

## Comparison of the Correlation Between the Reaction Time and In-Game Performance of the Elite Handball Teams

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**Abstract:** This study aimed at ascertaining the pre-game and post-game reaction times of handball teams based on one-leg league system and to examine the correlation between the reaction time and in-game performance. 48 male athletes playing for handball teams of universities and having trained for at least five years or more voluntarily partook in the study. The pre-game and post-game reaction times of the athletes were calculated by the Nelson Reaction Scale. The games were videotaped and based on the game value scale concerning the calculation of in-game performance index in handball according to Ulrich, the positive ( $\Sigma Pi$ ) and negative ( $\Sigma Ni$ ) scores were calculated and the performance analysis ( $V_i=V_t$ ) was carried out. In addition, the in-game (passes and shots on and off target, goal, goalkeeper and the shots hitting the crossbar) performance index of the athletes was calculated thus allowing to take a look at the correlation between the reaction time and in-game performance. The mean ( $M$ ) and standard deviation ( $S_D$ ) of the data scores were presented as well. The student t was the test performed in the dependant and independent groups for the comparison of the groups.  $p<0,05$  was adopted as the level of significance. The direction and capacity of the correlation between the reaction time and in-game performance were calculated through the Pearson correlation analysis. In the performance scales of the teams, the Team 1 taking the first place in the standing had recorded scores of  $\Sigma Pi$ ; 3.37,  $\Sigma Ni$ ; -2.81,  $V_t=V_i$ ; 20.56 as the Team 4 taking the last place in the standing had the following scores:  $\Sigma Pi$ ; 2.31,  $\Sigma Ni$ ; -3.46,  $V_t=V_i$ ; 18.85. When the reaction times and in-game performance of the teams were analyzed, all the teams (total in-game performance) turned out to have a strong relation between TGP+ and GP+ as well as TGP- and GP- ( $p<0.01$ ). The Pearson correlation analysis was helpful to ascertain the significant relation ( $p<0.05$ ) between GP+ and THRT ( $r= 708, p= 033$ ), GP+ and HRT ( $r= -790, p= 011$ ), GA- and HRT ( $r= 975, p= 025$ ), TGP+ and FRT ( $r= 580, p= 038$ ). Our research points out that the Team 1 taking the first place in Ulrich game value scale has the lowest reaction time as its  $V_i=V_t$  value is the highest. The Team 4 taking the last place has the highest reaction time as its  $V_i=V_t$  value is the lowest. When the relations between the reaction times and the in-game performances of the teams are analyzed, all the teams turn out to have a strong relation ( $p<0.01$ ) between TMP+ and MP+ as well as TMP- and MP.

**Key words:** Handball Players • Reaction Time • In-Game Performance • Game Analysis

### INTRODUCTION

The human memory system has its own limits and it is almost impossible to recall all that is going on in the game. Franks and Miller [1] found out in one of their studies that elite coaches could recall only 42% of the key factors regarded as strong plays in a game.

The analysis of the game; is an instrument to collect scores of the performance that we observe and to inform us with regard to the athletes. It is important to collect information pertaining to the actions in the game and to

let us identify the changes in the performances of the players or the teams. The technical analysis is an instrument to provide the coaches with a set of tools to some extent for both trainings and game preparations. The individual in-game performance efficiency of the players in a team can be effective in the decision-making process with regard to the goals and the strategies of the coach and the teams.

Efficiency rate; makes up the total sum of the difference between all the good and bad plays of the athlete during a game. It would let coaches to work on

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the efficiency scores obtained, analyze them and to awaken to the factors that are influential to win or lose the games as well as the individual and team performances [2].

Regarding performance perfection, The analysis systems enabling us to positively focus on the constructive criticism allowed for the micro-analysis of the performance and game components or the micro-analysis of the plays. The video allowed the researchers and athletes to share their savvy concerning the performance. The available information in a game for handball analysis is diverse and extensive. Constantly moving and dynamic athletes make it harder to collect objective data. Any quantitative analysis must be structured under such circumstances [3, 4]. The term "performance information" is referred to tell the difference between the information obtained as a result of a play and the play to complete the ability. Magill defines the conclusion information as the conclusion of the return or the information provided to the individual following the completion of the return with regard to what would happen to the characteristic performance produced out of that return [5]. Franks, Goodman and Miller suggest that the coaches must constantly update their realistic expectations in order for performance levels to be in line with the definition of success and failure. They suggested that "if the definitions are not realistic, then they will not be responsive to the performance changes" [6]. Performance development pace; is the basic indicator of sports efficiency and a factor to monitor the development in the characteristics (condition, technique, tactic etc.) having an impact on the sports performance and to conduct periodical evaluation and to functionally guide the athletes [7].

