Pol. J. Sport Tourism **2021**, *28(4), 10-15*
DOI: 10.2478/pjst-2021-0020

EFFECT OF SMALL SIDED GAME DURATION WITH FLOATER PLAYER ON INTERNAL AND EXTERNAL LOAD OF FEMALE HANDBALL PLAYERS

JAN BELKA[1], KAREL HULKA[1], VACLAV RIEDEL[1], MICHAL SAFAR[2]

Palacky University, Faculty of Physical Culture, Department of Sport[1], Department of Social Sciences in Kinanthropology[2], Olomouc, Czech Republic

Mailing address: Jan Belka, Department of Sport, Faculty of Physical Culture, Palacky University, 511/8 Křížkovského Street, 771-47 Olomouc, Czech Republic, tel.: +420603303920, e-mail: jan.belka@upol.cz

Abstract
Introduction. The present study deals with the effect of the duration of small-sided games (SSGs) with a floater player on the external (covered distance) and internal (heart rate) load of the elite female players. ***Material and methods.*** The research group consisted of nine professional elite female team handball field players (age 22.8 ± 4.5 years) playing in the first international league for female players in the Czech Republic. Their height was 170.4 ± 6.4 cm, weight 67.7 ± 9.2 kg, and maximal heart rate 200.2 ± 3.3 beats·min^{-1}. The duration of the SSGs was 4 (SSG4) minutes, 5 (SSG5) minutes, and 6 (SSG6) minutes. ***Results.*** The highest heart rate value of 177.2 ± 9.9 beats / minute resp. 88.5 ± 4.4% HR_{max} was measured in SSG5. The lowest mean heart rate values were measured at SSG6 of 172.01 ± 15.7 beats / min resp. 85.9 ± 6.8% HR_{max}. Most time 38 resp. 34% of the drill time, players were in the 85-90% HR_{max} load intensity zone of SSG4 and SSG5. There was a statistically significant difference in load intensity zones of 80-85% HR_{max} and ≥ 95% HR_{max} between SSG5 and SSG6 and p = .008 (η^2_p = 0.22) and .013 (η^2_p = 0.26), respectively. In the rating of perceived exertion (RPE) evaluation, there was a statistically significant difference in SSG6 and SSG4 p = .003 (η^2_p = 0.27) and between SSG6 and SSG5 p = .004 (η^2_p = 0.25). The total longest distance in SSG6 was 786.8 ± 41.9 m, but in the one-minute drill the longest average distance in SSG4 was 136.2 ± 21.1 metres per minute. ***Conclusions***. SSGs with a floater are a suitable means for training technical and tactical activities in handball with an overlap into fitness training in women's handball. According to our results, the intensity of the load will not decrease if we increase the game time to six minutes and also the covered distance will not decrease during the game.

Key words: sports performance, condition, interval training, heart rate, Borg scale

Introduction

Handball is a contact team sport game that involves high-intensity short-term player movements such as sprint, jumps, blocking or shooting [1]. Handball players must well coordinate their movements in running, jumping, changing direction with specific skills such as passing, catching, shooting, dribbling and ball release [2, 3, 4]. Players load is of an intermittent character in a handball match [1, 4, 5, 6]. The physiological response of players to the load during a handball game utilises the strong involvement of both aerobic and anaerobic energy systems [1].

In the training process it is necessary to respond to the above findings and one of the options is to include the so-called 'small-sided games (SSGs)' or training games in training. SSGs are preparatory games that allow coaches to manipulate several variables not only in football training but also in handball training that can change the intensity of exercises, such as the number of players on the pitch, the size of the pitch, changing the rules, coach intervention, introducing a floater player, etc. [7]. The training process in sports games should include game exercises that are as similar as possible to the intensity of the load and the character of the game itself [8] and imitate the fitness, technical and tactical requirements for players close to the sports game [9]. For this reason, SSGs have been involved in sports games training in recent years. Previously, coaches have favoured the use of the SSG in training to increase ball contact, increase player load intensity [10], and to tackle game situations that are similar to those in Owen, Twist, and Ford [11]. Including SSG into training is effective for improving endurance abilities without affecting sprinters' abilities [12].

One possibility of modifying SSGs is to change the number of players on the court or to include a so-called 'floater', who always plays with the attacking side, i.e. with players holding the ball [13]. In this variation, there are numerical imbalances of play, with increased pressure on fewer defenders, and specific game situations close to the actual match are again addressed [13]. So far, SSG research with a floater player has only been conducted in soccer [14].

