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## EFFECT OF OPPOSITION AND EFFECTIVENESS OF THROWING FROM FIRST AND SECOND LINE IN MALE ELITE HANDBALL DURING COMPETITION

## UČINEK OBRAMBE IN UČINKOVITOST META VRHUNSKIH ROKOMETAŠEV S PRVE IN DRUGE OBRAMBNE ČRTE MED TEKMOVANJEM

### ABSTRACT

The goalkeeper and defensive player's degree of opposition could influence throwing velocity and thereby success of scoring goals. Therefore, the aim of this study was to investigate the influence of opposition and contact on throwing velocity and effectiveness in elite team handball players from first and second offensive lines. Throwing velocity from 2893 throws carried out in 47 matches during the Men's World Handball Championship were analysed. A higher throwing velocity was obtained with opposition and no contact situations. In the comparison between the first and second offensive line players, the same results were obtained in relation to the higher throw speed. Significant relationships were found between the attack effectiveness and the type of opposition and contact. Throws carried out with no opposition either with or without contact are those that more likely end in a goal, while opposition without and with contact decreases the effectiveness in scoring goals. Concerning playing positions, both first and second line showed this significant relationship between attack effectiveness and the type of opposition and contact. It was concluded that opposition and defensive contact have a negative and significant effect on the scoring efficacy. Defensive contact is a determining factor causing a significant decrease on throwing velocity.

*Key Words:* shot, throwing speed, accuracy, high level, championship.

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### UVODNIK

Stopnja obrambe vratarja in obrambnega igralca lahko vpliva na hitrost meta ter s tem na uspešnost zadetkov. Cilj te raziskave je bil preučiti vpliv obrambe in telesnega kontakta na hitrost meta ter učinkovitost vrhunskih rokometišev na prvi in drugi obrambni črti. Analizirali smo hitrost 2893 rokometnih metov, izvedenih na 47 tekmah med moškim svetovnim rokometnim prvenstvom. Višja hitrost meta je bila dosežena ob obrambi in brez kontakta. Primerjava igralcev na prvi in drugi obrambni črti je pokazala enake rezultate pri višji hitrosti meta. Statistično značilni odnosi so bili ugotovljeni med učinkovitostjo napada ter vrsto obrambe in kontakta. Meti, ki so bili izvedeni brez obrambe, bodisi s kontaktom ali brez, so se najpogosteje zaključili z zadetkom, obramba s kontaktom in brez njega pa je zmanjšala učinkovitost doseganja zadetkov. Glede na igralna mesta se je tako na prvi kot na drugi obrambni črti pokazal značilen odnos med učinkovitostjo napada ter vrsto obrambe in kontakta. Zaključili smo, da imata obramba in obrambni kontakt negativen in značilen učinek na uspešnost doseganja zadetkov. Obrambni kontakt je odločilen dejavnik, ki povzroči značilno zmanjšanje hitrosti meta.

*Ključne besede:* strel, hitrost meta, natančnost, visoka raven, prvenstvo

## INTRODUCTION

In many team sports such as handball, cricket, baseball, or water polo, throwing is one of the most determining actions to win or lose a game (Andrade, Fleury, de Lira, Dubas, & da Silva, 2010; Gorostiaga, Granados, Ibanez, & Izquierdo, 2005; Ziv & Lidor, 2009). Its efficacy depends on several factors, such as throwing velocity (Bayios & Boudolos, 1998; Gorostiaga et al., 2005; Marques, van den Tillaar, Vescovi, & Gonzalez-Badillo, 2007; Sibila & Pori, 2003; van den Tillaar & Ettema, 2003a, 2003b; Wagner, Buchecker, von Duvillard, & Muller, 2010) and accuracy (Bayios & Boudolos, 1998; van den Tillaar & Ettema, 2003a, 2003b; van den Tillaar & Ettema, 2004; van den Tillaar & Ettema, 2006; Roland van den Tillaar & Gertjan Ettema, 2009), because the greater velocity and accuracy in a throw, the less time for the goalkeeper or the defender to save or block the ball.

