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COMPARISON OF THROWING VELOCITY BETWEEN FIRST AND SECOND OFFENSIVE LINE HANDBALL PLAYERS

PRIMERJAVA HITROSTI META ŽOGE V ROKOMETU GLEDE NA IGRALNA MESTA V NAPADU

ABSTRACT

Throwing velocity in handball gains importance as the throwing distance increases, and it is considered a key element in long distance throws to score goals. The main aims of this study were to investigate throwing performance between 1st and 2nd offensive line players from different competition level (i.e. elite, amateur and under-18) and effect of opposition upon maximal ball velocity. 94 handball players (first line: n=49; age 22.5 ± 6.1 years; height 1.85 ± 0.06 m; body mass 87.2 ± 7.5 kg and second line players: n=45; age 23.8 ± 5.3 years; height 1.81 ± 0.04 m; weight 84.1 ± 9.7 kg) were evaluated in running throws from 9 m without and with opposition. The main findings were that second line players (backs and centre backs) throw faster than first line players (wings and pivots) and that throwing performance increased from level to level (U18-amateur-elite). However, differences in maximal ball velocity was much bigger between first and second line players at U18 level than in players at amateur and elite level. In addition, Throwing with opposition always resulted in lower maximal ball velocities than throwing without opposition. It was concluded that the offensive line in handball play was determinant in specific throwing capacity, independently of the competitive level of the players and that opposition has a negative effect upon throwing velocity.

Keywords: maximal ball velocity, level, elite, running throw

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IZVLEČEK

V rokometu se pomen hitrosti meta žoge povečuje z večanjem razdalje meta in velja za ključni dejavnik uspešnega zadetka pri metih na dolge razdalje. Glavni cilj raziskave je bil preučiti uspešnost metov med napadalci na prvi in drugi liniji na različnih tekmovalnih ravneh (npr. vrhunska, amaterska in pod 18 leti) ter učinek obrambe ob maksimalni hitrosti žoge. 94 rokometista (prva linija: n = 49; starost: 22,5 ± 6,1 let; višina: 1,85 ± 0,06 m; telesna masa: 87,2 ± 7,5 kg in druga linija: n = 45; starost 23,8 ± 5,3 let; višina: 1,81 ± 0,04 m; telesna masa: 84,1 ± 9,7 kg) smo ocenjevali med metom žoge z zaletom z razdalje 9 m, z obrambo in brez nje. Glavne ugotovitve so bile, da je hitrost meta igralcev na drugi liniji (zunanji igralci in srednji zunanji igralci) večja od hitrosti igralcev na prvi liniji (krila in krožni napadalci) ter da se uspešnost metov povečuje glede na raven (U18 – amaterji – vrhunski). Vendar pa so bile razlike med maksimalno hitrostjo žoge precej večje pri igralcih na prvi in drugi liniji na ravni U18 kot pri amaterskih in vrhunskih igralcih. Poleg tega so bili pri metih ob obrambi maksimalne hitrosti žoge vedno manjše kot pri metih brez obrambe. Zaključili smo, da je napadalna linija v rokometu odločilna pri specifični sposobnosti meta ne glede na tekmovalno raven igralcev ter da obramba negativno vpliva na hitrost meta.

Ključne besede: maksimalna hitrost žoge, raven, vrhunski šport, met z zaletom

INTRODUCTION

In handball sport, throwing performance is one of the most important actions during the game (Andrade Mdos, Fleury, de Lira, Dubas, & da Silva, 2010; Ziv & Lidor, 2009). It is used to throw to each other and to score goals. Its success depends both on accuracy and velocity of the ball (Fleck, Smith, Craib, Denahan, Snow, & Mitchell, 1992; van den Tillaar & Ettema, 2003a, 2003b, 2009) to overcome the goalkeeper. Throwing velocity gains importance as the throwing distance increases, and it is considered a key element in long distance throws (Wagner & Muller, 2008). When velocity of the ball increases, less time the goalkeeper and defenders have to block the throw (Vila, Manchado, Rodriguez, Abrales, Alcaraz, & Ferragut, 2012).

