer tutoring, and socialization techniques to help these students reach their full potential, including quality motor skill acquisition (Schultz et al. 2013; Kurková & Scheetz 2016). To facilitate the learning of motor skills in IPE, teachers are increasingly taking an ecological approach to assessment and instruction (Goodwin 2000b). In this approach, curriculum activities are categorized by function and intention (i.e., moving from one point to another, propelling a stationary object). Achieving the outcome of the task (e.g., getting the ball into the opponent's court) takes precedent overachieving the 'correct' movement form (Davis & Burton 1991). Students, with the support of the teacher, try to identify the movement form that best meets the desired outcome. Movement solutions are often determined through exploration and self-discovery by the student and direct instruction by the teacher (Burton & Davis 1996).

The results of the present study further revealed a positive attitude of able-bodied students towards inclusion through the statement telling about the self-confidence of students with disabilities by IPE. On one hand in the study of Todorovich (2013) P.E. teachers believed that in IPE is a possibility of negative results, such as a lowering of self-esteem and self-confidence for students with disabilities and even a possible lack of confidence on the part of the P.E. teachers. On the other hand, the study of Hunt & McDonnel (2007) confirms, that the benefits of inclusion are many and important, mainly by improving the community and developing the self-confidence and self-respect of the disability student by helping him integrate smoothly into the formal classroom and later into society. Also, in the current study, we see a very high positive attitude of able-bodied students by the expression that integration of students with disabilities in IPE classes is important for their social inclusion. P.E. is considered to have a high potential for fostering social inclusion (Block 2016). Talbot (2001) claims that P.E. helps children to develop respect for others and enhances social development. Individual student variables are significant for the social inclusion of students with disabilities (Furrer et al. 2020). School performance of students (Huber 2009), behavioural characteristics (Schwab et al. 2014; Garrote et al. 2017) and cognitive ability (Frederickson & Furnham 1998) has a considerable impact on the social inclusion of students with disabilities in IPE classes.

Gender (DeBoer et al. 2012), psychomotor clumsiness (Ruiz-Pérez et al. 2018), and class variables like class climate (Gasser et al. 2017) heterogeneity (Grütter, Meyer & Glenz 2014) and class size (Park, Younghwan & Block 2014) also play an important role in social acceptance and interactions. Using an appropriate teaching strategy in IPE allows full integration into the student environment. Students with disabilities feel more comfortable, changing attitude toward themselves, manifested in the appropriate perception, finding camouflage disabilities struggle with her self-presentation (DeLeeuw, DeBoer & Minnaert 2019).

Conclusion

The findings of this study confirmed a positive attitude toward inclusive physical education for the inclusion of pupils with physical as well as intellectual disabilities in both genders of students of the non-inclusive high school. The highest level of a positive attitude toward IPE declared both genders of high school students by society inclusion through IPE and the lowest level of positive attitude by motor skills acquisition in IPE. Girls compared to boys presented significantly higher positive attitudes in achieving goals in IPE by exercising students with intellectual disabilities together with able-bodied students. It is necessary to continue this line of this research field with stress on exploring the attitudes of able-bodied students toward inclusive physical education by the inclusion of students with sensory disabilities, those who are deaf or hard of hearing, and visually impaired. In further research, we consider it important to focus on the opinions of P.E. teachers in Slovak non-inclusive schools, their readiness and willingness to teach pupils with different kinds of disabilities and with other special educational needs.

Acknowledgments

This scientific research was supported by the grant projects of the Ministry of Education, Science, Research and Sport of the Slovak Republic VEGA No. 1/0409/19 and KEGA No. 051UK-4/2022.

References

1. BAILEY, R., 2005. Evaluating the relationship between physical education, sport and social inclusion. In: *Educational Review.* **57**(1), pp. 71-90.

2. BENDÍKOVÁ, E., 2016. Curricular transformation of education on the field of physical and sport education in Slovakia. In: *European Journal of Contemporary Education.* **18**(4), pp. 410-417.
3. BENDÍKOVÁ, E. & B. DOBAY, 2017. Physical and Sport Education as a Tool for Development of a Positive Attitude toward Health and Physical Activity in Adulthood. In: *European Journal of Contemporary Education.* **6**(1), pp. 14-21.
4. BENDÍKOVÁ, E., M. MARKO & L. ŠMÍDA, 2018. Influence of Change in Content of Physical and Sport Education as Case Study on Level of Dynamic Function of Spine among Secondary School Female Students. In: *European Journal of Contemporary Education.* **7**(4), pp. 633-641.
5. BERTILLS, K., M. GRANLUND & L. AUGUSTINE, 2019. Inclusive teaching skills and student engagement in physical education. In: *Frontiers in Education.* **4**(74), pp. 1-13.
6. BLOCK, M.E., 1995. Development and validation of children's attitudes toward integrated physical education-revised (CAIPE-R) inventory. In: *Adapted Physical Activity Quarterly.* **12**(1), pp. 60–77.
7. BLOCK, M.E., 2016. *A Teacher's Guide to Adapted Physical Education: Including Students with Disabilities in Sports and Recreation*. London: Brookes Publishing.
8. BOOTH, T. & M. AINSCOW, 2011. *Index for Inclusion: developing learning and participation in schools*. Bristol: Centre for Studies on Inclusive Education.
9. BURTON, A.W. & DAVIS, W.E., 1996. Ecological task analysis utilizing intrinsic measures in research and practice. In: *Human Movement Science.* **15**(2), pp. 285-314.
10. DAVIS, W.E. & A.W. BURTON, 1991. Ecological Task Analysis: Translating Movement Behavior Theory into Practice. In: *Adapted Physical Activity Quarterly.* **8**(2), pp. 154–177.
11. DeBOER, A., S.J. PIJL, W. POST & A. MINNAERT, 2012. Peer Acceptance and Friendships of Students with Disabilities in General Education: The Role of Child, Peer, and Classroom Variables. In: *Social Development.* **35**(3), pp. 831–844.
12. DeLEEUW, R.R., A. DeBOER & A. MINNAERT, 2019. What do Dutch general education teachers do to facilitate the social participation of students with SEBD?" In: *International Journal of Inclusive Education.* **35**(4), pp. 1–24.
13. DOWNS, P. & T. WILLIAMS, 1994. Student attitudes toward integration of people with disabilities in activity settings: A European comparison. In: *Adapted Physical Activity Quarterly.* **11**(1), pp. 32–43.
14. FREDERICKSON, N.L. & A.F. FURNHAM, 1998. Sociometric-status-group classification of mainstreamed children who have moderate learning difficulties: An

investigation of personal and environmental factors. In: *Journal of Educational Psychology.* **90**(4), pp. 772–783.

15. FURRER, V., S. VALKANOVER, M. ECKHART & S. NAGEL, 2020. The role of teaching strategies in social acceptance and interactions; Considering students with intellectual disabilities in inclusive physical education. In: *Frontiers in Education.* **5**, pp. 586960.
16. GARROTE, A., R. SERMIER DESSEMONTET & E. MOSER OPITZ, 2017. Facilitating the social participation of pupils with special educational needs in mainstream schools: A review of school-based interventions. In: *Educational Research and Reviews.* **20**(4), pp. 12–23.
17. GASSER, L., J. GRÜTTER, L. TORCHETTI & A. BUHOLZER, 2017. Competitive classroom norms and exclusion of children with academic and behavior difficulties. In: *Journal of Applied Developmental Psychology.* **49**, pp. 1–11.
18. GILBERT, E.N., 2019. Designing Inclusive Physical Education with Universal Design for Learning. In: *Journal of Physical Education, Recreation and Dance.* **90**(7), pp. 15-21.
19. GOODWIN, D.L., 2000. Inclusive physical education: ecological instruction approaches and the use of adaptation and modification. In: *Journal CAHPERD.* **66**(1), pp. 12-13.
20. GOODWIN, D.L., 2001. Meaning of help in PE: Perceptions of students with physical disabilities. In: *Adapted Physical Activity Quarterly.* **18**(3), pp. 189–303.
21. GOODWIN, D. & E. WATKINSON, 2000. Inclusive physical education from the perspective of students with physical disabilities. In: *Adapted Physical Activity Quarterly.* **17**(2), pp. 144–160.
22. GRÜTTER, J., B. MEYER & A. GLENZ, 2014. Sozialer Ausschluss in Integrationsklassen: Ansichtssache? In: *Psychologie in Erziehung und Unterricht.* **62**(1), pp. 65–82.
23. HUBER, C., 2009. Soziale Ausgrenzung in der Integration von Schülern mit sonderpädagogischem Förderbedarf: Zusammenhang von Persönlichkeit, Gruppenheterogenität und sozialer Ausgrenzung. In: *Empirische Pädagogik.* **23**, pp. 170–190.
24. HUNT, P. & J. McDONNELL, 2007. Inclusive Education. In: Odom SL, Horner RH, Snell ME, Blacher J, editors. *Handbook of Developmental Disabilities*. New York: The Guilford Press; 2007. pp. 269-291.
25. HUTZLER, Y., 2012. Attitudes toward the participation of individuals with disabilities in physical activity: A review. In: *Quest.* **55**(4), pp. 347–373.

26. JANOŠKO, P., 2011. Inclusive education – Its benefits, perspectives and limits in the context of the Slovak Republic. In: *e-Pedagogium.* **11**(3), pp. 97-104.
27. KART, A. & M. KART, 2021. Academic and social effects of inclusion on students without disabilities: A review of the literature. In: *Education Sciences.* **11**(16), pp. 1-13.
28. KUDLÁČEK, M., O. JEŠINA & J. WITTMANNOVÁ, 2011. Structure of a questionnaire on children's attitudes towards inclusive physical education (CAIPE-CZ). In: *Acta Universitatis Palackianae Olomucensis. Gymnica.* **41**(4), pp. 43-48.
29. KUDLÁČEK, M., H. VÁLKOVÁ, C. SHERRILL, B. MYERS & R. FRENCH, 2002. An inclusion instrument based on planned behavior theory for prospective Czech physical educators. In: *Adapted Physical Activity Quarterly.* **19**(3), pp. 280–299.
30. KURKOVÁ, P. & D. NEMČEK, 2016. Attitudes of students with disabilities towards physical education lessons: Reasons for their indifference and preference for leisure time activities. In: *Journal of Physical Education and Sport.* **16**(1), pp. 222-229.
31. KURKOVÁ, P. & D. NEMČEK, 2018. Preferences and reasons for the lack of interest of Czech teenagers with sensory disability in physical education classes. In: *Physical Activity Review.* **6**, pp. 171-180.
32. KURKOVÁ, P. & N.A. SCHEETZ, 2016. Communication Strategies Used by Physical Education Teachers and Coaches in Residential Schools for the Deaf in the U.S. In: *Acta Facultatis Educationis Physicae Universitatis Comanianae.* **56**(1), pp. 1-15.
33. KURKOVÁ, P., 2018. Attitudes of Czech pupils who are deaf or hard of hearing toward physical education classes: A comparison of gender differences. In: *Acta Gymnica.* **48**(2), pp. 83-90.
34. KURKOVÁ, P., 2019. Comparison of differences students' viewing in the Czech elementary schools for the deaf in physical education classes with other studies. In: *Physical Activity Review.* **7,** pp. 168-174.
35. MEEGEAN, S. & A. MacPHAIL, 2006. Irish physical educators' attitude toward teaching students with special educational needs. In: *European Physical Education Review.* **12**(1), pp. 75–97.
36. NAVARRO-MATEU, D., J. FRANCO-OCHOA, S. VALERO-MORENO & V. PRADO-GASCÓ, 2020. Attitudes, Sentiments, and Concerns About Inclusive Education of Teachers and Teaching Students in Spain. In: *Frontiers in Psychology.* **11**(521), pp. 1-11.
37. NEMČEK, D. & P. BUMBERA, 2021. Názory žiakov druhého stupňa základných škôl na integrované vyučovanie telesnej a športovej výchovy [Opinions of second grade primary

school pupils on integrated physical education]. In: *Telesná výchova & šport.* **31**(2), pp. 34-39.

38. OBRUSNÍKOVÁ, I., H. VÁLKOVÁ & M.E. BLOCK, 2003. Impact of inclusion in general physical education on students without disabilities. In: *Adapted Physical Activity Quarterly.* **20**(3), pp. 230–245.
39. PAN, C.Y., C.L. TSAI, CH. CHU & K.W. HSIEH, 2011. Physical activity and self-determined motivation of adolescents with and without autism spectrum disorders in inclusive physical education. In: *Research in Autism Spectrum Disorders.* **5**(2), pp. 733-741.
40. PARK, S.S., K.O.H. YOUNGHWAN & M.E. BLOCK, 2014. Contributing Factors for Successful Inclusive Physical Education. In: *Palaestra.* **28**(1), pp. 42–49.
41. PRŮŽEK, M., I. CIHOVÁ, D. NOVAK, X. WANG, J. VAŠÍČKOVÁ, Ľ. TOMÁNEK & B. ANTALA, 2020. Inclusion in physical education on the basis of opinions of high school female students from Slovakia, Czech Republic and Croatia. In: *Journal of Physical Education and Sport.* **20**(3), pp. 1538-1542.
42. RIZZO, T.L. & D.R. KIRKENDALL, 1995. Teaching Students with Mild Disabilities: What Affects Attitudes of Future Physical Educators? In: *Adapted Physical Activity Quarterly.* **12**(3), pp. 205–216.
43. RIZZO, T.L., 1984. Attitudes of physical educators toward teaching handicapped pupils. In: *Adapted Physical Activity Quarterly.* **1**(4), pp. 267–274.
44. RUIJS, N.M. & T. PEETSMA, 2009. Effect of inclusion on students with and without special educational needs. In: *Educational Research Review.* **4**(2), pp. 67-79.
45. RUIZ-PÉREZ, L.M., M. PALOMO-NIETO, M.A. GÓMEZ-RUANO & J.A. NAVIA-MANZANO, 2018. When We Were Clumsy: Some Memories of Adults who were Low Skilled in Physical Education at School. In: *Journal of Physical Education Sports Management.* **5**(1), pp. 30–36.
46. SANSI, A., S. NALBANT & D. OZER, 2021. Effects of an Inclusive Physical Activity Program on the Motor Skills, Social Skills and Attitudes of Students with and without Autism Spectrum Disorder. In: *Journal of Autism and Developmental Disorders.* **51**, pp. 2254-2270.
47. SCHULTZ, J.L., L.J. LIEBERMAN, M.K. ELLIS & L.C. HILGENBRINCK, 20113. Ensuring the Success of Deaf Students in Inclusive Physical Education. In: *Journal of Physical Education, Recreation and Dance*, 2013; 84(5): 51-56.

48. SCHWAB, S., M. GEBHARDT, M. KRAMMER & B. GASTEIGER-KLICPERA, 2014. Linking self-rated social inclusion to social behaviour. An empirical study of students with and without special education needs in secondary schools. In: *European Journal of Special Needs Education.* **30**(1), pp. 1–14.
49. SEYMOUR, H., G. REID & G.A. BLOOM, 2021. Friendship in inclusive physical education. In: *Adapted Physical Activity Quarterly.* **26**(3), pp. 201–219.
50. SHERRILL, C., 2004. *Adapted physical activity, recreation and sport: Cross-disciplinary and lifespan.* 6th ed. Boston: Mc Graw-Hill.
51. SLININGER, D., C. SHERRILL & C.M. JANKOWSKI, 2000. Children's Attitudes Toward Peers with Severe Disabilities: Revisiting Contact Theory. In: *Adapted Physical Activity Quarterly.* **17**(2), pp. 176–196.
52. TALBOT, M., 2001. The case for physical education. In: Doll-Tepper G, Scoretz D, editors. *World Summit on Physical Education*. Germany, Berlin: ICSSPE, pp. 39-50.
53. TODOROVICH, J., 2013. Chinese teachers' beliefs about inclusive physical education. In: *Journal of Physical Education, Recreation and Dance.* **84**(2), 13.
54. TRISTANI, L., J. TOMASONE, H. GAINFORTH & R. BASSETT-GUNTER, 2021. Taking steps to inclusion: A content analysis of a resource aimed to support teachers in delivering inclusive physical education. In: *International Journal of Disability, Development and Education.* **68**(1), pp. 116-135.
55. UNESCO, 2017. *A guide for ensuring inclusion and equity in education*. Paris: UNESCO Publishing.
56. VOGLER, E.W., P. KORANDA & T. ROMANCE, 2021. Including a child of severe cerebral palsy in physical education: A case study. In: *Adapted Physical Activity Quarterly.* **17**(2), pp. 161–175.
57. WILHITE, B., G. BIREN & L. SPENCER, 2012. Fitness Intervention for Adults with Developmental Disabilities and their Caregivers. In: *Therapeutic Recreation Journal.* **46**(4), pp. 245-267.

sciendo

DOI 10.2478/afepuc-2021-0015
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 172-187

ROLE OF FITNESS PROGRAM IN A HEALTH IMPROVEMENT OF ADOLESCENTS

Gorana Tesanovic, Goran Bosnjak, Vladimir Jakovljevic, Radomir Zrnic

Faculty of Physical Education and Sport, University of Banja Luka, Bosnia and Herzegovina

Summary: Since physical activities affect the quality of life and activate a complete locomotor system, sports and physical activities can be treated as a determinant for a harmonious development of all child's characteristics and anthropological characteristics. Because, childhood and youth are the most important formative periods, and some segments of development, for example, specific motor skills can be developed only with means used in sports, this research was conducted to find out do the fitness program (aimed at improving strength) after eight weeks had a positive effect on body composition and mobility and stability of subjects. A control group consisted of 11 female subjects and experimental group were 11 female subjects aged 16 years. The effects of the program on the fitness condition of the subjects were determined by assessing the body composition parameters (data obtained using the Body composition analyser TANITA BC-418) - the total percentage of fat tissue (FAT), the percentage of fat tissue segmentally (percentage of fat tissue of the left leg (FATll), right leg (FATrl), left arm (FATla), right arm (FATra) and body (FATb)) and estimation of mobility and stability levels - based on the application of *Functional movement screening* (FMS) method (seven tests) before and after the program is implemented. The success of the implemented program was confirmed because the program showed a statistically significant difference between the mobility groups of the subjects in the experimental in relation to the control group (deep squat t=3,464 p=0,006, step over a hurdle t=2,390 p=0,038, active lift of a stretched leg t=2,887 p=0,016, rotatory body stability t=3,130 p=0,011 and FMS t=5,721 p=0,000), and a positive effect on the composition of the body in terms of reduction of the percentage of fatty body has been shown segmentally.

Keywords: fitness program, adolescents, body composition, FMS method

Introduction

Regular physical activity is very important for both men and women's health (US Department of Health and Human Services 1996), witha a recommendation that adults and elderly people should actively participate in all aspects of physical activity of moderate intensity for at least 30 minutes daily in order to maintain mobility (WHO 2010). Doing some sports, whether professional or recreational, is important for all people because exercises and every sporting activity are predictors of healthy and long life (Torbarina 2011), and since physical activities activate a complete locomotor system crucial to a transformation of energy which is much needed for the activity of all cells in the body, sports and physical activities can be treated as a determinant for a harmonious development of all child's characteristics and anthropological characteristics (Krželj 2009). Physical activity affects the quality of life (Pucci, Rech, Fermino & Reis 2012). Childhood and youth are the most important formative periods, and some segments of development, for example, specific motor skills can be developed only with means used in sports (Doupona & Petrovič 1997), so it is important that a selected sporting activity is not burdensome, the one which will make them feel pleasure and joy (Martinčević 2010), and the one which will, at the same time, relieve stress and, above all, create from young age a habit of doing sports which will continue during growing up and become part of everyday life (Krželj 2009). The fact is that a large number of children are involved in organized sports programs, but, entering into puberty, it is evident that most of them quit those programs (Fraser-Thomas, Côté & Deakin 2008; Horga 2009). Adolescence is a formative period for adopting behaviors relevant to attitudes, habits and lifestyles (Lacković-Grgin 2006). In youth, under the influence of hormones, the appearance of the body changes in girls (the high activity of lipoprotein lipase during puberty causes fat storage and problems with losing it) fat tissue is accumulated under the skin, the body becomes rounded, more feminine and they take on the characteristics of adult women), so a physical growth ends at the end of puberty, and weight gain can continue and is not in proportion to height (Prebeg & Prebeg 1985). Today, discontent with appearance, especially in girls, is considered a frequent occurrence, most notably in adolescent girls ((Đurović, Mohorić i Pokrajac-Bulian 2007). Physical activity plays an important role in the satisfaction of individuals' lives (Melin, Fugl-Meyer & Fugl-Meyer 2003), and one of the valuable means of increasing life satisfaction is physical activity (Maher, Pincus, Ram & Conroyd 2015). Physiological, anatomical, psychological and socio-cultural specifics of the female sex require special consideration in all spheres of their physical activities (Greydanaus

& Patel 2002). The term fitness is used in the process of development, raising or maintenance at the optimal level of general psychophysical abilities and characteristics of a body, and it implies a thorough preparation of bodies for efforts and goals of people who are engaged in physical activities for recreational reasons (Omrčen, Andrijašević & Štefić 2007).

It has been established that aerobic programs have a transformational effect on morphological and motor status, running and walking programs on changes in functional abilities (Sekulić, Rausavljević & Zenić 2003), while weight exercises have invaluable benefits for the development and maintenance of bone mass of women at all ages (Hagen 2005). The American College of Sports Medicine (ACSM 2010) recommends a cumulative of 20 – 60 minutes of moderate aerobic activity 3-5 times per week and resistance training 2-3 times a week by varying the general type of exercise to include muscular strength, muscular endurance, aerobic endurance, anaerobic endurance, flexibility, and mobility. According to the World Health Organization (Global recomendations on Physical activity for health,WHO 2010), physical activity in adults involves leisure activities, transportation (walking or cycling), work activities, housekeeping, games, sports, organized and individual exercise, and all activities that take place within a family, school and sports community.

In order to find ways to include young girls in sports activities, a fitness program aimed at improving strength was implemented in order to determine its effects after eight weeks on the fitness of subjects by comparing changes in their body composition and mobility and stability (FMS method) whose changes in a positive sense are indicators of health what can be a guideline in choosing activities that can be part of a fitness program of this population.

Methods

The study was conducted on a sample of 22 female subjects of young age (16 years ± 6 months), of which a control group consisted of 11 female subjects and experimental group were 11 female responders. Prior to the implementation of the program, respondents were not included in any sports-recreational activities and were of optimal health without injuries to the locomotor apparatus. The program was conducted over eight weeks and was focused on improving muscular endurance and fitness. The ACSM (2010) recommends 3 sets of 8-12 repetitions of strength training exercises, two to three times a week. The time, or duration, of a cardiovascular workout should be at least 20 – 30 minutes of continuous, rhythmic exercise of large muscle groups. “Time”

for a strength-training workout is best quantified in repetitions and sets. The type of training, broken into large categories, includes muscular strength, muscular endurance, aerobic endurance, anaerobic endurance, flexibility, and mobility. The type of training should vary daily throughout a training week. Many athletes find heart-rate training beneficial to ensure proper intensity. The ACSM (2010) recommends an intensity of 65 % - 90 % maximum heart rate (HRmax) during aerobic exercise. The ACSM (2010) recommends an intensity of 50 % to 85 % of HRR for aerobic exercise. This program has been developed by an Exercise Physiologist for those who have a basic level of fitness (that is, they are able to walk comfortably for 30 minutes) (more details at https://getontrackchallenge.com.au/assets/exercise-phys-guides/beginner_final_lowres.pdf). The training is designed to last 45 minutes. It is designed to use your own body weight (table 1). The effects of the program on the fitness condition of the subjects were determined by assessing the body composition parameters (data obtained using the Body composition analyser TANITA BC-418) - the total percentage of fat tissue (FAT), the percentage of fat tissue segmentally (percentage of fat tissue of the left leg (FATll), right leg (FATrl), left arm (FATla), right arm (FATra) and body (FATb)) and estimation of mobility and stability levels - based on the application of *Functional movement screening* (FMS) method (seven tests) before and after the program is implemented.

The statistical program SPSS 16,0 and the following statistical methods were used to obtain valid results: the basic descriptive statistics, the KS test-analysis of the normality of results, the independent t-test - analysis of differences between groups and the dependent t-test-analysis of differences within a group.