Most of the previous research concerning throwing velocity are related to throwing technique, the timing of the consecutive actions of body segments, and upper and lower-extremity muscle strength and power (Joris, van Muyen, van Ingen Schenau, & Kemper, 1985; van den Tillaar & Ettema, 2003b, 2006; Roland van den Tillaar & Gertjan Ettema, 2009; R. van den Tillaar & G. Ettema, 2009; van den Tillaar, Zondag, & Cabri, 2013; van Muijen, Joris, Kemper, & van Ingen Schenau, 1991). In fact, many studies analyzed the influence of technique on the throwing velocity (Fradet et al., 2004; Gorostiaga et al., 2005; Pori, Bon, & Šibila, 2005; Sibila & Pori, 2003; van den Tillaar & Ettema, 2003b, 2006; Roland van den Tillaar & Gertjan Ettema, 2009; R. van den Tillaar & G. Ettema, 2009; Wagner & Muller, 2008). However, these studies were performed without any opposition and no contact (Fradet et al., 2004; van den Tillaar & Ettema, 2003a, 2007; Wagner & Muller, 2008), which could influence maximal throwing velocity and its efficacy.

According to Párraga, Sánchez, and Oña (2001), the perception and decision making based on the external stimuli is what determines throwing velocity; that is, the position of the goalkeeper, the type of throw, the shooting angles and the position of the defenders influences in important ways in the throwing velocity. Wagner et al. (2010) showed that team handball players use different throwing techniques when defensive players are involved and select the direction of the ball according to the movements of the goalkeeper. Furthermore, decrease in throwing velocity was observed when the degree of opposition increased by goalkeeper and defensive players (Rivilla-Garcia, Grande, Sampetro, & Van Den Tillaar, 2011). In addition, Rivilla-Garcia, Calvo, and Van den Tillaar (2016) found that the second line players (backs and centre backs) threw faster than the first line players (wings and pivots), and that opposition slowed throwing velocity. For this reason, team handball players routinely practice throws with different degrees of opposition and defensive contact. According to this, the velocity-accuracy trade-off suggests that, when focusing on accuracy, velocity would decrease (Fitts, 1954). However, none of these studies has been made in a real competition, so their results could be different if the analysis was made in that situation.

Therefore, the aim of this study was two-fold: firstly, to investigate the influence of opposition and contact on effectiveness and throwing velocity in elite handball players during competition. Secondly, to know if opposition and contact have the same effect upon throwing performance between players from the first and second line. It was hypothesized that the opposition and contact would result in a decrease of maximal throwing velocity and that first lines throw better without opposition.

## MATERIALS AND METHODS

### Subjects

The 2013 Men's World Handball Championship held in Spain was chosen for analysis. During the championship, throwing velocity from 3211 throws out of the 5016 analysed were registered. To that effect, 47 out of the 76 matches played during the championship were observed: 31 during the group stage, eight during the qualifying round of 16, four in the quarter-finals, and four in the semi-finals and final. The study was carried out according to the Declaration of Helsinki.

### Procedures

The matches were recorded with two cameras positioned in a perpendicular area to the handball court. Each camera was focused to half field and recorded the match. In situ, two qualified observers per match gathered twelve variables regarding throwing using an observation tool. These variables were: playing time, first or second half, player who carries out the throw, zone of the playing field from where the shot is performed, distance, type (jump-, standing- or running shot), trajectory, opposition, contact and effectiveness, accuracy (where the ball hit the goal), attack phase, opposition degree and contact degree. For the purpose of this study only the variables: playing position, effectiveness and variables related to opposition and contact were taken for further analysis. The variable opposition had two levels: 1. Throwing with opposition, defined as an "action of throwing in which at least one defender player is interposed between the offensive player who has the ball and the goal." 2. Throwing without opposition was defined as an "action of throwing in which no defender player is interposed between the offensive player who has the ball and the goal." The variable contact also had two levels: 1. Throwing with contact, defined as an "action of throwing in which at least one defender touches the offensive player who has the ball." 2. Throwing without contact, defined as an "action of throwing in which no defender touches the offensive player who has the ball." All the observers were trained on collecting these data in the four weeks preceding the championship matches.

