DIFFERENCES IN THROWING CAPACITY BETWEEN SENIOR AND U-18 MEN HANDBALL PLAYERS

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Abstract

The purpose of this investigation was to analyze the differences in general and specific throwing capacity of handball players as a function of the age category. Differences between throwing velocity to goal without and with opposition have also been addressed. Ninety four handball senior and U-18 players were assessed in four different situations of throwing: 1) heavy medicine ball throw, 2) light medicine ball throw, 3) throwing velocity without opposition and 4) throwing velocity with opposition. Senior players were found to perform far better than the U-18 players in all four throwing situations (p<0.001; t₁=6.958; t₂=8.244; t₃=8.059; t₄=5.399; df=92). Throwing velocity was higher without than with opposition for both groups; the throwing velocity of the senior group was 7.79% lower (p<0.01; t=8.317; df=47) when there was opposition, whereas U-18 players’ velocity lowered by 6.03% (p<0.01; t=4.469; df=45). The results suggest that age can be a determining factor in handball players’ throwing capacity, both general and specific. Likewise, the presence and interference of a goalkeeper appears to affect throwing velocity in a negative way, especially in senior players.

Key words: Medicine ball throw, throwing velocity, opposition, handball

INTRODUCTION

Handball is an Olympic sport which requires a high level of physical fitness necessary for the relevant activities of the game, such as jumping, diving, blocking, sprint running and throwing. Among these, throwing capacity has been highlighted as the key to success [9]. It has been estimated that velocity and precision play a fundamental role in scoring a goal [4, 19].

The general kinematics of overarm throwing is comparable across disciplines (handball, baseball, water polo and javelin) [46]. Quantifications of landmark linear velocities have demonstrated a characteristic pattern of proximal to distal increases in segment velocities in handball [24], water polo penalty throws [9], baseball pitches [10] and javelin throws [53]. Whereas detailed information on baseball pitching [11, 15, 30, 44], baseball throws [9, 12, 13] or javelin throwing [53, 32, 27, 2] is available, the knowledge of team handball throwing is fragmented and scarce.

Previous studies in team handball throwing [16, 19, 24, 39, 46, 48, 52] analyzed standing throws, standing throws with run-up, as well as jump throws, and identified the ball release speed as the main performance factor determining the throwing movement.

The analysis of differences in conditioning qualities of athletes of different ages is a basic direction of research into athletes’ physical conditioning [25]. Judging by the evolution of strength and muscular power, it is logical to think that throwing capacity improves with age and that the competitive levels increase. This has been confirmed by various general physical and physiological capacities studies which found significant differences between senior handball players of different competitive levels [19, 20, 54] as well as between elite and non-elite under-16 [33]. This type of differences has likewise been shown for junior and senior players of other sports, such as rugby [18], ice hockey [22]; between elite and non-elite under-18 players of Australian rules football [26]; between an “older group” and a “younger group” of American baseball pitchers [8]; and between elite female and male baseball pitchers [6]. Notwithstanding, the use of general motor and physical tests has been questioned [28], proposing the use of a specific test [43].

On the other hand, several studies have also shown differences according to the specific playing positions in
throwing in relation to age, either in handball or in other sports. There are also few studies which estimate as well as on the sit-and-reach test (flexibility) between elite and non-elite soccer players [34].

14 and 15-17 years old, as well as a significant correlation (r=0.71) between age and serving velocity [31].

His group consisted of young players, aged 16-18. The senior group consisted of elite, 1st and 2nd national league players, aged over 18. The U-18 group consisted of young players, aged 16-18.