Table 1

Fitness program

exercises		**Week→**	**1**			**2**			**3**			**4**		
		Session→	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**1**	**2**	**3**	**2**	**3**
flexibility	Calf stretch	15 sec hold per leg												
	Lying hamstring stretch	15 sec hold per leg												
	Lying hip flexor stretch	15 sec hold per side												
	Lying glute-medius stretch	15 sec hold per side												
cardio	walking	5 mins												
resistance	Sit to stand no weights OR with 2 kg weight	Week 1=10 reps Week 3=15 reps												
	Bench push-ups	Week 5=20 reps Week 7=25 reps												
	Wall plank	Hold up to 1 min												
	Modified mountain climbers	Week 2=10 reps Week 4=15 reps												

	Suppored squats	Week 6=20 reps												
	One arm row	Week 8=25 reps												
	Wall plank	Hold up to 1 min												
repeat cardio														
repeat resistance for appropriate week														
repeat cardio														
repeat resistance for appropriate week														
cool down	Slow walk	5 mins												
	Calf stretch	15 sec hold per leg												
	Lying hamstring stretch	15 sec hold per leg												
	Lying hip flexor stretch	15 sec hold per side												
	Lying glute-medius stretch	15 sec hold per side												
	Lying hamstring stretch	15 sec hold per leg												

exercises		**Week→**	**5**			**6**			**7**			**8**		
		Session→	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
flexibility	Calf stretch	15 sec hold per leg												
	Lying hamstring stretch	15 sec hold per leg												
	Lying hip flexor stretch	15 sec hold per side												
	Lying glute-medius stretch	15 sec hold per side												
cardio	walking	5 mins												
resistance	Sit to stand no weights OR with 2 kg weight	Week 1=10 reps Week 3=15 reps												
	Bench push-ups	Week 5=20 reps Week 7=25 reps												
	Wall plank	Hold up to 1 min												
	Modified mountain climbers	Week 2=10 reps Week 4=15 reps												
	Suppored squats	Week 6=20 reps												
	One arm row	Week 8=25 reps												
	Wall plank	Hold up to 1 min												
repeat cardio														
repeat resistance for appropriate week														
repeat cardio														
repeat resistance for appropriate week														
cool down	Slow walk	5 mins												
	Calf stretch	15 sec hold per leg												
	Lying hamstring stretch	15 sec hold per leg												
	Lying hip flexor stretch	15 sec hold per side												
	Lying glute-medius stretch	15 sec hold per side												
	Lying hamstring stretch	15 sec hold per leg												

Results and discussion

Table 2

Descriptive parameters of body composition segmentally at initial and final measurements for both groups of subjects

groups			N	M	S. D	Ks test
experimental	initially	FATrl	11	36,9545	6,13178	0,741
		FATll	11	36,1727	6,75812	0,711
		FATra	11	31,7636	8,53642	0,990
		FATla	11	32,6455	8,72667	0,995
		FATb	11	29,9727	9,54307	0,977
		FAT%	11	23,5210	4,8700	0,852
	final	FATrl	11	33,9100	6,17368	0,857
		FATll	11	33,9300	5,56398	0,691
		FATra	11	28,4700	6,34106	0,932
		FATla	11	28,6900	6,86399	0,657
		FATb	11	29,4909	9,13252	0,992
		FAT%	11	21,7840	5,8700	0,852
control	initially	FATrl	11	34,7500	5,85591	0,857
		FATll	11	34,4000	5,35828	0,627
		FATra	11	28,9000	6,31489	0,954
		FATla	11	29,1500	6,83963	0,741
		FATb	11	36,5000	9,74394	0,905
		FAT%	11	23,7210	3,8700	0,852
	final	FATrl	11	36,5545	5,69304	0,963
		FATll	11	35,6182	6,28567	0,887
		FATra	11	32,7818	8,12672	0,996
		FATla	11	32,2636	8,79276	0,983
		FATb	11	33,5000	7,13754	0,634
		FAT%	11	23,2210	5,8700	0,852

From the values shown in Table 2 it can be seen that there was a change in the average values at both groups of subjects - in the experimental group there was a decrease in all the fat tissue values segmentally, and in the control group there was an increase in all fat tissue values, except for body fat tissue.

Table 3

Descriptive test parameters for assessing mobility and body stability-FMS method

groups			N	M	S. D	Ks test
experimental	initially	deep squat	11	1,5455	,52223	0,548
		hurdle step	11	1,5455	,52223	0,704
		Inline lunge	11	1,4545	,52223	0,452
		shoulder mobility	11	2,1818	,60302	0,356

		active straight-leg raise	11	2,0909	,83121	0,548
		trunk stability pushup	11	2,0000	,77460	0,704
		rotatory stability	11	2,3636	,67420	0,548
		FMS total	11	12,818	2,31595	0,704
	final	deep squat	11	2,0909	,53936	0,452
		hurdle step	11	1,8182	,75076	0,356
		Inline lunge	11	1,8182	,75076	0,548
		shoulder mobility	11	2,4545	,68755	0,704
		active straight-leg raise	11	2,5455	,68755	0,548
		trunk stability pushup	11	2,6364	,50452	0,704
		rotatory stability	11	2,8182	,40452	0,356
		FMS total	11	15,181	2,60070	0,548
control	initially	deep squat	11	1,6000	,51640	0,548
		hurdle step	11	1,7000	,48305	0,704
		Inline lunge	11	1,5000	,52705	0,452
		shoulder mobility	11	2,3000	,82327	0,356
		active straight-leg raise	11	2,5000	,52705	0,548
		trunk stability pushup	11	1,9000	,87560	0,704
		rotatory stability	11	2,4000	,51640	0,548
		FMS total	11	13,100	2,02485	0,704
	final	deep squat	11	1,5455	,52223	0,452
		hurdle step	11	1,4545	,52223	0,356
		Inline lunge	11	1,4000	,51640	0,452
		shoulder mobility	11	2,3000	,48305	0,356
		active straight-leg raise	11	2,0909	,83121	0,548
		trunk stability pushup	11	2,1000	,73786	0,704
		rotatory stability	11	2,3000	,82327	0,452
		FMS total	11	10,100	1,10050	0,356

Table 3 shows the values of descriptive statistics of the mobility variables and body stability the FMS method at the initial and final measurement for both groups of subjects. It can be seen from the values shown in Table 3 that there were changes in the average values for both groups of subjects - in the experimental group there was an increase in the average values of the results of mobility and body stability, and in the control group there was a decrease in the average values of mobility results and body stability.

Table 4 shows the results of the statistical analysis of the T-test for independent samples at the initial measurement. On the basis of significance, it can be concluded that there is no statistically significant difference in the initial measurement between the groups of subjects at the results of all tests. This shows that the groups are well selected, and the influence of unwanted factors in the further analysis is excluded.

Table 4

Difference between groups initial measurement of the results of all tests

	t-test	**Sig.**
FATrl	0,168	0,868
FATll	0,271	0,789
FATra	0,638	0,531
FATla	0,841	0,411
FATb	0,661	0,516
FAT%	0,796	0,445
deep squat	0,866	0,397
hurdle step	1,014	0,323
Inline lunge	0,825	0,420
shoulder mobility	0,209	0,837
active straight-leg raise	0,780	0,445
trunk stability pushup	1,021	0,320
rotatory stability	0,649	0,524
FMS total	-0,295	0,771

Table 5

Difference between groups final measurement of the results of all tests

	t-test	**Sig.**
FATrl	**3,218**	**0,009**
FATll	**2,498**	**0,032**
FATra	0,721	0,479
FATla	1,030	0,316
FATb	**4,059**	**0,002**
FAT%	**4,662**	**0,001**
deep squat	**3,464**	**0,006**
hurdle step	**2,390**	**0,038**
Inline lunge	0,721	0,479
shoulder mobility	1,472	0,157
active straight-leg raise	**2,887**	**0,016**
trunk stability pushup	1,936	0,082
rotatory stability	**3,130**	**0,011**
FMS total	**5,721**	**0,000**

Table 5 shows the results of the statistical analysis of the T-test for independent samples at the final measurement. On the basis of significance, it can be concluded that there is no statistically significant difference in the final measurement between the groups of subjects at the results of the tests which analyzed the percentage of fat tissue of the upper extremities (FATra and FATla) and

in the part of the tests which analyzed the mobility and stability of the body (step forward at the sagittal level, shoulder mobility and push-up stability), while on all other tests (FATrl, FATll, FATb, FAT%, FMS total - at tests: deep squat, step over a hurdle, active lifting of a stretched leg, rotatory body stability) a significant difference was observed. Based on the average values of the results that the groups of subjects showed at the final measurement, it can be concluded that after the application of the fitness program there was an improvement in the experimental group compared to the control group.

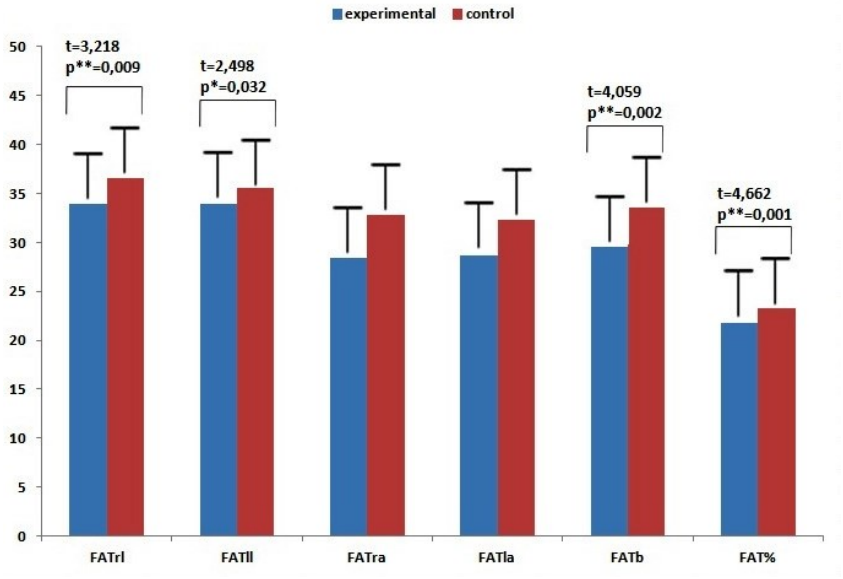

Figure 1

The difference between the results of the experimental and control group at the final measurement regarding variables that measured the body composition segmentally

The success of the implemented program was confirmed because the program showed a statistically significant difference between the mobility groups of the subjects in the experimental in relation to the control group (deep squat t = 3,464 p = 0,006, step over a hurdle t = 2,390 p = 0,038, active lift of a stretched leg t = 2,887 p = 0,016, rotatory body stability t = 3,130 p = 0,011 and FMS t = 5,721 p = 0,000) (Figure 2), and a positive effect on the composition of the body in terms of reduction of the percentage of fatty body has been shown segmentally (FATrl t = 3,218 p = 0.009, FATll t = 2.498 p = 0,032, FATb t = 4,059 p = 0,002 i FAT % t = 4,662 p = 0,001) (Figure 1).

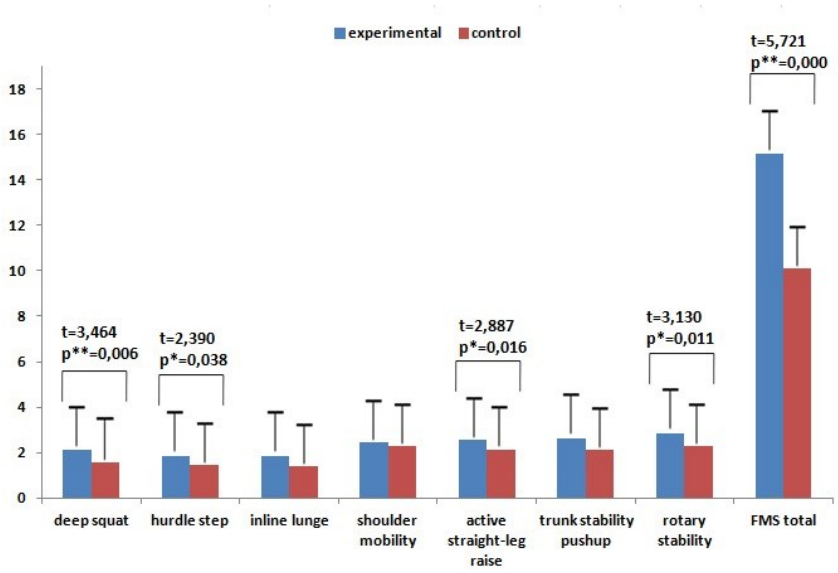

Figure 2

The difference between the results of the experimental and control group at the final measurement regarding the variables that measured stability and mobility

Stojiljković, Mandarić, Todorivić & Mitić (2010) state that the aerobics program led to significant changes in the morphological and motor skills of female examinees. It also states that programmed systematic exercise influences the transformation of a body composition of women (Fogelholm, Kukkonen-Harjula, & Oja 1999), and in particular a reduction of body fat percentage in an organism (Širić, Prelčec & Brčić 2005). It has also been found that in physically active individuals the level of fat oxidation is higher during training (Tremblay, Coveney, Despres, Nadeau & Prud'homme 1992).

By analyzing the group fitness program it can be noticed that the program was designed for beginners, and that the trainings consisted of several components that affect the morphological and functional characteristics - stretching which improves the mobility of the joints, a cardio part during which the examinees prepared for the main part of the training in which they worked on their strength using the exercise of resistance, and repeated stretching. The characteristic manifestation of the overall morphologically-anatomical, functional and psychological organization of the organism reflects the overall appearance of the human body, giving importance to the overall morphological status (Ross, Ward, Leahy & Day 1982), and in women, a greater percentage of body fat accumulates under the influence of estrogen hormone, which stimulates deposition of fat in the subcutaneous tissue, breast tissue and especially in the gluteal region and thighs. The program

has selected exercises for improving mobility and strength improvement training exercises that required an active operation of body muscles and lower extremities. It is known that stretching reduces muscle tension, increases an amplitude of a movement, prevents injuries to muscles and joints, back, stimulates circulation, increases joint mobility, cardio training helps to reduce fat tissue, strengthens the heart muscle and lungs, increases bone density, reduces stress, and that resistance exercises improve muscle strength and increase muscle tone and also increase muscle and fat ratio - when it gets muscles, the body continues to burn fat even at rest. All trainings were moderate to high intensity, and the main feature of high-intensity training is its efficiency in accelerating metabolism and practical application due to time efficiency compared to traditional aerobic exercise (Astorino, Allen, Roberson & Jurancich 2012). Besides the fact that high intensity training positively influences the reduction of body fat and massless body mass, it also produces positive results on the muscle mass of female subjects (Tremblay, Després, Leblanc, Craig, Ferris, Stephens & Bouchard 1990; Bryner, Toffle, Ullrich & Yeater 1997; Sijie, Hainai, Fengying & Jianxiong 2012; Guiraud, Nigam, Gremeaux, Meyer, Juneau & Bosquet 2012; Bacon, Carter, Ogle & Joyner 2013; Smith-Ryan, Trexler, Wingfield & Blue 2016), which has been shown in this study when it comes to the percentage of fat tissue because the percentage of fatty tissue of body, percentage of trunk fat, and the percentage of lower extremities fat tissue significantly decreased in subjects of the experimental group after the exercise of the fitness program. The body composition of women is characterized by a lower total mass and a smaller percentage of muscle tissue and a larger of fat mass. Women have less ability to generate absolute force, especially in the upper extremities, which is even 50 % lower than men (Kenney, Wilmore & Costil 2012), which is in line with the results obtained in this study, because although exercises were applied in order to improve the strength of the whole body, the percentage of fat tissue of the upper extremities did not significantly change in the female subjects of the experimental group compared to the subjects of the control group. Reducing fatty tissues of the lower extremities and body can be attributed to the selection of strength exercises because the exercises required the active operation of the muscles of the body and lower extremities. Since it was found that the selected stretching exercises and strength exercises acted positively on muscle activation and reduced fat tissue of the body and lower extremities, it was expected that mobility would improve and that a significant difference would be shown among the respondents of the experimental group compared to the

subjects of the control group in mobility and stability tests in which muscles of the lower extremities and muscles of the abdomen were more active.

Đug & Mikić (2007), using the fitness program of step aerobics, both in the anthropometric and motor characteristics of female students, achieved significant partial changes, and Pavić & Žuvela (2004) found that aerobic exercise led to reduced subcutaneous fat tissue, which confirms that the selection of activities compliant with the goal and age and sex with which it works, results in positive effects. This has also been shown in this research because the selection of a group fitness program, designed by experts and intended for beginners and focused on a comprehensive work of moderate intensity in parts of training dedicated to stretching and cardio programs with a moderately high intensity in improving strength resulted in positive changes in subjects of the adolescent age. As such, it has proven to be a good recreational activity at this age, because it can motivate one to engage further in some group or individual fitness program, because motivation is the main determinant of defining the intensity and depth of involvement in sports and recreational activities.

Conclusion

Proper understanding of what motivates people to participate will cause effective program planning and implications for health (Snepenger, King, Marshall & Uysal 2006), because physical activity improves the quality of life for both young and older adults (Joseph, Royse, Benitez & Pekmezi 2014) , and the selection of activities in line with the goal, age and gender which it works with results in positive effects. Adolescence is a period suitable for adopting behaviors relevant to attitudes, habits and lifestyles, because at that age changes in body appearance occur, and girls take on the characteristics of adult women, and physical growth ends at the end of puberty, and weight gain can continue. As more and more girls entering the puberty stops doing sports or recreational activities, it is desirable to motivate them to exercise some kind of physical activity of the type of such a group fitness program for beginners that is aimed at improving strength, since it has been shown that in the youth age of girls this had a positive effect on the reduction of percentage of fatty tissue, but also on increased mobility and stability whose changes in positive sense are indicators of health. All this points to the need to conduct research of a similar nature in order to enable girls to engage in sports-recreational activities of a type of group fitness program which do not require too much efforts and which have a positive impact on their health status.

References

1. ACSM, 2010. *ACSM'S Guidelines for Exercise Testing and Prescription*. (Senior editor: Thompson, W. R., associate editors: Gordon, N. F., Pescatello), L. S. Philadelphia: American College of Sports Medicine
2. ANONIMUS. beginner_final_lowres.pdf. [Internet] Retrived from https://getontrackchallenge.com.au/assets/exercise-phys-guides/beginner_final_lowres.pdf [14.03.2021.]
3. ASTORINO, T. A., R. P. ALLEN, D. W. ROBERSON & M. JURANCICH, 2012. Effect of High-Intensity Interval Training on Cardiovascular Function, VO2max, and Muscular Force. *The Journal of Strength & Conditioning Research.* ***26***(1), 138-145.
4. BACON, A. P., R. E. CARTER, E. A. OGLE & M. J. JOYNER, 2013. VO2max trainability and high intensity interval training in humans: A meta-analysis. *PloS one.* ***8***(9), e73182.
5. BRYNER, R. W., R. C. TOFFLE, I. H. ULLRICH & R. A. YEATER, 1997. The effects of exercise intensity on body composition, weight loss, and dietary composition in women. *Journal of the American College of Nutrition.* ***16***(1), 68-73.
6. DOUPONA, M. & K. PETROVIČ, 1997. Sport kao kakvoća življenja (Slučaj mladih). *Kineziologija.* ***29***(1), 21-24.
7. ĐUG, M., & MIKIĆ, B., 2007. *Uticaj step aerobika na transformaciju antropometrijskih karakteristika i motoričkih sposobnosti studenata.* Zbornik radova sa III Kongresa i IV Međunarodne naučnekonferencije Crnogorske sportske akademije. (pp. 129-133). Podgorica, MNE.
8. ĐUROVIĆ, D., T. MOHORIĆ & A. POKRAJAC-BULIN, 2007. Odstupajuće navike hranjenja, nezadovoljstvo tijelom i učestalost provođenja dijete kod hrvatskih srednjoškolaca. *Psihološke teme.* ***16***(1), 27-46.
9. FOGELHOLM, M., K. KUKKONEN-HARJULA & P. OJA, 1999. Eating control and physical activity as determinants of short-term weight maintenance after a very-low-calorie diet among obese women. *International Journal of Obesity & Related Metabolic Disorders*, *23*(2).
10. Fraser-Thomas, J., Côté, J., & Deakin, J. (2008). Examining Adolescent Sport Dropout and Prolonged Engagement from a Developmental Perspective, *Journal of Applied Sport Psychology.* ***20***, 318–333.

11. Greydanaus, D., & Patel, D. (2002). The female athlete before and beyond puberty. *Pediatr Clin N Am., 49,* 553–580. doi: 10.1016/S0031- 3955(02)00005-6
12. GUIRAUD, T., A. NIGAM, V. GREMEAUX, P. MEYER, M. JUNEAU & L. BOSQUET, 2012. High-Intensity Interval Training in Cardiac Rehabilitation, *Sports medicine.* ***42***(7), 587-605.
13. HAGEN, T., 2005. Sports medicine and the adolescent female. *J Pediatr Adolesc Gynecol, 18*, 9–15. doi: 10.1016/j.jpag.2004.11.005; PMid: 15749579
14. HORGA, S., 2009. *Psihologija sporta*. Zagreb, RH: Školska knjiga.
15. JOSEPH, R., K. ROYSE, T. BENITEZ & D. PEKMEZI, 2014. Physical activity and quality of life among university students: exploring self-efficacy, self-esteem, and affect as potential mediators. *Quality of Life Research*, 659-667.
16. KENNEY, L. W., H. J. WILMORE & L. D. COSTIL, 2012. Physical Activity for Health and Fitness. In: *Physiology of sport and exercise*. 5th ed. Champaign. IL: Human Kinetics.
17. KRŽELJ, V., 2009. *Dijete i sport*. Klinika za dječje bolesti Kliničkog bolničkog centra Split. Split: Medicinski fakultet Sveučilišta u Splitu. Retrived from https://bib.irb.hr/datoteka/513581.Dijete_i_sport.doc
18. LACKOVIĆ-GRGIN, K., 2006. *Psihologija adolescencije*. Jastrebarsko, RH: Naklada Slap.
19. MAHER, J., A. PINCUS, N. RAM & D. CONROYD, 2015. Daily Physical Activity and Life Satisfaction across Adulthood. *Developmental Psychology*. 1407–1419.
20. MARTINČEVIĆ, J., 2010. Provođenje slobodnog vremena i uključenost učenika u izvannastavne aktivnosti unutar škole. *Život i škola: časopis za teoriju i praksu odgoja i obrazovanja, 24*., 29-34.
21. MELIN, R., K. FUGL-MEYER & A. FUGL-MEYER, 2003. Life satisfaction in 18- to 64-year-old Swedes: in relation to education, employment situation, health and physical activity. *Journal of Rehabilitation Medicine*, 84-90.
22. OMRČEN, D., M. ANDRIJAŠEVIĆ & L. ŠTEFIĆ, 2007. Sport, rekreacija i fitnes - analiza odabranih kineziooloških naziva. *Društvena istraživanja*, 943-964.
23. PAVIĆ, R. & F. ŽUVELA, 2004. *Uticaj aerobik tretmana na redukciju masnog tkiva žena.* In Findak, V. (Eds.), Zbornik radova 13. ljetnje škole kineziolaga Republike Hrvatske. Rovinj, RH: Kineziološki fakultet, Sveučilišta u Zagrebu.
24. PREBEG, Ž. & Ž. PREBEG, 1985. *Higijena i škola*. Pedagoška biblioteka.

25. PUCCI, G. C. M. F., C. R. RECH, R. C. FERMINO & R. S. REIS, 2012. Association between physical activity and quality of life in adults. *Rev Saude Publica.* ***46***(1), 1-10.
26. ROSS, W. D., R. WARD, R. M. LEAHY & J. A. P. DAY, 1982. *Proportionality of Montreal athletes.* In J.E.L. Carter (Ed.), Physical structure of Olympic athletes: Part 1: The Montreal Olympic Games Anthropometrical Project (pp. 81-106). Basel: Karger.
27. SEKULIĆ, D., N. RAUSAVLJEVIĆ & N. ZENIĆ, 2003. Changes in motor and morphological measures of young women induced by the HI-LO and STEP aerobic dance programmes. *Kinesiology.* ***35****(1)*, 48-58.
28. SIJIE, T., Y. HAINAI, Y. FENGYING & W. JIANXIONG, 2012. High intensity interval exercise training in overweight young women. *The Journal of Sports Medicine and Physical Fitness.* ***52***(3), 255-262.
29. SMITH-RYAN, A. E., E. T. TREXLER, H. L. WINGFIELD & M. N. BLUE, 2016. Effects of high-intensity interval training on cardiometabolic risk factors in overweight/obese women. *Journal of Sports Sciences.* 1-9.
30. SNEPENGER, D., J. KING, E. MARSHALL & M. UYSAL, 2006. Modeling Iso-Ahola's Motivation Theory in the Tourism Context. *Journal of Travel Research.* ***45***(2) 140-149.
31. STOJILJKOVIĆ, S., S. MANDARIĆ, K. TODORIVIĆ & D. MITIĆ, 2010. *Efekti primjene „omnibus" aerobika na tjelesnu kompoziciju žena.* Beograd, RS: Fakultet za sport i fizičko vaspitanje. 796.1-055.2
32. ŠIRIĆ, V., S. PRELČEC & B. BRČIĆ, 2005. Utjecaj programiranog tjelesnog vježbanja na postotak tjelesne masti, *Stručni časopis „Edukacija, rekreacija, sport".* 38 – 42.
33. TORBARINA, Z., 2011. Sport – zaštitni čimbenik u suočavanju s rizničnim ponašanjima djece i mladih. *JAHR.* ***2***(3), 65–74.
34. TREMBLAY, A., S. COVENEY, J. P. DESPRES, A. NADEAU & D. PRUD'HOMME, 1992. Increased resting metabolic rate and lipid oxidation in exercise-trained individuals: evidence for a role of beta-adrenergic 2017. *TIMS Acta. 11*, 53-64.
35. TREMBLAY, A., J. P. DESPRÉS, C. LEBLANC, C. L. CRAIG, B. FERRIS, T. STEPHENS & C. BOUCHARD, 1990. Effect of intensity of physical activity on body fatness and fat distribution. *The American Journal of Clinical Nutrition.* ***51***(2), 153-157.
36. U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, 1996. *Physical activity and health*: A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human

Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion.

37. WHO. World Health Organisation, [Internet] Retrived from http://www.who.int/en/ [12.03.2021.]

DOI 10.2478/afepuc-2021-0016
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 188-202

PHYSIOLOGICAL RESPONSE OF THE PERFORMANCE OF YOUNG FOOTBALL PLAYERS DURING SMALL-SIDED GAMES

Nikolas Nagy[1], Miroslav Holienka[1], Matej Babic[2]

[1]Department of Sports Games, Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia

[2]Department of Physical Education and Sports, Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava, Slovakia

Summary: The main aim of the present study was to examine the cardiovascular response, time-motion characteristics, game performance and rated of perceived exertion (RPE) during small-sided games (SSGs) with different number of players. The research group consisted of elite youth male soccer players (n = 18) (aged 16.5 ±0.71 years, maximum heart rate (HR_{max}) 196.42 ±5.31 beats.min^{-1}) from the FC DAC 1904 Dunajská Streda U17 soccer club. Cardiovascular response measurements included heart rate (HR) expressed in minimum, mean and maximum values and time spent in different intensity zones. Total distance covered, high intensity running and the number of accelerations and decelerations were captured by GPS. Individual game performance and the number of technical-tactical actions were recorded during every SSGs. After the game time we collected the ratingsof perceived exertion scores from each player. Results showed that SSG with small number of players (3 vs. 3) triggered the highest HR response with mean value 168.00 ±8.48 beats.min^{-1}, players spent the most time in maximal intensity zone 0:09:06 minutes, of SSG duration. This format of SSG was the mostintensefor the players´ cardiovascular system, but we can't find statistically significant differences between the HR values in SSGs. External load was the most demanding in SSG1 too, like in internal load. The highest scores in individual game performance were recorded in SSG2. In RPE scores SSG1 was the most difficult from the players point of view. In conclusion, the present research demonstrates the effectiveness of SSG1 in training sessions. Therefore, the coaching staff has the possibility to choose between SSGs during training sessions according to their physical, technical, tactical and psychological objectives.