At the same time, throwing velocity was assessed using a radar gun (StalkerPro Inc., Plano, TX, USA) with 100 Hz recording frequency and 0.045 m/sec-1 sensitivity, placed behind the goal post. The radar was placed at a distance of 3 meters, at a height of 1.20 meters. Two observers carried out this task: one of them recorded throwing velocity; the other one registered the player who executed the throw.

Once the championship ended, the analysed matches were downloaded and viewed again in order to correct the possible mistakes that may have arisen while registering data in situ. The collected data were codified and registered on an Excel data entry form. Afterwards, the data were filtered, and a new variable was calculated from opposition and contact variables. The new variable was called opposition-contact and had four levels: 1. Throwing without opposition and without contact; 2. Throwing without opposition and with contact; 3. Throwing with opposition and with contact; 4. Throwing with opposition and without contact. The variable effectiveness had two levels: 1. Goal; 2. No Goal. The variable offensive lines had two levels: 1. First offensive line players, made up of the pivots and wing players; 2. Second offensive line players, made up of the backs and centre backs.

## STATISTICAL ANALYSIS

The reliability of the observation of the matches assessing the intra-observer concordance was studied using Cohen's Kappa index (Cohen, 1988). The interpretation of the agreement degree proposed by (Landis & Koch, 1977) was valued very positively.

Statistical analysis was carried out using SPSS software (version 22). A descriptive analysis of the variables throwing velocity, effectiveness and contact-opposition were made with all the players together and also by first and second offensive line players. The Kolgomorov-Smirnov test was used to check normality and homogeneity. The analysis showed that throwing velocity was a non-parametric variable. Subsequently, the Kruskal-Wallis test was used to identify differences in throwing velocity regarding contact-opposition. Significant interaction was further investigated using the Man-Whitney test. Effect size ( ) was calculated for each pair of groups, considering small ( $r=.10$ ), medium ( $r=.30$ ) and large ( $r=.50$ ) effects (Cohen, 1988).

In order to check the relationships between effectiveness and opposition-contact, a crosstab and, subsequently, a Chi-squared test were performed. Cramer's V ( was calculated to measure the strength of the relationship considering small ( $r=.10$ ), medium ( $r=.30$ ) and large ( $r=.50$ ) effects (Cohen, 1988). The  $p \leq 0.05$  criterion was used to establish statistical significance.

## RESULTS

The Kruskal-Wallis test showed significant differences in throwing velocity according to the opposition-contact type ( $p < 0.0001$ ). Post hoc comparisons revealed that the highest throwing velocity was obtained with opposition and no contact situation compared with the other three situations ( $z \leq -15.07$ ,  $p < 0.001$ ,  $r \geq 0.36$ ), while throwing velocity was the lowest when there was contact with no opposition compared to the other three situations ( $z \leq -4.94$ ,  $p < 0.001$ ,  $r \geq 0.18$ , Figure 1).

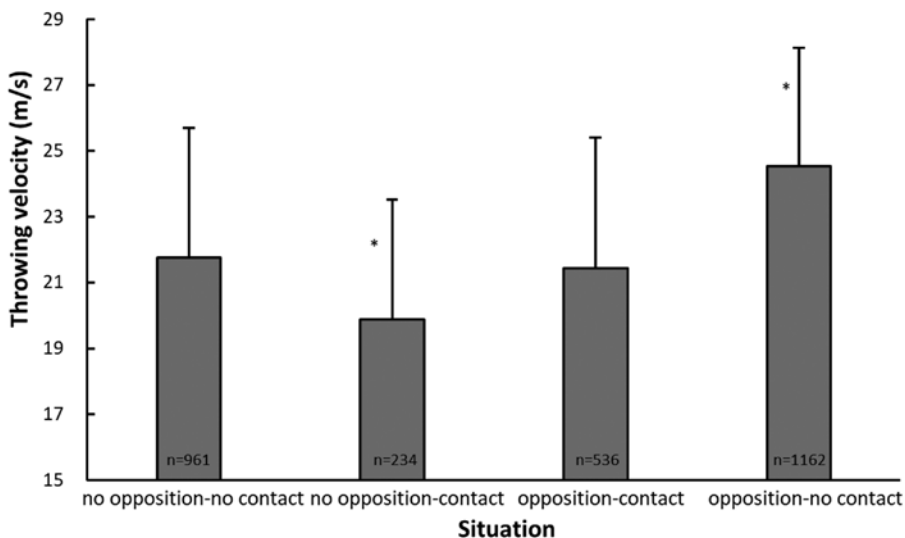


Figure 1. Throwing velocity ( $\pm$ SD) with different types of opposition-contact.

