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EFFECT OF SMALL-SIDED GAMES ON IMPROVEMENT IN SPRINTING AND CHANGE OF DIRECTION AMONG 14-15 YEAR- OLD, FEMALE HANDBALL PLAYERS

VPLIV MALIH IGER Z ŽOGAMI NA IZBOLJŠANJE ŠPRINTA IN HITROST SPREMEMBE SMERI PRI MLADIH ROKOMETAŠICAH

ABSTRACT

Small-sided games (SSG) have proven to be an effective method of organizing practice in team sports, and the purpose of this study was to examine if the use of SSG can contribute to enhanced sprinting and change of direction (COD) performances in 14-15 year-old female handball players. An experimental group (n= 13, age 15.6 ± 04 yrs., body height 1.68± 0.06 m, body mass 62.9±9.8 kg) trained according to the principles of small-sided games and handball activities organized to create a high volume of sprints and COD for 30 minutes, twice a week, for 7 weeks during regular handball training. A control group (n= 9, age 14.4 ± 0.3 yrs., body height 1.70± 0.03 m, body mass 60.7±4.7 kg) performed regular handball training. In pre- and post-tests, sprint (5-, 10- and 20-meters) and COD performance was measured. The results showed no significant positive development in the sprint tests ($p<0.05$) in either of the groups. However, the experimental group had a significant improvement in COD ($p<0.05$), while the control group had no significant change in COD. The enhanced COD performance was explained by a greater amount of training related to COD by practicing SSG, while the lack of improvement in sprint performance was probably due to a too low training load in this ability during training. The practical implication of this study was that handball training would benefit from focus upon small-sided games and handball activities with high intensity in order to improve COD for adolescent female players.

Keywords: adolescents, girls, team sport, maximal speed

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IZVLEČEK

Male igre z žogami so se izkazale kot učinkovita metoda organiziranja vadbe v skupinskih športih. Namen pričujoče študije je bil preučiti, ali lahko uporaba malih iger z žogami prispeva k izboljšanju šprinta in hitrosti spremembe smeri (COD) pri 14- in 15- letnih rokometašicah. Eksperimentalna skupina (n = 13; starost 15,6 ± 04 let; telesna višina 1,68 ± 0,06 m; telesna masa 62,9 ± 9,8 kg) je trenirala v skladu z načeli malih iger z žogo in rokometnih dejavnosti, 30 minut, dvakrat tedensko, v skupnem trajanju 7 tednov med rednimi treningi rokometa. Kontrolna skupina (n = 9; starost 14,4 ± 0,3 let; telesna višina 1,70 ± 0,03 m; telesna masa 60,7 ± 4,7 kg) je izvajala redne rokometne treninge. Obe skupini smo izmerili pred in po intervenciji. Rezultati v nobeni od skupin niso pokazali statistično značilnega izboljšanja šprinta ($p< 0,05$). Pri eksperimentalni skupini smo opazili znatno izboljšanje KPK ($p< 0,05$), medtem ko kontrolna skupina ni imela pomembnih sprememb v KPK. Okrepljeno delovanje KPK si razlagamo z večjim številom treningov, povezanih s KPK in z vadbo malih športnih iger.

Ključne besede: mladostniki, deklice, ekipni šport, največja hitrost

INTRODUCTION

Handball is a high-intensity sport, where performance is dependent on player's physiological, technical/tactical and psychological/social abilities (Michalsik, Aagaard, & Madsen, 2013). Research has shown that during a handball match, the total distance run by a full-time, elite, female player is about 4700 meters, and that the players make an average of 663 activity changes per match (Michalsik L.B., 2014). The activity changes (e.g. change of direction (COD) or acceleration) often play a decisive role in the handball match, both in defense and attack (Michalsik et al., 2013). When players in attack are trying to challenge a defender, the ability to accelerate and change direction quickly could be the decisive factor for success or failure (Spasic, Krolo, Zenic, Delextrat, & Sekulic, 2015). A study showed that the most frequent high-intensity actions during a handball match were changes of direction, stops and one-on-one situations (Póvoas et al., 2012).