Therefore, it would seem obvious that the players furthest away from the goal also called the second offensive line players (back players), should have greater throwing capacity than those who throw from nearer, the first offensive line (wing and pivot players). However, in spite of observed differences among the specific offensive positions with regard to anthropometric characteristics (Cavala, Rogulj, Srhoj, Shroj, & Katic, 2008; Chaouachi, Brughelli, Levin, Boudhina, Cronin, & Chamari, 2009; Rogulj, Srhoj, Nazor, Srhoj, & Cavala, 2005; Srhoj, Marinovic, & Rogulj, 2002), physical fitness and motor abilities (Zapartidis, Toganidis, Vareltsis, Christodoulidis, Kororos, & Skoufas, 2009; Zapartidis, Skoufas, Vareltsis, Christodoulidis, Toganidis, & Kororos, 2009) and psychological characteristics (Rogulj, Nazor, Srhoj, & Bozin, 2005), few studies have analysed the differences between first and second offensive line at different levels in throwing capacity. Zapartidis, Skoufas, Vareltsis, Christodoulidis, Toganidis, and Kororos (2009) found no differences in throwing velocity among young female handball players by playing position, except between back players and goalkeepers. The same conclusion was found for junior and senior elite female handball players, where no significant differences in throwing distance were found among players according player position with a medicine ball throwing test (Rogulj, Nazor, Srhoj, & Bozin, 2005). The fact that no significant differences throwing velocity were found in these studies could be based on several aspects. The female handball players evaluated by Zapartidis, Skoufas, Vareltsis, Christodoulidis, Toganidis, and Kororos (2009) were very young (i.e. 14.1 ± 1.0 years), they looked for differences by player position and applied only a support throwing test. Rogulj, Srhoj, Nazor, Srhoj, and Cavala (2005) used only elite female handball players and applied a medicine throwing test and compared goal keeper, back-, pivot- and wing players with each other. None of these studies compared throwing performances in male handball players between first and second line players. Information about eventual differences in throwing performances in first and second line players could help coaches and trainers in their selection of players and training regime to enhance throwing ability.

In most previous studies on handball throwing a standing throw or a throw with three preliminary steps were used to evaluate maximal throwing velocity aiming on a target without a goal keeper. (Fradet et al., 2004; Marques, Van Den Tillaar, Vescovi, & González-Badillo, 2007; Sibila & Pori, 2003; van den Tillaar & Ettema, 2006, 2009; Wagner & Muller, 2008). These could influence maximal throwing velocity and is perhaps not representative for their performance in matches. Only Gutierrez Davilla, Garcia, Parraga Montilla, and Rojas Ruiz (2006) and Rivilla-Garcia, Grande, Sampedro, and van den Tillaar (2011) studied the influence of opposition throwing performance. While Gutierrez Gutierrez Davilla, Garcia, Parraga Montilla, and Rojas Ruiz (2006) and Vila, Manchado, Rodriguez, Abrales, Alcaraz, and Ferragut (2012) did not find any effect of opposition in experienced handball players, Rivilla-Garcia, Grande, Sampedro, and van den Tillaar (2011) found that with increasing opposition (goal keeper and defence player) ball velocity

decreased. Furthermore, that playing level did not have an extra effect on this decrease. However, in that study (Rivilla-Garcia, Grande, Sampedro, & van den Tillaar, 2011) no difference was made between first and second line players, while these have, besides their different anthropometrics, also different throwing tasks during a match. Second line players shoot more from a longer distance to the goal than first line players (Michalsik, Aagaard, & Madsen, 2015; Michalsik, Madsen, & Aagaard, 2015). Thereby, probably throwing velocity is of more important for them to be able to score a goal than first line players.