Key Words*:* soccer, small-sided games, internal load, time-motion characteristics, individual game performance, RPE

Introduction

The purpose of thoughtful training process is to help increase the adaptation capacity of player´s organism to the load, with which players are frequently confronted during competitive soccer match. The systematic training process should prepare players for game demands in technical, tactical, physiological and psychological way.

Holienka (1998) claims that the current fundamental principle in well-thought soccer training process – all with a ball – fulfils the game training. Small-sided games (SSGs) play an essential part in the training process, which contain a lot of different game situation that are very similar to the real game situations during a match. Ideally, the training process has to contain SSGs, where the soccer players physiological curve moves at the level or above of the anaerobic threshold (ANT).

Different forms of SSGs are widely used in soccer practice (Clemente et al. 2012). SSGs allow the players to gain valuable soccer experience, because they have to deal with the game situations, which often occur during matches. When solving the various complex game situations during SSGs, players are able to improve their technical ability, tactical behaviour, fitness aspect of their game preparedness and their mental resistance as well.

Kačáni (2004) divides the SSGs according to the number of players into 3 groups:
1. group = SSG – small (from 1 to 3 players). During small forms of SSGs (1 vs. 1 to 3 vs. 3) the training load often higher than the real soccer match intensity.
2. group = SSG – medium (from 4 to 6 players). During medium forms of SSGs (4 vs. 4 to 6 vs. 6) the training load is at the same level of intensity as during the most intense periods of soccer matches.
3. group = SSG – large (from 7 to 9 players). During large forms of SSGs (7 vs. 7 to 9 vs. 9) the load in LSG at the same level like during the competitive matches.

SSGs involve a smaller number of players, play on reduced field area and often use modified rules not like traditional competitive soccer match. Therefore, these types of exercises, which induce greater heterogeneous response than traditional fitness training methods, are very popular and useful training drills for players of all ages and playing levels especially with younger age groups (Dellal et al. 2011).

Nowadays, previous studies have examined that soccer coaches can influence the intensity of training load in SSGs if they adequately change the variables, which are affecting the intensity of SSGs. The variables include: the number of participating players, size of the game field, coach encouragement, presence of goalkeepers, size of the goal, number of goals,

game rules, work interval and rest interval too (Owen et al. 2004; Rampinini et al. 2007; Hill-Haas et al. 2011; Köklü et al. 2013; Mikulič et al. 2018; Nagy a Holienka 2018; Peráček et al. 2018a, 2018b; Nagy & Babic 2019; Nagy et al. 2019; Nagy et al. 2020a; Nagy et al. 2020b).

Knowing that the number of participating players during SSGs could affect the physiological responses, time motion characteristics and game performance, soccer coaches need to consider the aim of the training session during the microcycle. Thus, the main goal of the present study was to compare the effects of 3 different forms of SSG with various number of players. These 3 forms of SSGs are indeed very popular and often used by soccer coaches during training sessions. The findings could potentially provide valuable and reliable information to the coaching staff for the design of different forms of SSGs as part of their training units.

Methods

Experimental approach to the problem

In our research we measured internal load (cardiovascular response – HR values), external load (time-motion characteristics), individual game performance (game activity) and rate of perceived exertion (RPE) during three forms of SSGs with small (3 vs. 3), medium (6 vs, 6) and large (9 vs. 9) number of players.

Participants

The research group consisted of male youth soccer players (n = 18) (aged 16.5 ±0.71 years, VO_{2max} 56.06 ±2.84 $ml.min^{-1}.kg^{-1}$, maximum heart rate [HR_{max}] 196.42 ±5.31 $beats.min^{-1}$) from the FC DAC 1904 Dunajská Streda U17 soccer club.

According to the maximal heart rate (HR_{max}) we determined 5 load zones. These zones were determined on the basis of level of intensities, which were defined by percentages of the HR_{max} values. One of the main methods to acquire the data used during this research was heart rate (HR) measurement. First of all, we ascertain the values of maximal heart rate (HR_{max}). To measure the HR the set of sports testers POLAR TEAM 2 PRO was used. The calculation of the percentage and time representation of HR values was done by using a special program and software POLAR TEAM 2. All soccer players were members of the same youth team competing in the top-level competition of this age group in Slovakia. Training frequency of the youth squad was seven training sessions a week and one soccer match. Before the research process the head coach divided the players into 2 well-balanced teams according to the player's performance-related level and playing position. Both teams included defenders, midfielders and

forward players. During the SSGs the goalkeepers did not have the sports tester fastened to their chest, since we did not monitor the level of their HR values.

Small-sided games

We measured the HR values, time-motion characteristics, game performance and RPE scores during 3 forms of SSG with different number of players but with fixed rules. The SSGs were played on artificial turf, relative grid area for 1 player was 75 m^2 in each SSG variants and was marked out with cones. On the pitch was placed standard goal (sized 7.32 x 2.44 m) at the centre of each goal line. For scoring in all formats of SSGs, all players had to be in the attacking half. All SSGs were played with unlimited touches of the ball and without offside rule. Replacement balls were immediately accessible along the entire pitch if the ball was kicked out of play. During SSGs were prepared 9 balls, 6 of them spread around the field, 2 of them were in goals and with one of them played the players soccer. The spare balls were also there in case if the ball would leave the playing field, the game could continue with another one. In this way, we tried to ensure the continuity of the game and to maintain the load intensity of the players. There was a minimum of coaches´ encouragement during the SSG, but players could verbally encourage each other with the aim to maintain the intensity of SSG. During the SSGs the clear load time was 12 minutes.

Table 1

SSGs characteristics

SSGs	Players	GK	Field dimensions		Field area	Area/ player	Batch load				
	(n = 18)	(n = 2)	Width [m]	Length [m]	[m^2]	[m^2]	LI [min.]	RS [min.]	NR	NS	CL [min.]
SSG1	3 vs. 3	1 / 1	18	25	450	75	2	1	6	1	12
SSG2	6 vs. 6	1 / 1	26	35	910	75	4	2	3	1	12
SSG3	9 vs. 9	1 / 1	34	40	1360	75	6	3	2	1	12

Cardiovascular response

One of the main methods to acquire the data used during this research was heart rate (HR) measurement. HRs were measured and stored by means of a heart rate monitor Polar Team 2 PRO(Polar Electro Oy, Kempele, Finland). The system recorded the heart rate into the interface with an immediate transfer of 5 Hz at one-second intervals, with a measurement error of 5 beats. Exercise intensity was expressed as %HR_{max} measured during the field test by Hipp (2014). Finally, exercise intensity was divided into 5 defined intensity zones: 50-59% HR_{max} – very low intensity, 60-69 % HR_{max} – low intensity, 70-79% HR_{max} – medium intensity, 80-89% HR_{max}

– submaximal intensity, 90-100% HR_{max} – maximal intensity (Moravec et al. 2007). After the SSGs' the calculation of the time representation of HR values was done using a special program and software. The data were downloaded to a PC afterwards.

Time-motion characteristics

During the different forms of SSGs Polar Team 2 PRO sport testers (Polar Electro Oy, Kempele, Finland) were firmly fastened to the participants' under the chest to record external load data with frequency of 5.0 GHz. GPS data were analysed to identify the total distance covered (TDC), high intensity running (HIR) distance, number of accelerations (A) and decelerations (D) during different variants of SSG.

Individual game performance

Players' individual game performance was assessed by the Team Sports Assessment Procedure (TSAP), which is described in detail by Gréhaigne et al. (2005). The instrument reflects both technical and tactical aspects of game play by using macro-indicators related to successful game-play. Briefly, 6 technical-tactical actions were quantified for each player throughout the SSGs:

CB – conquered ball - (CB, e.g., the player intercepted or stole the ball from an opponent or recaptured it after an unsuccessful shot)

RB – received ball – (RB, e.g., the player received the ball from a teammate and did not immediately lose control of the ball)

LB – lost ball – (LB, e.g., player lost control of the ball)

NB – neutral ball – (NB, e.g., it is a routine pass to a teammate that does not put pressure on the opponent's team)

P – pass – (P e.g., complete the pass to teammate that contributes to the displacement of the ball towards the opponent team's defensive region)

SS – successful shot on goals (SS, e.g., it is considered successful when it scores or ensures the possession of the ball).

VP – volume of play – CB + RB – it is the frequency of ball possession during SSGs.

AB – attacks with the ball – P + SS – it is the frequency of passes and successful shots, or in this case the way to score for each SSGs.

EI – efficiency index – AB/10 + LB – here AB indicates attacks with ball and LB indicates the balls lost.

PS – performance score – (VP/2) + (EI x 10) – using VP volume of play and EI efficiency index.

Video recordings by Spiideo camera system were used which cover the entire playing field to record and after that retrospectively quantify the number of selected actions and individual game performance respectively. Indices were computed for each SSGs based on the players' performance.

RPE - We got feedback from players by RPE scores of the previous exercise bout on a 15-point scale, ranging from 6-no exertional at all to 20-maximal exertion (Borg 1988).

Statistical analysis

The one-way ANOVA and Bonferroni post hoc test were used to determine the statistical significance of HR, time-motion characteristics, game performance and RPE. The level of statistical significance was set at 5 % level. The results were interpreted, compared and we also connections were found between them. On the basis of these data, we formulated conclusions and recommendations for the sport theory and training practice.

Results

The duration of SSGs was 18 minutes and the net load time of it was 12 minutes. The work and rest ratio (LI:RI) was 1:0.5. The cardiovascular response of players´ organism to load during SSGs is stated by the values of heart rate (HR). Details of the physiological response are given in table 2. Briefly, SSG with small number of players (3 vs. 3) triggered the highest HR response with 168.00 ±8.48 beats.min^{-1} on average. The HR was likely to decrease to 157.75 ±8.53 beats.min^{-1} during SSG2 when 6 players played against the same number of opponent team. We recorded the lowest average HR values of monitored players during SSG3 (large number of players) 153.82 ±10.48 beats.min^{-1}. The difference between mean HR values was trivial between SSG1 and SSG2 among SSG2 and SSG3. We found statistically significant differences between SSG1 and SSG3 ($T = 3.1466$; $p < 0.05$).

Table 2

HR values

SSGs	**HR$_{min}$**		**HR$_{mean}$**		**HR$_{max}$**	
	[beats.min^{-1}]	SD	[beats.min^{-1}]	SD	[beats.min^{-1}]	SD
SSG1	104.66	±9.07	168.00	±8.48	190.83	±6.55
SSG2	103.63	±4.05	157.75	±8.53	188.16	±8.90
SSG3	102.15	±14.15	153.82	±10.48	187.75	±11.05

The research situation represented an examination of different selected physiological load indicators. In this case, it concerned the HR of soccer players during various different forms of SSG. Game duration spent in different HR intensity zones is given in Table 3. With

respect to the proportion of the intensity zones, during SSG1 players spent the most time in maximal intensity zone 0:09:06 minutes of SSG duration. The longest time spent in the zone of submaximal intensity was throughout SSG2, 0:05:49 minutes.

Table 3

Time spent in different intensity zones during SSGs

Intensity zones	**50 – 59 % of HR_{max}**	**60 – 69 % of HR_{max}**	**70 – 79 % of HR_{max}**	**80 – 89 % of HR_{max}**	**90 – 100 % of HR_{max}**
Intensity	**Very low**	**Low**	**Medium**	**Submaximal**	**Maximal**
Time	**[min.]**	**[min.]**	**[min.]**	**[min.]**	**[min.]**
SSG1	0:00:09	0:00:49	0:03:13	0:04:31	0:09:06
SSG2	0:00:19	0:01:48	0:04:36	0:05:49	0:05:18
SSG3	0:00:49	0:03:01	0:03:30	0:05:15	0:04:26

The highest intensity was ascertained during SSG with small number of players (3 vs. 3). This form of SSGs was the most demanding for the players´ cardiovascular system.

Details of the time-motion characteristics are given in table 4. We can see that the external load is closely related to internal responses in SSGs with different number of players.

Table 4

Time-motion characteristics during SSGs

SSGs	**TDC**		**HIR**		**A**		**D**	
	[m]	SD	[m]	SD	[n]	SD	[n]	SD
SSG1	1617.00	±69.18	40.16	±19.61	6	±2	4	±2
SSG2	1491.66	±121.87	35.16	±19.31	3	±2	2	±2
SSG3	1586.68	±160.97	92.52	±38.57	4	±2	3	±2

The most total distance was covered during SSG1 1617.00 ±69.18 meters, the most high-intensive running distance was recorded during SSG3 92.52 ±38.57 meters, the most number of accelerations and decelerations we counted in SSG1. With respect to the overall distance covered, the distance moved in high intensity, the number of accelerations and decelerations, the differences between the SSGs were irrelevant.

Table 5

Individual game performance

IGP	*SSG1*	*SSG2*	*SSG3*
VP	128	154	116
AB	42	53	23
EI	1.75	1.39	0.51
PS	81.5	90.9	63.1

Individual game performance was measured after the SSGs. The highest volume of play was recorded in SSG2 where 6 players played against each other and 6 neutral players tried to help them successfully solve complex game situations, 154. The highest number of passes with adding pressure on the opponents' goal we counted after SSG2. Efficiency index was the highest in SSG2. In this case we found the highest performance score with 90.9 during SSG2, too. No noteworthy differences were found in RPE, ranging from 15.8 ±1.1 after SSG3 to 17.1 ±1.3 after SSG1.

Table 6
RPE scores

SSGs	**SSG1**	**SSG2**	**SSG3**
RPE points	17.1 ±1.3	16.4 ±1.6	15.8 ±1.1

Discussion

The purpose of the present research was to compare the cardiovascular response, time-motion characteristics, individual game performance and rate of perceived exertion during 3 different forms of SSG. Thus, 3 SSG variants with different number of players (3 vs. 3, 6 vs. 6, 9 vs. 9), but with same relative pitch area for 1 player was 75 m^2, work and rest ratio (1:0.5), unchanged rules were compared. Although the head coach provided only mild feedback and verbal instructions, players tried to encourage each other verbally with the aim to maintain the intensity of SSG. The HR response during SSG1 (3 versus 3) was on the same level as in competitive matches in different youth categories (Florida-James & Relly 1995; Helgerud 2001; Thatcher & Batterham 2004; Rodrigues et al. 2007; Castagna et al. 2009).

Table 7
Mean HR values in soccer matches

AUTHOR	**HR_{mean} [beats.min^{-1}]**	**LEVEL**	**COUNTRY**
Florida-James & Reilly (1995)	165	University competition	United Kingdom
Helgerud (2001)	171	Junior competiton	Denmark
Thatcher & Batterham (2004)	166	Professional competition U20	United Kingdom
Rodrigues et al. (2007)	166	Elit competiton U17	Brazil
Castagna et al. (2009)	170	U15	Italy

According to Peráček (2014) the training process must stimulate the energy systems

which prevail during soccer matches. In systematic training process this criterion is replaced by the cognition and adequate manipulation with variables of SSGs where we include the number of participating players, too. With respect to the proportion of time spent in various intensity zones, our data suggests that the cardiovascular response was the highest in SSG1, lower during SSG2 and less in SSG3. In SSG1 maybe the presence of small number of players played an important role because players should the entire time move to different spaces on the training field to create free space for themselves and help their teammates solve game situations adequately. Thus, we recommend SSG1 if the aim of the training session is to improve the load in maximal intensity zone. It can help the players to increase the level of their soccer specific endurance and game preparedness. During SSG1 players spent the most time in the maximum intensity zone 0:09:06 minutes, of SSG duration, which are very important from the view of soccer match and a systematic training process, in terms of load intensification.

Clemente et al. (2014) stated that SSGs that involve fewer players (3 vs. 3 a side forms of SSGs) could be used for high intensity soccer specific aerobic endurance training. If coaches want higher % of HR_{max} responses and players' time spent in high intensity zones, they should organize 3 vs. 3 SSGs. Heart rate is a generally accepted and often used physiological indicator of the players´ physical activity in training units (Holienka 2016; Holienka & Cihová 2016). The current results showed that SSG1 induced higher HR values than SSG2 and SSG3.

The highest intensity was ascertained during SSG1, in this conditions players spent the most time in the maximal intensity zone and above an anaerobic threshold. For players´ cardiovascular system this variation was the most intensive. Little (2009) stated that SSGs that involve more players, such SSG2 (6 vs. 6) can be used to develop the anaerobic threshold, whereas SSG1 (3 vs. 3) might be used with the aim of enhancing maximum oxygen consumption. The calculation of the total distance covered, high-intensive running distance, the number of accelerations and decelerations during SSGs with different number of players provided information about the physical efforts performed during each SSG.

Clemente et al. (2016) found out, that 3-a-side SSG provide players with the opportunity to spend sufficient time in high intensity zones, while 9-a-side SSG format provide players with the opportunity to spend sufficient time in low intensity zones, which are specific to match demands. We can say that the external load is closely related to internal responses in the different forms of SSGs. In SSG1 players need to move all the time if they want to create free spaces for themselves or for their teammates. How they worked in space with the space provided us with results, that the most total distance covered was 1617.00 ±69.18 metres, the most high-intensive running distance was achieved in SSG3 92.52 ±38.57 metres, most number

of accelerations and decelerations we counted during SSG1. Individual game performance is very important when we try to educate young soccer players. Our study findings are comparable with most technical analyses in soccer SSGs that observed a higher number of individual indicators of technical-tactical actions in smaller formats of SSGs (Capranica et al. 2001; Katis & Kellis 2009). Considering the effects of different number of players, volume of play, attacks with the ball, efficiency index and performance score were the highest in SSG2 (6 vs. 6 + 6 neutral players). Thus, a higher cardiovascular response suggests a pronounced participation in actions on the ball as only technical-tactical actions linked to winning or receiving the ball are summarized in VP. PS was most pronounced in SSG2, compared to SSG1 and SSG3. The individual game performance measure correlate positively with the proportion of the time spent above ANT, there is no evidence that the intensity of the investigated SSGs negatively affects the individual game performance as expressed by the TSAP.

Christopher et al. (2016) claims that the training of soccer players should take into account the specific technical, tactical and physiological requirements of the individual game performance, too. As a result, the SSG has become a favourite way in order to increase the level of physical preparedness that imitates the conditions that a player may encounter during the competitive match. During SSGs soccer players need to solve a lot of complex game situations. Evaluation of different game situations, choosing the right tactic option and implementation of individual game action is a sensomotoric activity. Soccer players need to be adequately cognitively prepared for the match and always try to solve the tasks during the game in a tactically and technically correct way. When we analyse individual game activity we need to consider these elements, too. The RPE scores ranging from 15.8 ±1.1 after SSG3 to 17.1 ±1.3 after SSG1. In contrast, previous studies that focused on rule changes (Brandes et al. 2017; Halouani et al. 2017) found statistically significant effects on RPE scores during different variants of SSGs. The discrepancy between the present results and those mentioned above could be due to the subjectivity of this measurement tool and the players' inexperience with this method. Indeed, the RPE is defined as a subjective measure of work intensity (Coquart et al. 2009) which may also be strongly affected by motivational or emotional factors.

In this study, we tried to find out more about the cardiovascular response, time-motion characteristics, individual game performance and RPE in 3 variants of SSG with different number of players. The results of this study suggest that SSG1 could be used for high intensity soccer specific aerobic endurance training, SSG2 is optimal for moderate intensity soccer specific endurance training and finally, SSG3 may be used for low intensity aerobic training by soccer coaches.

Conclusions

Soccer is developing and advancing unusually fast. It puts higher demands on the whole coaching staff and the entire training process and practice. Purposeful planning, appropriate management and innovative approaches in everyday training sessions are only small steps, things that lead every ambitious soccer coach to the right path of success. The use of modern technologies during training units, for example sport testers, GPS allows sport experts to identify the internal response of players organism and receive objective feedback on the adequacy of the training load.

After the rehabilitation process the medical staff and strength and conditioning experts need to be very careful with them after the injury. In the early process of the team training on the field we need them monitor the players' physical activity through GPS and in some cases change the training load. Soccer coaches need to be clear with the player and explain that this is precaution and not punishment.

Nonetheless, the present study proves that small-sided and conditioned soccer games can change players' individual performance, even in technical and tactical actions. From the obtained data it is possible to state that during SSGs with different number of players the HR values, time-motion characteristics, individual game performance, RPE scores were in different range. The most intense was in SSG1. During SSG1 players achieved the highest HR values, spent the most time in maximal intensity zone, in this case we recorded the biggest time-motion characteristics and the highest score of RPE.

Our recommendation is to integrate SSGs into the purposeful training process with different number of players to enhance players' technical ability, tactical decision-making skills, physical preparedness and mental resistance too. The reason for using above mentioned SSGs is that these situations place demands on the cardiovascular and movement system of the players that are similar to the competitive match conditions. Optimization, individualization and intensification the training load are very important in the systematic training process, there coaches should include SSGs with different number of players in the training process according to the aim of the day of the microcycle periodization and loading.

Acknowledgments

This study was supported by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences (No. 1/0089/20): ***Assessment of sensory and motor component of movement skills***

***in athletic training and rehabilitation*.**

References

1. ASCI, A., 2016. Heart rate responses during small sided games and official match-play in soccer. In: *Sports*. **4**(2), 1-7. ISSN 2075-4663.
2. BORG, G. A., 1982. Psychophysical bases of perceived exertion. In: *Medicine and Science in Sport and Exercise.* **14**(5), 377-381. ISSN 0195-9131.
3. BRANDES, M., L. MÜLLER a A. HEITMANN, 2017. Physiological responses, time–motion characteristics and game performance in 4 vs. 4 small-sided games in elite youth soccer players: Different number of mini-goals vs. stop-ball. In: *Science and Medicine in Football.* **1**(2), 126-131. ISSN 2473-3938.
4. CAPRANICA, L., 2001. Heart rate and match analysis in pre-pubescent soccer players. In: *Journal of Sports Sciences.* **19**(6), 379-384. ISSN 0264-0414.
5. CASTAGNA, C., F. IMPELLIZZERI, E. CECCHINI, E. RAMPININI a J.C.B. ALVAREZ, 2009. Effects of intermittent-endurance fitness on match performance in young male soccer players. In: *Journal of Strength and Conditioning Research.* **23**(7), 1954-1959. ISSN 1064-8011.
6. CLEMENTE, F. et al., 2012. The usefulness of small-sided games on soccer training. In: *Journal of Physical Education and Sport*. **12**(1), 93-102. ISSN 2247-8051.
7. CLEMENTE, F. M., D. P. WONG, F. M.L. MARTINS a R. S. MENDES, 2014. Acute effects of the number of players and scoring method on physiological, physical, and technical performance in small-sided soccer games. In: *Research in Sports Medicine.* **22**(4), 380-397. ISSN 1543-8627.
8. COQUART, J. B., R. LEGRAND, S. ROBIN, A. DUHAMEL, R. MATRAN a M. GARCIN, 2009. Influence of successive bouts of fatiguing exercise on perceptual and physiological markers during an incremental exercise test. In: *Psychophysiology.* **46,** 209-216. ISSN 1469-8986.
9. DELLAL, A., C. LAGO-PENAS, D. P. WONG a K. CHAMARI, 2011. Effect of the number of ball contacts within bouts of 4 vs. 4 small-sided soccer games. In: *International Journal of Sports Physiology and Performance.* **6**(3), 322-333. ISSN 1555-0265.
10. FLORIDA-JAMES, G. a T. REILLY, 1995. The physiological demands of Gaelic football. In: *British Journal of Sports Medicine*. **29**(1), 41-45. ISSN 0306-3674.

11. GRÉHAIGNE, J.F., J.F. RICHARD a L.L. GRIFFIN, 2005. *Teaching and Learning Team Sports and Games*. New York, NY: Routledge Falmer.
12. HALOUANI, J., H. CHTOUROU, A. DELLAL, A. CHAOUACHI a K. CHAMARI, 2017. Soccer small-sided games in young players: Rule modification to induce higher physiological responses. In: *Biology of Sport.* **34**(2), 163-168. ISSN 0860-021X.
13. HILL-HAAS, S. V., B. T. DAWSON, F. M. IMPELLIZZERI a A. J. COUTTS, 2011. Physiology of small-sided games training in football. In: *Sports Medicine*. **41**(3), 199-220. ISSN 0112-1642.
14. HIPP, M., 2014. *Futbal: Rozvoj vybraných pohybových schopností: Skúsenosti z praxe.* 2. vydanie. Nitra: For Press. ISBN 978-80-10-01146-9.
15. HELGERUD, J., 2001. Aerobic endurance training improves soccer performance. In: *Medicine and Science in Sports and Exercise.* **33**(11), 1925-1931. ISSN 0195-9131.
16. HOLIENKA, M., 1998. Tréningové zaťaženie a interval odpočinku, základné kategórie herného tréningu vo futbale. In: *Acta Facultatis Educationis Physicae Universitatis Comenianae*, 39. Bratislava: Univerzita Komenského, pp. 147-150. ISBN 80-223-1367-X.
17. HOLIENKA, M., 2016. Internal load of soccer players during preparatory games with a medium number of players. In: *Journal of Physical Education and Sport*. **16(**2), 546-550. ISSN 2247-8051.
18. HOLIENKA, M. a I. CIHOVÁ, 2016. Vnútorné zaťaženie hráčov vo futbale v prípravných hrách so stredným počtom hráčov. In: *Monitorovanie a regulovanie adaptačného efektu v rozličných obdobiach prípravy vrcholových športovcov a talentovanej mládeže*. Bratislava: ICM Agency, pp. 132-139. ISBN 978-80-89257-74-4.
19. CHRISTOPHER, J., M. BEATO a A. T. HULTON, 2016. Manipulation of exercise to rest ratio within set duration on physical and technical outcomes during small-sided games in elite youth soccer players. In: *Human Movement Science.* **48**(August), 1-6. ISSN 0167-9457.
20. KAČÁNI, L., 2004. *Futbal: Tréning hrou*. Bratislava, SK: Peter Mačura – PEEM.
21. KATIS, A. a E. KELLIS, 2009. Effects of small-sided games on physical conditioning and performance in young soccer players. In: *Journal of Sport Science and Medicine.* **8**(3), 374-380. ISSN 1303-2968.
22. KÖKLÜ, Y., M. ALBAYRAK, H. KEYSAN, U. ALEMDAROGLU a A- DELLAL, 2013. Improvement of the physical conditioning of young soccer players by playing small-sided games on different pitch size – Special reference to physiological responses. In: *Kinesiology.* **45**(1), 41-47. ISSN 1311-1441.

