Relationship between offensive and defensive rebounds and the outcome of games: analysis of rebounds data from the standpoint of counts, differences and ratios

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Summary

We measured offensive rebound (OR), defensive rebound (DR) and total rebound (TR) and the success or failure of the offense’s shot after OR in 8 games of the 2012 Olympic Games basketball tournament in London. Then we investigated relationships between game scores and differences in scores and the number of rebounds as well as success or failure ratios after getting OR. Results were as follows: 1) an increase in the number of OR and successful shots after getting OR led to high-scoring games, and 2) an increase in the number of ORs and the ratio of DRs was related to the outcome of the game.

1. Introduction

In basketball games, the percentage of successful shooting is said to be about 50% to 60% for two-point shots and about 30% to 35% for three-point shots. The remaining balls—40% to 50% of two-point shots and 65% to 70% of three-point shots—become rebounds (Yoshii, 1986, 1994). A DR, in which the defense gets the ball, decreases the chance of a play by the offense and provides a chance for a good fast break. An OR, in which the offense gets the ball, leads to a good chance of a second shot at scoring, as the rebound area is generally close to the basket. This fact often leads to the idea that “the team that controls the boards controls the game” (Allesen, 1967; Bryant, 1967; Huberty, 1970; Moormeier, 1971). Because the acquisition of rebounds is one of the most important factors in basketball games, many studies have been conducted regarding these balls, in particular forecasting where the rebounding ball will land (Kakihara, 1990; Kim, 2009; Ohga and Nagato, 2008; Shibata et al., 2002; Takagi, 1985; Takei et al., 1984a, 1984b; Uchiyama, 1987; Watanabe and Kobayashi, 2002).

At the same time, many studies on the relationship between the game outcome and the acquisition of rebounds have been conducted. In these studies, rebounds have been divided into OR and DR and the contribution to the game outcome has been investigated by type of rebound. Karipidis et al. (2001) investigated the relationship between the game outcome and plays in basketball games of the European basketball tournament in France (1999) and Spain (1997), the Olympic Games basketball tournament in Atlanta (1996), and the World Basketball Championship in Greece (1998) using multiple discriminant analysis. Dependent variables were the frequencies of 1) successful two-point shots,
2) unsuccessful two-point shots, 3) successful three-point shots, 4) unsuccessful three-point shots, 5) successful free throws, 6) unsuccessful free throws, 7) DRs, 8) ORs, 9) turnovers, 10) steals, 11) total possession, 12) fast breaks, 13) fouls, and 14) assists. They concluded that DRs (a partial coefficient of discriminant function=0.541), unsuccessful two-point shots (-0.335), and unsuccessful three-point shots (-0.288) were decisive factors of the game outcome in order of the size of the coefficient. Ibanez et al. (2003) used multiple discriminant analysis to analyze official game statistics from the 1999 Junior World Basketball Championship held in Portugal. The selected variables were points scored, points conceded, number of players used, successful and unsuccessful two-point shots, three-point shots, field goal shots, free throw and fast breaks, OR, DR and TR, steals, blocks, assists, fouls committed, and turnovers. They reported that more than 30% of the percent discrimination was explained by DRs (the structural canonical coefficient=0.50), successful two-point shots (0.36), and successful free throws (0.31) in very close games (<13 point difference between teams) and DRs (0.31) in close games (13-24 point difference between teams).

These two earlier studies focused on the importance of DRs over ORs and used the frequencies/numbers of plays, but not ratios, in their findings. However, the number of rebounds increases or decreases according to the TRs. For instance, a cap for ORs cannot be elevated unless many shots are taken, and DRs depend on the number of shots by the opposing team. On the basis of this fact, Ohga et al. (2003) studied the relationship between game performance and the percent of rebounds gotten, that is, the ratio of the number of rebounds to the total number of shots. They found a strong negative correlation between game scores and the number of rebounds and concluded that acquisition of rebounds contributed to a reduction in the opponent’s number of shots and game score.

Goto and Iwaki (2006) found that teams that got more rebounds were 88.8% more likely to win the game; teams with more DR and OR were 94.4% and 77.7% more likely to win the game, respectively. Overall, they showed that the team that got the most rebounds, no matter what type, was more likely to win.