Therefore the aim of this study was 1) to compare throwing velocity among the first and second offensive line players and the effect of playing level (elite, amateur and under-18). 2) to compare if using opposition (goal keeper) had an effect on the maximal ball velocity. It was hypothesized that the second line players would throw further and faster than the first line players due to the fact that backs execute the largest number of throws and from longer distance during competition games (Ohnjec, Vuleta, Milanović, & Gruić, 2008) and are by far the tallest players with the largest arm span (Chaouachi, Brughelli, Levin, Boudhina, Cronin, & Chamari, 2009). Furthermore, it was expected that the level of experience does influence the throwing performance, but the difference between the line players would be the same (Rivilla-Garcia, Grande, Sampedro, & van den Tillaar, 2011).

METHODS

Participants

A total of 94 male handball players (excluding goalkeepers) from seven handball teams who were classified into two groups according to playing position: first line ($n = 49$; age 22.5 ± 6.1 years; height 1.85 ± 0.06 m; body mass 87.2 ± 7.5 kg) and second line players ($n = 45$; age 23.8 ± 5.3 years; height 1.81 ± 0.04 m; weight 84.1 ± 9.7 kg) participated in this study. A closer look at the specific playing positions reveals that the second offensive line was composed of 28 backs and 21 center backs. First offensive line players consisted of 23 pivots and 22 wing players. When divided the same group by competition level, players were classified into 3 categories: 13 elite players (age 28.2 ± 3.11 years; height 1.96 ± 0.05 m; body mass 92.2 ± 10.7 kg; 18.2 ± 3.5 years training experience), 30 amateur players (age 23.5 ± 3.1 years; height 1.85 ± 0.06 m; body mass 89.1 ± 7.1 kg; 15.9 ± 4.8 years training experience) and 51 U-18 players (age 17.4 ± 1.2 years; height 1.74 ± 0.08 m; body mass 74.9 ± 9.3 kg; 10.0 ± 3.1 years training experience). The elite players were a clear example of the highest international level in handball for two reasons: 1) it had been champion at the highest national and international level (Champions League), and 2) during the present study all the members of the team were also members of their national teams. In contrast the amateur players belonged to senior (over 18 years) non-professional teams (2nd and 3rd Spanish National Division) and the U-18 players played at the highest division of their age group (Juvenile Division).

Before the study, all the players underwent a physical examination by the team physician and each player was cleared of any medication or endocrine disorders that might confound or limit their ability to participate fully in the investigation. The players participated voluntarily and gave a written informed consent. Parents or guardians in the case of the participants U-18, were fully informed about the procedure to be followed as well as the potential risks, and signed a consent form to participate in the study. The study was designed in compliance with the recommendations for clinical research of the Declaration of Helsinki 2008 of the World Medical Association and reviewed and approved by the University ethics committee.

Procedure

Firstly a general, non-standardized warm-up lasted about 15 m, included low-intensity running and stretching exercises performed followed by a specific warm-up included several acceleration runs, specific moves, practice of specific steps before the throw, specific shoulder flexibility exercises, as well as throws using different sized balls of different weights. Before the tests the subjects were familiarized with the testing protocol, practicing each test several times. The test session lasted about 90 min, including the warm-up and cooling down.

After the warm-up ball velocity was measured during running throws with three preliminary steps with and without opposition of a goal keeper. The participants had to throw as fast as possible, without taking more than three steps or crossing the 9 m line. To simulate real game action and have good grip resin was allowed to be used on the hands in all four conditions. To ensure that the test environment remained constant and reduce interference, all participants were tested at the same location and performed the tests in the same order. The members of each team were tested during the same session. Instructions were given for the throws to be accurate according to the criterion of goalkeeper's intervention difficulty. In both conditions the throws had to be aimed at the corners of the goal, the areas farthest from the goalkeeper, who was located on a line parallel to the goal at a distance of 0.5 m. The goal keeper was allowed to move along a drawn line (0.5 m in front of the goal), in the foreground only, and his movements were restricted to the frontal plane. The performance of the thrower and the goalkeepers was controlled by two observers using digital video camera, placed at a point on the side, and by the coaches who supervised the throwing technique.