Even though players only sprint 2.2 % of the total distance covered during the match (Michalsik et al., 2013), measured as a running speed of > 22 km · h – 1, the ability to sprint fast is an important factor for performance in handball (Granados, Izquierdo, Ibáñez, Ruesta, & Gorostiaga, 2013; Kale, 2016; Rakovic, Paulsen, Helland, Eriksrud, & Haugen, 2018; W. B. Young, McDowell, & Scarlett, 2001). When comparing female handball players at different levels and ages (from 15 years to adult), many studies show little difference in sprinting ability among the players (Granados et al., 2013; Hirose & Nakahori, 2015; Naisidou, Kepesidou, Kontostergiou, & Zapartidis, 2017; Pereira et al., 2018). However, in a study , top, elite, female players (16 years of age), outperformed elite players and non-elite players in a 10 meter sprint test (Moss, McWhannell, Michalsik, & Twist, 2015). This finding is also highlighted in a study in which female handball players in national teams from U15, U17, U19 levels and the A-team participated (Saavedra et al., 2018). The players in the youth teams' average sprint time in a 10-meter sprint was 1.94 seconds, while the A-team's average sprint time was 1.86. There were also significant differences in the sprint time between A-team players and players at U17 level. It could be argued that high ability in sprints may be one of the selection criteria for taking part in the A-team.

The natural development of sprinting ability in females reaches a plateau at the age of 15-16 (Papaiakovou et al., 2009), but research has shown that female athletes can improve sprinting by training. In a study, the effect of sprint training in combination with ordinary training, gave adult, elite, female handball players a small effect in sprint performance in 30 meter and

maximal sprint speed in an 8-week period, with 2 exercises per week (Rakovic et al., 2018). Plyometric training for 8 weeks has been shown to improve sprint performance in 15-16-year old female elite handball players (Chaabene et al., 2019). A positive effect on sprint performance was also found in a study examining speed exercises in an 8-week intervention period among female youth football players (Mathisen & Danielsen, 2014). Furthermore, a 6-week pre-season plyometric training intervention among high level, adult, female players showed a significant improvement in sprinting at 10-, 20- and 30-meters (Kale, 2016).

Many studies points toward performance in COD sprinting as an especially important physical factor for the performance of handball players (Luteberget & Spencer, 2017; Michalsik et al., 2013). Both COD and straight forward sprint are related to explosive movements of the body – both factors that are essential for a handball player (Michalsik L.B., 2014). The specificity of these physical abilities is shown in a study (W. B. Young et al., 2001). In their intervention study, one group of adult men practiced COD, while the other group practiced straight forward sprinting. The results showed a significant improvement in COD for the group practicing COD, while there was no significant improvement in sprint performances in the group practicing straight forward sprinting. This finding is supported in research showing that among highly trained, male handball players, shuffle sprint training improved 10-meter sprint performance more than a group training small sided games (SSG), while SSG gave a greater improvement in COD, than shuffle sprint training (Dello Iacono, Ardigò, Meckel, & Padulo, 2016). Furthermore, SSG gave a more significant improvement in 10- and 20-meter sprinting compared to high-intensity intermittent training for elite, adult, male handball players (Iacono, Eliakim, & Meckel, 2015).

To organize team sports training as SSG has been shown to be an effective method of improving aerobic fitness, team cohesion and skills acquisition (Halouani, Chtourou, Gabbett, Chaouachi, & Chamari, 2014; Sarmento et al., 2018). It is reported that 8 weeks of SSG training led to significant improvement in a handball associated COD test (Iacono et al., 2015). Also, a positive effect on COD was found among 13-year old, female football players after 8 weeks of specific sprint and COD training (Mathisen & Danielsen, 2014). On the other hand, young male Australian Rules football players did not change their COD after an intervention with SSG, but a reduction in reaction time was reported (W. Young & Rogers, 2014). It is also appropriate to highlight that coaches in adolescents' sports should organize their training in a way that motivates their athletes. Research has shown, furthermore, that, for adolescent football players, SSG gives more enjoyment in training than interval training (Los Arcos et al., 2015).