Goto and Iwaki (2006) also investigated the relationship between game scores and score differences and rebounds. They found statistically significant relations at the level of 1% between game scores and score differences and all OR, DR and TR. Because their analysis was done in both blowout and close-scoring games, the usefulness of all OR, DR and TR in multiple game situations appears to have been demonstrated.

As mentioned above, previous studies use either the number of rebounds or the ratio of rebounds in their measurements. However, using a ratio as a measure is more natural because it takes into account the total number of shots, which can differ by game. In addition, even though the number of shots or ratio of different rebounds are high, these effects are canceled out when both teams get a lot of rebounds. Thus, a measure of ratios should be used to provide a relative value.

This study investigates the relationship between OR and DR and the outcome of games using odds ratios. We comprehensively examined the effect of OR, DR and TR using not only the wins and losses but also the difference between teams in final game scores, and successful or unsuccessful shots after ORs because the shot after OR is called “the 2nd shot” and an effective OR gotten in the good conditions is expected to lead to a successful shot.

2. Methods
Sample and data resource
The sample chosen for our study was taken from the 2012 Olympic Games basketball tournament held in London (see Figure 1). All 8 matches including a
third-place play off among America, Australia, Brazil, Argentina, France, Spain, Russia, and Lithuania were analyzed. We carried out the analysis based on the official game statistics published by the official box score and the official web sites or “Road to London” and “Play by Play.” We also used observations from videotaped game scenes on television.

Measures
The measures selected in this study were the number of 1) ORs, 2) DRs, and 3) TRs, which were based on the official game statistics. We also recorded the success or failure of the offense’s shot after an OR, which was based on observations from the videotaped games.

Analysis
First, to simply investigate the contribution of the OR, DR and TR to a team’s final game score without regard to game outcome, we obtained the correlation between the number of OR, DR and TR and the number of successful and unsuccessful shots after getting ORs and game scores. A Wilcoxon rank sum test of the five variables mentioned above between winning and losing teams was conducted.
Second, to investigate the relationship of game outcome to rebounds, we used the Wilcoxon signed ranks test to compare the means of the five variables between winning and losing teams. The correlation coefficients between score differences and the five variables were computed.
Finally, to investigate the relationship between game outcome and the five rebound-related variables considering the number of shots, we computed the odds ratios of the five variables divided by the number of shots. The odds ratios of rations of successful and unsuccessful shots after getting ORs were also obtained. However, the total number of shots was computed as the sum of game scores, ORs, and opponent’s DRs. Statistical significance was set at the 5% significance level and significant odds ratios were determined by whether or not a 1 was included in the
interval confidence using the following equation:

\[
\exp \left( \ln \left( \frac{ad}{bc} \right) \pm 1.96 \sqrt{\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}} \right),
\]

where a, b, c, and d stand for the frequency of rebounds or shots in a two-by-two cross table.

### 3. Results

#### Game scores

Table 1 shows the number of game scores, OR, DR and TR and successful and unsuccessful shots after getting ORs of winning and losing teams by game. The correlation coefficients of game scores to ORs and successful shots after getting ORs were \( r = 0.687 \) (p<0.05, see Figure 2) and \( r = 0.756 \) (p<0.05, see Figure 3), indicating statistically significant relationships. No significant relationship was found in the other variables (DRs, \( r = 0.030 \); TRs, \( r = 0.384 \); unsuccessful shots after getting ORs, \( r = 0.132 \)).

#### Game outcome

First, a Wilcoxon rank sum test was used to compare the mean values of the number of OR, DR and TR and successful and unsuccessful shots after getting ORs for winning and losing teams. The only statistically significant difference was found at the 5% level in the number of successful shots after getting ORs (\( W = 53.5, p = 0.025 \)), showing more successful shots for winning teams.