The use of SSG as a training method has recently become the centre of scientific research because of its ability to develop physical prerequisites along with sport-specific tactical and technical skills [7, 15]. The primary benefits of SSG are that the game can replicate the movement patterns, physiological demands and technical requirements of a competition [16], while also requiring players to make decisions under conditions of pressure, stress and fatigue. In addition, SSG training is expected to increase player compliance and motivation compared to traditional training units, as it is perceived as a sports exercise that maximises ball training time [15].

There are currently six publications on SSG in male handball [15, 16, 17, 18, 19, 20]. There is only one publication on adult female handball players [21], and one [22] addressing the effect of SSGs on the fitness parameters of young female handball players. However, information on the specificity of SSGs in terms of loading on female handball players is still lacking.

For this reason, we focused our study on elite female handball players to expand the knowledge and increase the effectiveness of the specificity of the training process in handball, as it is necessary to analyse the training process in real sports training conditions. The main aim of the study was to investigate the effect of increasing the duration of SSG with floating on the external (distance covered) and internal (heart rate) load of elite female handball players.

Material and methods

Participants

The research group consisted of nine professional elite female handball field players (age 22.8 ± 4.5 years) (group mean ± SD) playing in the first international league (Women's Handball International League (WHIL)) for female players in the Czech Republic. Their height was 170.4 ± 6.4 cm, weight 67.7 ± 9.2 kg, body mass index (BMI) 23.0 ± 2.2 $kg \cdot m^2$ (fat tissue 16.2 ± 6.1 kg, muscle tissue 28.2 ± 3.1) and maximal heart rate 200.2 ± 3.3 $beats \cdot min^{-1}$. The female players regularly attended five training units a week. Goalkeepers were not involved in this study because their position's requirements differ from the roles of the other players.

All of the procedures were approved by the Ethics Committee of the Faculty of Physical Culture at Palacky University in Olomouc in the Czech Republic.

Measurements were taken in a sports hall on high-quality indoor courts with wooden block floors.

The measurements were always with the same female players every Monday (19.00-20.30 hours) in training sessions for nine weeks (a total of nine training sessions were measured). All SSGs were played on a standard size court (40 x 20 m). Each Monday training session started with a 15-minute warm-up (light jogging, dynamic stretching and passing the ball) and then the players played three equal duration small sided games (SSGs). The duration of the SSGs was 4 (SSG4) minutes, 5 (SSG5) minutes, and 6 (SSG6) minutes. Weeks 1-3, the time duration of each SSG in the training session was 4 minutes with a 4-minute break i.e. 3 x 4 min SSG with a 4 min pause between SSGs in each training session. Week 4-6, the duration of each SSG in training was 5 min with a 4 min pause i.e. 3 x 5 min SSG with a 4 min pause between SSGs in each training session. Week 7-9, the duration of each SSG in training was 6 min with a 4 min pause i.e. 3 x 6 min SSG with a 4 min pause between SSGs in each training session.

A similar load and rest model was used in other sports games, such as in the studies by Jake et al. [23] and Brandes et al. [24]. The 5-minute load interval was utilised by Owen, Wong, McKenna and Dellal [25], Castelano, Casamichana and Dellal [26]. Rampinini et al. [27] and Kelly and Drust [28] used a four-minute load and a four-minute rest period. The games were played according to a modified version of the team handball rules (no 2 min suspension or penalties) in order to increase continuity in the game. The disqualification foul was replaced with a free throw. The 7-metre shootings (penalties) were replaced with a free throw. The fixed zone defence in the SSG was 4 : 0. The female players monitored in the SSG used the same defence system that they had used in their matches. The floater player was always the center back (in all durations 4, 5, 6 min; the same player in this role). The coach verbally motivated players during the SSG.

Specific technical parameters (number of shots, number of goals, number of passes, number of dribblings used and technical errors) were analysed and evaluated from the SSG video recordings. The following types of technical errors were considered: errors in passing, catching and dribbling the ball; errors in taking steps with the ball; entering the goal area when penalised; offensive fouls.

Overall rating of perceived exertion (RPE) was recorded immediately after each SSG using the RPE 6-20 scale [29]. Standardised instructions for RPE were given [30], but female handball players were asked to refer their RPE to the exercise just completed rather than their perceived exertion at the time of rating. The players recorded their performance always 1 min after completion of exercise on a prepared RPE sheet.

