

# Relationship between origin of shot and occurrence of goals in competitive men's water polo matches

## *Relação entre a origem do arremesso e a ocorrência do gol em competição no polo aquático masculino*

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**Abstract** – Although some similar studies exist in water polo, there are no reports showing a possible association between the occurrence of goals and the origin of shots. The objective of this study was to correlate the origin of shot and the occurrence of goals in an official men's water polo match. Nine teams that competed in seven final matches of the Third National Men's Water Polo League were evaluated. The games were recorded using a camera installed along the length of the pool. Pearson's chi-square test was used to correlate the categorical variables studied. The effect size was calculated by the ratio between the chance of occurrence of a center goal and the chance of occurrence of a goal scored from the lateral position. An  $\alpha$  value  $< 0.05$  was adopted in all cases. There was a significant association between the occurrence of goals and origin of shot, with  $X^2(2) = 14.89$  and  $p = 0.001$ , i.e., the proportion of goals scored from the center position was higher than that of goals scored from the lateral position. A center shot was 2.70 times more likely to be converted to a goal by the attacker. It can be concluded that a center shot presented a higher chance to be converted to a goal. This finding might be explained by the inability of the technical-tactical defense to organize, permitting closer proximity of the attackers. The same situation does not seem to apply to high-level technical-tactical matches.

**Key words:** Athletic performance; Match analysis; Sports; Tactical indicators.

**Resumo** – Apesar da realização de algumas pesquisas desta natureza no polo aquático, não foram encontrados estudos que mostrem a possível associação entre a ocorrência do gol com a origem da realização do arremesso. Este estudo objetivou relacionar a origem do arremesso e a ocorrência do gol em uma competição oficial de polo aquático masculino. Foram avaliadas nove equipes que disputaram os sete jogos da fase final da III Liga Nacional de Polo Aquático Masculino. Os jogos foram gravados, utilizando-se uma filmadora localizada no sentido do comprimento do campo de jogo. Utilizou-se o Teste Qui-quadrado de Pearson com o objetivo de correlacionar as variáveis categóricas observadas. O tamanho do efeito foi calculado por meio da razão entre a chance do gol ocorrer pela região central, pela chance do gol ocorrer pelas laterais. Em todos os casos, considerou-se  $\alpha < 0,05$ . Houve uma associação significativa entre a origem do arremesso e a ocorrência do gol, com  $X^2(2) = 14,89$ , ( $p = 0,001$ ). Ou seja, a proporção de gols realizados pela região central da área de jogo foi maior do que aquela realizada pelas laterais. Um arremesso realizado pela região central teve 2,70 mais chances de ser convertido em gol a favor do atacante. Conclui-se que o arremesso realizado pela região central teve maior chance de ser convertido em gol. Isso pode dever-se a uma incapacidade técnico-tática da defesa se organizar e permitir maior proximidade dos atacantes. Este mesmo cenário parece não se repetir em jogos de maior qualidade técnico-tática.

**Palavras-chave:** Análise de jogo; Desempenho atlético; Esporte; Indicador tático.

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## INTRODUCTION

Invasion team sports are complex games due to the wide variety of actions that can occur during a match<sup>1</sup>. These actions behave in different manners depending on a set of variables<sup>2-4</sup>. Only a systematic observation method is able to collect and summarize these actions in order to transform them into useful data for sports training<sup>1,5</sup>. For this purpose, the division of match situations into micro-situations permits to maintain their specific structure for analysis<sup>6</sup>. On the basis of these data, it is possible to decide whether to maintain or alter the team organization during a match<sup>1,6</sup>. However, this type of data has become available only recently, even for more traditional sports.

In water polo, studies related to match analysis are available<sup>6-9</sup>, but only recently have researchers focused on the evaluation of technical-tactical interactions<sup>2-4,10,11</sup>. Although some of these studies<sup>2-4,10,11</sup> investigated the origin of shots and the ratio between goals and the total number of shots made, we found no reports showing a possible association between the occurrence of goals and origin of shots. Although knowledge of the number of attacks, passes, goals or shots is useful, it is important to establish how these parameters are related and to produce new game-related data and information of how teams behave.