23. LITTLE, T., 2009. Optimizing the use of soccer drills for physiological development. In: *Strength and Conditioning Journal.* **31(**3), 67-74.
24. MIKULIČ, M., P. PERÁČEK a M. BABIC, 2018. Vplyv prípravných hier na herný výkon elitných mládežníckych hráčov vo futbale. [Impact of small-sided games on the game performance of elite youth soccer players]. In: *Zborník vedeckých prác Katedry športových hier FTVŠ UK č. 25*. Bratislava: Slovenská vedecká spoločnosť pre telesnú výchovu a šport, pp. 116-133. ISBN 978-80-89075-75-1.
25. MORAVEC, R. et al., 2007. *Teória a didaktika výkonnostného a vrcholového športu*. Bratislava: Fakulta telesnej výchovy a športu Univerzity Komenského. ISBN 978-80-89075-31-7.
26. NAGY, N. a M. HOLIENKA, 2018. Intenzita tréningového zaťaženia v rôznych formách prípravných hier vo futbale. [Intensity of the training load in various forms of preparatory games in football]. In: *Telesná výchova & šport*. **28**(2), 24-29. ISSN 1335-2245.
27. NAGY, N. a M. BABIC, 2019. Intenzita tréningového zaťaženia futbalistov v prípravných hrách s rôznymi veľkosťami hracej plochy. [Intensity of soccer players´ training load in small-sided games with various playing field sizes]. In: *Scientia Movens 2019*. Praha: Fakulta tělesné výchovy a sportu, pp. 310-325. ISBN 978 80-87647-48-6.
28. NAGY, N., M. HOLIENKA, M. BABIC, J. MICHÁLEK a E. KUNZMANN, 2019. Intensity of soccer players´ training load in small-sided games with various content focus. In: *Acta Facultatis Educationis Physicae Universitatis Comenianae.* **59(**1), 44-68. ISSN 2585-8777.
29. NAGY, N., M. HOLIENKA a M. BABIC, 2020a. Intensity of training load in various forms of small-sided games in soccer. In: *Journal of Physical Education and Sport.* **20**(1), 53-62. ISSN 2247-8051.
30. NAGY, N., M. HOLIENKA, M. BABIC, J. MICHÁLEK a E. KUNZMANN, 2020b. Intensity of soccer players´ training load in small-sided games with different number of players. In: *Acta Facultatis Educationis Physicae Universitatis Comenianae.* **60**(1), 55-74. ISSN 2585-8777.
31. OWEN, A. L., C. TWIST a P. FORD, 2004. Small-sided games: The physiological and technical effect of altering pitch size and player numbers. In: *Insight.* **7**(2), 50-53. ISSN 1060-135X.
32. PERÁČEK, P., 2014. Evidencia a kontrola intenzity tréningového zaťaženia futbalistov. *Telesná výchova & šport*. **24(**2), 2-6. ISSN 1335-2245.

33. PERÁČEK, P., M. BÔŽIK a M. MIKULIČ, 2018a. Internal load of elite Malaysian young soccer players in small sided games with different parameters. In: *Acta Facultatis Educationis Physicae Universitatis Comenianae.* **58**(1), 32-43. ISSN 0520-7371.
34. PERÁČEK, P., M. BÔŽIK a M. MIKULIČ, 2018b. Vybrané charakteristiky vnútorného zaťaženia elitných mladých futbalistov v prípravných hrách s rôznymi parametrami. [Internal load of youth elite soccer players in various small-sided games]. In: *Studia Sportiva*. **12**(2), 79-86. ISSN 2570-8783.
35. RAMPININI, E., et al., 2007. Factors influencing physiological responses to small-sided soccer games. In: *Journal of Sports Sciences.* **25**(6), 659-666. ISSN 0264-0414.
36. RODRIGUES, V., L. MORTIMER, L. CONDESSA, D. B. COELHO, D. SOARES a E. GARCIA, 2007. Exercise intensity in training sessions and official games in soccer. In: *Journal of Sport Science and Medicine.* **6**(Suppl. 10), 57-61. ISSN 1303-2968.
37. THATCHER, R., a A. M. BATTERHAM, 2004. Development and validation of a sport-specific exercise protocol for elite youth soccer players. In: *Journal of Sports Medicine and Physical Fitness*. **44**(1), 15-22. ISSN 0022-4707.

DOI 10.2478/afepuc-2021-0017
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 203-213

INTRAINDIVIDUAL EVALUATION OF REACTION TIME AT THE WOMEN'S WORLD ATHLETICS CHAMPIONSHIPS 1999 – 2019

Peter Mitašík, Ladislava Doležajová, Anton Lednický

Comenius University in Bratislava, Faculty of Physical Education and Sports, Slovakia

Summary: The aim of the article was the intraindividual evaluation of reaction time at the Women's World Athletics Championships from 1999 to 2019.We generated the rating of sprinters from the age point of view with comparison of two periods with different false start rules. In the result section, we analysed the sprinters that took part at World Championships (WCH) at least 3 times and appeared in the final. We assessed the reaction speed from the ageing point of view, or more precisely with the changing conditions when judging the false start. The results confirm that the stricter start judging rules in sprint disciplines did not have a significant influence on the reaction speed. We also confirmed a research that the sprinters older than 30 years can achieve very low reaction time at the start.

Keywords: sprinters; reaction speed; age of competitors; change of rules at low start; World Championship

Introduction

By many experts the athletics is by considered as a queen of all sports. It has been very popular, not only between professional athletes but also among the general public. Our focus in the article was on the most popular athletic disciplines, the short distance sprints. The matter is an analysis of reaction times, which is a significant part of it (Mitašík et al. 2020/a; Mitašík et al. 2020/b). There is a simple reaction to an acoustic stimulus when speaking about short distance sprint start. In this modern ages performances of top level sprinters are differentiated only by hundredths and often hundredths are decisive of winners. Reaction speed is measurable by technical equipment into number, which is known as reaction time. Gunfire is the starting

stimulus in athletics which means the sprinters react to an acoustic stimulus. Every competitor that commits a false start (besides combined disciplines), will be disqualified, under the authority of the rule since January 2010. Before this year, the judgement of the false start was much softer (SAZ 2010).

The level of reaction time is influenced by number of factors, e.g. age (Botwinick & Thompson 1966; Fozard et al. 1994; Hultsch et al. 2002), gender (Jain, Bansal, Kumar & Singh 2015), warm-up (Magner et al. 2012), fatigue Brisswalter, Arcelin, Audiffren & Deligniéres (1997), training level (Jawoski, Lech, Ambrozy & Zak 2020), power of the start impulse (Germain, Smith, Maslovat & Carlsen 2020), running distance (Glesk 1986), psychological preparation (Kampmiller &Vanderka 2012), sprinters character (sport.cz).

Reaction time improves until 20th year of life, then gradually in slow pace prolongs until 60th year of life and among people over 70 years old prolongs radically (Jevas & Yan 2001; Luchies et al. 2002; Rose et al. 2002; Der & Deary 2006). The reaction time is influenced by psychological phenomenon as well, whereas older people tend to be more careful and think more (Botwinic 1966), MacDonald et al. (2002) observed adults and seniors, finding out that the variety of reaction time is possible to connect with generally slower reaction times to a specific stimulus.

Because our body is not able to keep a constant level of performance throughout the day, this fact influences reaction skills too. Štulrajter et al. (1989) focused their research on oscillation of reaction time during the day in accordance with biorhythm of the human body. The figures measured over 24 hours proved to be significantly oscillating. It shows that the shortest reaction time is in the morning before nine o'clock and in the evening after 18 o'clock. In their research, Tønnessen & Haugen (2013) analysed the reaction time of elite sprinters (n = 1 319) who took part in the World Championships during 2003 – 2009 showed that women over 30 years of age achieved the fastest reaction time (0.153 ± 0.020s).

The aim of this study is to compare the reaction time of sprinters between two different periods. In the second period was the rule for starts changed, which increased the assumption of exclusion of athletes from the competition, could cause their caution. Therefore we assumed, that their reaction time would be higher than before.

Methods

We carried out the research on a group of selected elite sprinters in the 100 m run, which took part in several final runs at the World Championships in Athletics in the years 1999 –

2019. In the first period (1999 – 2009) we watched the runners in the heats, the quarterfinals, the semifinals and in the final runs. In the second period (2011 – 2019) only heats, semifinals and final runs were realized, because quarter-final runs were excluded from the program. We obtained the figures of the starting reactions of sprinters from the mentioned periods from the official website of the IAAF (WA). We presented the results of selected athletes in pictures and tables, which show the year of the World Cup, discipline, runs, age of the athlete, the rate of reaction time and the rating of sports performance with placement (Table 1). In the final part, we analysed the competitors who participated in the World Championships at least three times and were always in the finals. How did you assess that their reaction rate in terms of increasing age, respectively, changed conditions when assessing a false start. We evaluated the reaction speed according to Gavaľa (2002), who set aside five levels: excellent (100 – 130 ms), very good (131 – 160 ms), average (161 – 185 ms), below average (186 – 210 ms) and unsatisfactory (211 and more ms).

Results

Selected competitors reached a reaction speed at a high level, regardless of their age, respectively, the period in which they ran in the final (Table 1).

In some cases (Block, Jetter, Fraser-Pryce) they had the fastest reaction at their higher age. This finding is confirmed by Tønnessen & Haugen (2013) that the reaction speed can be maintained and developed at an older age. In the table 1 above we see large intra-individual rates of reaction times of monitored sprinters not only in individual monitored years, but also in their entire compared period. Importantly the very low reaction times in the finals allowed the competitors to take advantage of it and won medals (Block 0.123 and 1st place; Thana 0.116 and 3rd place; Pryce 0.134 and 1st place; Schippers 0.129 and 2nd place).

Table 1

Reaction times of selected athletes, multiple finalists in the 100 m run at the World Athletics Championships

Year	Name	Reaction time				Time in final	Placement (finals)	Age
		Heats	Quaterfinals	Semifinals	Finals			
1999	**Zhanna BLOCK**	**0,203**	**0,136**	**0,127**	**0,135**	**10,95**	**4.**	**27**
2001	**Zhanna BLOCK**	**0,142**	**0,131**	**0,122**	**0,123**	**10,82**	**1.**	**29**
2003	**Zhanna BLOCK**	**0,130**	**0,153**	**0,134**	**0,160**	**DQ**	**DQ**	**31**
1999	Christine ARRON	0,178	0,168	0,176	0,162	10,97	6.	26
2005	Christine ARRON	0,167	0,157	0,166	0,165	10,98	3.	32
2007	Christine ARRON	0,170	0,181	0,186	0,164	11,08	6.	34
1999	**Ekateríni THÁNOU**	**0,209**	**0,125**	**0,123**	**0,116**	**10,84**	**3.**	**24**
2001	**Ekateríni THÁNOU**	**0,159**	**0,127**	**0,143**	**0,145**	**10,91**	**2.**	**26**
2003	**Ekateríni THÁNOU**	**0,150**	**0,147**	**0,120**	**0,219**	**11,03**	**3.**	**28**
1999	Chandra STURRUP	0,131	0,160	0,117	0,134	11,06	7.	28
2001	Chandra STURRUP	0,176	0,161	0,160	0,154	11,02	3.	30
2003	Chandra STURRUP	0,132	0,153	0,129	0,136	11,02	2.	32
2005	Chandra STURRUP	0,155	0,144	0,142	0,113	11,09	4.	34
2009	Chandra STURRUP	0,158	0,153	0,127	0,137	11,05	7.	38
2005	**V. CAMPBELL-BROWN**	**0,171**	**0,184**	**0,150**	**0,139**	**10,95**	**2.**	**23**
2007	**V. CAMPBELL-BROWN**	**0,143**	**0,175**	**0,144**	**0,167**	**11,01**	**1.**	**25**
2009	**V.CAMPBELL-BROWN**	**0,138**	**0,156**	**0,148**	**0,135**	**10,95**	**4.**	**27**
2011	**V. CAMPBELL-BROWN**	**0,224**		**0,200**	**0,234**	**10,97**	**2.**	**29**
2007	Carmelita JETER	0,200	0,286	0,181	0,189	11,02	3.	28
2009	Carmelita JETER	0,197	0,140	0,144	0,160	10,90	3.	30
2011	Carmelita JETER	0,201	-	0,191	0,167	10,90	1.	32
2013	Carmelita JETER	0,217	-	0,175	0,156	10,94	3.	34
2009	**Kerron STEWART**	**0,182**	**0,149**	**0,155**	**0,170**	**10,75**	**2.**	**25**
2011	**Kerron STEWART**	**0,160**	**-**	**0,270**	**0,212**	**11,15**	**6.**	**27**
2013	**Kerron STEWART**	**0,189**	**-**	**0,187**	**0,229**	**10,97**	**5.**	**29**
2009	Ann FRASER-PRYCE	0,187	0,191	0,156	0,146	10,73	1.	23
2011	Ann FRASER-PRYCE	0,194	-	0,174	0,194	10,99	4.	25
2013	Ann FRASER-PRYCE	0,159	-	0,193	0,174	10,71	1.	27
2015	Ann FRASER-PRYCE	0,237	-	0,151	0,161	10,76	1.	29
2019	Ann FRASER-PRYCE	0,173	-	0,133	0,134	10,71	1.	33
2011	**Blessing OKAGBARE**	**0,180**	**-**	**0,160**	**0,147**	**11,12**	**5.**	**23**
2013	**Blessing OKAGBARE**	**0,173**	**-**	**0,181**	**0,154**	**11,04**	**6.**	**25**
2015	**Blessing OKAGBARE**	**0,146**	**-**	**0,147**	**0,185**	**11,02**	**8.**	**27**
2015	Dafne SCHIPPERS	0,149	-	0,130	0,129	10,81	2.	23
2017	Dafne SCHIPPERS	0,170	-	0,150	0,155	10,96	3.	25
2019	Dafne SCHIPPERS	0,164	-	0,119	DNS	DNS		27

The reaction speed of selected finalists compared to the average rates of all finalists (Table 2) was often lower reaction time. E.g. in 2003, Sturrup had a reaction time of 0.136 s, the average time of the finalists was 0.171 s; in 2005, this runner had a reaction time of 0.113 s

and the average time of all runners was 0.139 s; in 2015 Okagbare had a reaction speed of 0.146 s, the average time of the finalists was 0.155 s.

The reaction speed of selected finalists was also often comparable to the average rates (in 1999 Block reached 0.135 s, the average of the finalists was the same; in 2011 Okagbere had a reaction speed of 0.180 s, the average time was 0.176 s; in 2007 Arron had a speed reaction 0.164 s, the average was 0.163 s), or worse (in 2011 Stewart had a reaction rate of 0.212, the average of the finalists was at the level of 0.178 s; in 2015, Okagbare reacted at a speed of 0.178 s, but the average was 0.155 s).

Table 2

Average age and reaction times of finalists at 100 m sprint in 1st and 2nd observed period

Period	WCH	Average age	Average reaction time (final) [s]
1st	1999	26.50	0.135
	2001	27.00	0.149
	2003	29.13	0.171
	2005	25.88	0.139
	2007	26.75	0.163
	2009	28.88	0.151
Average		27.36	0.151
Max.		29.13	0.171
Min.		25.88	0.135
Vr		3.25	0.033
2nd	2011	26.88	0.178
	2013	26.13	0.171
	2015	26.50	0.155
	2017	27.38	0.168
	2019	27.38	0.142
Average		26.85	0.156
Max.		27.38	0.178
Min.		26.13	0.142
Vr		1.25	0.036

The mean reaction time of sprinters in the first period and in the second period was very similar (Table 2). It seems that the new rules of starts do not affect the reactions of sprinters. In the second period, the runners had almost the same average reaction time (+0.05 s) and small differences were also in the longest and shortest reaction (+0.07 s in both cases). However, the mentioned differences in the balance of the top sprinters often mean the difference of one, resp. two places in the overall standings. E.g. WCH 2009: 1. Fraser-Pryce 10.73 s (reaction time 0.146), 2. Stewart 10.75 s (0.170); WCH 2011: 1. Jeter 10.90 s (0.167), 2. Campell Brown 10.97

s (0.234), 3. Baptiste 10.98 s (0.151), 4. Fraser-Pryce 10.99 s (0.194); WCH 2013: 1. Fraser-Pryce 10.71 s (0.174), 2.Ahoure 10.93 s (0.165), 3. Jeter 10.94 s (0.156); WCH 2017: 1. Bowie 10.85 s (0.182), 2. Ta Lou 10.86 s (0.180).

In the individual assessment of changes in reaction time, we analysed the competitors who participated in the World Championships four or more times, always participating to the finals.

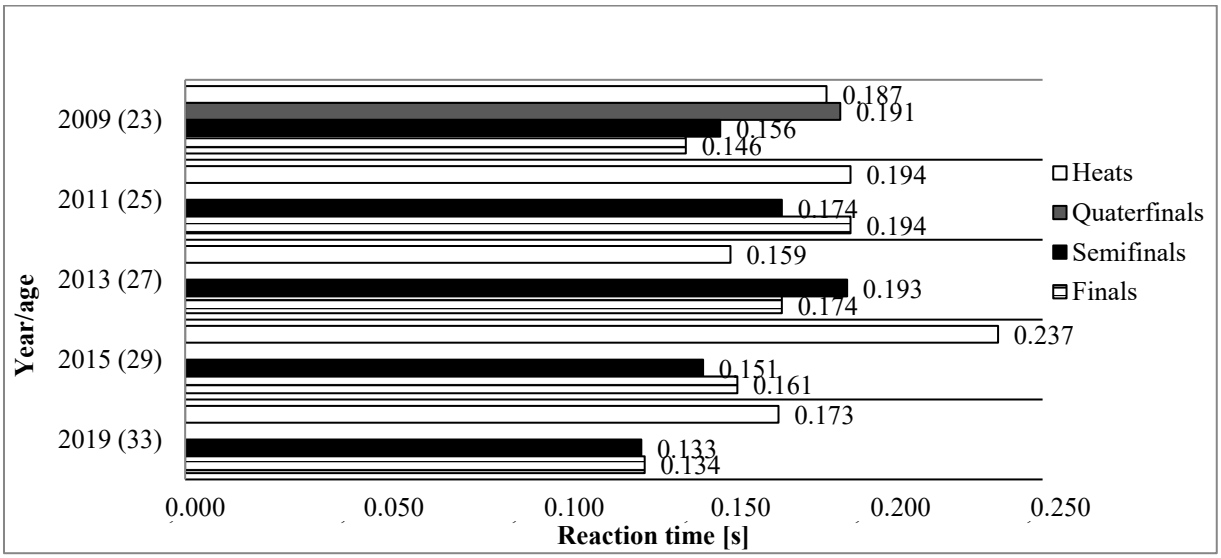

Figure 1

Intra-individual evaluation of the Shelly-Ann Fraser-Pryce reaction time at the World Championships in the 100 m run

The competitor achieved a reaction rate of less than 0.2 s on all MS. The only exception was r. 2015 in the heats, in which she probably believed that she would proceed to the next run without any problems and did not take any risks. Its reactions ranged mostly from average to below average (according to Gavaľa 2002). It is interesting that she recorded the most balanced performances at the last World Championships at the age of 33 and came closest to the evaluation of the excellent reaction speed. After tightening the rule, the runner reached the same or better reaction speed.

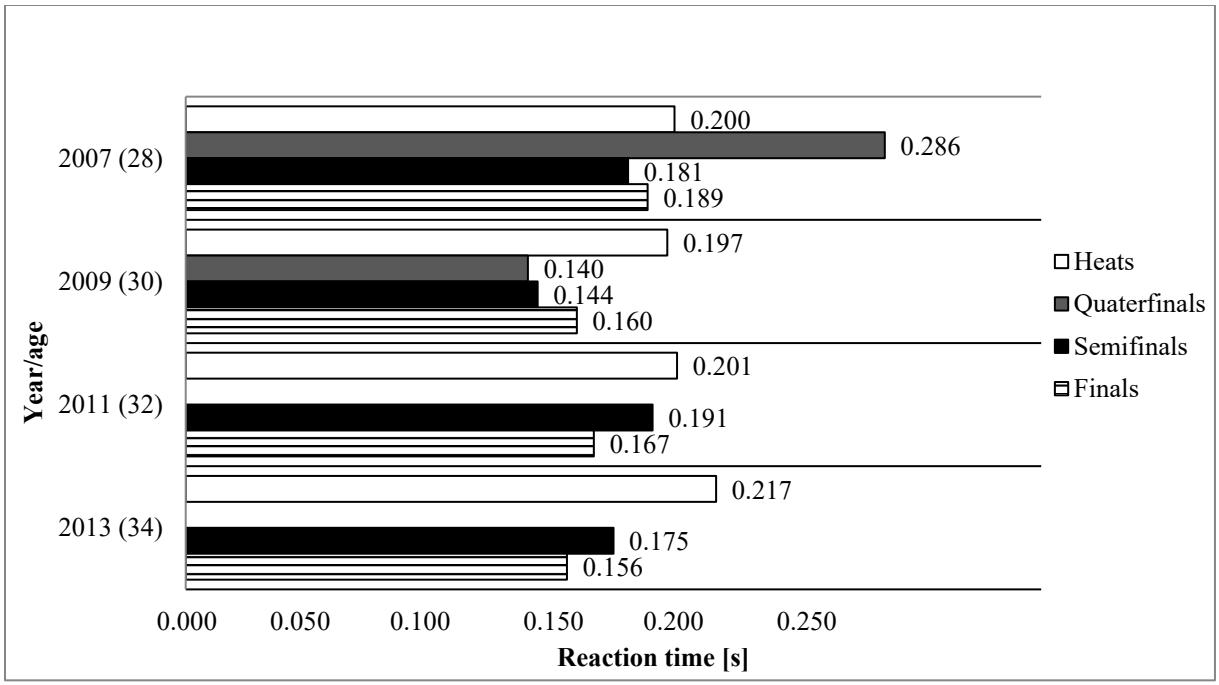

Figure 2

Intra-individual evaluation of the reaction time Carmelita Jeter at the World Championships in the 100 m run

The sprinter had a fairly large variance in reaction rate (unsatisfactory level to very good). It is interesting that in the last two World Championships (at an older age) she had the shortest reaction time in the final compared to previous runs and with the finals at previous World Championships. There is practically no difference in the speed of the reaction between the first and the second period.

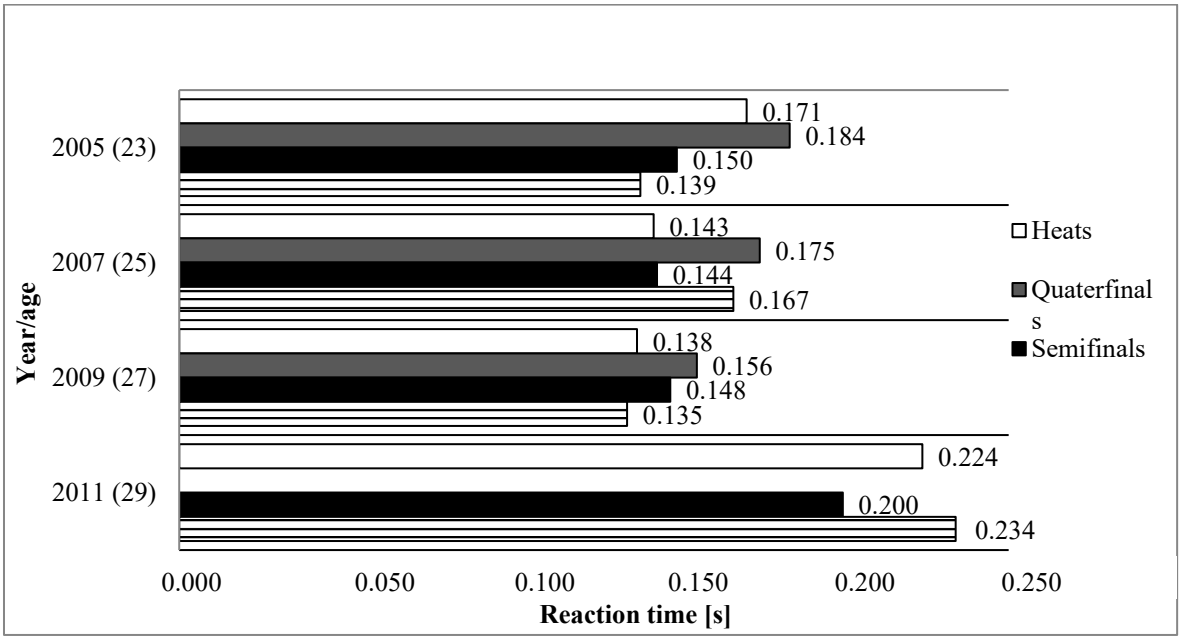

Figure 3

Intra-individual evaluation of the reaction time of Veronica Campbell-Brown at the World Championships in the 100 m run

When analysing the reaction speed of this competitor, you can see the stability of the speed on the first three MS, on which the reaction speed was close to excellent, resp. very good level. The exceptions are the last World Championships (below-average to unsatisfactory level, which could have been affected by the stricter rule and the competitor did not cope with the change). The reaction above the 0.2 s limit was the cause of its 2nd place (time 10.97). The winning Jeter (10.90) was by 0.067 s faster at the start.