Heart rate

The players' heart rates (HR) were monitored during all the SSGs at regular 5-second intervals using Polar TEAM Pro sport testers (Polar Electro, Kempele, Finland). HR was monitored during live playing time (i.e. the complete time that the players were on the court). The maximal HR values were measured by means of the Yo-Yo Intermittent Recovery Test Level 1 (YYIRT1) [31] and were established for each player individually [32]. The female players ran the YYIRT1 test with sporttester Polar Team2 in a sports hall with plyurethane floor before the start of the season in the first training session. The YYIRT1 is characterised by 20-m shuttle runs with 10 s of recovery between each run. The YYIRT1 has four running bouts at 10-13 kilometers per hour ($km \cdot hr^{-1}$), and another seven runs at 13.5-14 $km \cdot hr^{-1}$. Following this, the YYIRT1 continues with stepwise 0.5 $km \cdot hr^{-1}$ speed increments after every eight running bouts until exhaustion [33]. The test was considered to be over in two instances: one, when the player failed twice to reach the finishing line in time; or two, when the player was physically unable to complete another shuttle at the designed speed [34].

The zones of load intensity (distribution of the percentage of peak heart rate ($\%HR_{max}$) were divided into intervals according to [35, 36]:

< 75% HR_{max}, 75-80% HR_{max}, 80-85% HR_{max}, 85-90% HR_{max}, 90%-95% HR_{max}, ≥ 95% HR_{max}.

We computed the average time covered in each zone for each SSG as well as the peak heart rate (HR_{mean}) and maximum heart rate (HR_{max}) values of each player. These were presented as the percentage of peak heart rate ($\%HR_{max}$).

Time-motion analyses

Each of the 27 SSGs was recorded using two digital camcorders (Panasonic SDR-H80 and Canon HF10) placed in a static position approximately 6 metres from the sideline and 9 metres above the court; each camera recorded one half of the court. Time–motion analyses of the handball players were analysed from the video recordings, using the authorised [37] software package Video Manual Motion Tracker 1.0 (Palacky University Olomouc, Czech Republic).

Based on the recommendations of other authors [6, 18, 38], we categorised the players' gross movements into standing and walking 0-1.4 $m \cdot s^{-1}$ (1st speed zone), jogging 1.4–3.4 $m \cdot s^{-1}$ (2nd speed zone), high-intensity running 3.4-5.2 $m \cdot s^{-1}$ (3rd speed zone) and maximal speed running (sprinting) > 5.2 $m \cdot s^{-1}$ (4th speed zone). From the video recording we analysed the number of acyclic activities: shots to the goal; goals; dribbling (one and multiple bounce); passes; turnovers.

Statistical Analysis

Software Statistica (12.0 version, StatSoft, Inc., Tulsa, USA) was used to process the data. Descriptive statistics mean (mean) and standard deviation (SD) were used to describe participants' performance during the SSGs. The average heart rate and covered distance values measured during the SSGs were compared. To compare the collected data, ANOVA of repeated measures and Bonferroni post hoc test were used. Partial eta-squared (η^2_p) was utilised as a measure of effect size for each ANOVA, and values were interpreted as no effect ($\eta^2_p < 0.04$), minimum effect ($0.04 < \eta^2_p < 0.25$), moderate effect ($0.25 < \eta^2_p < 0.64$), and strong effect ($\eta^2_p > 0.64$) [39]. ANOVA preconditions were checked by the Lilliefors test for normality and the Levene's test of homogeneity. The statistical significances for all parts of the analyses were determined at $p \leq .05$.

Results

The internal load analysis of the players was performed on the basis of the evaluation of the heart rate data from the individual load intervals. The highest heart rate value of 177.2 ± 9.9 beats / minute resp. 88.5 ± 4.4% maximal heart rate (HR_{max}) was measured at 5-minute intervals during SSG5 (Tab. 1). The lowest mean heart rate values were measured at SSG6 172.01 ± 15.7 beats / minute and mean heart rate intensities were 85.9 ± 6.8% HRmax. In SSG4 and SSG5, players spent 38 and 34% of the drill time, respectively, in the load intensity zone of 85-90% HR_{max}, respectively. For SSG6, female players spent the most time (32% of the drill time) in the load intensity zone of 80-85% HR_{max}. A statistically significant difference occurred in the load intensity zones of 80-85% HR_{max} and ≥ 95% HR_{max} between SSG5 and SSG6, with p = .008 (η^2_p = 0.22) and .013 (η^2_p = 0.26), respectively.