This study aimed to ascertain the pre-game and post-game reaction time differences in handball games that were ongoing on one-leg basis for five days and to research into the impact of the reaction time on the in-game performances.

## MATERIALS AND METHODS

A total number of 48 male handball players – with a training age over five years or more,  $21.25 \pm 2.21$  year in age,  $179.04 \pm 5.93$  cm in height and  $82.12 \pm 15.63$  kg in weight – playing for four teams participating in the 2nd division games for the lead in the group voluntarily took part in the study. The teams were named in accordance with their seeds in the standings (Team 1, Team 2, Team 3 and Team 4). The Team 1 taking the first place in the end had no defeat as the Team 4 taking the last place had no win.

The athletes taking part in the study provided their demographic information. Their height was measured by a measuring apparatus in cm as their weight was measured by an electronic bascule in kg. The reaction time calculation in the pre-game and the post-game of the handball games that were ongoing on one-leg basis for five days was performed within the first 15 minutes as the winner (W) and the defeated (D). Nelson Hand Reaction Test and the reaction time of the dominant hand (HRT), the Nelson Foot Reaction Test and the reaction time of the dominant foot (FRT) as well as the Nelson Motion Speed Test and two-hand reaction time (THRT) were measured. The results for these three measurements were obtained for five times and the best and the worst scores were excluded as the average of three remaining measurements was registered as the scale range. The results of these three measurements allowed for the value on the read-out scale to be calculated in the following formula and thus facilitating to ascertain the reaction times of the test subjects. Reaction Time =  $v \times 2 \times$  Scale Range / Speed Varying on the Gravity, Reaction Time =  $v \times 2 \times$  Range (cm) / 980 sec [8].

The method was based on the positive and negative scores in Ulrich's "Game Value Scale Regarding the Calculation of the In-Game Performance Index in Handball" [9]. The games were videotaped (the footages of the athletes playing in the game for 40 minutes or more) and analyzed in addition to the performance analysis (passes, shots on and off target, goal, goalkeeper and the shots hitting the crossbar). The positive and negative scores of Ulrich were then added thus allowing for the arithmetic average to be individually calculated as the game value scale of the Ulrich performance index was calculated with the help of the following formula by Taborsky (Flagan Critical Incident Technique evaluation) [7]  $V_i = \Sigma P_i + (1/2 M_i) + \Sigma N_i$ .

( $V_i$ ; Score for In-Game Performance,  $\Sigma N_i$ ; Total of the Negative Scores,  $\Sigma P_i$ ; All of the Positive Scores, ( $1/2 M_i$ ); Half of the Time Played)

The performance of the team was calculated with the arithmetic average of the scores for all the athletes. The game value scale with regard to the calculation of in-game performance index turned out to be  $V_t = \Sigma V_i$ .

A software package was employed on the computer. One-Sample Kolmogorov-Smirnov test was referred to test whether the data had shown a normal indication of dispersion and the data turned out to do so. The results of the measurements were presented in mean ( $M$ ) and standard deviation ( $S_D$ ). The comparison for the pre-game and post-game measurements of the groups was

performed by the student t test in dependant and independent groups.  $p < 0,05$  was considered as the level of significance. The Pearson correlation analysis was performed for the direction and the capacity of the relation between the reaction time and in-game performance.

## RESULTS

When pre-game and post-game reaction times were compared, the reaction time scores of hand and two-hand reaction times of the winners (W) turned out to be shorter than they were in pre-game and this difference was significant ( $p < 0.01$ ). The hand, two-hand and foot reaction time scores of the defeated, however, turned out to be longer than they were in pre-game and these differences were statistically significant ( $p < 0.01$ ).

When the hand, foot and two-hand pre-game and post-game reaction times of the athletes in Team 1 taking the first place and the Team 4 taking the last place in the standing were compared, the handball players of the Team 1 proved to have shorter reaction times as the differences were statistically significant ( $p < 0.05$ ).