The previous discussion highlighted that handball players need a variety of skills and physical abilities to succeed in handball, where performance in sprinting and COD seem to be two physical abilities of major importance (Michalsik et al., 2013). The use of SSG in training is shown to be effective in the development of sprinting, COD and decision making (Iacono et al., 2015; W. Young & Rogers, 2014), as well as increasing the athlete`s enjoyment in participating in sport (Los Arcos et al., 2015). The purpose of the study is to evaluate the development of sprinting and COD performance among 14-15-year old female athletes, using an experimental intervention study with SSG and a control group. To the best of our knowledge, this is a research area where knowledge is limited – especially relating to female adolescents.

METHODS

Experimental Approach to the Problem

The intervention was organized with an experimental group (EG) and a control group (CG). In EG, 30 minutes of their regular training time were replaced with SSG and sprinting straight forward in handball activities, twice a week for a 7-week period. Four exercises were selected to create many sprints and COD and were organized as SSG (see Figures 1-4). Each of the four exercises lasted 10 minutes, with 3 of them being used each training day. The exercises were rotated during the intervention, leading to equal time being spent on the four exercises during the 7 weeks of intervention. During the exercises, the coach never stopped the activity to give individual feedback, and he encouraged the players to provide maximum effort. Competitiveness in SSG led to a high intensity in sprints and COD. To ensure that the intensity was maximal in the sprints and COD, short periods of rest (approximately 1 minute) were included between the exercises. The chosen activities and no interruption from the coach, led to a high amount of maximal actions in sprinting and COD.

The CG group practiced traditional handball training, planned and executed by their coaches. In their training, there was little focus on a high volume of sprints and COD, but more on strength training and development of technical and tactical issues to develop handball skills. The chosen activities in CG gave few high intensity sprints and COD, and the activity was often stopped by the coach, who gave individual feedback. This led to considerably fewer repetitions of maximal action in sprinting and COD in CG compared to the EG. To verify the difference in training load in EG and CG, the training was observed by the authors five times during the total of 14 sessions.

The difference in training load between the two groups was the 30-minute sessions performed in EG, where the players made a large number of maximal actions in sprinting and COD. Beside the 30-minute sessions performed in the EG, the training- and competition loads were, as far as we could see, relatively equal in the two groups. Their training diary showed that subjects in the EG took part in 10.6 hours of physical activity per week, while CG had in average 9.2 hours during the experimental period.

Subjects

The subjects were part of two female handball teams in the same club in the middle of Norway. Both teams participated in the regional league, at a medium level. An U16 team was selected as the EG (n= 13, age 15.6 ± 0.4 years, body height 168.3 ± 6.0 cm, body mass 62.9 ± 9.8 kg, 9.4 ± 1.8 years handball experience, total time spent on training and matches in the experimental period per-week 10. 6 ± 2.5 hours). An U15 team was selected as the CG (n= 9, age 14.4 ± 0.3, body height 170 ±3 cm, body mass 60.7 ± 4.7 kg, handball experience 8.3 ± 1.1 years, total time spent on training and matches in the experimental period per week 9.2 ± 1.2 hours).

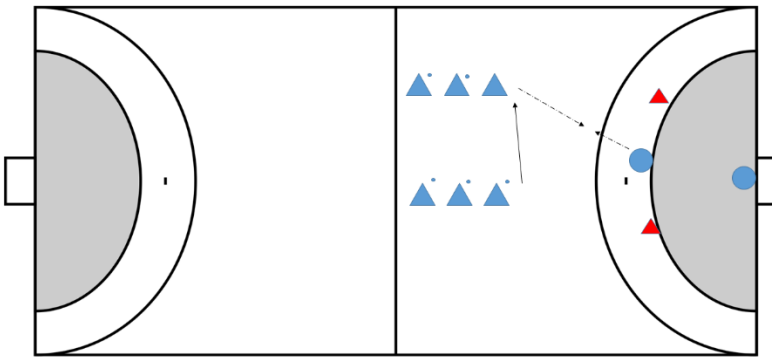
Inclusion criteria for participation were that the subjects were without injury or sickness during the training intervention, and that the subjects participated in a minimum of 12 of the 14 training sessions. All players agreed to take part in the study and they and their parents signed a written consent form, according to the regulations of the Norwegian Centre for Research Data. Approval to use the data and to conduct the study was given by the Norwegian Centre for Research Data.