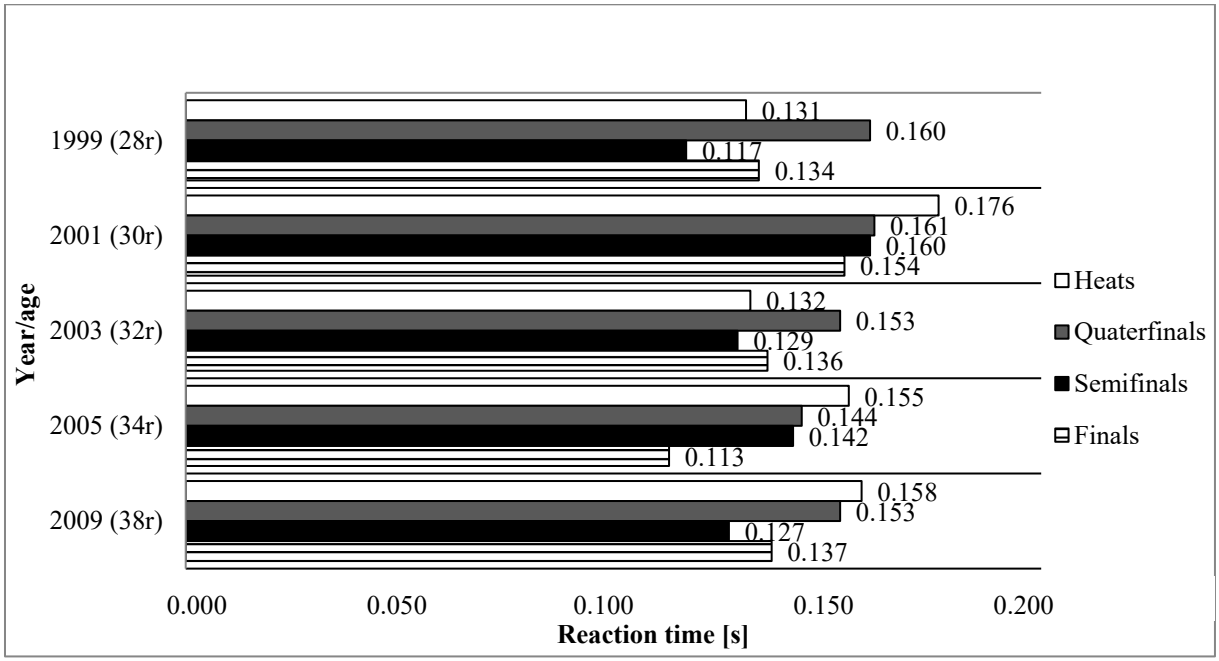

Figure 4

Intra-individual evaluation of the reaction time of Chandra Sturrup at the World Championships in the 100 m run

The reaction times of the competitors were stable at a high level throughout the 10-year period. It approached significantly or achieved an excellent level of reaction speed. Most of the times were very good and only two times were in the average category. The athlete only competed in the first period, so we can't compare how she would react after tightening the rule. From tab. 3 it can be seen that the age of the competitors did not affect the reaction speed in the final runs. At an average age of about 26 years, we recorded an average reaction time of 0.135 and 0.163 s, respectively, at about 27 years of age 0.142 and 0.168 s.

Table 3

The average age and reaction time of sprinters at the World Championships in the final of the 100 m run in individual years

	1999	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**	**2013**	**2015**	**2017**	**2019**
Average age (years)	26.50	27.00	29.13	25.88	26.75	28.88	26.88	26.13	26.50	27.38	27.38
Average reaction time [s]	0.135	0.149	0.171	0.139	0.163	0.151	0.178	0.171	0.155	0.168	0.142

The speed of the reaction, as we mentioned, is influenced by many factors, and even in older age it is possible to achieve an excellent level of reaction speed. The correlation between these two parameters is shown in fig. 5.

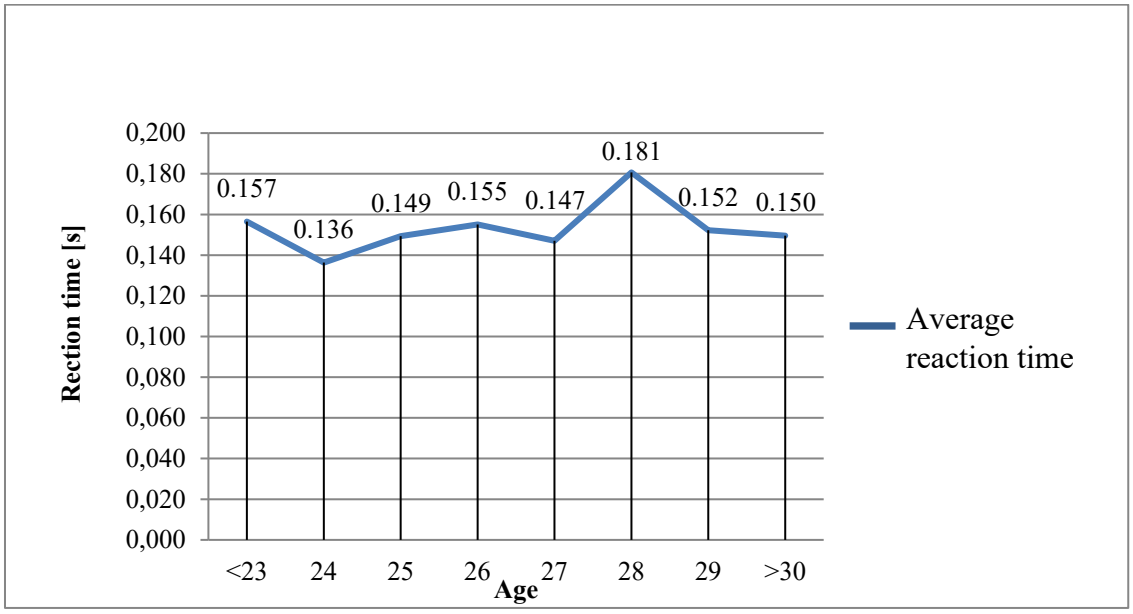

Figure 5

Development of the average reaction time of women in the 100 m run at the World Championships in the final runs in correlation with age

Conclusions

1. By analysing the starting reaction speed of the top runners at 100 m at the World Championships in Athletics, we found that two different rules for judging a failed start did not have effect on prolonging the reaction speed even after tightening the rule.
2. Despite the conclusions of some authors about the slowing down of the reaction rate with increasing age, some competitors refuted them and achieved the best reaction times over the age of 30. They confirmed that training can not only maintain but also improve this indicator.
3. Although we analysed the top competitors, only a few of them achieved an excellent level of reaction speed (100 – 130 ms) according to the Gaval'a scale (2002).
4. We assumed in addition to the above, the reaction speed is influenced by other important factors - the time zone in which the competitor moved to the race; the weather; quality of opponents.
5. An interesting judging factor for female sprinters would be observation of reaction time change, if any of them had become a mother and how the reaction speed changed in this period.

References

1. BOTWINICK, J. & L. W. THOMPSON, 1966. Components of reaction time in relation to age and sex. *The Journal of Genetic Psychology: Research and Theory on Human Development.* ***108***(2), 175–183. https://doi.org/10.1080/00221325.1966.10532776
2. BRISSWALTER, J., R. ARCELIN, M. AUDIFFREN & D. DELIGNIÈRES, 1997. Influence of Physical Exercise on Simple Reaction Time: Effect of Physical Fitness. *Perceptual and Motor Skills*. ***85***(3), 1019–1027. https://doi.org/10.2466/pms.1997.85.3.1019
3. DER, G. & I. J. DEARY, 2006. Age and sex differences in reaction time in adulthood: Results from the United Kingdom Health and Lifestyle Survey. *Psychology and Aging.* ***21***(1), 62–73. https://doi.org/10.1037/0882-7974.21.1.62
4. FOZARD, J. L., M. VERCRYSSEN, S. L. REYNOLDS, P. A. HANCOCK & R. E. QUILTER, 1994. Age differences and changes in reaction time: the Baltimore Longitudinal Study of Aging. *Journal of gerontology.* ***49***(4), P179–P189. https://doi.org/10.1093/geronj/49.4.p179
5. GLESK, P. (1986). Behy na krátke vzdialenosti. In *Atletika behy*, Bratislava, 15-39. ISBN: 77-028-8611-4.
6. HULTSCH, D. F., S. W. MACDONALD & R. A. DIXON, 2002. Variability in reaction time performance of younger and older adults. *The journals of gerontology. Series B, Psychological sciences and social sciences.* ***57***(2), P101–P115. https://doi.org/10.1093/geronb/57.2.p101
7. JAIN, A., R. BANSAL, A. KUMAR & K. D. SINGH, 2015. A comparative study of visual and auditory reaction times on the basis of gender and physical activity levels of medical first year students. *International journal of applied & basic medical research.* ***5***(2), 124–127. https://doi.org/10.4103/2229-516X.157168
8. JAWOSKI, J., G. LECH, T. AMBROZY & M. ZAK, 2020. Profile of coordination motor abilities in elite judokas and badminton players compared to non-athletes. *Biomedical human kinetics.* **12**, 17-24. http://apps.webofknowledge.com/full_record.do?product=WOS&search_mode=GeneralSearch&qid=1&SID=F5vn6HSLeXqB6j8USYQ&page=1&doc=1
9. KAMPMILLER, T. & M. VANDERKA, 2012. Rýchlostné schopnosti a ich rozvoj. In T. KAMPMILLER, M. VANDERKA, E. LACZO & P. PERÁČEK (Eds.). *Teória športu a didaktika športového tréningu* (s. 157-177). ICM Agency. ISBN: 978-80-89257-48-5.

10. LUCHIES, C. W., J. SCHIFFMAN, L. G. RICHARDS, M. R. THOMPSON, D. BAZUIN & A. J. DEYOUNG, 2002. Effects of age, step direction, and reaction condition on the ability to step quickly. *The journals of gerontology. Series A, Biological sciences and medical sciences.* ***57***(4), M246–M249. https://doi.org/10.1093/gerona/57.4.m246
11. MAGNER, A., K. CHATHAM, B. SPRADLEY, S. WIRIYAPINT, W. PRICE & T. AKINS, 2012. Static stretching versus dynamic warm-up: The effect on choice reaction time as measured by the Makoto arena 2. *The sport jurnal.* https://thesportjournal.org/article/2012/
12. MITAŠÍK, P., L. DOLEŽAJOVÁ, A. LEDNICKÝ & D. VÉGH, 2020. Changes in the Start Reaction Times in the 200 m Run at the World Championships After the Tightening of False Start Rule. *Acta Facultatis Educationis Physicae Universitatis Comenianae.* ***60***(2), 207-216. doi: https://doi.org/10.2478/afepuc-2020-0017
13. MITAŠÍK, P., M. VAVÁK, L. DOLEŽAJOVÁ & A. LEDNICKÝ, 2020. Changes in the start reaction times of male and female sprinters in world athletic championships. *Acta Facultatis. Journal of Physical Education and Sport*. https:// doi:10.7752/jpes.2020.s3302
14. Online magazín deníku Právo & Seznam.cz. (n.d.). https://www.sport.cz/
15. ROSE, S. A., J. F. FELDMAN, J. J. JANKOWSKI & D. M. CARO, 2002. A longitudinal study of visual expectation and reaction time in the first year of life. *Child development.* ***73***(1), 47–61. https://doi.org/10.1111/1467-8624.00391
16. SLOVENSKÝ ATLETICKÝ ZVÄZ, 2017. Pravidlá atletických súťaží IAAF 2018-2019 (pravidlo129,s.14).Bratislava.https://www.atletika.sk/wpcontent/uploads/2018/03/pravidla_atletickych_sutazi_2018-19.pdf
17. ST. GERMAIN, L., V. SMITH, D. MASLOVAT & A. CARLSEN, 2020. Increased auditory stimulus intensity results in an earlier and faster rise in corticospinal excitability. *Brain Research. 1727,* Article 146559. https://doi.org/10.1016/j.brainres.2019.146559
18. TØNNESSEN, E., T. HAUGEN & S. A. SHALFAWI, 2013. Reaction time aspects of elite sprinters in athletic world championships. *Journal of strength and conditioning research.* ***27***(4), 885–892. https://doi.org/10.1519/JSC.0b013e31826520c3

sciendo

DOI 10.2478/afepuc-2021-0018
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 214-227

12 MONTHS OF BALANCE TRAINING DECREASES ANKLE-JOINT INJURY FREQUENCY IN YOUNG GIRL BASKETBALL PLAYERS

T. Nováková, J. Tufano, A. Veseláková

Charles University in Prague, Faculty of Physical Education and Sport, Department of Physiotherapy, Czech Republic

Summary: Aim: Balance training can help reduce the frequency of ankle joint injuries in adults, but data on young girls is relatively scant. **Methods**: Out of 91 female basketball players (7-16 years), 40 players were assigned to an experimental balance training group, and 51 players were assigned to a control group. Both groups performed their typical basketball training but the experimental group performed additional balance-focused exercises during the warm-up of their basketball training sessions. **Results**: A total of 47 girls (52 %) reported at least one ankle joint injury in their entire basketball history (52.5 % in the experimental, 50.9% in the control group). There was a positive correlation between the number of ankle joint injuries and age before the experiment ($r = 0.34$, $p < 0.001$). During the 12-month study period, girls who participated in balance training suffered significantly fewer ankle joint injuries than the control group ($\chi 2 = 3.8423$, df = 1, p-value < 0.05). Increased risk for ankle joint injury in the future was confirmed according to logistic regression for girls with previous ankle joint injury in history (4.33 times) and girls who did not participate in the balance training program (3.97 times). **Conclusions:** A progressive, barefoot balance training program that is simple and short enough to be performed during normal warm-ups can reduce the likelihood of suffering an ankle joint injury in young girls basketball players, which may be useful for athletes in other sports as well.

Key Words: ankle sprain, female, instability, school age players, sensorimotor exercises.

Introduction

From 1997 to 2007, it was reported that over 4 million injuries occurred during basketball games in players under 20 years old in the United States (Randazzo et al. 2010),

making basketball one of the five most common settings for sport injuries in young athletes (Schwebel & Brezausek 2014). Within basketball, epidemiological studies repeatedly point to a high percentage of ankle injuries (Borowski et al. 2008; Cumps et al. 2007), specifically ankle joint sprains (Messina et al. 1999; Colliander et al. 1986). Such injuries occur in both genders and across all levels of competition (Leanderson et al. 1993), but a higher frequency has been documented in females (Agel et al. 2007; Deitch et al. 2006; Dick et al. 2007; Drakos et al. 2010; Waterman et al. 2010). Unfortunately, when a basketball player suffers an ankle joint injurie (AJI), frequent relapses are not uncommon, which can deactivate a player for the remainder of the season and possibly contribute to the development of chronic ankle joint instability (Postle et al. 2012; van Rijn et al. 2008; Verhagen & Bay 2010). Although chronic ankle joint instability is never desired, developing such a condition at a young age could be detrimental to a child's future.

In adult athletes, the treatment and prevention of AJI and their relapse is well documented, but studies investigating the same in youth players are rare. In the event of an AJI, a balance training program implemented throughout a sports season can reduce the rate of ankle sprains (McGuine & Keene 2006) and can increase functional ankle joint stability (Kaminski et al. 2013; McGuine & Keene 2006; Sandlin et al. 2017; Zech et al. 2010). Therefore, although a balance training program as a primary intervention can be useful in preventing sprains in athletes with healthy ankles, but it must also be part of secondary prevention if an AJI has already occurred in the past. Specifically, performing balance training "barefoot" is recommended due to increased proprioceptive facilitation in the foot and ankle area, thereby increasing the efficiency of sensorimotor training (Sefton et al. 2011; Freeman et al. 1965; Page 2006; Frank et al. 2009; Ghram et al. 2017). However, few studies state whether balance training with proprioceptive functions can reduce the risk of injury while reducing the severity of subsequent ankle sprains, and such data is lacking in young girls. Therefore, the aim of our study was to first, provide an account of the incidence rate and prevalence period of AJIs in female basketball players aged from 7 to 16 years old. Then, we examined the effectiveness of regular barefoot balance training for reducing the occurrence of AJIs throughout an entire calendar year. We hypothesized that performing a progressive barefoot balance training program twice a week would reduce the number of AJIs in young female basketball players compared to players who did not perform the barefoot balance training program.

Methods

The main objectives of this research were to determine the number of AJIs in girl basketball players aged from 7 to 16 years old and then to evaluate the effectiveness of balance exercises integrated into the regular basketball training sessions of the experimental group. A total of 91 girls (7 to 16 years old) participated in this study. In an attempt to control for various factors including playing level, experience, age, cultural playing styles, and the like, all 91 girls were recruited from three basketball clubs with teams that spanned across the 7- to 16-year-old categories, played in the same competition league (i.e. regional level teams), and trained 2 to 3 times a week. Additionally, all of the girls had been playing basketball for at least two years prior to the beginning of the study according to the age category. The study was approved by the university's institutional review board (n. 048/2015), and as all participants were under 18 years old, both parental and child consent were obtained.

First, AJI frequency data (AJI_PRE) were collected from all 91 girls via written questionnaires that were completed with the assistance of their parents after volunteering for the study but before the start of the 12-month study period. Next, the girls were assigned to either an experimental group (n = 40) or a control group (n = 51). In either case, all of the girls on a single team were assigned to the same group so that there were not members of the experimental group and control group on the same team. Although this decision meant that the girls were not randomized between the groups, we did not want girls in the control group to see what their teammates were doing before practice (possibly then doing their own exercises at home despite being told not to). During the 12-month study period, both groups performed their normal basketball training, but the experimental group (BAL) performed additional barefoot balance training twice a week before practice in the beginning of their basketball training session (i.e. twice a week from 2-3 basketball trainings). Girls in the control group (CON) did not perform additional balance training. After 12 months, surveys were administered again to determine the effect of balance training on the frequency of AJI (AJI_POST).

Personal sport injury history data

The quantity and frequency of AJIs were determined using a hard-copy survey containing 12 questions (personal sport history and injury data), both closed and open-ended questions. Specifically, questions focused on whether the athlete had suffered an AJI in in their basketball history (AJI_PRE), the number of recurrent AJIs, the exact type of injury as diagnosed by a medical doctor, and other questions that were not related to the data within the

present study. Baseline surveys were administered during February, at the end of the competitive season. Parents were asked to prepare the medical documentation of any and all previous AJI-related injuries ahead of time. Then, the girls completed the surveys during practice time alongside their parents, and the surveys were immediately returned to their coach who then gave the hard copies to the researchers. At this time, the players and their parents were asked to register all of the injuries suffered in the next 12 months, during the study period. After 12 months, the same survey process was repeated, also in February, from which the post-intervention data were collected (AJI_POST).

12-Month Study Period

During the 12-month study period, BAL players completed supervised balance exercises during their twice weekly basketball practices (the frequency of twice a week was maintained even though basketball training was conducted three times a week). After the team's warm-up, the girls removed their shoes and socks and performed the balance exercises barefoot, lasting approximately 10 to 15 minutes. The elements of the balance exercises were based on sensorimotor exercises according to Freeman (Page 2006, Rohde 2012, Sefton et al. 2011, Freeman et al. 1965), but were modified according to space and equipment availability. In the preparatory phase, the emphasis was on achieving the full range of motion of the soles of the feet and ankles, active movements, and stretching (i.e. proprioceptive neuromuscular facilitation). In the next stage, exercises emphasized position awareness and movement control with the eyes closed (i.e. somatognosis and kinesthesia) by adjusting the position of the feet and ankles to maintain the center of pressure with the body in different positions. In the next phase, there was an emphasis on performing exercises on balance aids while focusing on the proper alignment of the lower limbs and trunk. Throughout the 12-month study period, the time devoted to the various stages and the intensity of the exercises were progressively adjusted (Table 1). Progress to higher levels of balance training was dependent on the quality of performance in each level and individualized by a supervisor (difference was just in weeks), and finally all girls reached the final level.

Table 1

The balance training plan

	Balance exercise focus	Focused area	Examples of specific exercises	Approximate time in minutes			
				Months 0-2	Months 3-4	Months 5-6	Months 7-12
Preparatory phase	Increase passive and active ankle range of motion	The extrinsic muscles mainly responsible for eversion, inversion, plantarflexion, and dorsiflexion of the foot.	Passive stretching of triceps surea, muscles participate on dorsiflexion and in inversion and eversion, Active movements to inversion and eversion, gradually using elastic resistance bands and increasing difficulty from simple positions to positions requiring high postural stabilization functions.	6′	5′	4′	2′
	Increase mobility in the sole of the foot	The intrinsic muscles responsible for the fine motor actions of the foot, for example movement of individual digits	Plantar aponeurosis stretching, passive increasing of ROM in abduction of big toe. Using e.g. treads with a holding time on a tennis ball to an increased mobility of soles into plantar flexion.				
	Facilitate propriocepti on of ankle and foot area	All joints, ligaments and muscles in the ankle joint and foot area.	Stretching, increased segmentally localized activity and targeted relaxation of muscles and increased joint play in all previous exercises are a prerequisite for facilitating proprioception.				
Switching from awareness to automatic control phase	Improve kinaesthetic awareness	The awareness of the position and movement in ankle and foot area.	Exercise focused on vision-controlled change of position in the ankles, feet and toes. Games based on the manipulation of objects using foot and toes. Walking on different surfaces and reliefs of the pad.	6′	5′	1′	1′
	Improve kinaesthetic awareness without visual stimuli	The awareness of the position and movement in ankle and foot area without visual control.	Exercises with an emphasis on awareness of the position and movement of the area without visual control. All previous exercises without visual control performance.				
	Improve kinaesthetic awareness without visual	Load soles body weight at different positions on a solid support	Stepping and lunges in all directions with controlled straightening of the trunk and axial adjustment entire lower extremity (avoiding internal				

	stimuli		rotation of the hip and valgosity in knee and ankle). One leg stands. All exercises can be more difficult with another task (throwing and catching the ball).				
Specific balance training phase	Improve static balance, placing focus on aligning the lower limbs and trunk on balance surface	Controlling the position and distribution of foot load by weight of the body in different positions on balance pads and aids	Exercise in stand or in stepping on balance pad. One leg stands. All exercises can be more difficult with another task (throwing and catching the ball).	3′	5′	10′	12′
	Improve dynamic balance, placing focus on aligning the lower limbs and trunk on balance aids	exercises on balance aids with an emphasis on the alignment of the lower limbs and trunk	Exercise based on movement task on balance aid. Exercises with balls, jumps, multitask in movement, walk on balance walkway.				

Statistical analysis

All data were analysed using statistical software R. We examined the relationship between the binary quantities AJI_POST and belonging to a group (undergoing balance training). We evaluated it using the Chi square test with Yates' continuity correction for significance of number of AJI_POST in both groups. When modeling this relationship, we decided to adjust for the presence of other potential factors such as age and an indicator of previous injury (AJI_PRE).

To this end, a logistic regression model was used, which models the conditional probability of injury (within 12 months) given the age of the player (at the beginning of the experiment) ranging from 7 to 16 years, previous experience of AJI_PRE (0=none, 1=at least one) and their assigned group (BAL for experimental balance group and CON for the control group).

Results

Entire basketball history

In their entire basketball history, 47 girls (51.6 %) reported having at least one AJI. Older players had been at risk for longer and therefore had more numbers of previous injuries (AJI_PRE), as supported by a statically significant positive correlation between age and number of AJIs ($r = 0.34$, $p < .001$). The number of AJIs varied from one to six with a maximum of four AJIs on the same ankle joint, the medical diagnoses of which (in AJI_PRE) were described as a distortion in 87.2 %. Then, in the occurrence of about 2 % of all AJI_PRE, there was a distortion with calcaneal fracture, a distortion with malleolus lateralis fracture, a distortion with malleolus lateralis fracture and contusion of surrounding muscles, a distortion and contusion of surrounding muscles, a malleolus lateralis fracture, and a luxation of the ankle joint. Only one player (16 years old) mentioned that surgery was needed for ankle joint luxation; the rest of the injured girls were treated in a conservative way (rest or fixation).

12-month study period

According to the results in Table 2, 21 girls (52.5 %) from BAL had suffered at AJI_PRE at some point in their history before the experiment.

Table 2

Ankle joint injuries related to age categories and basketball teams before (AJI_PRE) and after (AJI_POST) the experiment in balance training group (BAL) and control group (CON)

	Total number of players	Number of injured players (n=47) AJI_PRE			Number of injured players (n=16) AJI_POST		
AGE	n=91	total	BAL	CON	total	BAL	CON
7	2	0	0	0	0	0	0
8	7	0	0	0	0	0	0
9	6	1	1	0	1	0	1
10	14	7	4	3	1	0	1
11	14	8	5	3	1	1	0
12	12	5	4	1	2	1	1
13	6	3	2	1	2	0	2
14	7	4	1	3	2	0	2
15	10	9	1	8	3	0	3
16	13	10	3	7	4	1	3
	91	47	21	26	16	3	13

However, during the 12-month intervention, only 3 girls (7.5 %) from BAL suffered an AJI_POST. In CON, 26 girls (50.9 %) had suffered at AJI at some point in their history before the experiment, and during the 12-month intervention, 13 girls (25.5 %) from CON suffered an AJI_POST. The girls from BAL suffered significantly fewer AJI_POST than CON group in the 12-month study period (Table 3) according to the Pearson's Chi-squared test ($\chi 2$= 3.8423, df = 1, p = 0.049).