When the reaction times and Ulrich game value scale were analyzed, the Team 1 taking the first place proved to have a shorter (good) reaction times than the other teams as the  $V_i = V_t$  value was the highest. The reaction times of all the teams when they were the winners were better than they were in pre-game and the Team 1 taking the first place turned out to have the highest  $V_i = V_t$  value in the Ulrich game value scale as the Team 4 taking the last place in the standing had the lowest  $V_i = V_t$  value in the Ulrich game value scale.

When the reaction times and performance analysis were reviewed, the Team 1 proved to have a shorter (good) reaction time than the other teams as its performance analysis ( $V_i = V_t$ ) is the highest. The reaction times of all the teams when they were winners were better than they were in pre-game and the Team 1 taking the first place had the highest performance analysis scores as the Team 4 taking the last place turned out to have the lowest performance analysis ( $V_i = V_t$ ) value.

## DISCUSSION AND CONCLUSION

As it is the case in all ballgames, the handball player taking the pass must have an eye on the ball, foresee the direction and the speed of the ball, plan and get ready for his next move. The maintenance of the versatile performance skill and the utilization of the individual and team performance development are of importance in

handball and essential to develop a significant performance profile [10]. The versatile athletes interacting with each other, speedy and frequent moves and unpredictable plays are typical characteristics of competitive sports such as handball. It is a requisite to develop a system in order to be able to analyze the game since the variables in the handball are numerous. The systematic approach for the analysis of the sports may be open to discussion. An objective evaluation with a basic principle is, however, an absolute must for a thorough analysis [11]. An objective measurement is required to schedule a training program and plan for the future of the team. The systematic analysis, therefore, planned to assist the coaches must be cooperative in order to minimize the concerns, meet the requirements of the game for the data selected and define all of this [12]. Our study with a view to ascertaining the relation between the reaction time and the in-game performance proved that the Team 1 taking the first place recorded  $\Sigma P_i$ ; 3.37,  $\Sigma N_i$ ; -2.81,  $V_t = V_i$ ; 20.56 in Ulrich game value scale and the Team 2 taking the second place turned out to have  $\Sigma P_i$ ; 2.65,  $\Sigma N_i$ ; -3.13,  $V_t = V_i$ ; 19.52 as the Team 3 taking the third place had  $\Sigma P_i$ ; 2.65,  $\Sigma N_i$ ; -2.70,  $V_t = V_i$ ; 19.95 in scores and the Team 4 taking the last place recorded  $\Sigma P_i$ ; 2.31,  $\Sigma N_i$ ; -3.46,  $V_t = V_i$ ; 18.85 in scores. The Team 1 recorded  $\Sigma P_i$ ; 16.68,  $\Sigma N_i$ ; -7.06,  $V_t = V_i$ ; 29.62 in performance analysis and Team 2 had  $\Sigma P_i$ ; 15.34,  $\Sigma N_i$ ; -6.45,  $V_t = V_i$ ; 28.89 in the same category as the Team 3 turned out to have  $\Sigma P_i$ ; 15.47,  $\Sigma N_i$ ; -8.33,  $V_t = V_i$ ; 27.14 as the Team 4 taking the last place recorded  $\Sigma P_i$ ; 12.85,  $\Sigma N_i$ ; -9.26,  $V_t = V_i$ ; 23.59 in the analysis. The positive scores ( $\Sigma P_i$ ) of the Team taking the first place in the Ulrich game scale and performance analysis were the highest (Table 1) as the scores of the Team 4 taking the last place was the lowest (Table 2) and these tables mark the importance of the analysis for the positive and negative scores. The fact that the reaction time of the Team 1 taking the first place in Ulrich game value scale and performance analysis proved to have the highest (Table 6 and 7)  $V_i = V_t$  value as the Team 4 taking the last place had the lowest (Table 6 and 7)  $V_i = V_t$  value proves that the reaction times have an impact on overall Team performance. Zırhlıoğlu [13], benefited from this method for the complex model of the recurrent measurements to analyze the performances of the athletes in Turkey Women's National Volleyball Team participating in the World Volleyball Championship held in Japan and researched into whether the performances of the athletes varied on games and the way they scored. He suggested that there could be a significant difference in the performances of the athletes