For each condition, each participant performed attempts until three correct throws were recorded. Verbal encouragement was provided at each test. The average of last two correct attempts in each condition was calculated and taken for further analysis.

Measurements

All players were tested at the same indoor handball court to ensure that the temperature and humidity test environment remained constant. An official handball ball (480g, 58cm circumference) was used for the throwing tests with and without opposition. Maximal ball velocity was determined using a Doppler radar gun (Stalker Pro, Applied Concepts Inc., Plano, Texas), with ± 0.028 m/s accuracy within a field of 10 degrees from the gun. The radar gun was located at 15 from the goal behind the participant at ball height during the throw (Figure 1).

Statistical analysis

To assess the effects of first and second line players and playing levels on ball velocity a multivariate analysis of variance (MANOVA) (Offensive Line [2] x Competition Level [3]) was performed on both conditions (with and without goal keeper) and anthropometrics. Due to different sample size of the groups, Gabriel's post Hoc test was performed. In addition a One-way ANOVA with repeated measures between maximal ball velocity with and without opposition was performed. All results are presented as means \pm standard deviations and effect size was evaluated with (Eta partial squared) where $0.01 < \eta^2 < 0.06$ constitutes a small effect, a medium effect when $0.06 < \eta^2 < 0.14$ and a large effect when $\eta^2 > 0.14$ (Cohen, 1988). Intra-session reliability of maximal ball velocity with and without opposition on the different levels was tested by using Crombachs' Alpha. The ICC of maximal ball velocity was 0.93. Statistical analysis was performed using SPSS 22.0 for Windows (SPSS, inc., Chicago, IL).

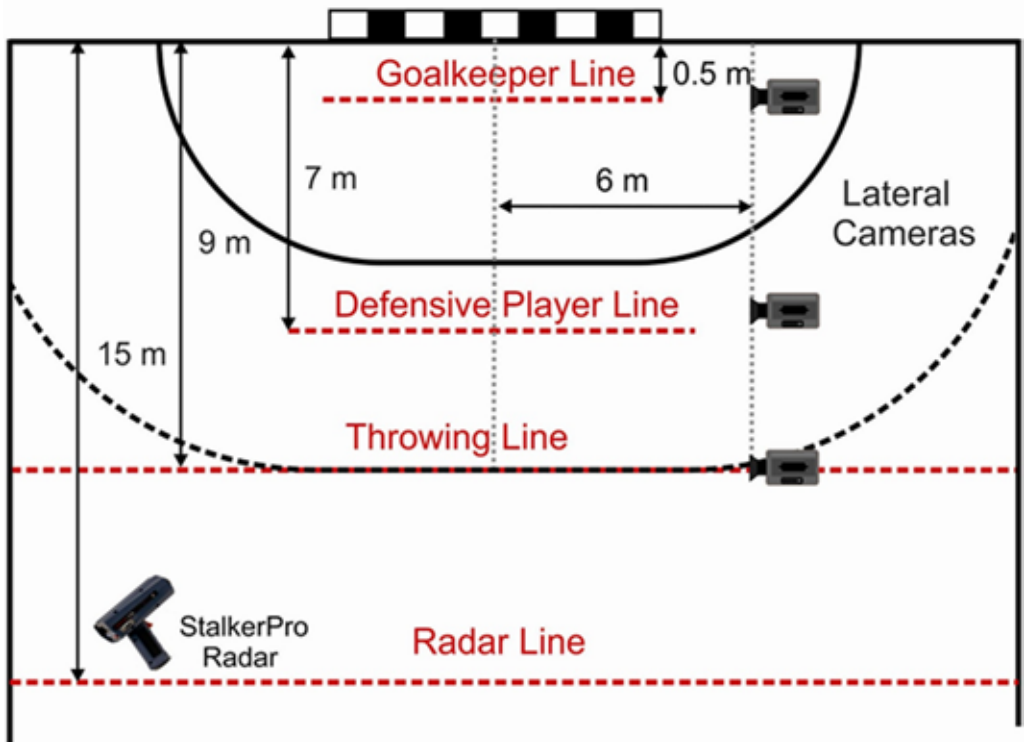


Figure 1. Schematic representation of the experimental set up.