Table 1. General characteristics of the participants (Mean ± SD)

<table>
<thead>
<tr>
<th>GROUPS OF AGE</th>
<th>AGE (years)</th>
<th>HEIGHT (cm)</th>
<th>WEIGHT (kg)</th>
<th>TRAINING EXPERIENCE (yrs.)</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior players (N= 48)</td>
<td>24.9±2.81$^a$</td>
<td>188±4.8$^a$</td>
<td>90.1±10.3$^a$</td>
<td>17.72±3.9$^a$</td>
<td>Elite (n=15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1stNational (n=18)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2ndNational (n=15)</td>
</tr>
<tr>
<td>U-18 players (N=46)</td>
<td>18.02±1.22</td>
<td>178 ±6.17</td>
<td>76.93±7.8</td>
<td>9.98±3.1</td>
<td>National Competition (n=16)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Regional Competition (n=30)</td>
</tr>
</tbody>
</table>

$^a$ Shows significant difference (p<0.05) between senior and youth male handball players.

TESTING PROCEDURE

The participants were assessed in four different situations of progressive specificity: throw with a heavy medicine ball (HMBT), throw with a light medicine ball (LMBT), throwing velocity without opposition (TVWO), i.e. with no goalkeeper at the goal, and throwing velocity with opposition (TVO), i.e. with a goalkeeper at the goal.

In order to reduce the interference of the environment, fatigue and the external conditions effect, each group was assessed in the four throwing tests in only one session and following the same order of test execution. To minimize the learning effect during the test session the total throws performed were controlled and limited.

The participants were informed in detail about the procedure and they provided a voluntary consent to participate. All participated in a standardized 10 minutes’ warming up, which consisted of various exercises focusing on the acceleration and the stop preceding the throw.

THROWS WITH A HEAVY AND A LIGHT MEDICINE BALL

The initial position in the throw of a 3 kg ball (HMBT) was the following: the thrower stood with his legs apart, at shoulder width. The throw consisted of raising the ball with both hands above and behind the head, allowing for the trunk to stretch, the arms and legs to flex and the heels to rise without lifting the toe cap off the floor. Finally, an explosive movement was performed to throw the ball at the longest possible distance. The thrower should not overstep the line of the throw.

In the throw of a light medicine ball (LMBT) the thrower made three steps previous to the throw and held the ball with one hand. In this case the use of resin was allowed to simulate real play. The ball was adapted to the hand. The starting position was the following: the thrower was positioned behind the throwing line at a distance he chose (considering the three previous steps), with his legs stable and comfortable on the ground with the body facing the direction of the throw. The description of the throw: three specific steps were made and the thrower began and finished with the leg opposite to the throwing hand. The thrower used only one hand with the ball totally adapted to it. The line of throw should not be overstepped.
**Throwing Velocity With and Without Medicine Ball**

Both tests were subject to the following instructions: throw the ball at the highest possible speed, using only one hand and the technique appropriate to a throw at a goal; make a maximum of three steps prior to throwing and throw from behind the free-throw line, at 9 m from the goal.

With the purpose of simulating real play, the throwers were allowed to use resin on their hands. The subjects were also instructed to make precise shots following the goalkeeper intervention difficulty criterion [56]. Each test involved a different task: in TVWO the throws had to target the corner of the goal, whereas in TVO the throw had to target the area furthest to the goalkeeper, giving priority to the corners. The goalkeeper was instructed to move along a line drawn at 0.5 m away from the goal, in the forefront only. An observer, positioned at his side, controlled his movements using a slow motion camera which recorded each throw. The coaches supervised the throws to assure the proper execution and the application of the correct technique.

Each participant performed various throws before three values were obtained. The highest two were registered in each test. The procedure was the following [19, 20]: each subject performed a series of three consecutive throws with a 10-15 sec pause between them. If a thrower failed to meet either a distance or a velocity throw requirement, then a second series of throws was performed, with a 1-2 min break. The maximum number of series allowed was three. With the purpose of motivating the players, they were informed about the distance and velocity value obtained immediately after each throw. The best velocity value achieved by each player was chosen for the subsequent analysis.

The Interclass Correlation Coefficient (ICC) obtained was 0.99 (HMBT), 0.98 (LMBT), 0.99 (TVWO) and 0.97 (TVO). The Coefficient of Variation (VC) was 3.5% (HMBT), 4.1% (LMBT), 3.7% (TVWO) and 5.2% (TVO).