Table 1: Positive scores concerning the calculation of the Ulrich in-game performance index

| Variables                                       | Teams  |        |        |        |
|---|--------|--------|--------|--------|
|   | Team 1 | Team 2 | Team 3 | Team 4 |
| The number of goals scored by the playmaker     | 3.0    | 4.2    | 3.5    | 1.4    |
| 2-min penalty                                   | 2.3    | 2.1    | 3.2    | 0.9    |
| A goal at close range                           | 2.4    | 1.2    | 2.0    | 1.5    |
| Stopping the goal attempts with a help          | 3.5    | 3.6    | 1.6    | 6.4    |
| An assist leading to a goal shot at close range | 4.8    | 3.2    | 2.8    | 3.2    |
| A well-done block                               | 4.4    | 2.4    | 1.6    | 1.6    |
| 7-meter penalty shot (against)                  | 0.8    | 1.6    | 3.6    | 0.8    |
| Stealing  | 8.0    | 4.4    | 3.6    | 4.0    |
| 7-meter shot (for)                              | 1.2    | 1.2    | 2.0    | 1.0    |
| M=  | 3.37   | 2.65   | 2.65   | 2.31   |

Table 2: Negative scores concerning the calculation of the Ulrich in-game performance index

| Variables                       | Teams  |        |        |        |
|---------------------------------|--------|--------|--------|--------|
|                                 | Team 1 | Team 2 | Team 3 | Team 4 |
| A failed block                  | -2.8   | -2.0   | -3.6   | -3.2   |
| A turnover                      | -3.6   | -4.0   | -2.4   | -3.6   |
| A wasted back court shot        | -0.4   | -0.4   | -1.6   | -1.6   |
| A wasted close range goal shot  | -1.2   | -6.4   | -1.8   | -1.2   |
| Yellow card 2-min penalty       | -5.3   | -5.1   | -3.2   | -3.2   |
| Losing in the tackles           | -2.8   | -4.8   | -3.2   | -10.4  |
| Turnover leading to a goal shot | -4.8   | -0.8   | -3.2   | -3.2   |
| Causing to 7-meter shot         | -1.6   | -1.6   | -2.6   | -1.3   |
| M=                              | 2.81   | -3.13  | -2.70  | -3.46  |

Table 3: The Taborsky Flaganan Critical Incident Technique evaluation for the positive and negative Ulrich scores of the teams

| Team 1 | ΣPi      | 1/2Mi | ΣNi       |
|--------|----------|-------|-----------|
| 11     | 0.7625   | 20    | -0.26667  |
| 7      | 1.875    | 20    | -0.65714  |
| 4      | 1.375    | 20    | -1.3      |
| 9      | 1.1      | 20    | -0.825    |
| 20     | 1.757143 | 20    | -0.65714  |
| 5      | 1.3875   | 20    | -0.71429  |
| 8      | 1.181818 | 20    | -0.8      |
| Team 2 | ΣPi      | 1/2Mi | ΣNi       |
| 9      | 1.625    | 20    | -1.36     |
| 4      | 1.166667 | 20    | -0.96     |
| 3      | 1.1      | 20    | -0.85715  |
| 5      | 1.2      | 20    | -0.84     |
| 8      | 1.371429 | 20    | -0.6      |
| 7      | 1.466667 | 20    | -0.688889 |
| Team 3 | ΣPi      | 1/2Mi | ΣNi       |
| 3      | 1.314286 | 20    | -0.82857  |
| 5      | 1.8      | 20    | -1.28     |
| 9      | 1.744444 | 20    | -1        |
| 12     | 1.266667 | 20    | -1.2      |
| 10     | 1.6      | 20    | -1.12     |
| 7      | 1.6      | 20    | -1.12     |
| 11     | 1.022222 | 20    | -0.93333  |
| Team 4 | ΣPi      | 1/2Mi | ΣNi       |
| 6      | 0.885714 | 20    | -0.8      |
| 14     | 0.9      | 20    | -0.8      |
| 13     | 2        | 20    | -0.86667  |
| 4      | 1.042857 | 20    | -0.94286  |
| 10     | 2.185714 | 20    | -0.94286  |
| 9      | 1.625    | 20    | -1.08     |
| 18     | 1.083333 | 20    | -0.8      |