The lowest RPE value was recorded by SSG6 players (Tab. 1). Nearly similar values were found for RPE in SSG4 and SSG5. In the RPE evaluation, there was a statistically significant difference in SSG6 and SSG4 p = .003 (η^2_p = 0.27) and between SSG6 and SSG5 p = .004 (η^2_p = 0.25). The total longest distance in SSG6 was 786.8 ± 41.9 m, but in the 1-minute drill the longest average distance in SSG4 was 136.2 ± 21.1 metres per minute. The smallest distance in all SSGs (2-5% of the total distance covered) was covered by players in the 4th speed zone.

The specific technical characteristics of the SSGs are given in Table 2. They are recalculated for better clarity per minute of game. The only statistically significant difference occurred between SSGs in passes per minute of exercise for SSG5 and SSG6 p = .04 (η^2_p = 0.24). The most passes and dribbling per minute of exercise were in SSG5 21.3 ± 2.3 resp. 4.1 ± 0.9. Other technical parameters were very similar.

Discussion

The results of this study have shown that all established SSG durations with a floater player have a high-intensity character in terms of the details of the match and are a particular stimulant for the handball training process in terms of specific skills.

The average heart rate intensity during a handball match is between 85.8 ± 3.2 and 89.2% SF_{max} [3, 5, 6]. Our results of mean heart rate intensity (85.9 ± 6.8 - 88.5 ± 4.4) from SSGs are comparable to match results. Above the anaerobic threshold of 85% SF_{max}, players spent the least time of all SSGs on SSG6 and that was 53% drill time. In SSG6, the heart rate was the lowest, which may probably be psychological due to the onset of fatigue, both physical and psychological especially in our case, as confirmed by RPE results, when this value was the lowest and statistically significant compared to SSG4 and SSG5. It should be important for each coach to get feedback on the subjective perception of the player's effort during the training process. Evaluation of perceived exertion seems to be a suitable indicator of the magnitude of physical activity intensity compared to heart rate and lactate concentration in preparatory games [40]. In basketball and soccer studies, it has been found that fewer players on the pitch will increase the load perception (RPE) rating of players [17, 27], as in our investigation.

Our results confirmed the same findings as in other studies on football preparatory games [27] and also from handball [18] that increases in heart rate increase RPE. Monitoring and perception of the amount of physical load in the training process is one of the important components in the sports training of athletes. Exercise perception is influenced by physiological, psychological (e.g. hypnotic suggestion, expected exercise time, expected level of performance, social impact of others, motivation, emotional state, stimulus intensity modulation style, cognitive style) and other factors (environment, gender and age, smoking and medication) [30, 41, 42]. Other factors include signals from working muscles and joints, blood lactate, heart rate, ventilation, oxygen consumption, hormonal secretion, exercise-induced pain, etc. [42]. Psychological factors contribute to the perception of exertion at about 33%, predominantly at low and medium intensity [41]. At high intensity, physiological stimuli predominate, where physiological sensations are a stronger signal [41]. Examples include hypnotic suggestion, expected exercise time, expected level of performance, social impact of others, motivation, emotional state, stimulus intensity modulation style, cognitive style, and other factors [31]. Other factors influencing load perception are environment, gender, age, smoking and medication [42]. As early as in 1985, Carton and Rhodes [43] called the anaerobic threshold (AnP) a certain threshold of perception of stress. They considered the physiological perception of the muscles to be the primary stimulus to perceiving exercise intensity during low intensity levels. They claimed that if the intensity exceeds the AnP level, the increased lactate level works together with stimuli from the neuromuscular apparatus. Central stimuli (heart rate, VO2) also contribute to the perception of exertion when reaching the anaerobic threshold (AnP) [43]. Peripheral stimuli (blood lactate, adenosine triphosphate, creatine phosphokinase, glycogen) are predominant in most cases, but even central stimuli can affect the perception of exertion. Carton and Rhodes [43] also considered the possibility of influencing the perception of exertion by training, as demonstrated by higher intensities.

Several studies of women's handball matches show that the handball players will exceed 4693 ± 333 - 6796.6 ± 391 m during the match, which means that within a minute the players will cover a distance of 78.2 ± 5.5 - 113.3 ± 8.6 $m \cdot min^{-1}$ [3, 6, 44]. This distance varies from one game position to the other with wings of 4086 ± 523 - 6915.3 ± 362.6 m and pivots 3417 ± 485 - 6337.1 ± 477.3 m and backs 3867 ± 386 - 7138.3 ± 334.4 m [3, 44]. In our SSGs, players exceeded the distance from 127.1-136.2 $m \cdot min^{-1}$, which is higher than in the competition match. We attribute the greater distance covered in SSG to a smaller number of players and shorter playing time than during a handball match. There was no statistically significant difference in distance covered between individual SSGs of varying duration with a floater player. The total distance covered increases linearly with the length of the SSG, but when calculating the distance covered per minute, the differences are already diverse, and the greatest distance covered in this case is 4 minutes for the SSG. One reason may be the onset of fatigue with each extension of the length of the SSG exercise.