Large investments have been made in Brazilian water polo in recent years in an attempt to improve participation in the 2016 Olympic Games which the country will host. Improvement of training quality and an increase in the participation in international tournaments are some of the strategies used for this purpose in all categories. The data obtained in this study should therefore contribute to the development of water polo.

The data reported above highlight the importance of studies designed to describe and correlate the interactions developed during a match. Therefore, the objective of the present study was to analyze the association between the origin of shots and occurrence of goals in an official men's water polo match, maintaining the competitive structure of the discipline unchanged.

## METHODOLOGICAL PROCEDURE

### Sample

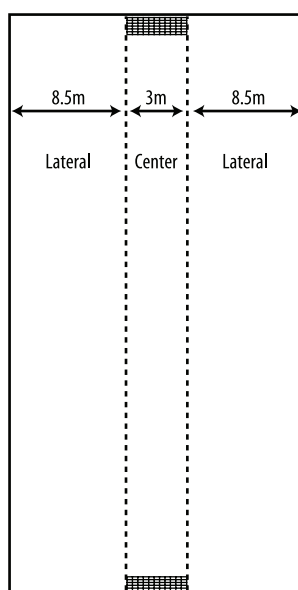
The Third National Men's Water Polo League is an open tournament with no age restrictions carried out in Brazil which includes 58 matches. This competition is one of the most important of the national calendar for this discipline. It starts with regional competitions in the main Brazilian states and the classified teams participate in the final games in Rio de Janeiro. The competition started on September 29, 2010, and the final phase occurred on December 12, 2010. The organizers of the championship agreed to the collection of images for subsequent scientific use. The study was approved by the Ethics Committee on Human Research of the Federal University of Rio Grande do Sul (Universidade Federal do Rio Grande do Sul) (Permit

No. 70263). Seven teams that participated in the seven games of the final phase of the competition were selected for this study. These games were chosen because they are considered to be of the best technical-tactical level. A total of 628 attack situations and 344 shot situations were evaluated.

### Procedure and Instrument

The matches were recorded with a Sony camera (HDR-HC9 MiniDV Handycam Camcorder) mounted on a specific tripod (Weifeng, WT3111, with a height of 1.065 m) installed along the length of the pool, about 4 m above water level. The images were stored directly with the Dartfish Team-Pro 5.0 software through an *i-link* cable. The configuration of the Dartfish software for the requirements of this study permitted the direct collection of data regarding shot outcomes during the matches. Data regarding shot position were obtained after the matches through the observation and interpretation of game actions. The same experienced observer analyzed all matches, thus minimizing interobserver variation.

The matches were analyzed to obtain data regarding the origin of the shot and outcome of this action. With respect to shot origin, the following possibilities were considered: a) lateral: when the shot was made from the left or right side of the goal of the defending goalkeeper, with the post on the same side serving as a reference, and b) center: when the shot was made between the two posts of the goal of the defending goalkeeper (Figure 1). The following possibilities were considered for shot outcome: a) DBGB: defensive block (when the ball was stopped by the player on the line from reaching the goal after the shot) or goalkeeper block (when the ball was stopped by the goalkeeper who continued or not in possession of the ball); b) SOBP: when the ball went outside or touched the post, and c) GOAL: when a goal was scored.



**Figure 1.** Schematic drawing of the division of the game area for analysis of possible origins of the shot.

## Statistical Analysis

Pearson's chi-square test was used to correlate the categorical variables studied. The effect size was calculated by the ratio between the chance of occurrence of a center goal and the chance of occurrence of a goal scored from the lateral position as follows:

$$\text{Chance}_{\text{center goal}} = \frac{\text{Number of center shots that resulted in a goal}}{\text{Number of center shots that did not result in a goal}} \text{ and}$$

$$\text{Chance}_{\text{lateral goal}} = \frac{\text{Number of lateral shots that resulted in a goal}}{\text{Number of lateral shots that did not result in a goal}}.$$

Thus, the relative risk<sup>(12)</sup> =  $\frac{\text{Chance}_{\text{center goal}}}{\text{Chance}_{\text{lateral goal}}}$ .

An  $\alpha$  value < 0.05 was adopted in all cases. Statistical analysis was performed using the SPSS 17.0 program.