Procedures

Training program

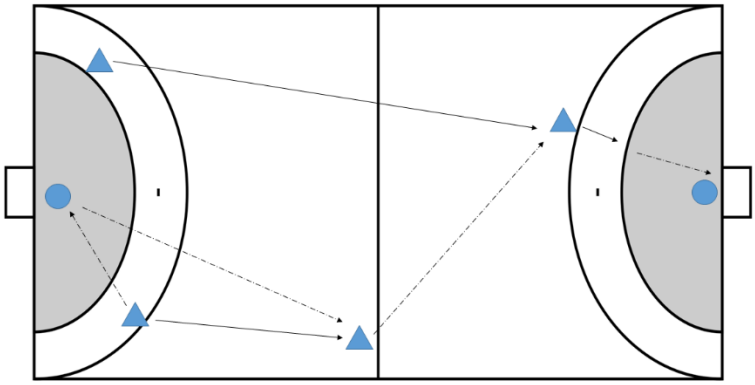
In Exercise 1, the first attacking player in the left line (without the ball) will make a jump shot after receiving the ball from the first player at the right position (see Figure 1). The player in the right position is making an attacking movement forward, before passing the ball to the player to the left. The defensive player is trying to tackle the attacker and prevent her from scoring a goal. When one attack is finished, a new attack arrives from the player on the right position, trying to pass the defender and score a goal - this after receiving the ball from the player in the left line, after she has made an attacking movement forward. After 6 attacks are completed, a new player becomes the defender. All attacks from the left are done as a jump shot, and all attacks from the right are an attempt to dribble the defender.

Figure 1: Exercise 1.



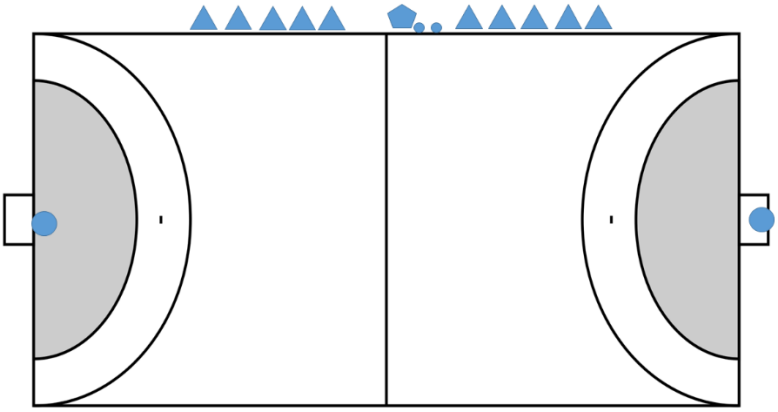
In Exercise 2, one player starts on the wing while one player starts in the middle of the field (see Figure 2). The player in the middle starts with the ball, makes a pass to the goalkeeper, starts a maximum run to the side of the field, receives the ball from the goalkeeper, and makes a pass to the wing-player, who starts a maximum run down the field, when the goalkeeper throws the ball to the middle player. The wing player receives the ball and tries to score a goal. The players walk back to the goal for a new attempt.

Figure 2: Exercise 2.



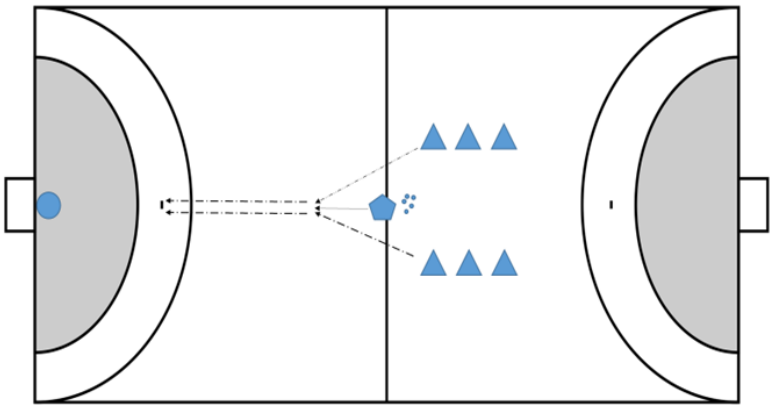
In Exercise 3, the players are divided into two teams, standing outside the playing field (see Figure 3). The coach serves the ball and yells out a number between one and four (i.e. one means a one against one match, two a two against two match). The players make a maximum run to try to capture the ball and score a goal. The match is ended when the ball is out of play, or there is a goal. When one match is ended, the players walk back to the line and wait for the next match.