In terms of the speed of movement, in the preparatory games, the players again approached the values of the match, where the players 30.8 ± 5.9 – 52.6% of the distance covered stand or walk, 27.8% are in trot, 12.4% run at mean running intensity, 2.3% run at high running intensity and 0.2-10.5 ± 4.1% sprint [3, 6]. Our SSG results, where the player spends 2-5% sprinting and the SSG players spend 28-31% standing or walking, are comparable to the match values.

A sprint in a match is not only a quick attack, but many other short accelerations during a match. The average time and length of such a sprint is 0.9 m resp. 6 m [3]. According to Michalsik et al. [3], players are in a fast attack that lasts 4-5 seconds and they cover up to 30 m, all the time in the sprint. In women's handball, sprint movements, acceleration and straight running are typical of sprint, with a length of up to 15 m [3]. All this information depends on the character of the match, tactics, gender, performance level, etc. The training should primarily include exercises aimed at developing the reaction and acceleration speed associated with the development of strength [3], but also exercises to slow motion or stop quickly.

The use of training games with different numbers of players in training, as in our case using SSGs with nine players, allows for simulation of the movement activities that players must perform under pressure and fatigue, as in a match [45]. In a handball match, players normally run into situations where there is a numerical imbalance in relation to their opponents. These are mainly in rapid attack, exclusion and renumbering in a progressive attack situations. For this reason, it is important that these situations occur in practice and that they are as similar as possible to the match values in terms of the external and internal load of the players. A suitable form seems to be the use of a neutral player, the so-called 'floater player', in modified games such as in football. This floater player always plays with the team in possession of the ball, thereby temporarily creating 'more pressure on defence' or 'simplifying offensive situations'. This type of SSG is usually used to develop players' defensive or attacking skills and to increase the physical load of players and the floater player [7].

As the number of players on the pitch decreases during the preparatory games with the sliding player, the number of passes is reduced and the use of dribbling and the number of shots increase. The main reason for this is that players use dribbling more often in solving game situations, because the free space between defence players is increased. Players could thus better move to the more advantageous shooting positions by dribbling. For this reason, players more often complete their attacks. The presence of a floater player may be an incentive for defensive players trying to get the ball to gain the advantage over the other team as quickly as possible, while the team with the superiority has the advantage and should have a facilitated situation in dealing with offensive combinations and defenders should make more effort in defensive situations [13].

SSGs with a floater player may be a suitable means to maintain or increase the anaerobic endurance of the handball players, as in similar football studies [46, 47]. For this reason, it is advisable to increase the length of SSGs to an appropriate level, but it is important to monitor this in order to avoid a decrease in the load intensity of SSGs. The primary benefits of SSG are that the game can replicate the movement patterns, physiological demands and technical requirements of a competition [16], while also requiring players to make decisions under conditions of pressure, stress and fatigue. The number of specific technical-tactical elements is large in SSG, so the opportunities for making decisions grow in SSG games.

According to our results, we are in favour of the idea of Buchheit et al. [15] and Corvino et al. [18], that the short duration of the game and the reduction in the number of players on the SSG field leads to an increase in the volume of cyclical movements in the short term. The total number of shots, passes and goals increased in our study, but if we recalculate these values for one minute of play, the number of passes, shots and goals hardly differed in each modified game. There was only a statistically significant difference in the number of passes between SSG5 and SSG6 (p = .04). Only with increasing fatigue did the number of technical mistakes increase, as is the case in handball. An important finding of the present study is that a longer duration of SSG can be used in the handball training process without significantly reducing the intensity of the exercise. This fact allows us to use the six-minute stretch of the modified game as a specific training by the interval method, while maintaining almost all handball rules.

This is mainly supported by studies in the football environment, where, according to Scanlan and Lewthwaite [48], the fitness experience affects the motivation of players to load more. Brière, Vallerand, Blais, and Pelletier [49] and McAuley and Tammen [50] argue that athletes who play sufficient sports are better motivated. And this is confirmed in the study by Alvarez, Balaguer, Castillo, and Duda [51], who claim that when young football players perceive their psychological satisfaction, they show a higher degree of sports motivation.

We are aware that the study has some limitations such as experience of female players, non-monitoring of blood lactate and menstruation, so in future studies it would be appropriate to monitor these parameters.