Second, a Wilcoxon signed ranks test was used to compare differences in the five variables mentioned above in the number of winning and losing teams by game. Only the TRs showed a statistically significant difference at the 5% level between winning and losing teams (\( V = 33.5, p = 0.033 \)), indicating that winning teams were superior to losing teams in terms of the

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**Table 1. Number of offensive, defensive, and total rebounds and successful and unsuccessful shots after getting offensive rebounds by game**

<table>
<thead>
<tr>
<th>Team</th>
<th>Game score</th>
<th>Number of offensive rebounds</th>
<th>Number of defensive rebounds</th>
<th>Number of total rebounds</th>
<th>Successful and unsuccessful shots after getting offensive rebounds</th>
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<tr>
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<td>Winning</td>
<td>Losing</td>
<td>Winning</td>
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</table>

**Figure 2. Relationship between game score and number of offensive rebounds**

**Figure 3. Relationship between game score and successful shots after getting offensive rebounds**
TRs.

**Differences in scores**

Correlation coefficients of the difference in scores to the differences in the OR, DR and TR between winning and losing teams were computed. Statistically significant correlations were detected between difference in scores and the number of ORs (r=0.889, p<0.05, see Figure 4), TRs (r=0.677, p<0.05, see Figure 5), successful shots (r=0.761, p<0.05, see Figure 6), and unsuccessful shots (r=0.768, p<0.05, see Figure 7) after getting ORs. No statistically significant relationship was detected in DRs (r=0.027, ns).

**Game outcomes using odds ratios**

Tables 2 shows the odds ratios and confidence intervals at the 5% significance level between winning and losing teams in OR, DR and TR and that of successful shots after getting ORs.

The outcome of the game was significantly associated with the number of DRs (odds ratio=1.233, upper and lower bounds=1.515 and 1.004, p<0.05) and successful shots after getting ORs (odds ratio=2.230, upper and lower bounds=4.168 and 1.194, p<0.05). We did not find any significant differences in other variables.
4. Discussion
High- and low-scoring games and the number of rebounds
Based on the fact that we found statistically significant relationships between game scores and the numbers of ORs as well as successful shots after getting ORs, if the team increases the number of ORs and the successful shots after getting ORs, the team will get high-scoring games irrespective of game outcome. This idea is supported by the finding that successful shots after getting ORs was significantly related to the difference in scores between winning and losing teams.

Contribution of offensive and DRs to game outcome
In terms of differences in scores, we found significant positive relationships in differences in scores to all variables assessed in this study except for DRs. In particular, even unsuccessful shots after getting ORs had a positive relationship to differences in scores. This fact can be explained by the increase in the number of shots themselves for the winning team. Namely, many shots result in an increase of successful shots after getting ORs.

In contrast, from the standpoint of odds ratios, we found a significant relationship between the game outcome and the ratio of successful DRs. Although the number of ORs can be elevated by an increase in the number of shots by one’s own team, the number of DRs cannot be increased by one’s own team and depends on the opponent’s team. Considering this result, we should not think in terms of whether ORs or DRs are more important for the outcome of the game, but rather that it is important to increase the number of ORs, which will increase the number of shots. It appears that it is also important to increase the ratio of DRs.

Since performances in Olympic Games are extremely high, it is considered that their performances are representative of the features in basketball games. However, as this study uses only 8 games, obtained results and discussion are established on the limitation
of small sample size in this study.

Partial results of this study were orally presented at the 6th Biennial Meeting of Asia-Pacific Conference on Exercise and Sports Science held in Taipei, Taiwan on November 2 to 4, 2013.

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References


和文抄録

2012 ロンドンオリンピック男子バスケットボール決勝トーナメント8試合でのディフェンスリバウンド数、オフェンスリバウンド数および総リバウンド数、そしてオフェンスリバウンド獲得後のシュートの成否の本数と成功率と、ゲームの勝敗および得失点差との関連を検討した。本数は相関係数およびウィルコクスンの順位和検定、成功率はオッズ比を用いて関連の有意差を検討した。結果、以下の結論を得た。

1) オフェンスリバウンド数とオフェンスリバウンド後のシュートの成功数の増加は勝敗に関わらず、得点数と関連があることから比較的高得点を取り合うゲームを成立させる。

2) 自らがその本数をコントロールすることが可能なオフェンスリバウンドではその獲得数が勝敗に関与していたが、相手のシュート数に依存し、自らがその数の増減に関与することのできないディフェンスリバウンドではその獲得率の増加が勝敗に関与していた。