\* indicates a significant difference with all other situations on a  $p < 0.001$  level.

When the throws were divided by position (first and second line players), it was found that second line players threw faster than first line players ( $23.19 \pm 4.12$  vs  $22.11 \pm 4.10$  m/s;  $z \leq -2.43$ ;  $p \leq 0.015$ ;  $r \geq 0.10$ ) in each of the situations (Figure 2). Furthermore, it was found that first line players threw in percentage most throws with no opposition and no contact (39%), while the second line players threw in percentage most throws (43%) in situations with opposition and without contact (Figure 2).

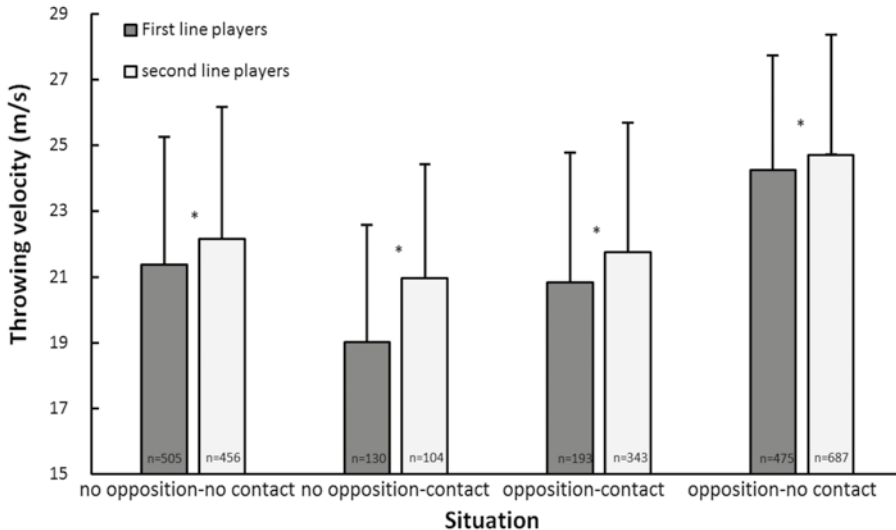


Figure 2. Throwing velocity ( $\pm$ SD) with different types of opposition-contact averaged for first and second line players.

\* indicates a significant difference in velocity between first and second line players on a  $p < 0.001$  level.

Significant relationships were found between the attack effectiveness and the type of opposition-contact ( $\chi^2(3) = 509.39$ ,  $p < 0.001$ ,  $V = 0.32$ ). Regarding throwing effectiveness, we can observe that throws without opposition, both the ones carried out with and without contact, are more effective than throws with opposition in all cases (opposition with and without contact). The most effective throws are those that are executed both without opposition and without contact, and the less effective throws are the ones executed with opposition and with contact (Figure 3).