Conclusions

SSGs with a floater are a suitable means for training technical and tactical activities in handball with an overlap into fitness training in women's handball. According to our results, the intensity of the load will not decrease if we increase the game time to six minutes and also the covered distance will not decrease during the game.

The SSG format with a floater is suitable for inclusion in specific handball training because of the sufficient number of game situations that players solve in numerical imbalance both in terms of attack and defence, which are typical game situations in handball competitive matches. Another added value of the observed SSG with a floater is the training of fast breaks. The results of our SSG study with a floater player and the varying duration of exercise should be interpreted with caution due to the small size of the research sample. On the other hand, the research sample is, in our opinion, representative of the age and performance group, whereby they are the female players from the highest competition with experience of national selection. In the training process it is necessary to respond to the actual requirements of the match and to adapt the training to these requirements. It would be advisable to monitor blood lactate in further research, but this is often problematic during the handball training process. In future studies, it would be advisable to monitor the SSG player load at longer load intervals of as much as six minutes, and whether it is appropriate to use longer periods of time in the training, so as not to reduce the intensity of the exercise. For future research, we recommend monitoring the SSG of this format in terms of the effect related to female players' fitness.

References

1. Povoas S.C., Seabra A.F., Ascensao A.A., Magalhaes J., Soares J.M., Rebelo A.N. (2012). Physical and physiological demands of elite team handball. *The Journal of Strength & Conditioning Research* 26(12), 3365-3375. DOI: 10.1519/JSC.0b013e318248aeee.
2. Michalsik L.B., Aagaar P., Madsen K. (2013). Locomotion characteristics and match-induced impairments in physical performance in male elite team handball players. *International Journal of Sports Medicine* 34(7), 590-599. DOI: 10.1055/s-0032-1329989.
3. Michalsik L.B., Madsen K., Aagaard P. (2014). Match performance and physiological capacity of female elite team handball players. *International Journal of Sports Medicine* 35(7), 595-607. doi: 10.1055/s-0033-1358713.
4. Michalsik L.B., Madsen K., Aagaard P. (2015). Physiological capacity and physical testing in male elite team handball. *Journal of Sports Medicine and Physical Fitness* 55(5), 415-429.
5. Belka J., Hulka J., Weisser R., Safar M., Samcova A. (2014). Analyses of time-motion and heart rate in elite female players (U 19) during competitive handball matches. *Kinesiology* 46(1), 33-43.
6. Manchado C., Pers J., Navarro F., Han A., Sung E., Platen P. (2013). Time-motion analysis in women's team handball: importance of aerobic performance. *Journal of Human Sport & Exercise* 8(2), 376-390. DOI: 10.4100/jhse.2012.82.06.
7. Hill-Haas S.V., Dawson B.T., Impellizzeri F.M., Coutts A. J. (2011). Physiology of small-sided games training in football: A systematic review. *Sports Medicine* 41, 199-220. DOI: 10.2165/11539740-000000000-00000.
8. Bompa T. (1983). *Theory and methodology of training*. Dubusque, Iowa: Kendall/Hunt.
9. Jones S., Drust B. (2007). Physiological and technical demands of 4 vs. 4 and 8 vs. 8 games in elite youth soccer players. *Kinesiology* 39(2), 150-156.
10. Dellal A., Lago-Penas C., Wong D.P., Chamari K. (2011). Effect of the number of ball touch within bouts of 4 vs. 4 small-sided soccer games. *International Journal of Sports Physiology Performance* 6(2), 78-89. DOI: 10.1123/ijspp.6.3.322.
11. Owen A., Twist C., Ford F. (2004). Small-sided games: The physiological and technical effect of altering pitch size and player numbers. *Insight* 7, 50-59.