RESULTS

There were no significant differences found between first and second line players in weight ($F = 0.83, p = 0.36, \eta^2 = 0.009$) and height ($F = 2.5, p = 0.12, \eta^2 = 0.03$). However, playing level had a significant effect upon weight ($F = 82.1, p = 0.001, \eta^2 = 0.65$) and height ($F = 82.2, p < 0.001, \eta^2 = 0.65$) i.e. height increased significantly for each playing level, while weight was only significantly lower for the U18 players compared to the other two groups (table 1).

Table 1. Anthropometrics of the first and second line players at the different levels

Level	Weight		Height	
	First line	Second line	First line	Second line
Elite	91.8±7.5	93.1±5.3	1.95±0.05	1.96±0.04
Amateur	87.8±4.9	90.2±6.1	1.84±0.06	1.88±0.05
Under 18	74.5±6.0	74.7±5.8	1.74±0.06	1.75±0.07

In both throwing tests an effect of playing position line ($F \geq 41.4, p < 0.001, \eta^2 \geq 0.32$, figure 2) and playing level ($F \geq 40.5, p < 0.001, \eta^2 \geq 0.48$, figure 3) was found. Post hoc comparison showed that second line players threw faster than first line players at every level for the throws with opposition, while without opposition the same was observed, but at elite level the difference did not reach the level of significance ($p=0.078$). Maximal ball velocity increased from level to level

(U18-amateur-elite, figure 3) in both conditions. However, for throwing without opposition a significant interaction (playing level-position line) effect was found ($F = 3.3$, $p = 0.043$, $\eta^2 = 0.07$) i.e. differences in maximal ball velocity was much bigger between first and second line players at U18 level than in players at amateur and elite level (Figure 3). Maximal ball velocity was always higher when throwing without opposition compared with opposition ($F = 62.0$, $p < 0.001$, $\eta^2 = 0.40$, figure 2).