## RESULTS

One hundred lateral shots were made (29.1% of all shots analyzed, n = 344); of these, 45 (45%) resulted in DBGB, 34 (34%) in SOBP, and 21 (21%) in GOAL. On the other hand, 244 center shots were made (70.9% of all shots analyzed, n = 344) and 68 (27.9%) resulted in DBGB, 75 (30.7%) in SOBP, and 101 (41.4%) in GOAL (Table 1).

**Table 1.** Outcomes of the 344 shots made from the center or lateral position of the goal.

Shot outcome	Lateral (n = 100)	Center (n = 244)	Total (n = 344)
	%	%	%
DBGB	45.0	27.9	32.8
SOBP	34.0	30.7	31.7
GOAL	21.0	41.4	35.5
Total	100.0	100.0	100.0

Among all shots whose outcome was DBGB (32.8%, n = 113), 39.8% were made from the lateral position and 60.2% from the center position. For SOBP (31.7%, n = 109), 31.2% of the shots were made from the lateral position and 68.8% from the center position. For shots that resulted in GOAL (35.5%, n = 122), 17.2% were lateral shots and 82.8% were center shots. Thus, most of the shots resulting in goals were made from the center position. As a consequence, a significant association was observed between the origin of the shot and occurrence of goals during the matches analyzed, with  $X^2(2) = 14.89$  and  $p = 0.001$ , i.e., the proportion of goals made from the center position was higher than that of goals made from the lateral positions. About 83% of all goals made were shots from the center position and only 17% from the lateral positions. Analysis of relative risk showed that a shot on the center defensive goal is 2.70 times more likely to result in a goal by the attacker than a lateral shot.

## DISCUSSION

The objective of the present study was to evaluate the relationship between the

origin of shots and the ability of the attacker to score a goal in matches of the Third National Men's Water Polo League (Brazil). Invasion team sports are characterized by variability in the actions that can occur and reproducibility of these situations is sometimes difficult<sup>4</sup>. Different variables can alter the behavior of the players and of the technical-tactical actions performed<sup>2-4,11</sup>. However, studies on this topic are important to increase the knowledge of this discipline and to help coaches improve the training of their teams.

In general, the percent frequency of occurrence of DBGB, SOBP and GOAL was similar for the total number of shots ( $n = 344$ ). A difference in the variables was observed when the origin of the shot (center or lateral) was taken into consideration. The absolute and relative frequency of the variable GOAL was higher for shots made from the center position. Similar relative frequencies (34% vs. 30.7% for lateral and center shots, respectively) were obtained for SOBP. It therefore seems that an increase in the percentage of goals scored from the center position occurs at the expense of DBGB values in the same area, which are reduced. This hypothesis is supported by the results of another study which showed that one of the defensive qualities that differentiate winning from losing teams in women's water polo matches was the greater ability of the goalkeeper and defenders to block the shot of the opponent<sup>2</sup>. The central zone inside the 5-m area is considered the most favorable position to score a goal. However, this situation is only facilitated when the defense is weak<sup>11</sup>.

Lupo et al.<sup>3</sup> studied the origin of shots, among other variables, made by Italian players of three different competition levels: (a) international, (b) elite, and (c) sub-elite. Shots originating from six different zones of the court were analyzed: three inside the 5-m area and three outside the 5-m area, including two in the right lateral region, two in the center position (in alignment of the defensive goal), and two in the left lateral region. This division of the game area is similar to that adopted in the present study, but did not take into consideration the distance of the shot from the goal line. The authors observed that teams of different competition levels present a distinct technical-tactical organization for variables such as the frequency of shots during counterattack and power-play actions, frequency of goals in even situations, and frequency of shots originating from different zones of the court<sup>3</sup>. Similar results have been reported in other studies<sup>11</sup>.

Another study<sup>11</sup> using the same division of the game area for origin of shots found that in even situations more shots are made from the center position than from the right and left side. However, the authors did not report whether this difference was significant. The focus of that study was to compare the final score between winning and losing teams. The difference in final score is an indicator of whether teams are similar or differ in terms of technical-tactical performance level. In contrast to the present study which related the origin of shots to the ability to score a goal, Lupo et al.<sup>11</sup> investigated the effect of the origin of shots on winning or losing outcome of the team. The origin of the shot exerted no significant effect on the ability to win, since victory is considered to depend on the relationship

between the ability to score a goal in the opponent's goal and to prevent it from occurring in their own goal.