Table 3

The girls from BAL had suffered significantly fewer AJI than CON group in 12-month study period according to the Pearson's Chi-squared test ($\chi 2$= 3.8423, df = 1, p-value = 0.04997) - test the independence of two categorical variables

		BAL	CON
AJI_POST in 12 months	0	37	38
AJI_POST in 12 months	1	3	13

Although, becoming one year older increases the risk of suffering an AJI_POST by 14%, this increase was not statistically significant (p > 0.05) and, therefore, age (one year older) cannot be considered to be a significant risk factor. Girls in the CON group had almost 4-times (3.97) higher risk of AJI_POST than if they were in the BAL group (p ≤ 0.05). Girls who had already experienced an AJI_PRE in the past had more than 4-times (4.33) higher risk of an AJI_POST (Table 4).

Table 4

The logistic regression model which models the probability of injury (within the 12-month study period) to account for the age and the previous experience with the basketball player's injury

Coefficients	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**
β_0 intercept	-5.1156	1.6994	-3.010	0.00261 *
β_1 age	0.1342	0.1382	0.971	0.33174
β_2 group CON	1.3778	0.7294	1.889	0.05891
β_3 pre_AJI	1.4667	0.7574	1.937	0.05280
	Df	**Wald**	**P(W>w)**	**LRT P(LR > lr)**
age	1	0.942088	0.9529251	0.32897584
group	1	3.567857	4.1108966	0.04260777
pre_AJI	1	3.750083	4.2959585	0.03820306

*Signif. code: *0.05*
P (W> w) corresponds to the p-value based on the Wald test
P (LR> 1r) corresponds to the p-value based on the Likelihood Ratio test

Combining the significant results we can claim that a basketball player avoiding balance training with previous ankle injury has about 17-times (17.19) higher risk of (another) AJI than a basketball player practicing the balance training with no prior injury of the same age. From the baseline survey, it was found that out of 91 girls, 51% had previously suffered an AJI_PRE at some point, but more importantly and as hypothesized, the balance-training program seemed to have a positive effect on reducing the occurrence of AJIs during the 12-month study period, with fewer BAL girls suffering an AJI_POST (n = 3) compared to CON girls (n = 13). Together, these data highlight the importance of implementing balance-specific training at a young age to serve as a type of AJI countermeasure in young female basketball players.

Discussion

Reducing the risk of injuries should be one of the main aims of all coaches working with children, especially where repeated injuries may prematurely terminate a child's sports career or active lifestyle. Fortunately, basketball-specific injury prevention programs can significantly reduce the incidence of ankle sprains in basketball (Kaminski et al. 2013; McGuine & Keene 2006; Sandlin et al. 2017; Zech et al. 2010) or volleyball athletes (Farzami & Anbarian 2020), and prevention programs that emphasize proprioception and balance training can be successful in reducing AJIs in other high-risk multidirectional sports (Taylor et al. 2015). Balance exercises are often used to increase the muscle strength, coordination, postural control, and mobility of individual structures (Zech et al. 2010; McGuine & Keene 2006; Sierra-Guzman et al. 2018; Melam et al. 2018; Farzami & Anbarian 2020), and according to one systematic survey of postural management and acute lateral instability (McKeon & Hertel 2008), balance exercises may be more beneficial for patients who have a history of ankle-rupture sprain and who have been practicing for 2 years. Therefore, the reduction in AJI_POST in the BAL group of the present study agrees with their findings.

Considering the ages of the girls, the percentage of injuries among the 10- to 14-year-olds ranged from 41.7 % to 57.1 %, whereas 90 % of 15-year-olds were injured, and 69 % of 16-year-olds. These values exceed those of other studies that were conducted in adults showing that injuries occurred in 20.8 % out of 204 players (Kofotolis & Kellis 2007) and 24.7 % of professional players regardless of gender (Fong et al. 2007), as was expected (Doherty et al. 2014). As for the girls in the present study, an increase in the number of girls injured around 15 years old could be partly associated with how the game is played at older ages, with more physical contacts during the game, a greater total training time, and more matches as all teams

at this age have training at least 3 times a week and some girls start playing simultaneously with other teams. Another possible explanation could be a relatively quick change in body mass ratios (Kofotolis & Kellis 2007; Randazzo et al. 2010), which the girls may not be prepared for, decreasing their self-control and kinesthetic awareness. However, these hypotheses remain purely speculative, as the data from the current study cannot confirm or refute these claims, indicating that future research should delve deeper into these possible relationships.

In addition, attention was focused on the number of recurrent AJI, with 23 girls reporting two or more injuries in their basketball history (48.9 % of all the injured girls). In one meta-analysis (Postle et al. 2012), it was reported that the AJI sprain recurrence rate in active athletes can be upwards up 70 to 80 %, which is a problem that has received a lot of attention within the literature (Hung 2015; Kaminski et al. 2013; van Rijn et al. 2008; Sandlin et al. 2017; Cumps et al. 2007). The recurrence rate of ankle sprains can be affected by the severity of the first AJI sprain, the use of passive support, the involvement of balancing exercises, a quick return to play, or the time played during basketball. In the present study, there was a positive correlation between the number of AJI and age before experiment. The number of AJI_PRE varied from one to six with a maximum of four AJIs on the same ankle joint. Such a high number of repeated AJIs (i.e. recurrent ankle sprains) may partially be explained by the questionnaire used in the present study where the presence of sprains was evaluated only on the basis of an inquiry, where the significance of the sprain was explained and the basic clinical manifestations described. Due to the nature of the research, no evaluation system was used to determine the degree of severity of ankle joint sprain (Mann et al. 2006). Therefore, injuries from non-serious clinical manifestations (ankle joint pain, no swelling, short-term walking inability) to serious sprain with ligament damage and persisting functional instability were included in the sprain data (AJI_PRE). This may also be one of the reasons why the percentage of sprains is high compared to other studies that included adult basketball players.

It is important to note that the teams included in our research belong to training centers that should not be compared to most regular school sports clubs. The generally high training doses and early sport specialization that occurs in these clubs may lead to more injuries in the long-term. In the present study, the majority of AJIs occurred in January (19.1 %). In February, the number of injuries decreased to almost half (10.6 %) and then subsequently, March to July displayed the lowest injury frequency (only 2.2 % in a month). This injury pattern can be explained by the season's schedule, as most of the competitions end in April, with a hiatus from official training during the summer months. In August, camps resume, where 8.5 % AJIs occurred. Then, the incidence of injuries increased with the start of the new season, from

September to December, the injury rate averaged at 12.8 % each month. These data agree with one study that found that most injuries of school aged basketball players occur in the winter season (44.4% from December to March), with the most injuries in January (12.6 %) (Randazzo et al. 2010). Although not in children, other research showed that for male and female high-school basketball players, AJI frequency was greatest in-season, with fewer AJIs in the post-season and even fewer during the pre-season (Agel et al. 2007). The results of these studies coincide with the results of our work, as the most frequent injuries in the playing season, namely the winter season. An exception is the period from March to April, when the frequency of the injury was low.

Conclusions

In summary, 47 girls out of 91 reported that they had experienced at least one AJI, and almost half of the injured girls mentioned recurrence of injury. The most frequent injuries were reported on the right leg, and most players were injured in the winter, particularly in January. The balance exercises based on the elements of sensorimotor stimulation (10 to 15 minutes twice in a week) were included in basketball training of the BAL group, and a basketball player who underwent balance training had 3.97 times lower risk of AJI than those who did not participate in the additional balance training (Likelihood Ratio test $p = 0.043$), regardless of her age and previous injury status. Furthermore, a previously injured player had 4.33 times higher risk of an AJI in the12 months study period than a player from the same group (BAL or CON) and of the same age who had not suffered an AJI before the experiment (Likelihood Ratio test $p = 0.038$). As a result, the girls from BAL suffered significantly fewer AJI in the 12-month study period ($p < 0.05$) than the CON group that did not complete the additional barefoot balance training. This positive effect of balance exercises to decrease the rate AJI is especially important for coaches who coach young girls, a population that has shown to be quite susceptible to AJIs compared to other populations.

Acknowledgments

We sincerely thank to all the players who participated so willingly in the study and Mgr. Jan Vávra for help with the statistical processing of the results.

Disclosure of interest

The authors declare that they have no competing interest.

References

1. AGEL, J., D. E. OLSON, R. DICK, E. A. ARENDT, S. W. MARSHALL & R. S. SIKKA, 2007. Descriptive epidemiology of collegiate women's basketball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2003–2004. *J Athl Train.* **42,** 202-210.
2. BOROWSKI, L. A., E. E. YARD, S. K. FIELDS & R. D. COMSTOCK, 2008. The epidemiology of US high school basketball injuries, 2005-2007. *Am J Sports Med.* **36,** 2328-35.
3. COLLIANDER, E., E. ERIKSSON, M. HERKEL & P. SKOLD, 1986. Injuries in Swedish elite basketball. *Orthopedics,* 9**,** 225-7.
4. CUMPS, E., E. VERHAGEN & R. MEEUSEN, 2007. Prospective epidemiological study of basketball injuries during one competitive season: ankle sprains and overuse knee injuries. *J Sports Sci Med,* 6**,** 204-11.
5. DEITCH, J. R., C. STARKEY, S. L. WALTERS & J. B. MOSELEY, 2006. Injury risk in professional basketball players: a comparison of Women's National Basketball Association and National Basketball Association athletes. *Am J Sports Med.* 34**,** 1077-83.
6. DICK, R., J. HERTEL, J. AGEL, J. GROSSMAN & S. W. MARSHALL, 2007. Descriptive epidemiology of collegiate men's basketball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2003–2004. *Journal of athletic training.* **42,** 194.
7. DOHERTY, C., E. DELAHUNT, B. CAULFIELD, J. HERTEL, J. RYAN & C. BLEAKLEY, 2014. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. *Sports Med.* 44**,** 123-40.
8. DRAKOS, M. C., B. DOMB, C. STARKEY, L. CALLAHAN & A. A. ALLEN, 2010. Injury in the national basketball association: a 17-year overview. *Sports Health.* 2**,** 284-90.
9. FARZAMI, A. & M. ANBARIAN, 2020. The effects of fatigue on plantar pressure and balance in adolescent volleyball players with and without history of unilateral ankle injury. *Science & Sports.* **35,** 29-36.
10. FONG, D. T., Y. HONG, L. K. CHAN, P. S. YUNG & K. M. CHAN, 2007. A systematic review on ankle injury and ankle sprain in sports. *Sports Med.* 37**,** 73-94.
11. FRANK, C., P. PAGE & R. LARDNER, 2009. *Assessment and treatment of muscle imbalance: the Janda approach*, Human kinetics.

12. FREEMAN, M., M. DEAN & I. HANHAM, 1965. The etiology and prevention of functional instability of the foot. *The Journal of bone and joint surgery. British volume.* **47,** 678-685.
13. GHRAM, A., M. DAMAK & P. COSTA, 2017. Effect of acute contract-relax proprioceptive neuromuscular facilitation stretching on static balance in healthy men. *Science & Sports.* 32**,** e1-e7.
14. HUNG, Y. J., 2015. Neuromuscular control and rehabilitation of the unstable ankle. *World J Orthop.* 6**,** 434-8.
15. KAMINSKI, T. W., J. HERTEL, N. AMENDOLA, C. L. DOCHERTY, M. G. DOLAN, J. T. HOPKINS, E. NUSSBAUM, W. POPPY, D. RICHIE & A. NATIONAL ATHLETIC TRAINERS, 2013. National Athletic Trainers' Association position statement: conservative management and prevention of ankle sprains in athletes. *J Athl Train.* 48**,** 528-45.
16. KOFOTOLIS, N. & E. KELLIS, 2007. Ankle sprain injuries: a 2-year prospective cohort study in female Greek professional basketball players. *J Athl Train.* 42**,** 388-94.
17. LEANDERSON, J., G. NEMETH & E. ERIKSSON, 1993. Ankle injuries in basketball players. *Knee Surg Sports Traumatol Arthrosc.* 1**,** 200-2.
18. MANN, G., M. NYSKA, I. HETSRONI & J. KARLSSON, 2006. Scoring systems for evaluating ankle function. *Foot Ankle Clin.* 11**,** 509-19.
19. MCGUINE, T. A. & J. S. KEENE, 2006. The effect of a balance training program on the risk of ankle sprains in high school athletes. *Am J Sports Med.* 34**,** 1103-11.
20. MCKEON, P. O. & J. HERTEL, 2008. Systematic review of postural control and lateral ankle instability, part I: can deficits be detected with instrumented testing. *J Athl Train.* 43**,** 293-304.
21. MELAM, G., A. ALHUSAINI, V. PERUMAL, S. BURAGADDA, A. ALBARRATI & R. LOCHAB, 2018. Effect of weight-bearing overload using elastic tubing on balance and functional performance in athletes with chronic ankle instability. *Science & Sports.* 33**,** e229-e236.
22. MESSINA, D. F., W. C. FARNEY & J. C. DELEE, 1999. The incidence of injury in Texas high school basketball. A prospective study among male and female athletes. *Am J Sports Med.* 27**,** 294-9.
23. PAGE, P. 2006. Sensorimotor training: A “global” approach for balance training. *Journal of Bodywork and Movement Therapies.* 10**,** 77-84.

24. POSTLE, K., D. PAK & T. O. SMITH, 2012. Effectiveness of proprioceptive exercises for ankle ligament injury in adults: a systematic literature and meta-analysis. *Man Ther.* 17**,** 285-91.
25. RANDAZZO, C., N. G. NELSON & L. B. MCKENZIE, 2010. Basketball-related injuries in school-aged children and adolescents in 1997-2007. *Pediatrics.* 126**,** 727-33.
26. ROHDE, J., 2012. Die sensomotorische Fazilitation (Kurzfußtechnik) nach Janda. *Manuelle Medizin.* 50**,** 183-188.
27. SANDLIN, M. I., C. E. TAGHAVI, T. P. CHARLTON & R. D. FERKEL, 2017. Lateral Ankle Instability and Peroneal Tendon Pathology. *Instr Course Lect.* 66**,** 301-312.
28. SEFTON, J. M., C. YARAR, C. A. HICKS-LITTLE, J. W. BERRY & M. L. CORDOVA, 2011. Six weeks of balance training improves sensorimotor function in individuals with chronic ankle instability. *Journal of orthopaedic & sports physical therapy,* 41**,** 81-89.
29. SCHWEBEL, D. C. & C. M. BREZAUSEK, 2014. Child development and pediatric sport and recreational injuries by age. *J Athl Train.* 49**,** 780-5.
30. SIERRA-GUZMAN, R., F. JIMENEZ-DIAZ, C. RAMIREZ, P. ESTEBAN & J. ABIAN-VICEN, 2018. Whole-Body-Vibration Training and Balance in Recreational Athletes With Chronic Ankle Instability. *J Athl Train.* 53**,** 355-363.
31. TAYLOR, J. B., K. R. FORD, A. D. NGUYEN, L. N. TERRY & E. J. HEGEDUS, 2015. Prevention of Lower Extremity Injuries in Basketball: A Systematic Review and Meta-Analysis. *Sports Health.* 7**,** 392-8.
32. VAN RIJN, R. M., A. G. VAN OS, R. M. BERNSEN, P. A. LUIJSTERBURG, B. W. KOES & S. M. BIERMA-ZEINSTRA, 2008. What is the clinical course of acute ankle sprains? A systematic literature review. *The American journal of medicine.* 121**,** 324-331. e7.
33. VERHAGEN, E. A. & K. BAY, 2010. Optimising ankle sprain prevention: a critical review and practical appraisal of the literature. *Br J Sports Med.* 44**,** 1082-8.
34. WATERMAN, B. R., B. D. OWENS, S. DAVEY, M. A. ZACCHILLI & P. J., JR. BELMONT, 2010. The epidemiology of ankle sprains in the United States. *J Bone Joint Surg Am.* 92**,** 2279-84.
35. ZECH, A., M. HUBSCHER, L. VOGT, W. BANZER, F. HANSEL & K. PFEIFER, 2010. Balance training for neuromuscular control and performance enhancement: a systematic review. *J Athl Train.* 45**,** 392-403.

DOI 10.2478/afepuc-2021-0019
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 228-237

SELECTED GOAL – SCORING CHARACTERISTICS IN THE NATIONAL HOCKEY LEAGUE

Silvio Parničan[1,2], Pavol Peráček[1], Igor Tóth[1]

[1] Comenius University in Bratislava, Faculty of Physical Education and Sports, Department of Sports Games, Slovakia

[2]Stjernen Hockey Fredrikstad, Norway

Summary: The variables impacting the efficiency of the offensive phase of the game in ice hockey may be determining factor for both the training process and game strategies. The research aimed to acquire and expand the knowledge about selected goal-scoring characteristics in the National Hockey League. A total of 511 even-strength goals were recorded in 129 randomly selected games in a regular-season 2020/2021 by indirect observation. Goals were differentiated by selected variable dimensions: location of the offensive team's puck possession gain before scoring a goal, game situation preceding a goal, and the number of passes of the offensive team preceding a goal. Data were analyzed by performing a one–way ANOVA. Post hoc multiple comparisons were performed using the Tukey HSD test. The significance level of $p \leq 0.05$ was used. Significant differences were found within all variable dimensions ($p= 0.00001$). In terms of the puck possession gain location, zone 1 (along the boards in the offensive zone) was the zone with the significantly highest mean score ($p= 0.00305$). Offensive zone play was significantly the game situation preceding most of the goals ($p= 0.00000$). The interval of the passes that preceded most of the recorded goals was the interval of 1 – 2 passes ($p= 0.00000$). Acquired results point out the dominance of particular variables and may help coaches to determine the content of the training process and game strategies. Based on the assumption of the realization of similar research in different environments in terms of the quality and age category, if the analogy would be found between the results of the present study and the results of potential studies, we can state the trends applicable to youth training.

Key words: National Hockey League, ice hockey, game performance, trends, goals.

Introduction

Performance analysis has been rapidly increasing in top-class ice hockey over the past years, which has produced growing interest both from spectators and club representatives (Lignell et al. 2020). However, the question of the variables with significant impact on increasing the number of goals requires further research. The rigorous research has been conducted on goal scoring characteristics (GSC) in various team sports stating that particular tactical and contextual variables influence GSC (González-Rodenas et al. 2020; Kubay 2020; Li and Zhao 2021; Mitrotasios et al. 2019; etc). Equally, in ice hockey, it is necessary to determine the variables impacting the efficiency of an offensive phase of the game (OPG). Increased efficiency of OPG results in a higher frequency of goals.

Goal-scoring characteristics should be considered from two standpoints. The primary is from the player's performance (IPP). It is characterized by the player's manifestation during the game (Peráček 2018). IPP simultaneously shows the player's capability to participate in the team's game performance (GPT). GPT is the second important aspect when parsing the GSC. Generally, the GPT and IPP exist in very close connection. GPT is the synthesis of players' performances but in no case their mechanical sum (Peráček 2018).

When we are on the subject of the second standpoint of the GSC – GPT, we mean the mutual activity of the group of players. GPT consists of the IPP of all players (Peráček 2018). From the GSC viewpoint, GPT it is visible in the playing style, which is, according to Fernandez-Navarro et al. (2016, as cited in González-Rodenas et al. 2021) regarded as the general behavior of the team when participating in the tasks of offensive and defensive game. Cooperation between two or more players, coordinated in time and space, is called game combination (Peráček 2003; Tóth 2010). According to Tóth (2010), the mastery of combinations is a precondition for the mastery of the game systems since the game system is realized by combinations (Peráček 2018). The game system is a very foundation of the strategy in both the game's offensive and defensive phase. Výboh (2005) states the following offensive systems: progressive attack, counter-attack (turnover), quick attack, positioning attack, reorganized attack, pressure-based game (offensive zone play). Every game system has its specific features, and its use depends on factors such as the coach's philosophy, typology of the players, level of their cooperation, opponent's style of play, situational context, etc. There is a close relationship between some of the offensive and defensive game systems. Expansion of the knowledge about the most frequent variables that are raising the efficiency of the offensive phase of the game, should be reflected in the higher number of scored goals, and may be the instructive source of information. We assumed that there might be significant differences between the variable categories. With regard to specificities of every particular league or

competition, if there is an analogy between the results of studies focused on senior and youth age categories, we can name them the trends applicable to youth training.

Methods

Sample and variables

The context of the indirect observation was the regular season of the National Hockey League 2020/2021. A total of 511 even-strength goals were recorded in 129 randomly selected games in a regular game time. Every variable was the component of the uninterrupted period from the start of the scoring team's puck possession to the goal's moment. The team's puck possession starts when any one of its players starts controlling the puck. Data were obtained from the available live game broadcasts solely for video analysis and from the official National Hockey League's statistics website (available at http://www.nhl.com/stats/). We designed and used the record sheets for each particular game. Through the option of pause and replay of the goal situations, we could record the data objectively.

Table 1

Description of the variable categories in terms of the team's game performance

The location of gained puck possession (Figure 1): The location on the ice rink where the offensive team gained the puck.
1. **Zone 1:** Location along the boards in the offensive zone.
2. **Zone 2:** Location along the boards in the defensive zone.
3. **Zone 3:** Centrally located open ice location.
4. **Zone 4:** Locations along the boards in the neutral zone.
The game situation: The situational context of the moment of scoring the goal.
1. **Slow advanced attack:** Used when the opponent's defence is organized. Based on a slower pace, a higher number of passes, and continuous actions.
2. **Quick attack:** Used when the opponent's defense isn't organized. Based on the secured defense of the offensive team and the straight penetration pass. It is organized chiefly through the central open ice.
3. **Turnover:** Immediate and straight response on the opponent's offensive action based on immediate penetration pass.
4. **Offensive zone play:** Based on the aggressive offensive play associated with the defensive game in the offensive zone. It is characterized by a frequent incidence of shooting attempts.
5. **The goal following a face-off:** Immediate action after a successful face-off with no interruption of scoring team's offensive play.
The number of passes (n): Interval of the offensive team's passes before scoring a goal from the moment of the puck possession gain.
1. **0**
2. **1 – 2**
3. **3 – 4**
4. **5 or more**

Three variable dimensions in terms of the team's game performance (Table 1) were evaluated. The variables are related to the offensive phase of the game ending with the goal scored.

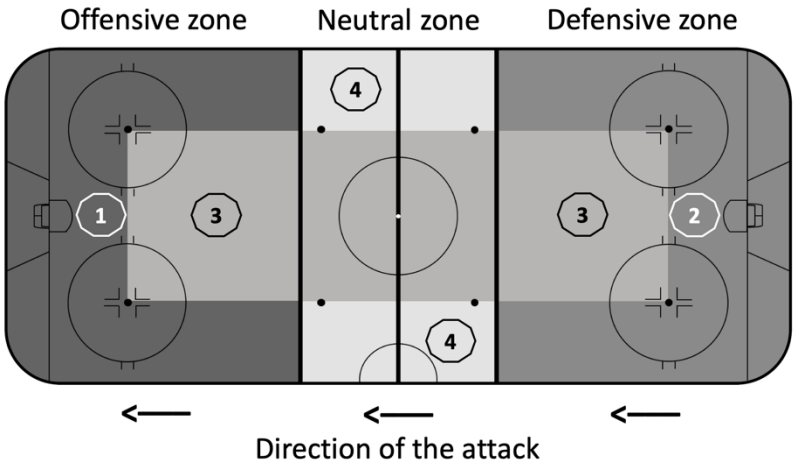

Figure 1
Locations of gaining the puck possession before scoring a goal

Data analysis

In every goal action considered, the one-way ANOVA was performed to the mutual comparison of the categories of particular variables. Post hoc multiple comparisons were performed using the Tukey HSD test. The significance level of $p \leq 0.05$ was used.

Results & Discussion

As shown in Table 2, there were significant differences found within the goals scored after the gained puck possession in the different locations [F (3,512) = 47.2798; p = 0.00001]. Post hoc comparisons using the Tukey HSD test indicated the differences between the mean scores of the goals scored after gaining the puck possession in the single locations except between zone 3 (M = 0.62, SD = 0.78) and zone 4 (M = 0.39, SD = 0.64). Zone 1 was the location with the highest mean score (M = 1.69, SD = 1.23). Individual comparisons of mean scores are shown in Table 3.

Table 2
Analysis of the goals in terms of the locations of gained puck possession

Source of variation	SS	df	MS	F	p
Between groups	137.3081	3	45.7694	47.2798	0.00001
Within groups	495.6434	512	0.9681		
Total	632.9516	515			

Legend: SS – the sum of squares; df – degrees of freedom; MS – mean square; F - test statistic; p – ANOVA p-value

Table 3

Comparisons between the goals in terms of the locations of gained puck possession – post hoc Tukey HSD test

Comparison of locations							
V_1 vs V_2	**M_1**	**SD_1**	**M_2**	**SD_2**	**Q**	**p**	**inference**
Z1 > Z2	1.69	1.23	1.26	1.20	4.92	0.00305	** p < 0.01
Z1 > Z3	1.69	1.23	0.62	0.78	12.35	0.00000	** p < 0.01
Z1 > Z4	1.69	1.23	0.39	0.64	15.03	0.00000	** p < 0.01
Z2 > Z3	1.26	1.20	0.62	0.78	7.43	0.00000	** p < 0.01
Z2 > Z4	1.26	1.20	0.39	0.64	10.11	0.00000	** p < 0.01
Z3 > Z4	0.62	0.62	0.39	0.64	2.69	0.22988	n.s.