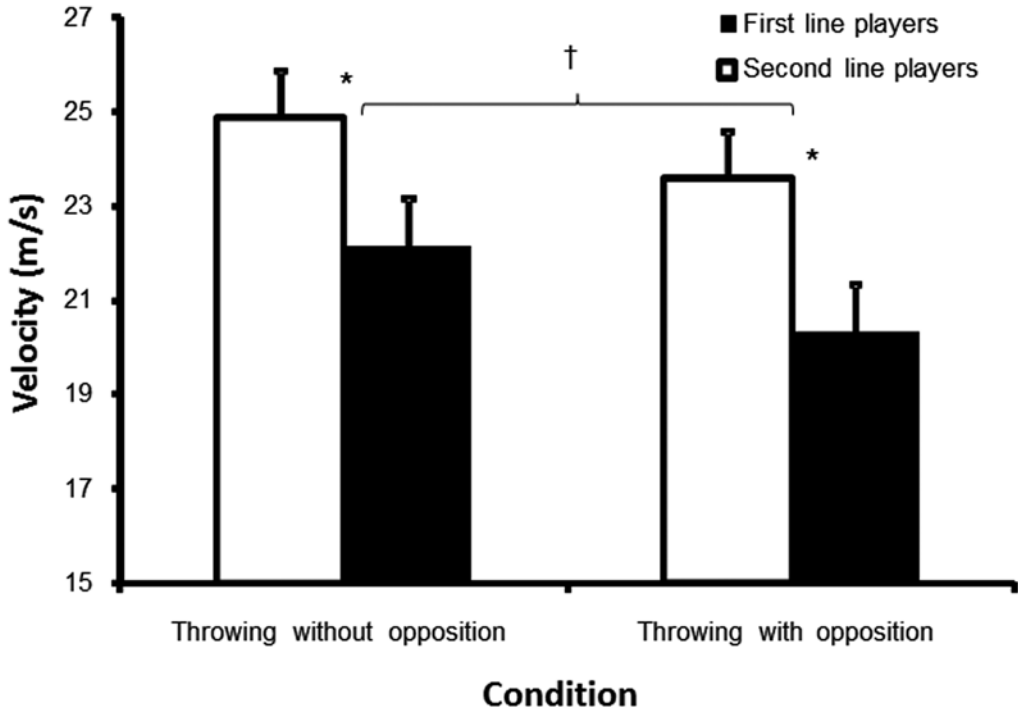


Figure 2. Maximal ball velocity (SD) of first and second line players in throwing with and without opposition.

† indicates a significant difference between these two throwing tests

* indicates a significant difference between these two playing positions on a $p < 0.05$ level.

DISCUSSION

The main aim of this study was to investigate throwing performances between 1st and 2nd offensive line players. Furthermore, to investigate if level of experience does influence throwing performance between the players from the different offensive lines in throws with and without opposition. The main findings were that second line players (backs and centre backs) throw faster than first line players (wings and pivots) and that throwing performance increased from level to level (U18-amateur-elite). However, differences in maximal ball velocity was much bigger between first and second line players at U18 level than in players at amateur and elite level (Figure 3). In addition, Throwing with opposition always resulted in lower maximal ball velocities than throwing without opposition.