Figure 3: Exercise 3.



In Exercise 4, the players stand in two lines 5 meters behind the coach (see Figure 4). The first player in each line competes for possession of the ball and to score a goal, when the coach throws the ball in the air. When the players are finished with one attempt, they walk back to their line, and makes themselves ready for a new attempt.

Figure 4: Exercise 4.



Testing procedures

Height was measured with a stadiometer (Kawe, NorEngros, Oslo, Norway), permanently connected to the wall. The subjects did not wear shoes, and height was rounded up or down to the nearest centimetre. Weight was measured using Seca Digital WeighingScales (Seca Gmbh & Co., Germany, Model 877, accuracy of 0.1 kilo). The players were interviewed about their age and years of experience of handball before the intervention began. A training diary was kept by the players during the 7-week intervention period.

Both tests were conducted in an indoor, hard-court, handball hall. The tests were always conducted on the same day of the week and at the same time of the day (19:00), with the same

test leaders at each performance test. Two weeks before the training intervention and the tests were conducted, the two groups (EG and CG) participated in one session of familiarization to the tests. The subjects were instructed to rest the day before testing.

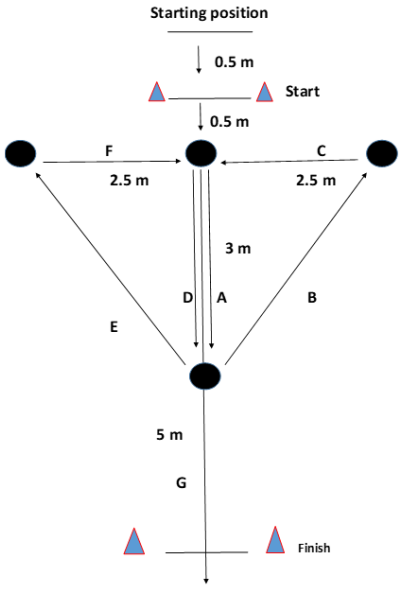
Sprint test

After a standardized general warm-up of 10 minutes, each subject was randomly tested in sprinting. The sprint performances were measured by two maximum effort sprints of 20 meters, for which the time was measured at 5-meters, 10- meters and 20- meters, using Brower equipment (Wire-less Sprint System, USA). The subject's starting position was 0.5- meter behind the timer system, and the timer system were placed at a height of 0.25-meter. Before both the sprint and COD test, the players were instructed to continue running past the finish line, and to not stretch a foot or hand out to stop the timer. The players performed sprints, separated by 3 minutes of rest. The best performance of the two tests was used in the analysis. The need for familiarization is reported to give no effect (Moir, Button, Glaister, & Stone, 2004).

COD test

After a 5-minute recovery, the subjects had a 10-minute familiarization period (2 attempts each at a submaximal intensity) on the COD test. After this period, the players conducted three maximum effort COD tests, modified according to the instructions of (Tillaar, Waade, & Roaas, 2015) (see Figure 5). It is recommended that subjects do at least four COD runs to ensure measurement reliability (Lam et al., 2018), and the best attempt was used in the statistical analysis. The start position was 0.5-meter behind the timer system, and the timer system was placed at a height of 0.25-meter . The test course was made up of flat markers, and the players were instructed to step on the markers , before continuing the course. If a player did not step on the marker , she was stopped, and had to rerun the course after 3 minutes' rest. The COD test showed maximal movement in a specific pattern related to team handball movements in defense (maximal running forward and sideways), measuring the time in seconds.

Figure 5. Schematic representation of the COD test modified according to the instructions of (Tillaar et al., 2015). The players get ready in the starting position 0.5 meter behind the timer, running forward as quickly as possible (A), running sideways (B and C), forward (D), sideways (E and F) and finally forward (G), until they pass the finish line.



Statistical Analyses

Independent t-tests were used to identify differences between the control group and the experimental group at pretest. Furthermore, paired sample t-tests were used to examine differences between pre-test and post-test at 5-meter sprint, 10-meter sprint, 20-meter sprint, and in COD. Statistical significance was set at $p \leq 0.05$. SPSS (version 26.0: IBM, Armonk, NY, USA) was used to analyse the data.