**Material**

The tests were executed in an indoor handball pavilion. The medicine balls “Salter” of 3 kg and 0.8 kg with a circumference of 72.22cm and 58cm respectively were used for the medicine ball throws. The throwing distance was measured with a measuring tape of 0.01 m resolution whereas the exact spot of the medicine ball hit was determined using a smooth black canvas (20 x 3 m) which reflected the mark left by the ball.

A standard handball ball of 0.48 kg weight and 58 cm circumference was used in the throw velocity tests. The velocity was calculated considering the time of the ball flight from the moment it passed the 6 m line to the moment it made contact with either the goal or the goalkeeper (positioned at 0.5 m away from the goal).

The time measurement was carried out with the precision of 0.001 s, using a chronometer system (Sportmetrics, Valencia, Spain) consisting of a photoelectric cell pace sensor and a sound sensor. The pace sensor was situated at 2 m away from the 6 m line. It consisted of eight photoelectric cells vertically and uniformly distributed, with a distance of 15 cm between them (at a range of 1.40-2.50 m over the floor). The sound sensor of gradable intensity was situated in the inner central part of the goal crossbar. The chronometer was set off automatically any time the ball crossed the photocells and switched off when the ball got in contact with the goal or the goalkeeper, the latter being possible in the case of a throw with opposition only. Since the distance between the ball impact and the sound sensor was never longer than 2.5 m and given that the sound generates a delay of 0.001 s every 30 cm approximately, a measuring mistake not higher than 0.008 s was estimated. In order to control the goalkeeper’s movements in the TVO a video camera was situated at his side.

**Statistical Analysis**

The mean values and the typical deviations of the variables HMBT, LMBT, TVWO and TVO were calculated. Student’s t test for independent samples was applied to analyze the difference between the two groups in each test. Student’s t test for related samples was applied to analyze the differences between TVWO and TVO. The differences between HMBT and LMBT were not calculated because of the different ball size and throwing technique performed. Statistical calculation was done by means of the Statistics software SPSS 10.0.

**Results**

**A Heavy Medicine Ball Throw and a Light Medicine Ball Throw**

The data gathered in the four throwing tests are given in continuation (Table 2).

<table>
<thead>
<tr>
<th>GROUPS OF AGE</th>
<th>HMBT (m)</th>
<th>LMBT (m)</th>
<th>TVWO (m·s⁻¹)</th>
<th>TVO(m·s⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior players (n=48)</td>
<td>11.55±1.48</td>
<td>37.45±4.27a</td>
<td>25.19±2.14a</td>
<td>23.22±2.63a</td>
</tr>
<tr>
<td>U-18 players (n=46)</td>
<td>9.55±1.29</td>
<td>28.12±6.51</td>
<td>21.67±2.08</td>
<td>20.58±2.06</td>
</tr>
</tbody>
</table>

*a Shows significant difference (p<0.01) between senior and youth male handball players.*
Senior players obtained significantly greater values than U-18 players in the medicine ball throws (Figure 1). In the HMBT test the senior group was by 17.32% (p<0.01; t=6.958; df=92) better than the U-18 group and in the LMBT test the differences were even larger: the senior group was by 24.92% (p<0.01; t=8.244; df=92) better than the U-18 group.

**Figure 1.** Mean values (±SD) of distance in HMBT and LMBT, according to age category

*marks significant differences (p<0.01) between senior and U-18 group

**Throwing Velocity Without Opposition and With Opposition**

Significant differences were registered concerning throw velocity, both in TVWO and TVO (p<0.001; df=92; t\textsubscript{TVWO}=5.399; t\textsubscript{TVWO}=8.059). Similar to HMBT and LMBT, the senior group was superior in both tests (Figure 2), in particular, by 13.98% better than the U18 group in the TVWO test whereas the difference in the TVO tests was higher by 11.37%.