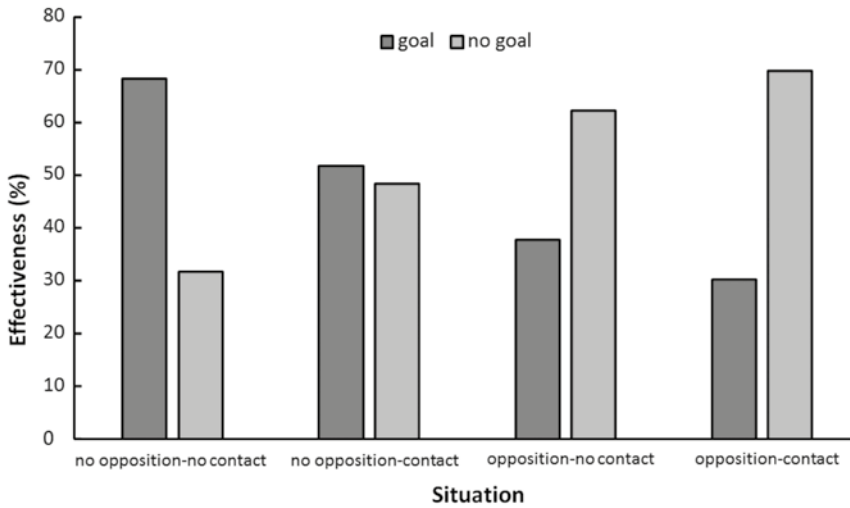


Figure 3. Effectiveness (goal-no goal) of throwing related to opposition-contact during 2013 Men’s World Handball Championship.

When effectiveness was divided by position (first and second line players) in three of the four situations, effectiveness was the same between the two lines. Only second line players had a significantly higher effectiveness ( $\chi^2(2) = 6.7; p=0.01; V= 0.07$ ) in situations involving opposition and no contact than the first line players (Figure 4). It was found that second line players threw faster than first line players. Furthermore, it was found that first line players are more effective when they throw with opposition and contact than when they do it with opposition and without contact. On the contrary, second line players were more effective when they threw with opposition and without contact than when they did it with opposition and with contact.

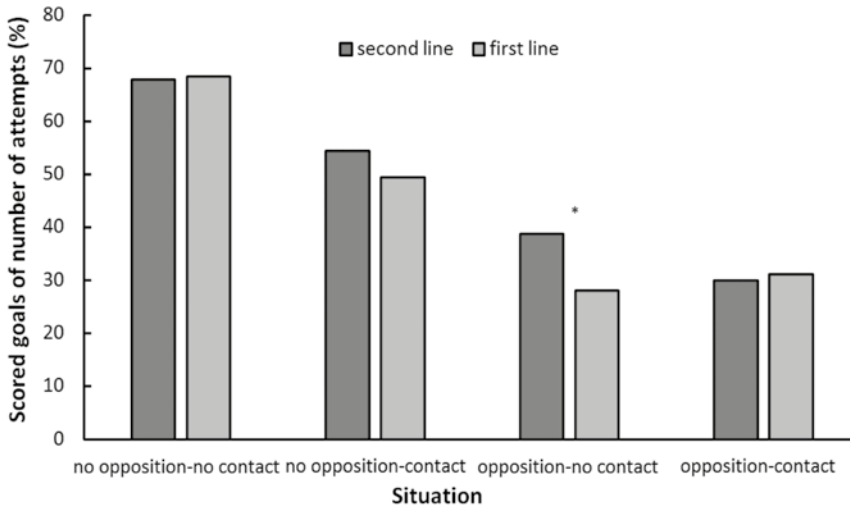


Figure 4. Percentage of scored goal of total number of attempts in the four different situations specified for first and second line players.

\* indicates a significant difference between first and second line players on a  $p<0.05$  level.

## DISCUSSION

The main goal of this study was to investigate the influence of opposition and contact on throwing velocity and effectiveness in elite team handball players in competition at world championship, and if the influence was the same for the first and second line players. The main findings were that both opposition and contact have a decisive influence on effectiveness but throwing velocity did not follow the same pattern of decrease when opposition and contact is involved during the throws of first and second line players.