Legend: V_1 – first variable; V_2 – second variable; M_1 – mean score of the first variable; SD_1 – standard deviation of the first variable; M_2 – mean score of the second variable; SD_2 – standard deviation of the second variable; Tukey HSD Q statistic; p – Tukey HSD p – value; inference – Tukey HSD inference; M – mean score, SD – standard deviation; Z1 – zone 1; Z2 – zone 2; Z3 – zone 3; Z4 – zone 4

Table 4

Analysis of the goals in terms of the game situations preceding the goal

Source of variation	SS	df	MS	F	p
Between groups	169.8822	4	42.4705	53.68807	0.00001
Within groups	506.2791	640	0.7911		
Total	676.1612	644			

Legend: SS- the sum of squares; df- degrees of freedom; MS- mean square; F- test statistic; p- ANOVA p-value

Table 5

Comparisons between the goals in terms of the game situations preceding the goal – post hoc Tukey HSD test

Comparison of the game situations							
V_1 vs V_2	**M_1**	**SD_1**	**M_2**	**SD_2**	**Q**	**p**	**inference**
SAA > QA	0.74	0.88	0.26	0.49	6.04	0.00022	** p < 0.01
SAA < TO	0.74	0.88	1.00	1.03	3.37	0.12203	n.s.
SAA < OZP	0.74	0.88	1.66	1.23	11.78	0.0000	** p < 0.01
SAA > FFO	0.74	0.88	0.30	0.61	5.54	0.00093	** p < 0.01
QA < TO	0.26	0.49	1.00	1.03	9.40	0.00000	** p < 0.01
QA < OZP	0.26	0.49	1.66	1.23	17.82	0.00000	** p < 0.01
QA < FFO	0.26	0.49	0.30	0.61	0.49	0.99680	n.s.
TO < OZP	1.00	1.03	1.66	1.23	8.41	0.00000	** p < 0.01
TO > FFO	1.00	1.03	0.30	0.61	8.91	0.00000	** p < 0.01
OZP > FFO	1.66	1.23	0.30	0.61	17.32	0.00000	** p < 0.01

Legend: V_1 – first variable; V_2 – second variable; M_1 – mean score of the first variable; SD_1 – standard deviation of the first variable; M_2 – mean score of the second variable; SD_2 – standard deviation of the second variable; Q – Tukey HSD Q statistic; p – Tukey HSD p – value; inference – Tukey HSD inference; M – mean score; SD – standard deviation

Significant differences were found between the goals scored differing by the game situation preceding the goal [F (4,640) = 53.68807; p = 0.0001]. Results are shown in Table 4. Post hoc multiple comparisons (Table 5) determined the significant differences between the mean scores of variables, excluding the comparison between the goals scored after the slow advanced attack (M = 0.74, SD = 0.88) and the turnover (M = 1.00, SD = 1.03). Insignificant difference was equally shown in comparison quick attack (M = 0.26, SD = 0.49) and the goals following the face-off (M = 0.30, SD = 0.60). The game situation with the highest mean score was the offensive zone play (M =1.66, SD = 1.23).

The ANOVA results of the goals in terms of the number of passes preceding the goal are summarized in Table 6. Significant differences were shown between the categories [F (3,512) = 69.52454; p = 0.0001]. Tukey HSD post hoc multiple comparisons found that except of the comparison of the 0 – passes (M = 0.46, SD = 0.68) and 5 or more passes (M = 0.41, SD = 0.62) mean scores, all comparisons found significant differences (Table 7). The 1 - 2 passes interval had the highest mean score (M = 1.98, SD = 1.45).

Table 6

Analysis of the goals in terms of the number of the passes preceding the goal

Source of variation	SS	df	MS	F	p
Between groups	207.5252	3	69.1751	69.52454	0.00001
Within groups	509.4264	512	0.995		
Total	716.9516	515			

Legend: SS – the sum of squares; df – degrees of freedom; MS – mean square; F - test statistic; p – ANOVA p-value

Table 7

Comparisons between the goals in terms of the number of the passes preceding the goal – post hoc Tukey HSD test

Comparison of the number of passes							
V_1 vs V_2	**M_1**	**SD_1**	**M_2**	**SD_2**	**Q**	**p**	**inference**
0 < 1-2	0.46	0.68	1.98	1.45	17.30	0.00000	** p < 0.01
0 < 3-4	0.46	0.68	1.12	1.01	7.50	0.00000	** p < 0.01
0 > 5 or more	0.46	0.68	0.41	0.62	0.53	0.98209	n.s.
1-2 > 3-4	1.98	1.45	1.12	1.01	9.80	0.00000	** p < 0.01
1-2 > 5 or more	1.98	1.45	0.41	0.62	17.83	0.00000	** p < 0.01
3-4 > 5 or more	1.12	1.01	0.41	0.62	8.03	0.00000	** p < 0.01

Legend: V1 – first variable; V2 – second variable; M1 – mean score of the first variable; SD1 – standard deviation of the first variable; M2 – mean score of the second variable; SD2 – standard deviation of the second variable Tukey HSD Q statistic; p – Tukey HSD p - value; inference – Tukey HSD inference; M – mean score; SD – standard deviation

Several related studies focusing on goal-scoring characteristics were conducted in the last two decades (Andrews 2009; Garbe 2013; Elomo and Poikonen 2015; Lignell et al. 2020, etc.). However, there can be differences seen in the systematics, terminology, and data analysis in most cases. As mentioned in the introduction part, characteristics of scored goals or goal-scoring patterns are mostly studied in the environment of the different sports games, such as in soccer. In ice hockey, this issue needs to be deeply reviewed. In Garbe's NHL research (2013), 50 % of goals were scored following the puck possession gain in the deeper offensive zone. The mean score of the goals scored after gaining the puck possession in zone 1 (M = 1.69, SD = 1.23), representing the location along the boards from the deeper offensive zone, through the grey area up to the blue line, was the highest. The area along the boards is generally the area with the highest incidence of the challenges for the puck. Andrews (2009) stated that most of the NHL goals (58%) were scored after OZP. Elomo and Poikonen (2015) state the following distribution of even-strength goals in terms of the situational context: OZP – 36 %, rush- 33 %, and turnover- 31 %. Authors characterize the rush as a controlled attack from a defensive or neutral zone when the opponent has an organized defense. As we can see in this case, the different systematics, methodology, and in particular, the league (Finnish Liiga) must be considered because of the different rink dimensions and level of the competition. In our findings, the goals after gaining the puck in the OZP had the highest mean score (M = 1.66, SD = 1.23). Garbe (2013) states that most of the goals in the NHL are scored from the counter-attacks (36.6%) with the unorganized defense of the opponent. This proportion of the goals was not significantly different compared to the number of goals after the slow attack with the organized defense of the opponent (31.11 %) and after the fast break when the opponent is organized (32.29 %). Garbe (2013) has recorded the goals according to the number of passes before a goal: 1 pass- 22.3 %, 2 passes- 18.6 %, which is a total of 40.9 % of scored goals. Likewise, in our research, most of the goals in terms of the number of passes preceding the goal were scored after 1 – 2 passes (M = 1.98, SD = 1.45). Although the authors used a different statistical approach, we can state that the most dominant variables in most of the referred studies are comparable to our results. Except for Elomo's and Poikonen's study (2015) that was focused on the Finnish Liiga, our data are commensurable with the findings of mentioned studies. The fact is that the NHL differs from the European ice hockey leagues by the level of the game performance and different rink dimensions what causes the different game styles, pace, and tactics. Garbe's findings (2013) are comparable partially due to different systematics of the variables and the different data analysis approach. In addition to the different systematics,

methodology, and data analysis, the development trends may be another important factor impacting the differences.

Conclusion

The research aimed to deepen the knowledge about selected characteristics of the National Hockey League goals. Our assumptions about the significant differences between the particular variable categories were confirmed ($p < 0.05$). Together with the mentioned studies, our research has shown the dominance of specific variables. In terms of the location of gaining the puck possession, zone 1 (along the boards in the offensive zone) was the zone with the significantly highest mean score ($M = 1.69$, $SD = 1.23$; $p = 0.00305$). Offensive zone play [OZP] ($M = 1.66$, $SD = 1.23$; $p = 0.00000$) was the game situation preceding significantly most of the goals. Interval of the passes that preceded most of the recorded goals, was the interval of 1 – 2 passes ($M = 1.98$, $SD = 1.45$; $p = 0.00000$). In terms of the game's defensive phase (DPG), acquired results showed the dominance of zone pressing, characterized by an aggressive forechecking to minimize the room for the opponent's offensive play by using double pressure and switching. To maximize the chances of success when using the zone pressing, high activity and efficiency from all five players are necessary. Even the defensemen need to be active when forechecking, most commonly in the pinching activity when the offensive team dumps the puck out by the rim for the winger waiting in the area between the grey zone and the blue line. In this case, the defensive player needs to be supplied on the blue line by the closest player, which is the center in most cases. From the offensive standpoint, the most frequent variable (OZP) points out the association of zone pressing with the aggressive offense play system when the players produce scoring chances immediately after gaining the puck. The most common interval of passes (1-2) preceding the goal confirms this statement.

With regard to different rink dimensions in the NHL, where the rink is smaller than in Europe, we recommend realizing similar research in the elite European senior and youth leagues (e.g., Kontinental Hockey League, Swedish Hockey League, Liiga, etc.). If there is an analogy between the potential results in training, it is necessary to implement the game-based drills and modified games with the forechecking, double pressure, and switching principle in the offensive zone with an effort to quick transition and immediate production of scoring chances. When focusing on the breakout mastering, the emphasis should be put on the drills under pressure with the game's simple transfer to the rink's end zone.

References

1. ANDREWS, J., 2009. *2006 – 2007 NHL season goal scoring analysis: Top 15 goal scorers & top 5 goal scoring teams*. Haaga – Helia. University of Applied Sciences.
2. ELOMO, M & T. POIKONEN, 2015. *Analyzing reasons behind the goals in ice-hockey.* Haaga-Helia: University of Applied Sciences.
3. FERNANDEZ-NAVARRO, J., et al., 2016. Attacking and defensive styles of play in soccer: analysis of Spanish and English elite teams. In: *Journal of Sports Sciences.* **34**(24), 2195-2204. ISSN 1466-447X
4. GARBE, N., 2013. *Goal scoring analysis based on team level in National Hockey League in the season 2006/2007.* Haaga – Helia: University of Applied Sciences.
5. GONZÁLEZ-RODENAS, J., et al., 2020. Playing tactics, contextual variables and offensive effectiveness in English Premier League soccer matches. A multilevel analysis. In: *Plos One.* **15**(2), e0226978. ISSN 1932-6203.
6. GONZÁLEZ-RODENAS, J., et al., 2021. The effect of contextual variables on the attacking style of play in professional soccer. In: *Journal of Human Sport and Exercise.* **16**(2), 399-410. ISSN 1988-5202.
7. KUBAY, A., 2020. Analysis of goal scoring patterns in the 2018 FIFA World Cup. In: *Journal of Human Kinetics.* **71**(1), 205-210. ISSSN 1640-5544.
8. LI, C. & Y. ZHAO, 2021. ''The big five'' European football leagues. In: *Frontiers in Psychology.* 11, 619304. ISSN 2010-9999.
9. LIGNELL, E., et al., 2018. Analysis of goal scoring opportunities in elite male ice hockey in relation to tactical and contextual variables. In: *International Journal of Performance Analysis in Sport.* **20**(6), 1003-1017. ISSN 1474-8185.
10. MITROTASIOS, M., et al., 2019. The creation of goal scoring opportunities in professional soccer. Tactical differences between Spanish La Liga, English Premier League, German Bundesliga and Italian Serie A. In: *International Journal of Performance Analysis in Sport.* **19**(3), 452-465. ISSN1474-81185.
11. PERÁČEK, P., et al., 2003. *Teória a didaktika športových hier.* Bratislava: Peter Mačura – PEEM. ISBN 80-88901-77-4.
12. PERÁČEK, P., 2018. *Teória športových hier. Vysokoškolská učebnica pre študentov FTVŠ UK v Bratislave*. Bratislava: KO&KA spol s.r.o. ISBN 978-80-89075-74-4.
13. TÓTH, I. et al., 2010. *Tréner ľadového hokeja. Vysokoškolská učebnica pre trénerov špecializácie v ľadovom hokeji.* Bratislava: TO-MI Ice Hockey Agency. ISBN 978-80-970545-1-9.

14. VÝBOH, A., et al., 2005. *Teória a didaktika ľadového hokeja III: obsahové zameranie tréningového procesu vekových kategórií mladších žiakov, starších žiakov, dorastu a juniorov.* Bratislava. ISBN 80-969475-1-6.

DOI 10.2478/afepuc-2021-0020
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 238-248

SOCIAL MEDIA FITNESS CHALLENGE – RISKS AND BENEFITS

Petr Schlegel, Adam Křehký, Radka Dostálová

Department of Physical Education and Sport, Faculty of Education, University of Hradec Králové, Czech Republic

Summary. Social media is part of the lives of young adults. Their influence extends to health behavior or nutrition. "Fitness challenges" often appear and they should affect the motivation to exercise, body composition changes, performance improvement. 67 healthy young adults (32 women, 20.3 years; 35 men, 20.8 years) took part in the "challenge", where they completed 3 series of 12 – 15 push-ups every day for 30 days. After the intervention, both groups showed a statistically significant (α = 0.01) improvement, women 5.8 repetitions, men by 7 repetitions. The research was supplemented by a questionnaire, which showed a positive effect on increasing motivation for this activity. Furthermore, it has been shown that "fitness challenges" bring obvious health risks that need to be taken into account. It seems that with the optimal setting of the content of the exercise program, the "fitness challenge" can be a good instrument of increasing the physical acitivty, motivation to exercise, and positively influencing strength performance.

Keywords: push-up, exercise, motivation, performance

Introduction

The use of social media has become an integral part of young people's lives. According to Ilakuvan et al. (2018), 88 % of young adults (18 – 29 years) use them regularly. This virtual space has become, among other things, a source of information, a means of communication, or self-presentation. Over time, groups have been formed within social networks focusing on healthy lifestyles, nutrition, exercise, and appearance (Alberga et al. 2018). These are open groups (e.g. Fitspiration, fitspo, Thinspiration), where users can freely contribute or be just passive recipients. These groups have tens of millions of posts and even a higher number of followers (Raggat et al. 2018). The content includes pictures, videos, texts to help with

motivation to exercise, and a healthy diet (Tigemann and Zaccardo 2018). Followers (“likers”) can thus encounter motivational contributions containing intensive exercise, proper exercise technique, presentation of training or certain methods, or weight reduction.

Part of the "life" of social media are "challenges" that cut across different areas. This phenomenon also applies to exercise groups. Usually, "likers" are encouraged to perform a certain type of exercise that is not demanding on material security, for a relatively short period of up to several weeks. The purpose of the “fitness challenge” is to increase motivation to exercise, achieve visible changes in the body, fun (Polsgrove and Frimming 2013). Similar interventions are rather an exception (Yoshimoto et al. 2016), but still show positive results in the development of physical fitness parameters.

Western society is struggling with an inadequate exercise regime (Choi et al. 2017). By influencing health behavior (Carrotte et al. 2015), modern technologies or social networks could be a way to increase adherence to exercise. Increasing a regular physical activity is an important step in the development of overall health and the fight against civilization diseases.

The aim of this research was to evaluate the effectiveness of the "fitness challenge" and to assess its limitations and threats.

Material and methods

Participants

The subjects were students of the University of Hradec Králové; 32 women (20.3 ± 2.1 years, 161.8 ± 6.3 cm, 62.2 ± 7.9 kg), 35 men (20.8 ± 1.9 years, 181.9 ± 6.4 cm, 79.7 ± 7.9 kg). Students were contacted via email and social networks, which described the "fitness challenge" - 30 days of push-ups. Any student could participate, regardless of the field of study, age or sport experience. Prior to registration, the particpants were acquainted in detail with the intention of the research. The participants who missed more than 5 days were excluded from the research.

Measures

As part of the pre- and posttest, the subjects passed the test of the maximum number of push-ups. Push-up test: Starting position with arms outstretched, palms shoulder-width apart. It is important to follow the standard of the push-up with each repetition it visibly touches the chest of the ground, in the upper position the elbows must be straight. Except for the toes,

palms, and chest, no other part of the body should touch the ground. The subject can stop the movement at will, but s/he must hold the starting position. The maximum test time is 60 seconds. After completion of the „fitness challenge“ and posttest, the participants filled out a questionnaire, which included questions about social networks, health aspects, subjective feelings of the "challenge", or motivation.

Procedures

The goal was to perform 3 working series of push-ups each day for 12 – 15 repetitions (pause between sets of 2 minutes), preceded by warm-up and 2 "warm-up" series. Participants were given a stack of different difficulty variants so that everyone could complete the prescribed repetitions. The day before the start, a pretest was performed and the day after the end of the posttest. The "Challenge" was conducted online, each of the participants had to shoot a video according to the required standards and put it in a group on Facebook (FB). Contributions about warming up, exercise techniques, or motivation to exercise were given to this group during the course. It was also possible to submit videos privately. During the research, participants could supplement the push-ups with other physical activities, but they were not allowed to include push-exercises on the upper half of the body. Furthermore, they were not allowed to change their eating habits or exercise regime. The research group was instructed to interrupt the research and contact the organizers in the event of any health problems.

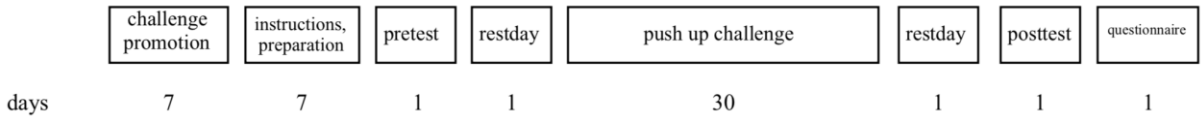

Figure 1
Study time course

Statistical analysis

The pre- and posttest results were analyzed on a group-by-group basis and also by gender. A parametric t-test was used to evaluate the changes, using the IBM SPSS software, version 20. Furthermore, the Spearman's rank correlation coefficient was applied to verify the relationship of selected quantities. The described software was also used for creating tables and descriptive statistics for the obtained data sample.

Results

The results compared the performances of men, women and the whole group. The pretest results show large differences between the sexes (men 24.9 ± 11.9, women 4.8 ± 5.1 repetitions). The mean value of the whole group was 15.2 repetitions. Both groups showed a statistically significant improvement ($\alpha = 0.01$) (Table 1). In women, the posttest result was 10.5 ± 6.7 repetitions, in men 31.9 ± 10.2 repetitions. Men improved by more repetitions, but in terms of percentage increase, the shift was more visible in women (119 %). The whole group also showed statistically significant progress with the value of the posttest 21.7.

Table 1

Pre- and posttest results

	N	pre	post	difference	%	t
Women	32	4.8	10.5	5.8	119	-9.133
Men	35	24.9	31.9	7	28	-8.505
All	67	15.3	21.7	6.4	42	-12.177

pre - pretest average; post - posttest average; %- proventual diffence; t- t value ($p<0,01$)

Within the statistical data processing, the correlation of selected quantities was performed. The relationship between the values, height and weight was investigated. Due to significant differences between men and women, they were compared separately (Tables 2 and 3). A weak correlation was found between the variables in both groups (maximum -0.279). It can be stated that neither height nor weight were significantly related to the results of pre- and posttest in men and women.

Table 2

Correlation of height, weight and test results in women

	average	SD	pretest	posttest	height	weight
pretest	4.75	5.10	1	**0.851**	-0.202	-0.122
posttest	10.53	6.72	**0.851**	1	-0.269	-0.180
height	168.13	6.27	-0.202	-0.269	1	**0.578**
weight	62.16	7.90	-0.122	-0.180	**0.578**	1

Table 3

Correlation of height, weight and test results in men

	average	SD	pretest	posttest	height	weight
pretest	24.86	11.92	1	**0.914**	-0.213	-0.207
posttest	31.86	10.25	**0.914**	1	-0.279	-0.236
height	79.69	7.93	-0.213	-0.279	1	**0.489**
weight	181.89	6.42	-0.207	-0.236	**0.489**	1

The selected results of the questionnaire show (Table 4) that almost all (95 %) use social networks on a daily basis. Facebook (95 %) and Instagram (92 %) have a dominant representation. Most respondents have already encountered a "fitness challenge" and more than half (52 %) have actively participated in it. During the "challenge", 20 % developed certain health problems (pain), which led to the omission of exercise. Nevertheless, 30 % of participants exercised every day and 34 % missed 3 or 4 days. In five participants (7.5 %), the consequences remained in the form of certain pain, which concerned the shoulder and wrist area. It is important to mention that overall the "challenge" was perceived positively (7.9 / 10) and the majority of participants would be involved in another similar activity (82 %).

Table 4

Questionnaire results

How often do you follow social networks?	95 % daily
What social networks do you use?	95 % facebook, 92 % instagram
Have you participated a similar "fitness challenge"?	82 % yes
Have you participated in such a "challenge" before?	52 % yes
Have you posted posts about your workout on social networks more often?	19 % yes
How often have you missed an exercise?	0x 30 %, 1x 25 %, 2x 26 %, 3x 20 %, 4x 14 %
Did health problems (pain) occur during the course that led to the omission of exercise?	20 % yes
Are there any pains left after (caused by "challenge")?	8,3 % yes (shoulder, wrist)
How do you perceive the "fitness challenge"?	7.9/10 (10 - absolutely positive)
Would you join the next "challenge"?	82 % yes

Discussion

Young adults very often use social networks (Ilakuvan et al. 2018), which was confirmed in this research. 95 % of respondents use them daily and are mainly on Facebook and Instagram. This finding has consequences in the form of a strong influence of social media on humans. The frequent exploitation of social media can be used to disseminate information and positively influence the target group (Berg et al. 2020). Facebook (closed group) has in this research proven to be a suitable tool. The content was carefully chosen to educate and also motivate. The nature of the contributions is an important factor that can influence the approach to the exercise or body image (Tiggemann & Zaccardo 2015). This aspect must be respected because the content of groups of the type "fitspiration" is often focused on appearance

(displaying edited photos, presentation of unreal beauty), which can negatively affect followers/likers (Tiggemann & Zaccardo, 2018).

The existence of "fitness challenges" is not unusual and was met by 82 % of participants. Even more than half (52 %) have actively participated in it in the past. This is an activity that deserves attention and it is important to know its strengths and weaknesses. It is confirmed that young adults are confronted with groups, pictures, or texts, which have the potential to influence a healthy lifestyle, exercise, and nutrition (Williams et al. 2014). In this context, it is important to note that the content and quality of a message may vary and is perceived accordingly by the user (Raggatt et al. 2018).

The chosen intervention is non-traditional and represents a high-frequency one-sided program. The usual length is at least 6 – 8 weeks (Schoenfeld et al. 2017). A similar design can be found in Takai et al. (2013) and Yoshimoto et al. (2016), where participants completed 100 squats each day for 45 days. Both studies have proven to be positive in the development of strength performance and body composition. In the case of push-ups, no comparable research was found. However, the inclusion of push-ups twice a week for 8 weeks has been shown to develop upper body strength (Chulvi-Medrano et al. 2012). In the case of this "challenge", 90 work series were completed during the whole period, which represents a significantly higher volume than is usually applied (Lima et al. 2018). Due to the number and size of muscle groups involved, there is a lower potential to change body composition. In order to achieve measurable changes (fat, lean body mass), it would be appropriate to supplement such program with other exercises and adapt the exercise method (Myers et al. 2015).

Participants achieved a statistically significant ($\alpha = 0.01$) improvement, as well as a separate group of women and men. The reason for the improvement may be the relatively high volume of exercise. Another possible factor may be the exercise of the push-up, which may not have been a regular part of their physical activity, which brings the potential for a complete adaptation in the form of inter and intramuscular coordination. Due to the short duration of the intervention, no muscle hypertrophy could occur that would affect the results (Schoenfeld et al. 2017). In particular, women recorded significant progress in the absolute number of push ups, the number more than doubled. Performance in men can be described as above average, women showed values that indicate a lower level of strength of the upper half of the body. These are the expected outcomes (Paoli & Bianco 2015).

For bodyweight strength performances (pull-up, push-up), weight is essential, which is directly proportional to the number of repetitions performed (Lima et al. 2018). However, the correlation did not confirm this fact (Table 4). For the sample, the weight had no statistically

significant relationship with the number of push-ups before or after the intervention. According to the average weight (females 62.2 kg, males 79.7 kg), it was a group without major deviations from the standard (overweight, obesity), otherwise they would probably show the opposite tendency (Sword 2012).

The push-up is one of the basic exercises for developing upper body strength (Calatayud et al. 2014). When placed alone without further exercise, an asymmetric load is created that is not optimal for the shoulder joint, spine, or posture (Dhahbi et al. 2018). The content of the intervention was set to correspond to the real situation on social networks. A proper exercise program must include exercises that affect all the large joints, spine and will strenghten large muscle groups. It should also include activities that develop the function of the cardiovascular system. Only in this way a harmonious development of fitness can be achieved (Paoli & Bianko 2015).

The questionnaire showed that only 30 % of participants had not missed a single exercise, 34 % had missed three or four times. It turns out that maintaining motivation to exercise on a daily basis is difficult. At the same time, it is related to the information that 20 % of the sample experienced increased discomfort in the form of some pain, which was then a reason to skip the exercise session. For the sporting population, such a condition is often received positively, but may also have the opposite effect (Duncan et al. 2010).

The unsupervised exercise that has been the subject of this research carries certain risks. Although participants receive instructions on exercise techniques, or warm-up, they are not under professional supervision. The technique has a clear effect on muscle activation, joint loading and overall health effect. In the case of the push-up, it is mainly the area of the shoulder blade, shoulder and wrist (Dhahbi et al. 2018). In five participants, the health problems persisted even after the end of the "challenge" and the problem was in the mentioned parts of the body. This could be due to technical deficiencies, excessive loads or previous injuries (Goossens et al. 2019). A related problem in these "challenges" is the absence of musculoskeletal diagnostics, which would determine the organism's readiness for such a program (Toivo et al. 2018). Participants must assess their own health, which can be risky.