RESULTS

The independent t-test showed that in relation to three of the four pretests, there were no significant differences between the control group and the experimental group ($p > 0.05$). There was a significant difference between the two groups at 5-meter sprint, however, at a borderline level ($t = 2.2$, $p = 0.042$).

Figure 6: Performances of the control group in 5-meter, 10-meter and 20-meter sprints, between pre-test and post-tests.

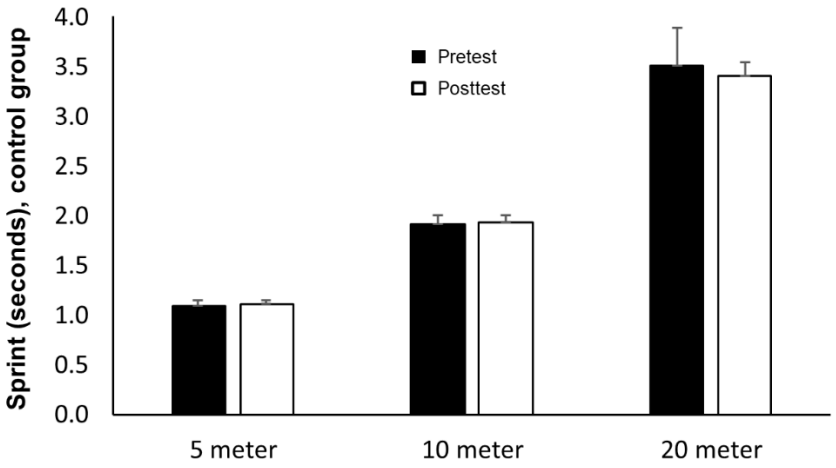


Figure 6 shows that there were no significant differences between the performance in the control group at pre-test and post-test on 5-meter, 10 meter and 20-meter sprints ($p > 0.05$).

Figure 7: Performances of the experimental group in 5-meter, 10-meter and 20-meter sprints, between pre-test and post-test. *Significant difference between pre-test and post-tests ($p < 0.05$).

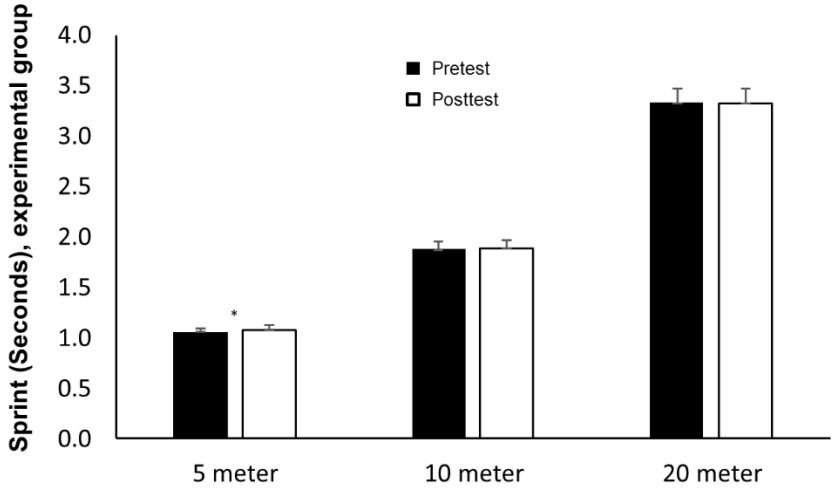


Figure 7 show that there were no significant differences in the experimental group between the performance on pre-test and post-test in 10-meter and 20-meter sprints ($p > 0.05$). However, there were significant differences between the performance on pre-test and post-testing 5-meter sprints ($t = -3.6$, $p = 0.003$), where the experimental group ran 0.02 seconds slower at the post-test, compared with the pre-test.

Figure 8: Performances of the control group and the experimental group, between pre-test and post-test on COD. * Significant difference between pre-test and post-test ($p < 0.05$).