Vt: Score of In-Game Performance, ΣPi: Total Positive Scores, 1/2Mi: Half of the Time Played ΣNi: Total Negative Scores

Table 4: The results for the pre-game and post-game reaction times of the athletes taking part in the games

| Variables |                  | Pre-game - Post-game winner |       |       |         | Pre-game - Post-game defeated |       |       |        |         |
|-----------|------------------|-----------------------------|-------|-------|---------|-------------------------------|-------|-------|--------|---------|
|           |                  | Mean                        | SD    | t     | p       | Mean                          | SD    | t     | p      |         |
| HRT       | Pre-game         | 0.235                       | 0.025 | 4.622 | 0.000** | Pre-game                      | 0.245 | 0.023 | -4.891 | 0.000** |
|           | Post-game winner | 0.214                       | 0.017 |       |         | Post-game defeated            | 0.263 | 0.018 |        |         |
| THRT      | Pre-game         | 0.253                       | 0.021 | 7.141 | 0.000** | Pre-game                      | 0.259 | 0.020 | -3.922 | 0.000** |
|           | Post-game winner | 0.226                       | 0.027 |       |         | Post-game defeated            | 0.274 | 0.012 |        |         |
| FRT       | Pre-game         | 0.214                       | 0.017 | 0.816 | 0.420   | Pre-game                      | 0.245 | 0.019 | -3.344 | 0.002** |
|           | Post-game winner | 0.210                       | 0.019 |       |         | Post-game defeated            | 0.261 | 0.020 |        |         |

Table 5: The comparison for the reaction times of the Team 1 taking the first place and the Team 4 taking the place in the standing

| Variables | Teams  | n  | Pre-game |       |        |        | Post-game |       |         |         |
|-----------|--------|----|----------|-------|--------|--------|-----------|-------|---------|---------|
|           |        |    | Mean     | SD    | t      | p      | Mean      | SD    | t       | p       |
| HRT       | Team 1 | 12 | 0.232    | 2.98  | -2.784 | 0.010* | 0.212     | 0.020 | -9.797  | 0.000** |
|           | Team 4 | 14 | 0.257    | 0.015 |        |        | 0.274     | 0.011 |         |         |
| THRT      | Team 1 | 12 | 0.249    | 0.018 | -2.317 | 0.029* | 0.227     | 0.014 | -10.660 | 0.000** |
|           | Team 4 | 14 | 0.265    | 0.016 |        |        | 0.277     | 0.009 |         |         |
| FRT       | Team 1 | 12 | 0.228    | 0.017 | -1.762 | 0.091  | 0.206     | 0.023 | -7.826  | 0.000** |
|           | Team 4 | 14 | 0.244    | 0.026 |        |        | 0.265     | 0.014 |         |         |

Table 6: The reaction time average of teams and Ulrich game value scale (Vi=Vt).

| Teams  | Pre-game |       |       | Post-game winner                        |       |       | Post-game defeated   |       |       | Vi = Vt |
|--------|----------|-------|-------|---|-------|-------|--|-------|-------|---------|
|        | HRT      | FRT   | THRT  | HRT                                     | FRT   | THRT  | HRT  | FRT   | THRT  |         |
| Team 1 | 0.232    | 0.249 | 0.228 | 0.212                                   | 0.227 | 0.206 | The Team 1 taking the first place in the end had no defeat |       |       | 20.56   |
| Team 2 | 0.236    | 0.251 | 0.243 | 0.215                                   | 0.216 | 0.221 | 0.255  | 0.273 | 0.255 | 19.52   |
| Team 3 | 0.237    | 0.260 | 0.248 | 0.215                                   | 0.234 | 0.205 | 0.257  | 0.270 | 0.262 | 19.95   |
| Team 4 | 0.258    | 0.265 | 0.244 | Team 4 taking the last place had no win |       |       | 0.274  | 0.277 | 0.265 | 18.85   |