Throwing velocity did not follow the hypothesis and findings of earlier studies in which opposition had a negative effect upon throwing velocity (Gutiérrez, García, Párraga, & Rojas, 2006; Rivilla-Garcia et al., 2016; Rivilla-Garcia et al., 2011). This discrepancy can be explained by the fact that in the previous studies these measurements were not done during matches and the defensive contact was not taken into account; these results should not become widespread to competition. In the present study, the lowest ball velocities were found in situations of no opposition with contact, while the highest ball velocities were reached in situations with opposition and no contact. The fact that the highest throwing velocities were reached with opposition and no contact could be explained because players try to throw fast to avoid contact or blocking by defenders. Also, in the presence of opposition there was more distance to the goal and the player threw faster to try and beat the goalkeeper (Michalsik, Madsen, & Aagaard, 2015; Vila et al., 2012). In these types of throw, players have the time necessary to use throws with a circular wind-up, which can produce higher ball velocities than whip-like wind-ups (van den Tillaar, 2016; van den Tillaar et al., 2013). When players are in contact with defence, the whip-like wind-up is often used as seen in the pivot throw, which results in lower ball velocities than the jump shot or set shot with run-up (Wagner, Pfusterschmied, von Duvillard, & Muller, 2011).

The strategy used in throwing velocity seems to be the same for both first and second line players. The fact that second line players throw faster than first line players may be due to the condition that second line players are normally taller and have greater wingspan than first line players (Fieseler et al., 2017) which results in longer levers that can produce faster throws as shown by van den Tillaar and Cabri (2012). Furthermore, second line players train more to throw from longer distances (Rivilla-Garcia et al., 2016), since their throws are usually made in opposition and from the 9-meter line with the possibility to use the circular wind-up (Wagner & Muller, 2008). On the contrary, first line players throw more often from shorter distances, with a whip-like wind-up and with more focus on accuracy since the angle shot in the goal is smaller, especially for shots from the wing positions.

The reason why throwing velocity was lower when throwing without opposition and no contact might be due to the fact that players, being in a very good situation to carry out the throw, like when a player is alone in front of the goalkeeper in a fast break, could focus their attention on where to throw the ball in the goal. By focusing on accuracy, throwing velocity is affected negatively (Rivilla-Garcia et al., 2011; van den Tillaar & Ettema, 2003a, 2003b). This was shown by the higher number of scored goals in this situation compared to the other situations.

Indeed, in situations without opposition or contact, players scored almost 7 goals out of 10 throws. Additionally, when the throws were done with opposition and contact, efficiency was 3 goals out of 10 throws. It seems that opposition is a more determinant factor than defensive contact. Throws with opposition are probably executed from a greater distance (9-meters). This gives

the goalkeeper more time to try to stop the ball. Even when throwing velocity is lower without opposition and contact, but from 6-m (21.4 vs. 24.8 m/s), the time for a goalkeeper to react is still longer than when throwing from 9-m (0.37 s vs. 0.28 s), thereby the effectiveness decreases.

Only one significant difference in effectiveness between the two lines of players was found in the actions with opposition and no contact. This is understandable since second line players throw most of the time with opposition without contact in matches (43%) compared to the first line players who throw most of the time (38%) without opposition and contact. Thereby, second line players have more experience in these situations, which results in a higher scoring rate.

In this sense, a line of research is opened in which the relationship speed-precision must be approached from the different situations that occur during the real game. These results emphasize the need to work during training situations with opposition, with contact and without contact, and, perhaps, minimizing the accent on the gain of throwing speed, since both situations register the highest speeds during the competition. Therefore, the results of this study confirm an important role of opposition and defensive contact in throwing performance. For this reason, the training of the throw with defence situations should be focused on both factors in order to increase the performance. On the other hand, the throw execution could improve if the coaches used training situations that included defensive contact or opposition.

As a conclusion, in handball matches at the highest level both opposition and contact have a decisive influence on the effectiveness but throwing velocity does not follow the same pattern of decrease when opposition and contact was involved during the throws. Throwing velocity is higher for second line players in every situation compared with first line players. Effectiveness is similar for both line positions for three of the four situations. Only in the situation of opposition without contact, effectiveness is greater for second line players, which is probably caused by throwing experiences in these situations in matches.

Considering that efficiency is much higher when there is no opposition and no contact, players must seek situations of throw with no opposition and no contact. Given that both the opposition and the contact largely determine the effectiveness of goal and taking into account the large number of shots that take place in these conditions, coaches must train the throw in conditions where both factors are present, either together or separately. Since defensive contact is a highly determinant factor in throwing velocity, it is strongly recommended that coaches and physical trainers use exercises with the aim of improving throwing velocity with defensive contact.

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