12. Castillo D., Raya-González J., Sarmento H. Sarmento H., Yanci J. (2021) Effects of including endurance and speed sessions within small-sided soccer games periodization on physical fitness. *Biology of Sport* 38(2), 291-299. DOI: 10.5114/biolsport.2021.99325.
13. Hill-Haas S.V., Couts A.J., Dowson B.T., Rowsell G.J. (2010). Time-motion characteristics and physiological responses of small-sided games in elite youth players: The influence of player number and rule changes. *The Journal of Strength & Conditioning Research* 24, 2149-2156. DOI: 10.1519/JSC.0b013e3181af5265.
14. Halouani J., Chtourou H., Gabbett T., Chaouachi A., Chamari K. (2014) Small-sided games in team sports training: A brief review. *The Journal of Strength & Conditioning Research* 28(12), 3594-3618. DOI: 10.1519/JSC.0000000000000564.
15. Buchheit M., Laursen P.B., Kuhnle J., Ruch D., Renaud C., Ahmaidi S. (2009). Game-based training in young elite handball players. *International Journal of Sports Medicine* 30(4), 251-258. DOI: 10.1055/s-0028-1105943.
16. Iacono A.D., Eliakim A, Meckel Y.(2015). Improving fitness of elite handball players: small-sided games vs. high--intensity intermittent training. *The Journal of Strength & Conditioning Research* 29(3), 835-843. DOI: 10.1519/JSC.0000000000000686.
17. Abade E., Abrantes C., Ibánez S., Sampaio J. (2014). Acute effects of strength training in the physiological and perceptual response in handball small-sided games. *Science & Sports* 29, e83-e89. DOI: 10.1016/j.scispo.2014.07.015.
18. Corvino M., Tessitore A., Minganti C., Sibila M. (2014). Effect of court dimensions on players' external and internal load during small-sided handball games. *Journal of Sports Science and Medicine* 13, 297-303.
19. Iacono D.A., Ardigo L.P., Meckel Y., Padulo J. (2016). Effect of small-sided games and repeated shuffle sprint training on physical performance in elite handball players. *The Journal of Strength & Conditioning Research* 30(3), 830-840. DOI: 10.1519/JSC.0000000000001139.
20. Ravier G., Hassenfratz C., Bouzigon R., Groslambert A. (2019). Physiological and affective responses of 30s-30s intermittent small-sided game in elite handball players: A new alternative to intermittent running. *Journal of Human Sport and Exercise* 14(3), 538-548. DOI: 10.14198/jhse.2019.143.05.
21. Gumus H., Gencoglu C. (2020). Playerloadtm and heart rate response to small-sided games specialized to additional field player rule in handball. *Human. Sport. Medicine* 20(S1), 55-61.
22. Jurisic M.V., Jaksic D., Trajković N., Rakonjac D., Peulić J., Obradović J. (2021). Effects of small-sided games and high--intensity interval training on physical performance in young female handball players. *Biology of Sport* 38(3), 359-366. DOI: 10.5114/biolsport.2021.99327.
23. Jake N., Tsui M.C., Smith A.W., Carling C., Chan G.S., Wong D.P. (2012). The effects of man-marking on work intensity in small-sided soccer games. *Journal Sports Science Medicine* 11(1), 109-114.
24. Brandes M., Heitmann A., Muller L. (2012). Physical responses of different small-sided games formats in elite youth soccer players. *The Journal of Strength & Conditioning Research* 26(5), 1353-1363. DOI: 10.1519/JSC.0b013e318231ab99.
25. Owen A.L., Wong D.P., McKenna M., Dellal A. (2011). Heart rate responses and technical comparison between small- vs. large-sided games in elite professional soccer. *The Journal of Strength & Conditioning Research* 25(8), 2104-2110.
26. Castellano J., Casamichana D., Dellal A. (2013). Influence of game format and number of players on heart rate responses and physical demands in small-sided soccer games. *The Journal of Strength & Conditioning Research* 27, 1295-1303. DOI: 10.1519/JSC.0b013e318267a5d1.
27. Rampinini E., Impellizzeri F.M., Carlo Castagna C., Grant Abt G., Karim Chamari K. et al. (2007). Factors influencing physiological responses to small-sided soccer games. *Journal of Sport Sciences* 25(6), 659-666. DOI: 10.1080/02640410600811858.
28. Kelly D.M., Drust B. (2009). The effect of pitch dimensions on heart rate responses and technical demands of small-sided soccer games in elite players. *Journal Science Medicine Sport* 12(4), 475-479. DOI: 10.1016/j.jsams.2008.01.010.