**Figure 2.** Mean values (±SD) of velocity in throw with and without opposition, according to age category

*marks significant differences (p<0.01) between senior and U-18 group

**Figure 3.** Mean values (±SD) of velocity in throw with and without opposition.

* shows significant differences (p<0.01) between TVWO and TVO in each group: senior and U-18.
Likewise, differences were found between the throwing velocity with and without opposition in the two groups. The mean value of the TVWO was higher than the TVO in both groups. Particularly, the throwing velocity in the senior group was 7.79% lower (p<0.01; t=8.317; df=47) when there was opposition, whereas U-18 players lowered their velocity by 6.03% (p<0.01; t=4.469; df=45) when there was a goalkeeper at the goal.

**DISCUSSION AND CONCLUSION**

The literature research showed that there are surprisingly few comparative studies related to light and heavy medicine ball throws despite the fact that these have a broad application in sports training. Neither are there many tests of throw velocity with opposition.

The most significant finding of our research is the fact that we found significant differences between the groups' values obtained in the four throwing situations. The senior group's values were much higher than those of the U-18 group. The principal reason for this difference could be the better physical condition of the senior group but the influence of a better throwing technique must also be considered.

The results of the general tests are consistent with the studies existing in the handball literature where physiological and general physical ability tests were used [19, 20, 33]. Likewise, the results are similar to the findings obtained in other team sports [18, 21, 22, 31]. In the same line, the importance of this type of tests have been shown in determining selection in elite junior Australian Rules Football teams [26] though in handball this statement has been questioned and the study of the usefulness of tests reflecting more specific physical ability and cognitive characteristics has been suggested [28].

Concerning the specific throwing velocity tests, we could not find similar studies in handball. Notwithstanding, there has been similar research in other team sports, such as cricket [17, 40], baseball [21] and volleyball [31]. The results obtained in these investigations coincide with the results of our study.

On the other hand, the values obtained in TVWO were higher than those of TVO in both groups, with larger differences in the senior group. This could be due to the higher degree of specialization of the senior players, who have more experience in the specific throws with opposition and also have higher specific physical preparation than the U-18 players. Likewise, the improvement of the perception and decisional factor in the opposition situations could explain this difference between TVWO and TVO but psychological and technical variables require further analysis.

In any case, these results are in accordance with those obtained in handball [36, 41], where much higher values were obtained in jump and standing throwing velocity without opposition than in throwing velocity with opposition. Similarly, [37] estimated jump throwing velocity with decision making and goalkeeper opposition. However, the purpose of their study did not include the differences between this type of throw and a throw in an isolated situation without a goalkeeper. In any case, it should be highlighted that the values obtained in their study are inferior to the values obtained in a similar study carried out approximately at the same period [3]. This could be due to the fact that the analysis done was bi-dimensional (2D) and thus underscored the transversal component of velocity.

Similar results were obtained in water polo [49, 50] where differences were found in throwing velocity with and without opposition, the values being lower in the case of opposition from a goalkeeper. The explanation of this situation could be found in the uncertainty created by the presence of a goalkeeper. Junior players, with less experience, show a higher level of uncertainty than senior players.

On the contrary, no differences in jump throwing velocity with and without opposition have been estimated [29]. This could be due to the fact that the jump throw technique is much different from the support throw technique, applied in the present study.

**PRACTICAL APPLICATION**

In the light of the data obtained, we think that the age category could be a determining factor in the general and specific throwing capacity of handball players. The lower the age category, the higher its impact is. This information will allow coaches to identify and evaluate their players according to the age group they belong.

On the other hand, the opposition could also be a very important variable in throwing velocity. The decrease in the throwing velocity in the presence of opposition shows the importance of the cognitive factors for the specific physical condition of this handball activity. Therefore, the means of optimization of the throw, from the point of view of physical condition, should include factors related to decision making.

The principal application for coaches must be to include throwing exercises with opposition in the specific physical preparation. Handball players displayed different maximal throwing velocity depending on the throwing situation: with or without opposition. If we only propose situations without opposition during our specific physical preparation for throwing, then we do not train throwing velocity that handball players display in more specific situations (with opposition), which is more similar to real competition situation.

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