Table 7: The reaction time averages of teams and Performance Analysis (passes, shots on and off target, goal, goalkeeper and Vi=Vt of the shots hitting the crossbar)

| Teams  | Pre-game |       |       | Post-game winner                        |       |       | Post-game defeated   |       |       | Vi = Vt |
|--------|----------|-------|-------|---|-------|-------|--|-------|-------|---------|
|        | HRT      | FRT   | THRT  | HRT                                     | FRT   | THRT  | HRT  | FRT   | THRT  |         |
| Team 1 | 0.232    | 0.249 | 0.228 | 0.212                                   | 0.227 | 0.206 | The Team 1 taking the first place in the end had no defeat |       |       | 29.62   |
| Team 2 | 0.236    | 0.251 | 0.243 | 0.215                                   | 0.216 | 0.221 | 0.255  | 0.273 | 0.255 | 28.89   |
| Team 3 | 0.237    | 0.260 | 0.248 | 0.215                                   | 0.234 | 0.205 | 0.257  | 0.270 | 0.262 | 27.14   |
| Team 4 | 0.258    | 0.265 | 0.244 | Team 4 taking the last place had no win |       |       | 0.274  | 0.277 | 0.265 | 23.59   |

varying on the game. It differs from our study in place, time and method. When the reaction times and the in-game performances of the athletes were analyzed in our study, all the teams (total game performance) turned out to have a strong relation between TGP+ and GP+ as well as TGP- and GP- ( $p < 0.01$ ). The Pearson correlation analysis helped us to ascertain a significant relation ( $p < 0.05$ ) between GP+ and THRT ( $r = 708, p = 033$ ), GP+ and HRT ( $r = -790, p = 011$ ), GA- and HRT ( $r = 975, p = 025$ ), TGP+ and FRT ( $r = 580, p = 038$ ). A lack small amount of study in this discipline lays an emphasis on the importance of our study.

Çelikbilek [14] was able to ascertain a significant difference - in his study of video analysis - in steals, failed fast breaks, goal, 6-meter defense, block, foul as he found no difference in passes off target although he did so in blocks and goalkeepers. It differs from our study in terms of its method. Akpınar *et al.* [15], in their study on the kinematic analysis of the basic shots of the handball players in various levels found out that the ball release speed had the highest value and in the basic shot where you take 3 steps back, the angle of the elbow and the shoulder was no different when the arm was behind and the shot was placed. The scores of the Super league teams were found to be higher than the scores of the athletes in the 1st division. Ağaoglu *et al.* [16], suggested focusing more on the studies shortening the reaction time to enhance the accomplishments. Dündar [17], put emphasis on the fact that the reaction time could be improved through regular trainings [17, 18]. In our study for the comparison (Table 4) of the pre-game and post-game reaction times of all the teams, the winner is

HRT (PRE-GAME; 0.235 - W; 0.214), THRT (PRE-GAME; 0.253 - W; 0.226) and the defeated is HRT (PRE-GAME; 0.245 - D; 0.263), THRT (PRE-GAME; 0.259 - D; 0.274), FRT (PRE-GAME; 0.245 - D; 0.261) in scores and they have parallels with the standing of the teams.

Fox [19], suggests that the athletes with high performance have better reaction times. Ahin [20], in his study with regard to the comparison of the reaction times of a goalkeeper and players in various positions suggests that the handball players playing in various positions have different reaction times. Koç *et al.* [21], as a result of his study with a view to comparing the reaction times of men's handball teams participating in the interuniversity handball tournament suggests that the reaction speed, one of the major motor characteristics of the athletes, is the most important criterion having an impact on the success in handball as, Karakuş *et al.* [22] points out that what they accomplished as a result of their study is directly proportionate to the reaction time. The findings as a result of this study are supportive to our findings as well. More *et al.* [23], points out in his research that better athletes have shorter reaction times than the others. Our study differs from it in terms of material, method and performance method.

As a conclusion, this study – aiming to ascertain the relation between the reaction time and in-game performance – proves that there is actually a relation between the reaction time and in-game performance. The reaction time of the Team 1 taking the first place in the tournament is the shortest (good) as Vi=Vt parameters, the indicator of in-game performance, are the highest. The Team 4 taking the last place in the

tournament has a longer reaction time as the  $V_i=V_t$  parameters, the indicator of in-game performance, are the lowest. This result proves out the relation. We are of the opinion that the analysis of handball games is essential to periodically evaluate the performances of the athletes, functionally guide athletes and supervise scientific methods. A well-done analysis of the relation between the reaction times and in-game performances would contribute to norm studies thus paving the way for an analysis on more handball players and shaping the training program accordingly.

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