29. Borg G.A. (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise* 14, 377-381. DOI: 10.1249/00005768-198205000-00012.
30. Borg G.A. (1998). *Borg's perceived excretion and pain scales*. Champaign, IL: Human Kinetics.
31. Bangsbo J., Iaia M., Krustrup P. (2008). The Yo-Yo intermittent recovery test. A useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine* 38(1), 37-51. DOI: 10.2165/00007256-200838010-00004.
32. Krustrup P., Mohr M., Amstrup T., Rysgaard T., Johansen J. et al. (2003). The Yo-Yo intermittent recovery test: Physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise* 35(4), 697-705. DOI: 10.1249/01.MSS.0000058441.94520.32.
33. Lockie R.G., Moreno M.R., Lazar A., Orjalo A.J., Giuliano D.V. et al. (2018). The physical and athletic performance characteristics of Division I collegiate female soccer players by position. *The Journal of Strength & Conditioning Research* 32(2), 334-343. DOI: 10.1519/JSC.0000000000001561.
34. Banda D.S., Beitzel M.M., Kammerer J.D., Salazar I., Lockie R.G. (2019). Lower-body power relationships to linear speed, change-of-direction speed, and high-intensity running performance in DI collegiate women's basketball players. *Journal of Human Kinetics* 68, 223-232. DOI: 10.2478/hukin-2019-0067.
35. Bishop D.C., Wright C. (2006). A time-motion analysis of professional basketball to determine the relationship between three activity profiles: high, medium and low intensity and the length of the time spent on court. *International Journal of Performance Analysis in Sport* 6(1), 130-139. DOI: 10.1080/24748668.2006.11868361.
36. McInnes S.E., Carlson J.S., Jones C.J., McKenna M.J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sports Sciences* 13(5), 387-397. DOI: 10.1080/02640419508732254.
37. Hulka K., Cuberek R., Svoboda Z. (2014). Time-motion analysis of basketball players: a reliability assessment of Video Manual Motion Tracker 1.0 software. *Journal of Sports Sciences* 32(1), 53-59. doi:10.1080/02640414.2013.805237.
38. Sibila M., Vuleta D., Pori P. (2004). Position-related differences in volume and intensity of largescale cyclic movements of male players in handball. *Kinesiology* 36(1), 58-68.
39. Ferguson, C. J. (2009). An effect size primer: a guide for clinicians and researchers. *Professional Psychology* 40, 532-538. doi: 10.1037/a0015808.
40. Coutts A.J., Rampinini E., Marcora S.M., Impellizzeri S. (2009). Heart rate and blood lactate correlates of perceived exertion during small-sided soccer games. *Journal of Science and Medicine in Sport* 12(1), 79-84. DOI: 10.1016/j.jsams.2007.08.005.
41. Noble B.J., Robertson R.J. (1996). *Perceived exertion*. Champaign, IL: Human Kinetics.
42. Watt B., Grove R. (1993). Perceived exertion. Antecedents and applications. *Sports Medicine* 15(4), 225-41. DOI: 10.2165/00007256-199315040-00002.
43. Carton R.L., Rhodes E.C. (1985). A critical review of the literature on ratings scales for perceived exertion. *Sports Medicine* 2(3), 198-222. DOI: 10.2165/00007256-198502030-00004.
44. Belka J., Hulka K., Safar M., Weisser R. (2016). External and internal load of playing positions of elite female handball players (U19) during competitive matches. *Acta Gymnica* 46(1), 12-20.
45. Gabbett T.J. (2006). Skill-based conditioning games as an alternative to traditional conditioning for rugby league players. *The Journal of Strength & Conditioning Research* 20(2), 309-314. DOI: 10.1519/R-17655.1.
46. Castellano J., Silva P., Usabiaga O., Barreira D. (2016). The influence of scoring targets and outer-floaters on attacking and defending team dispersion, shape and creation of space during small-sided soccer games. *Journal of Human Kinetics* 51, 153-163. DOI: 10.1515/hukin-2015-0178.
47. Los Arcos A., Vazquez J.S., Martín J., Lerga J., Sanchez F. et al. (2015). Effects of small-sided games vs. interval training in aerobic fitness and physical enjoyment in young elite soccer players. *PLoS ONE* 10(9), 1-10. DOI: 10.1371/journal.pone.0137224.
48. Scanlan T.K., Lewthwaite R. (1986). Social psychology social psychological aspectsof competition for male youth sport participants: IV. Predictors of Enjoyment. *Journal of Sport Psychology* 8, 25-35.
49. Briere N., Vallerand R., Blais. N., Pelletier L. (1995). Development and validation of ameasure of intrinsic, extrinsic, and a motivation in sports: The Sport Motivation Scale (SMS). *International Journal of Sport Psychology* 26, 465-489.
50. McAuley E., Tammen V. (1989). The effects of subjective and objective competitive outcomes on intrinsic motivation. *Journal of Sport Exercises and Psychology* 11, 84-93.
51. Alvarez M. S., Balaguer I., Castillo I., Duda J.L. (2009). Coach autonomy support and quality of sport engagement in young soccer players. *Spanien Journal of Psychology* 12(1), 138-148. DOI: 10.1017/s1138741600001554.

Submitted: August 17, 2021
Accepted: December 7, 2021