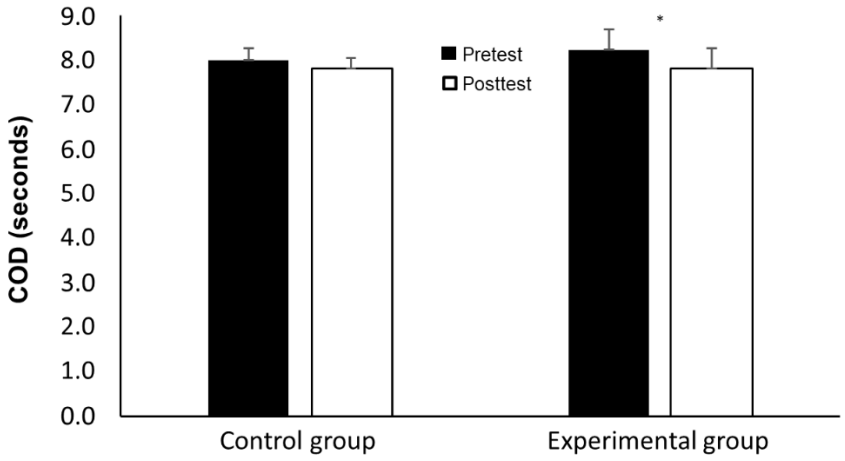


Figure 8 show that there were no significant differences between the performance in COD at pre-test and post-test in the control group ($p > 0.05$). However, there were significant differences between the performance in pre-test and post-test COD in the experimental group ($t = -3.6$, $p = 0.003$), where the experimental group ran 0.4 seconds faster at post-test, compared with the pre-test.

DISCUSSION

The main finding in this study is a significant improvement in COD ($p<0.05$) in the EG, where the players in this group had, on average, an improvement on 0.4 seconds from post-test, to the pre-test (total time about 8 seconds). These results are similar to a study were the authors concluded that when increasing the total quantity of changes of direction in training, athletes improve their ability (W. B. Young et al., 2001). This is supported by (Dello Iacono et al., 2016), who found that SSG gave a higher degree of improvement in COD, than did shuffle sprint training. We will argue that the high volume of SSG in the EG may explain the improvement in COD in the EG. A sign of the effect of the training intervention, is that all the players in the EG improved their performance in the COD test in the post-test. Previous studies reporting an increased performance in COD after SSG activities, only involve males (Dello Iacono et al., 2016; Iacono et al., 2015; W. B. Young et al., 2001). Our findings showed a similar development among 14-15-year old, female handball players. The improvement in COD is important for handball players, especially for players with the ambition to reach a high level in their career (Luteberget & Spencer, 2017; Michalsik et al., 2013; W. Young & Rogers, 2014).

We found no significant improvement in COD for CG – a finding that supports our argument regarding the importance of SSG in relation to COD. According to the study's design and our observations of the training sessions, the subjects in CG took part in exercises that gave fewer maximal actions in sprinting and COD than EG. They also had more interruptions in their training, because the coach gave more individual feedback on skill acquisition. The difference in training load in COD was observed by the authors during observation of the training sessions in the intervention. According to general training principles, we will argue that the low training load of maximal actions in the exercises in CG may explain no significant improvement in the COD test in the CG. Our interpretation is supported by the results of a study who found no development in COD after an intervention with SSG among male, Australian Rules, football players (W. Young & Rogers, 2014). They suggested that a 7-week intervention, where the players take part in 11 sessions each of 15 minutes, gives too low a training load to produce positive adaptation, because the players are already performing a considerable amount of COD in training and matches.

Another main finding in this study was no significant positive development of sprinting ability in EG. More unexpectedly, the EG group had a significant decrease in the 5-meter sprint performance from pre-test to post-test, while no significant change was detected in 10-meter and 20-meter sprints. This increased sprint time for the EG group is difficult to explain. On test-day, the players performed the same warm-ups and they were told to rest the day before. Both tests (sprints and COD) were executed on the same day, and the sprint tests were completed first on both test days. If the players had been suffering from fatigue before the test day, this would have affected both the 5-meter sprint performance and the performance in the COD-test. A plausible reason for our finding is probably a low reliability in this test, because of the short duration of the test (approximately 1 second). The average increase in sprint times for the EG group was only 0.02 seconds, and there is some degree of coincidence about the player's body position and where the foot was placed when they passed the timer system. This is relevant, since the timers were placed 0.25 meter over the floor. The increase in 5-meter sprint times for EG - with no change in 10-meters and 20-meters, indicates that the players ran faster from 5-meters to 10- and 20-meters in post-test, compared to pre-test.