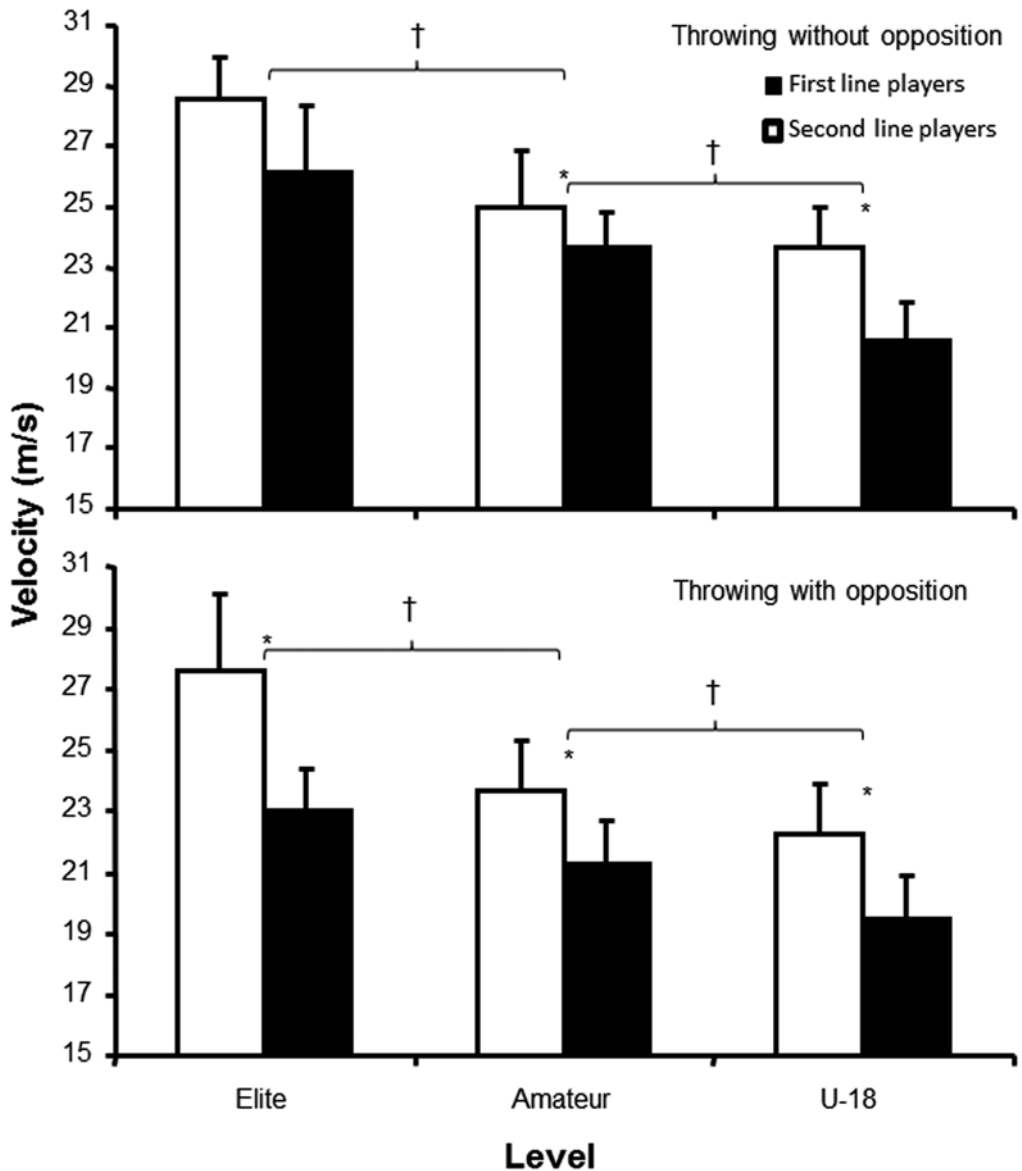


Figure 3. Maximal ball velocity (SD) of first and second line players per playing level (Elite, amateur and U18) in throwing with and without opposition.

† indicates a significant difference between these two competition levelled groups.

* indicates a significant difference between these two playing positions on a $p < 0.05$ level.

Differences in throwing performances between the players from the two offensive lines can be explained by the fact that 2nd line players throw more during games than 1st line players do (Ohnjec, Vuleta, Milanović, & Gruić, 2008) and therefore have had more opportunity to optimize their throwing technique for longer distances. Repetition of a skill leads generally to

improvement and optimization of its technique aspect that favors better execution of the throw by the 2nd line players. van den Tillaar and Ettema (2004) found height had a positive influence upon the maximal ball velocity. In the present study it was also found that height had a positive correlation with maximal ball velocity ($r=0.66$). However, no differences in height were found in 1st and 2nd line players (table 1). Our results contradict with earlier studies (Rogulj, Srhoj, Nazor, Srhoj, & Cavala, 2005; Zapartidis, Toganidis, Vareltzis, Christodoulidis, Kororos, & Skoufas, 2009) who found no significant differences in throwing velocity among field players by playing position. The mean reason for this difference could be the participant's characteristics of these studies. Zapartidis, Toganidis, Vareltzis, Christodoulidis, Kororos, and Skoufas (2009) and Rogulj, Srhoj, Nazor, Srhoj, and Cavala (2005) tested female players, while in our study males were investigated. In addition, Zapartidis, Toganidis, Vareltzis, Christodoulidis, Kororos, and Skoufas (2009) analysed 14 year old handball players who threw a standing throw (7 m throw), which could influence the results. In the study of Rogulj, Srhoj, Nazor, Srhoj, and Cavala (2005) throwing ability between the different positions was evaluated with a medicine ball test. In that study the weight they threw with and with what kind of technique was not known.