The best team should present conditions to make a shot from different positions and to modify tactics according to the characteristics of the opponent. Lupo et al.<sup>11</sup> showed that winning teams perform fewer even actions and more counterattacks than losing teams. This ability is indicative of defensive efficiency in gaining possession of the ball and interrupting the opponent's counterattack. Similarly, winners of matches that present a smaller difference in the final score perform a larger number of attacks in power-play situations (playing situation in which a team is defending with one player less than the offensive team because of an exclusion foul) than winners and losers of matches in which the difference in final score is greater. In general, a technical-tactical balance between teams favors the occurrence of defensive exclusions. Finally, winning teams perform more shots from outside the 5-m area (except for counterattacks)<sup>11</sup>. Taken together, these findings show that the origin of the shot is modified by the characteristic of the attack situations of the teams.

Argudo et al.<sup>6</sup> demonstrated a difference in the efficacy of actions between winning and losing teams in water polo. For men, a significant difference is observed between winning and losing teams in terms of the ability to make a shot and score a goal in different playing situations such as even-play, power-play and counterattack. These differences are not observed when winning teams with similar playing aspects are compared. Although the authors did not indicate the origin of the shot, the results of the present study suggest that low-level teams permit the opponent to make a shot closer to the goal from the center position. According to Escalante et al.<sup>2</sup>, the greater the difference in the skill level between teams, the larger the number of variables that differentiate winners from losers. Lupo et al.<sup>11</sup> suggested that the range in the number of goals scored between winning and losing teams should also be taken into consideration. In this respect, one of the offensive criteria that differentiated winners was the greater ability to score goals from the center position and outside the 5-m area. These results differ from those reported above<sup>11</sup>.

Lupo et al.<sup>3</sup> found that in sub-elite matches more shots are made from the center position of the court (outside the 5-m area) in both even-play (52%) and power-play (60%) situations. Considering the whole center zone (outside and inside the 5-m area), these percentages increase to 68% and 63%, respectively. These values found for the even-play situation are similar to those obtained in the present study (70.9%), despite considering shots in different situations. The small increase in the percentage of center shots (60% to 63%) observed by those authors in the power-play situation considering the whole center zone might be explained by the greater facility of approach that the opponent's defense offers attackers in low-competition level matches<sup>3</sup>.

In international and elite Italian matches, Lupo et al.<sup>3</sup> observed a higher frequency of diagonal shots originating outside the 5-m area in even situations (55% and 53%, respectively). For the same competition levels, the fre-

quency of occurrence of shots in power-play situations was similar at three different positions ( $\approx 25\%$ ), increasing variability of the action. These results differ from those of the present study which indicated a higher frequency of occurrence of center shots. According to Lupo et al.<sup>3</sup>, shots originating close to the goal line and inside the center zone indicate low efficiency of the defense and, consequently, of the team, or even superiority of the opponent's attack. Teams of higher technical level force the opponent to perform shots outside the 5-m area. This fact is supported by the observation that in women's water polo the winning teams performed more shots originating inside the 5-m area than the losing teams in even-play situations. The losing teams performed a larger number of shots outside the 5-m area<sup>4</sup>.

The same trend of seeking shots in the center zone was reported by Lupo et al.<sup>10</sup> for a youth water polo match (mean age of the players: 12.3 years). In that study, most shots originated inside the 5-m area. However, the authors did not mention whether these shots were made from the center or lateral position. The same was observed in even, counterattack and power-play situations. Since in this case developing young players were studied, it is believed that the technical-tactical defensive deficiency permits that the opponent comes closer to the goal line to perform the shot. In addition, lower strength levels for the shot and for elevation of the body out of the water require that the attacker gets closer to the goal. This does not seem to occur in trained subjects who are able to maintain an adequate body position in the water even under fatigue, keeping shot speed and precision<sup>13</sup>.

During training, the teams should simulate situations that create opportunities to make shots from different positions of the court. Teams of lower technical-tactical level seem to create opportunities closer to the attackers at the defensive goal line through the central zone. In contrast, teams of higher technical-tactical level force the opponent to make a shot at a greater distance from the goal line. When the technical-tactical level of the teams is similar, there is an increase in the frequency of power-play situations. During an attack, the team should create conditions that permit the participation of more players, increasing the variability of possible actions, with efficient and rapid passes, in order to destabilize the opponents defense<sup>3</sup>. However, the most important aspect is that the players perceive the adequate moment to make the shot, since teams of lower technical level tend to permit that the opponent's shot occurs early<sup>4</sup>.