Overall, the "challenge" was perceived positively (7.9 points out of 10), despite the problems in the form of discomfort/pain during the exercise. The assessment may be affected by performance improvements (Duncan et al. 2010), which may have been surprising to many. Although the participants had to practice on their own, they were part of a group that helped them. In this context, a stable contact via Facebook in the form of regular posts was also

important. The "Challenge" had a positive motivational impact, 82 % of participants would again engage in a similar activity.

The exercises were checked only in the pre- and posttest, the participants were not supervised during the intervention. It is therefore not possible to assess with certainty to what extent the numbers of series or repetitions were observed. However, it was a research plan to create real conditions for the "fitness challenge". During the research, the weight of some participants may also have changed, which may have affected the test result (Chulvi-Medrano et al. 2012). Although participants were encouraged to follow their current eating habits and exercise regimen, this fact cannot be excluded. The video performance evaluation is not standard, however, but it is similarly used in other sports (Serafini et al. 2018).

Conclusion

Social networks are a space where groups have formed to spread information about exercise, nutrition and a healthy lifestyle. One means is the "fitness challenge", which aims to increase motivation to exercise, help reduce weight or improve performance. In the research, the "challenge" focused on push-ups proved to be a good means of developing the strength abilities of the upper body. In the case of optimally chosen content, a "fitness challenge" can be a good source of motivation, information, improved strength performance or a positive effect on body image in young adults. At the same time, it can help increase the amount of physical activity that is generally insufficient in Western society. It is important to take into account the health risks and deficiencies associated with exercise without professional supervision.

References

1. ALBERGA, A. S., S. J. WITHNELL & K. M. von RANSON, 2018. Fitspiration and thinspiration: A comparison across three social networking sites. In: *Journal of Eating Disorders.* ***6***(1), 39.
2. BERG, S., J. FOREST & F. STENSENG, 2020. When Passion Does Not Change, but Emotions Do: Testing a Social Media Intervention Related to Exercise Activity Engagement. In: *Frontiers in Psychology.* ***11***, 71.
3. CALATAYUD, J., S. BORREANI, J. C. COLADO, F. MARTIN & M. E. ROGERS, 2014. Muscle activity levels in upper-body push exercises with different loads and stability conditions. In: *The Physician and Sportsmedicine.* ***42***(4), 106–119.

4. CARROTTE, E. R., I. PRICHARD & M. S. C. LIM, 2017. “Fitspiration” on Social Media: A Content Analysis of Gendered Images. In: *Journal of Medical Internet Research.* ***19***(3).
5. DHAHBI, W., H. CHAABENE, A. CHAOUACHI, J. PADULO, D. G BEHM, J. COCHRANE & K. CHAMARI, 2018. Kinetic analysis of push-up exercises: A systematic review with practical recommendations. In: *Sports Biomechanics.* 1–40.
6. DUNCAN, L. R., C. R. HALL, P. M. WILSON & O. JENNY, 2010. Exercise motivation: A cross-sectional analysis examining its relationships with frequency, intensity, and duration of exercise. In: *International Journal of Behavioral Nutrition and Physical Activity.* ***7***(1), 7.
7. GOOSSENS, L., R. DE RIDDER, G. CARDON, E. WITVROUW, R. VERRELST & D. DE CLERCQ, 2019. Injury prevention in physical education teacher education students: Lessons from sports. A systematic review. In: *European Physical Education Review*. ***25***(1), 156–173.
8. CHOI, J., M. LEE, J. LEE, D. KANG & J.-Y. CHOI, 2017. Correlates associated with participation in physical activity among adults: A systematic review of reviews and update. In: *BMC Public Health.* ***17***(1), 356.
9. CHULVI‐MEDRANO, I., E. MARTÍNEZ-BALLESTER & L. MASIÁ-TORTOSA, 2012. Comparison of the Effects of an Eight-Week Push-Up Program Using Stable Versus Unstable Surfaces. In: *International Journal of Sports Physical Therapy.* ***7***(6), 586–594.
10. ILAKKUVAN, V., A. JOHNSON, A. C. VILLANTI, W. D. EVANS & M. TURNER, 2019. Patterns of Social Media Use and Their Relationship to Health Risks Among Young Adults. In: *Journal of Adolescent Health.* ***64***(2), 158–164.
11. LIMA, C., LI, Y., LOW, J. L., HERAT, N., & D. G. BEHM, 2018. Superior Training-Specific Adaptations With an 8-Week Yoak Push-up Training Program. In: *Journal of Strength and Conditioning Research*, ***32***(9), 2409–2418.
12. MYERS, T. R., M. G. SCHNEIDER, M. S. SCHMALE & T. J. HAZELL, 2015. Whole-body aerobic resistance training circuit improves aerobic fitness and muscle strength in sedentary young females. In: *Journal of Strength and Conditioning Research.* ***29***(6), 1592–1600.
13. PAOLI, A., & A. BIANCO, 2015. What Is Fitness Training? Definitions and Implications: A Systematic Review Article. In: *Iranian Journal of Public Health.* ***44***(5), 602–614.
14. POLSGROVE, M. J. & R. E. FRIMMING, 2013. A Creative Way to Utilize Social Media to Enhance Fitness and Health Knowledge. In: *Strategies*. ***26***(2), 3–7.

15. RAGGATT, M., C. J. C. WRIGHT, E. CARROTTE, R. JENKINSON, K. MULGREW, I. PRICHARD & M. S. C. LIM, 2018. “I aspire to look and feel healthy like the posts convey”: Engagement with fitness inspiration on social media and perceptions of its influence on health and wellbeing. In: *BMC Public Health.* ***18***(1), 1002.
16. SERAFINI, P. R., Y. FEITO & G. T. MANGINE, 2018. Self-reported Measures of Strength and Sport-Specific Skills Distinguish Ranking in an International Online Fitness Competition. In: *Journal of Strength and Conditioning Research.* ***32***(12), 3474–3484.
17. SCHOENFELD, B. J., J. GRGIC, D. OGBORN & J. W. KRIEGER, 2017. Strength and Hypertrophy Adaptations Between Low- vs. High-Load Resistance Training: A Systematic Review and Meta-analysis. In: *Journal of Strength and Conditioning Research.* ***31***(12), 3508–3523.
18. SWORD, D. O., 2012. Exercise as a Management Strategy for the Overweight and Obese: Where Does Resistance Exercise Fit in? In: *Strength & Conditioning Journal*, ***34***(5), 47–55.
19. TAKAI, Y., Y. FUKUNAGA, E. FUJITA, H. MORI, T. YOSHIMOTO, M. YAMAMOTO & H. KANEHISA, 2013. Effects of Body Mass-Based Squat Training in Adolescent Boys. In: *Journal of Sports Science & Medicine.* ***12***(1), 60–65.
20. TIGGEMANN, M., & M. ZACCARDO, 2015. “Exercise to be fit, not skinny”: The effect of fitspiration imagery on women’s body image. In: *Body Image*, ***15***, 61–67.
21. TIGGEMANN, M. & M. ZACCARDO, 2018. ‘Strong is the new skinny’: A content analysis of #fitspiration images on Instagram. In: *Journal of Health Psychology.* ***23***(8), 1003–1011.
22. TOIVO, K., P. KANNUS, S. KOKKO, L. ALANKO, O. J. HEINONEN, R. KORPELAINEN & J. PARKKARI, 2018. Musculoskeletal examination in young athletes and non-athletes: The Finnish Health Promoting Sports Club (FHPSC) study. In: *BMJ Open Sport & Exercise Medicine.* ***4***(1), e000376.
23. WILLIAMS, G., M. P. HAMM, J. SHULHAN, B. VANDERMEER & L. HARTLING, 2014. Social media interventions for diet and exercise behaviours: A systematic review and meta-analysis of randomised controlled trials. In: *BMJ Open.* ***4***(2), e003926.
24. YOSHIMOTO, T., Y. TAKAI, Y. FUKUNAGA, E. FUJITA, M. YAMAMOTO & H. KANEHISA, 2016. In: Effects of school-based squat training in adolescent girls. In: *The Journal of Sports Medicine and Physical Fitness.* ***56***(6), 678–683.

DOI 10.2478/afepuc-2021-0021
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(2): 249-257

EFFECT OF USING WEIGHTED BALLS ON PERFORMANCE SPEED IN WHEELCHAIR BASKETBALL PLAYERS

Benzidane Houcine, Menad Fodil, Ahmed Benklaouz Touati

Laboratory of Programs Optimization in APS, Institute of Physical Education and Sports, University of Mostaganem, Algeria

Summary: The researchers seek to identify the impact of weighted balls on performance speed in wheelchair basketball players**.** An experimental method has been used in conformity with research nature between pre-tests and post-tests sample. The sample was selected by the intended manner and divided into two equal groups (10 players experimental sample, 10 players control sample) for the 2019/2020 sports season. A speed test (5 m and 20 m without ball), speed test (5 m and 20 m with ball) were used. After statistical treatment of the results, the researchers concluded: The weighted balls are important to develop performance speed in wheelchair basketball players, and the best improvement of the experimental group based on of weighted balls is marked comparing to the control group. A regular physical training with weighted balls is very important to improve of performance speed of persons with disabilities in basketball game.

Keywords: weighted balls, performance speed, wheelchair basketball players.

Introduction

Wheelchair basketball is one of the most popular sports among the Paralympics disciplines and is practiced by people with different disabilities. And it is one of the most popular sports for disabled (Filoramo 2007). It is a team sport that requires physical effort and a high degree of skill, technical expertise, and teamwork. Acceleration, speed, and agility are of particular importance since the game is often played at a fast pace and excellent chair and ball skills are fundamental to the game. A superior level of conditioning is required to maintain work intensity and to prevent injury (Goosey-Tolfrey 2010, 2002).

The training program for persons with disabilities should comprise five major motor abilities that are endurance, flexibility, coordination, strength, and speed (DePauw & Gavron 1995; Knechtle & Köpfli 2001). Rudenko (2014) has carried out a number of researches on the effect of physical therapy measures upon physiological condition of athletes with disabilities (Rudenko 2014).

Wheelchair basketball (WB) trainers should include special exercises beside these drills in their training program to enhance the condition of their players: weight training, speed training; endurance training; and exercises for special muscle groups. Developing offensive and defensive skills aids to conditioning. Sprints, repeated often enough to improve your wheelchair handling and supervised weight training to help improve the strength of muscle groups used in wheelchair basketball should be dispersed in the training both before and during the competitive season (Green 1999).

Just as sprints are repeated often enough to improve your wheelchair handling and supervised weight training to help improve the strength of muscle groups used in wheelchair basketball should be dispersed in the training both before and during the competitive season (Owen 1982; Green 1999).

Some of the previous studies focused mainly on the issues of improvement of sports training, pedagogical and psychological aspects of support for athletes with disabilities, methods of disabled people integration in modern society, physiological changes in the body under the influence of physical activity (Yun-A & Won-Ho 2018; Köse 2018; Benzidane et al. 2017; Bashkin & Makarova 2012; Kravchenko & Chkhajlo 2008; Bozon & Vanlandewijck 2007).

Wheelchair users who participate in some type of physical activity had better pulmonary functions, muscular strength, endurance and anaerobic power in comparison to those who do not (Wells & Hooker 1990). Therefore, participation in sport has the potential to act as a vehicle of health and fitness for those individuals with disabilities. As more persons participate in sports, teams are raising concerns about training and fitness issues, increased physical weakness and motor performance of persons on wheelchairs and it is the participation of some teams in the competition without regular training or absence from training all this led us to think about the application of exercises using the weighted balls in training program to improve performance speed in wheelchair basketball players.

Objectives

The objective of the study was to identify the effect of weighted balls in training program to improve performance speed of wheelchair basketball players. And detect differences between control and experimental sample in performance speed under consideration among wheelchair basketball players.

Methods

Methodology: Researchers used the experimental method by choosing two groups, one experimental and the other control.

Participants: Twenty (20) male wheelchair basketball athletes from two different clubs in the same league (national league) participated in the study, in age between 23 and 31 years. The two teams were randomly assigned to the group experimental sample: 10 players from a team of Mostaganem (Algeria). Moreover, control sample: 10 players from a team of Oran (Algeria), of the sports season 2019/2020.

Tests applied

Test (01): Sprint test (05m)

Test (02): Sprint test (20 m)

Test (03): Sprint test (05 m with ball)

Test (04): Sprint test (20 m with ball) (De Groot et al. 2012), (Vanlandewijck et al.1999).

Training program

- The proposed training sessions were held on September, 09th2019 until the end of October, 18th2019 during evening training sessions. After defining the physical exercise program using weighted balls, the researchers applied this training program, which aims to develop speed performance of wheelchair basketball players. The program included three (03) training units in a week of six (06) weeks.
- Weighted balls were used in the experimental group of wheelchair basketball players in the main stage of the training unit at a rate of 20 to 30 minutes.

Weighted ball exercises:

- Passing and receiving exercises
- Conversational exercises in place
- Conversational exercises with mobility
- Speed exercises without and with weighted balls

- Dribbling exercises.

Data Analysis

The results are presented as the mean ± standard deviation (SD). The mean and standard deviation were calculated with the measured results, paired T-test was applied for mean difference test between groups. Statistical significant level was set at α=0.05.

Results

View the results of tribal and remote tests of the control and experimental sample.

Table 1

Comparing the results of tests (pre and post-test) of the control sample

Tests	Pre-test Mean ± SD	Post-test Mean ± SD	T Calculated	*P*
Sprint test (05m)	2.85±.049	2.66±.034	1.52	*0.071*
Sprint test (20 m)	6.61±0.32	6.26±0.31	2.42	*0.041**
Sprint test (05 m with ball)	.431±.062	4.11±.052	1.97	*0.037**
Sprint test (20 m with ball)	8.42±0.42	8.11±0.31	2.07	*0.045**

T tabular=1.83, p=0.05

There are statistically significant differences between the pre-test and the post-test in favor of the post-test in the control group, because the calculated T is greater than the tabular T, and p≤0.05 in the applied tests, except the speed test (sprint 05 m without ball), where T was calculated 1.52 and is smaller than the value of the T tabular (table1).

Table 2

Comparing the results of tests (pre and post-test) of the experimental sample

Tests	Pre-test Mean ± SD	Post-test Mean ± SD	T Calculated	*P*
Sprint test (05m)	2.71±.049	2.35±0.32	2.42	*0.039**
Sprint test (20 m)	6.56±0.51	5.90±0.30	3.47	*0.042**
Sprint test (05 m with ball)	.448±.059	4.07±.051	2.86	*0.040**
Sprint test (20 m with ball)	8.16±0.51	7.80±0.32	1.98	*0.033**

T tabular=1.83, p=0.05

There are statistically significant differences between the pre-test and the post-test in favor of the post-test in the experimental group, because the calculated T is greater than the tabular T, and p ≤ 0.05 in the applied tests as shown in the table 2.

Comparison of dimensional results

Table 3

Compare the results after tests between experimental and control samples

Tests	Control Mean ± SD	Experimental Mean ± SD	T Calculated	*P*
Sprint test (05m)	2.66±.034	2.35±0.32	2.06	*0.041**
Sprint test (20 m)	6.26±0.31	5.95±0.30	2.14	*0.042**
Sprint test (05 m with ball)	4.11±.052	4.07±.051	1.16	*0.076*
Sprint test (20 m with ball)	8.11±0.41	7.80±0.32	1.94	*0.036**

T tabular=1.73, p=0.05

There are statistically significant differences between the experimental group and the control group in favor of the post-test in the experimental group, because the calculated T is greater than the tabular T, and $p \leq 0.05$ in the technical test, Except the speed test (sprint 05 m with ball), Where T was calculated 1.16 and is smaller than the value of the T tabular ($p>0.05$) as shown in the table 3.

Discussion

Depending on the statistically processing, in the (Table2), there are significant statistical differences in the pre-test and post-test in the experimental sample in speed performance (sprint without and with ball). According to the researchers this results was the results of the proposed training program based on scientific foundations of the application of physical exercises of quality that are related to the game, especially the use of the weighted balls [06 weeks & 03 training units in one week]. Where those results line with outcomes proved by (Coutts 1990; DePauw & Gawron 1995; Knechtle & Köpfli 2001) that the benefits training program for persons with disabilities should comprise the progression of the major physical abilities, which are endurance, flexibility, coordination, strength, and speed.

Giacobbi et al (2008), exercise and sport may be more important for individuals with disabilities because of their limited physical activity. In people with disability, sport and exercise participation can improve both physical and psychological health problems (Giacobbi et al. 2008). Because wheelchair basketball (WB) is a physically demanding team sport that requires a high degree of skill, technical expertise, and teamwork. Acceleration, speed, and agility are of particular importance since the game is often played at a fast pace and excellent chair and ball skills are fundamental to the game. A high level of conditioning is required to maintain work intensity and to prevent injury (Goosey-Tolfrey 2010). Upper-extremity muscle strength is important for wheelchair athletes (Wang & Chen 2005; Ozmen et al. 2014; De Groot et al. 2012).

In the (Table 3) shows that there are statistically significant differences in post-tests between control and experimental samples in favor of the experimental sample in the tests of speed performance, due to the use of weighted balls in the training program. There are several studies that have measured sprint performance without and with the ball in wheelchair basketball players (Vanlandewijck et al.1999; Yanci et al. 2015; Hunter et al.1993). Chahinaz (1994), Hyo-Bin et al. (2013) noted that disabled basketball players rely entirely on the strength of the arms in their movements and movements, whether through crutches or wheelchair. In addition to the performance of all basic skills, and therefore the development of explosive capacity because of special exercise has contributed significantly to the development of the accuracy of long handling performance. From above the shoulder in the members of the research sample, and this is confirmed by many studies on the importance of the explosive power of the arms of the disabled and the impact of the positive effect of the performance of motor skills in various sports activities. And yessis (2003), bouzakaria et al (2018) adds that is necessary for the trainers to take part of the physical preparation of weight training to develop the muscular system of the athlete, with the development of certain physical attributes such as strength and speed.

As a summary of what has been achieved the researchers appreciate that the diversification of the content of the exercises using weighted balls improve the level of performance speed, because training in basketball as a plus tool increase strength, speed, power flexibility, endurance and stability to have good performance on field. However, this is of great importance to the possibilities of applying for wheelchair basketball programs in the investigation of the integral development of disabled person's physical and technical abilities. Appreciation in this modest study in the use of training program with weighted balls as the effective tool to improve speed performance (sprint without and with ball) among wheelchair basketball players.

Conclusions

Researchers suggest that the proposed training program using weighed balls has a positive impact on performance speed (sprint without and with ball) of wheelchair basketball players. It was approved in this study as addition task which can improve performance speed after six (06) weeks to develop strength training appreciated in the improvement of maximum speed phase of sprinting (05 and 20 meters), strength training related to the progress of the acceleration phase of sprinting (05 and 20 meters with ball) of wheelchair basketball players.

Thus, this study showed that regular physical training is very important to improve speed performance of persons with disabilities, through the use of wheelchair basketball as a regular activity of high density for people with motor disabilities.

Acknowledgements

We appreciate all the people (administrators, coaches and players) who helped us to finish this work.

References

1. BASHKIN, I.M., U.V. MAKAROVA, 2012. Okremi problemy fizychnoji reabilitaciji na suchasnomu etapi [certain problems of physical rehabilitation at present]. *Proceedings of the Aktualjni pytannja formuvannja zdorovogho sposobu zhyttja ta vykorystannja ozdorovchykh tekhnologhij : materialy mizhnarodnoji naukovo-praktychnoji konferenciji* (Ukraine, Kherson, September 6–8, 2012), Kherson, pp.3–8.
2. BENZIDANE, H., D. MOKRANI & M. ZERF, 2017. The impact of weighted basketball balls in improving certain physical performances via wheelchair basketball players. In: *Turkish Journal of Kinesiology*. **3**(2), pp.17-21.
3. BOUZAKARIA, T., D. A. SEKARNA, M. AMROUCHE & K. LABANE, 2018. Weight Training for Speed and its Impact on the Skillful Performance of Basketball Players. In: *J Phy Fit Treatment & Sports.* **5**(2), pp.1-5.
4. BOZON, S. & Y. VANLANDEWIJCK, 2007. *Perspektyvy : vydy Sportu dlia Osib z obmezhenymy mozhlyvostiamy*. Berlin: Mizhnarodna Rada zi Sportyvnoji Nauky i fizychnoho vehovannia (ICSSPE). tom 7.
5. CHAHINAZ, E. B, 1994. *Impact of sport activities programme amended some elements of fitness and personal social adaptation of disabled children*. Faculty of physical education for girls. Cairo.
6. COUTTS, K. D., 1990. Kinematics of sport wheelchair propulsion. In: *Journal of Rehabil Res Dev.* 27, pp.21–26.
7. De GROOT, S., I. J. BALVERS., S. M. KOUENHOVEN & T. W. JANSSEN, 2012. Validity and reliability of tests determining performance-related components of wheelchair basketball. In: *Journal of Sports Sci.* **30**(9), pp879-887.
8. DePAUW, K. P. & S. GAVRON, 1995. *Disability and sport.* Champaign, IL: Human Kinetics.

9. DEWELL, R, 2001. Path Theory: Wheelchair Tripping. In: *Basketball News.* **15**(1), pp.27–28.
10. FILORAMO BAL L, 2007. *Disabilità e Sport.* Celid, Torino.
11. GIACOBBI, J. R., M. STANCIL., B. HARDIN & L. BRYANT, 2008. Physical activity and quality of life experienced by highly active individuals with physical disabilities. In: *Adapted Physical Activity Quarterly.* **25**(3), pp.189-207.
12. GOOSEY-TOLFREY, V., 2010. *Wheelchair Sport*. Champaign, IL: Human Kinetics
13. GOOSEY-TOLFREY, V., D, BUTTERWORTH. C, MORRISS, 2002. Free Throw Shooting Technique of Male Wheelchair Basketball Players. In: *Adapted Physical Activity Quarterly.* **19** (2), pp.238–250.
14. GREEN, S., 1999. *Specific Exercise Programs In D.A. Apple (ed.), Physical Fitness: A Guide for Individuals with Spinal Cord Injury.* (pp 45-96). Department of Veterans Affairs-Veteran Health Administration. retrieved, from http://www.vard.org/mono/sci/scigreen.html
15. HUNTER, G. R., J. HILYER & M. A. FOSTER, 1993. Changes in fitness during 4 years of intercollegiate basketball. In: *J Strength Cond Res.* **7**, pp. 26-29.
16. HYO-BIN, M., P. SEUNG-JAE., K. Al-CHAN., J. JEE-HUN, 2013. Characteristics of upper limb muscular strength in male wheelchair tennis players. In: *Journal of Exercise Rehabilitation.* ***9***(3), pp.375-380.
17. KNECHTLE, B., W. KOPFLI, 2001. Treadmill exercise testing with increasing inclination as exercise protocol for wheelchair athletes. In: *Spinal Cord.* 39, pp. 633–636.
18. KOSE, B., 2018. Does the weight of basketball shoes affect speed and jumping performance? In: *physical education and students.* **22**(6), pp.316–319.
19. KRAVCHENKO, A. & M. CHKHAJLO, 2008. Aktualjni problemy korekciji fizychnogho stanu futbolistiv iz vadamy zoru iz zastosuvannjam pryrodnykh zasobiv [Topical problems of physical condition correction of visually impaired football players by means of natural remedies]. *Fizychne vykhovannja, sport i kuljtura zdorov'ja u suchasnomu suspiljstvi : zb. nauk. pr. [Physical education, sport and health culture in modern society: collection of scholarly papers]*. Lutsk, t. 3, pp.69 -74.
20. MALONE L. N., 2000. Expanding the Dichotomous Outcome in Wheelchair Basketball Shooting of Elite Male Players. Adapted. In: *Physical Activity Quarterly.* 17, pp.437-449.
21. OWEN, E., 1982. *Playing and Coaching Basketball*. Champaign: University of Illinois Press.

22. OZMEN, T., B. YUKTASIR., N.U. YILDIRIM., B. YALCIN & M. E. WILLEMS, 2014. Explosive strength training improves speed and agility in wheelchair basketball athletes. In: *Brazilian Journal of Sports Medicine.* **20**(2), pp.97-100.
23. RUDENKO R., A. MAHLIOVANY, O, SHYYAN & T. PRYSTUPA, 2015. Physical rehabilitation and thermoregulatory processes in athletes with disabilities. In: *Journal of Physical Education and Sport.* **15**(4), pp.730 – 735.
24. VANLANDEWIJCK, Y. C., D. J. DALY & D. M. THEISEN, 1999. Field test evaluation of aerobic, anaerobic, and wheelchair basketball skill performances. In: *Int J Sports Med.* **20**(8), pp.548-554.
25. WANG, Y. T., S. CHEN, W. LIMROONGREUNGRAT & L. S. CHANGE, 2005. Contributions of selected fundamental factors to wheelchair basketball performance. In: *Med Sci Sports Exerc.* **37**(1), p.130.
http://dx.doi.org/10.1249/01.mss.0000150076.36706.b2
26. WELLS, C. L., S. P. HOOKER, 1990. The spinal injured athlete. In: *Adapted Physical Activity Quarterly*. **7**(3), pp.265-285.
27. YANCI, J., C. S. GRANADOS, M. OTERO, A. BADIOLA, J. OLASAGASTI, I. BIDAURRAZAGA-LETONA, A. ITURRICASTILLO & S. M. GIL, 2015. Agility, strength and endurance capacity in wheelchair basketball players. In: *Biology of Sport.* 32, pp.71-78.
28. YESSIS, M., 2003. *Explosive Basketball Training*. Roché, USA.
29. YUN-A, SHIN, WON-HO CHOI, 2018. Effects of weighted baseball throwing during warm-up on ball velocity and upper extremity muscle activation in baseball pitchers. In: *Journal of Exercise Rehabilitation.* **14**(3), pp.436-444.