The purpose of this study was to evaluate if SSG in handball activities with a large number of sprints would improve sprinting ability in young female handball players. SSG is proven to give several positive effects in both physical factors, as well as skill acquisition in male athletes (Halouani et al., 2014). However, knowledge about the development of sprinting and COD

among female athletes by means of SSG in training, is a research area with limited knowledge. The present study found no positive development in sprinting in the EG, despite the inclusion of exercises who should influence the EG group's sprinting ability (see Exercises 2 and 4, Figures 2 and 4). A plausible reason for this could be that the total load of straight forward sprints was too low in this study, compared to an another study of female adolescents athletes (Mathisen & Danielsen, 2014). Furthermore, in their study, the subjects were 13 years old, while the subjects in our study were 14 and 15 years old. The natural development of sprinting for females is shown to be reaching a plateau at 14-15 years of age (Papaiakovou et al., 2009), indicating a larger challenge to get a development in the sprinting ability among 14 and 15-year-old females, than among 13 years old females. On the other hand, an 8 weeks intervention study with SSG showed a significant improvement in sprint performances in 10- and 20-meter sprints among elite adult male handball players (Iacono et al., 2015).

Our study showed that the CG had no development in their sprinting ability at 5, 10 and 20-meters. This result is similar to other studies, showing that sprint performances is relatively stable among female athletes at the age of 15-20 (Hirose & Nakahori, 2015; Zapartidis, Nikolaidou, Vareltzis, & Kororos, 2011). This is as expected, taken into account the training design and accomplishment in CG, which led to few repetitions in sprinting and COD.

The ability to sprint straight forward is shown to be higher among top players than players at lower levels in handball, and for ambitious young players, improving sprinting should be a natural goal of training (Moss et al., 2015; Saavedra et al., 2018). Studies have shown that focusing on speed exercises (Mathisen & Danielsen, 2014), or plyometric training (Chaabene et al., 2019; Kale, 2016) gave improvement in sprint performance for female, athletes. Furthermore, a study reported a greater improvement in 10-meter sprinting for a group of adult men practicing repeated shuffle sprint training, compared with a similar group practicing SSG (W. B. Young et al., 2001).

The strength of this study is that it is based upon theory relating to the development of sprinting and COD. The selection of exercises organized as SSG creates a high training load in sprints and COD. The subjects are young female handball players, and no study has used this type of group in experimental research evaluating the effect of SSG on sprinting and COD. The training intervention contains both EG and CG, and there is a clear difference in their training load concerning sprinting and COD. The tests are reliable and made as similar as possible each time,

with standardized test protocols. The use of observation of many of the training sessions increases the reliability of the study.

Limitations and strengths

However, the study has several limitations. There are few subjects in the two groups (13 players in the EG group and 9 players in CG group). The statistical analysis of the effect of the training groups, would had been different with larger groups, and there is an real danger of making a type 2 failure (O'Donoghue & 2012). Furthermore, the experimental period is relatively short (7 weeks).

CONCLUSION

In conclusion, we will argue that the players in the EG achieved a high training load in COD in this intervention, which led to an improvement in COD. However, they may not get enough load on straight forward sprint to achieve improvement in sprinting ability. In the CG, the training load on sprinting and COD were lower than in the EG, and this may explain the absence of no significant change in sprinting and COD in the CG.

PRACTICAL APPLICATIONS

The practical implication of this study is that coaches who organize the training of adolescent female players would benefit from focusing on SSG and handball activities with high intensity, to improve COD in handball. This type of training will also most likely have a positive impact on important skill acquisition related to both defensive and offensive skills in the handball game, as well as a positive effect on the players' endurance and motivation. Improvement in sprinting for female adolescent handball players is probably difficult to attain with SSG or handball activities with a focus on high intensity in only a 7-week period but could be reached by a larger focus on speed exercises or plyometric training.

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Declaration of Conflicting Interests

The authors declare that they have no conflict of interest.

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