When analyzing the level of experience a reduction of difference between the two offensive lines in the maximal ball velocity was found (U-18, amateur and elite) i.e. 1st and 2nd line players showed significant differences in all tests with U-18 handball players while elite players only showed significant differences in velocity throwing test with opposition (Figure 3). This difference can be explained by the fact that 2nd line players throw more in a match than 1st line players (Michalsik, Aagaard, & Madsen, 2015; Michalsik, Madsen, & Aagaard, 2015). Furthermore, the test was a running throw from 9 m distance straight forwards with three preliminary steps, which was similar to what many 2nd line player perform during a match, while 1st line players shoot more with a jump shot from other angles or from the 6 m line (Michalsik, Aagaard, & Madsen, 2015; Michalsik, Madsen, & Aagaard, 2015). By training experience differences between the two offensive line decreases as shown in the present study, while throwing performance increases in general with experience (Gorostiaga, Granados, Ibáñez, & Izquierdo, 2005) as expected (elite players performed better than amateur and U-18 players). A possible explanation for the reduction between 1st and 2nd offensive line players at elite level is that at this level probably both groups perform the same number of throws during training and their throwing ability is optimized due to training experience. Therefore, when growth and maturation process ends and handball players increase the training volume strength characteristics and throwing capacity could be more similar besides eventual anthropometrical differences but longitudinal studies must be performed to investigate this statement.

A decrease in throwing velocity was found when throwing with a goal keeper as opposition compared to throwing without opposition. This was in accordance to earlier studies in water polo (Vila, Ferragut, Argudo, Abalades, Rodriguez, & Alacid, 2009) and handball (Rivilla-Garcia, Grande, Sampedro, & van den Tillaar, 2011) that also found that with opposition of a goal keeper maximal ball velocity decreases. The findings of the decreased maximal ball velocity with opposition can be partly explained, as Rivilla-Garcia, Grande, Sampedro, and van den Tillaar (2011), by the speed-accuracy trade-off (Fitts, 1954). It states that there exists a trade-off between the accuracy and speed at which a task is performed. In handball van den Tillaar and Ettema (2003a, 2003b, 2006, 2009) observed that when accuracy is more important, maximal ball velocity decreases, which was also the case in our study. The presence of a goalkeeper increases the number of visual stimuli (position goal keeper) that have to be processed. This causes rivalry

among the task (velocity or/and accuracy) at the cognitive level to achieve the order in which they are processed and used to control behaviour (Desimone & Duncan, 1995). Thereby, giving attention to one task (accuracy) leaves less available for others (Desimone & Duncan, 1995; Fitts, 1954). Thus in the case of throwing with a goal keeper, accuracy could be prioritized resulting in a decrease in attention to achieve maximum ball velocity. The position and movements of the goalkeeper can also result in an adaptation of the throwing movement e.g. to throw more to a one corner you have to change your throwing technique (change the movement of the trunk and throwing arm). Probably adjusting the throw to the opposition may change the throwing kinematic pattern and could consequently change maximal ball velocity (Wagner, Buchecker, von Duvillard, & Muller, 2010). However, no kinematic analyses of the used throwing techniques under both condition were performed that could underline this statement. This is a limitation of the present study is that we only measured ball velocity and no kinematic variables. Detailed 3D kinematic analysis of throwing with opposition compared with throws without opposition should be conducted to get a better understanding of eventual changes in the execution of the throw under these conditions.

CONCLUSION

The present findings indicated that second line players (backs and centre backs) throw faster than first line players (wings and pivots) independently of the competitive level of the players. Differences in maximal ball velocity was probably caused by the experimental set up in which was thrown from 9 m distance. Second line players have had more opportunity to optimize their throwing technique for these longer distances due to their position on the field during matches compared with the first line players that mainly shoot from shorter distances. Furthermore, opposition had a negative influence on maximal ball velocity indicating that an increase of tasks (including more accuracy to score) probably influences throwing kinematics and thereby maximal ball velocity. A detailed 3D kinematic analysis of throwing with opposition compared with throws without opposition should be conducted to get a better understanding of eventual changes in the execution of the throw under these conditions.

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