The present study showed a relationship between origin of shot and a higher frequency of occurrence of goals in the water polo matches analyzed. Although this study did not evaluate the distances of shots in relation to the goal, the results of the cited studies<sup>3,11</sup> permit to raise the hypothesis that they frequently originate inside the 5-m area. However, this scenario does not seem to apply to elite water polo matches<sup>3,11</sup>. In order to better understand these associations, it is necessary to determine whether a relationship exists between the distance of the origin of the shot and the occurrence of goals using methods that already exist for this purpose<sup>3,4,11</sup>, and to evaluate these variables in men's and women's water polo teams of different competition levels.

## CONCLUSIONS

Despite the limited capacity to reproduce the actions that occur in a water polo match, this type of study permits to compare how a team plays and contributes to the understanding of specific training needs. A significant association was observed between the origin of shots and the occurrence of goals in the water polo matches analyzed. Center shots are more likely to be converted to a goal by the attacker than lateral shots. This finding might be explained by the inability of the technical-tactical defense to organize, permitting closer proximity of the attackers to the goal line. This scenario does not seem to apply to matches involving teams of high competition level, which are characterized by a greater variation in shot position and even-play situations outside the 5-m area.

## REFERENCES

1. Prudente J, Garganta J, Anguera MT. Desenho e validação de um sistema de observação no andebol. *Rev Port Cien Desp* 2004;4(3):49-65.
2. Escalante Y, Saavedra JM, Tella V, Mansilla M, García-Hermoso A, Dominguez AM. Water polo game-related statistics in Women's International Championships: Differences and discriminatory power. *J Sports Sci Med* 2012;11:475-82.
3. Lupo C, Tessitore A, Minganti C, Capranica L. Notational analysis of elite and sub-elite water polo matches. *J Strength Cond Res*. 2010;24(1):223-9.
4. Lupo C, Tessitore A, Minganti C, King B, Cortis C, Capranica L. Notational analysis of American women's collegiate water polo matches. *J Strength Cond Res* 2011;25(3):753-7.
5. João PV, Mesquita I, Sampaio J, Moutinho C. Análise comparativa entre o jogador libero e os recebedores prioritários na organização ofensiva, a partir da recepção ao serviço, em voleibol. *Rev Port Cien Desp* 2006;6(3):318-28.
6. Argudo Iturriaga F, Ruiz E, Alonso JI. Were differences in tactical efficacy between the winners and losers teams and the final classification in the 2003 Water Polo World Championship? *J Hum Sport Exerc* 2009;4(2):142-53.
7. Argudo Iturriaga F, Roque JIA, Marín PG, Lara ER. Influence of the efficacy values in counterattack and defensive adjustment on the condition of winner and loser in male and female water polo. *Int J Perform Anal Sport* 2007;7(2):81-91.
8. Argudo Iturriaga F, Ruiz Lara E, Ignacio Alonso Roque J. Influence of the efficacy values in numerical equality on the condition of winner or loser in the 2003 Water Polo World Championship. *Int J Perform Anal Sport* 2008;8(1):101-12.
9. Argudo Iturriaga F, Arias JL, Ruiz E, Alonso JI. Effect of first ball possession on partial and final scores in 2003, 2005, and 2007 Water Polo World Championships. *Percept Mot Skills* 2011;112(2):349-52.
10. Lupo C, Tessitore A, Cortis C, Ammendolia A, Figura F, Capranica L. A physiological, time-motion, and technical comparison of youth water polo and Acquagoal. *J Sports Sci* 2009;27(8):823-31.
11. Lupo C, Condello G, Tessitore A. Notational analysis of elite men's water polo related to specific margins of victory. *J Sports Sci Med* 2012;11:516-25.
12. Field A. *Descobrimos a estatística usando o SPSS*. Porto Alegre: Artmed; 2009.
13. Royal KA, Farrow D, Mujika I, Halson SL, Pyne D, Abernethy B. The effects of fatigue on decision making and shooting skill performance in water polo players. *J Sports Sci* 2006;24(8):807-15.

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