Contributions to the team score by male wheelchair basketball players with different physical capacities at the Rio 2016 Paralympics

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Abstract. [Purpose] The contributions of male wheelchair basketball players with different capability classifications to the team score at the Rio 2016 Paralympics were evaluated. The roles required for team members belonging to each such classification were determined. [Participants and Methods] Statistics obtained from the official box scores of all 42 games included at the Rio 2016 Paralympics were used in this study. Players who participated for >20 minutes in each game were included in the analysis. Players were divided into 3 groups (low, middle, and high) based on their capability classification. The mean statistical data related to each group were compared, and the covariance structure was analyzed to determine the role of each player group. [Results] Many statistical values were higher in players belonging to the high group. In the high group, the relevant variables were field goals scored, field goals attempted, assists, and turnovers. In the low group, the relevant variables were field goals made, steals, and turnovers. [Conclusion] Many plays related to the ball depended on the high group. High-group players are required to demonstrate strong scoring ability and to reduce turnovers. Conversely, low-group players should increase the numbers of field goals made, increase steals, and reduce turnovers.

Key words: Male wheelchair basketball, International Wheelchair Basketball Federation Classification, Contribution to scoring

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INTRODUCTION

Wheelchair basketball is a competitive sport where players with different functional physical capacities play at the same time. In wheelchair basketball, players are grouped into eight classes (categories) based on their physical capacity to execute fundamental basketball movements1). The International Wheelchair Basketball Federation (IWBF) rates players’ capacities from 1.0 (minimal physical capacity) to 4.5 (maximal physical capacity); the summed ratings of all players on the court must not exceed 14. The capacity rating depends on differences in trunk function. A player rated 1.0 has no active trunk movement in the vertical plane (rotation), has little or no controlled trunk movement in the forward plane, and, when unbalanced, has to rely on his arms to return upright. On the other end of the scale, a player rated 4.5 has complete trunk movement in the vertical plane, in the forward plane, and to both sides1). Players with higher ratings are more advantageous from a competitive point of view. However, in order to score more points, teams must be able to create a variety of situations in which they can take shots. Therefore, teams must carefully consider the
combination of five players and the roles that players in each rating class play.

In basketball, several studies have been conducted to clarify differences in game performance by position and important statistics\(^5\)–\(^7\). However, the few existing studies on performance in wheelchair basketball\(^8\) are simple comparisons between the rating classes. In a previous study, to further elucidate performance differences among wheelchair basketball teams, we considered the relationship between teams’ game scores, on the one hand, and the roles played by players with different rating classifications, on the other. Our data were drawn from the female wheelchair basketball statistics from the Rio 2016 Paralympics\(^8\). We found that high-rated players were required to have high scoring ability, and low-rated players were required, not to score, but to contribute by creating more scoring opportunities.

Compared with women, men have differences in upper body muscular strength and motor ability. These differences could mean that the role of players with each rating classification is different in men’s wheelchair basketball compared with women’s wheelchair basketball. Therefore, the purpose of this study was to clarify how male wheelchair basketball players with different rating classifications contributed to their teams’ scores at the Rio 2016 Paralympics, and to discuss the optimal roles required for successful teams.

**PARTICIPANTS AND METHODS**

The Human Ethics Review Committee of Ibaraki Prefectural University of Health Sciences approved this study (approval no. e132). Since the method for this study was similar to that of our previous report\(^8\), it is described in brief here. Data were drawn from the box scores of all 42 male wheelchair basketball games at the Rio 2016 Paralympics. This included the team’s score (TS) and players’ personal statistics. Twelve countries participated: the United States, Spain, the United Kingdom, Turkey, Brazil, Australia, the Netherlands, Germany, Japan, Iran, Canada, and Algeria. Individual statistics drawn from the box score were: playing time (Min), points (PTS), field goals made (FGM), field goals attempted (FGA), field goal percentage (FG%), free throws made (FTM), free throws attempted (FTA), free throw percentage (FT%), offensive rebounds (OR), defensive rebounds (DR), assists (AS), turnovers (TO), steals (ST), block shots (BS), personal fouls (PF), and fouls drawn (FD).

Following Sampaio et al.\(^2\), we analyzed the statistics of 403 players in games with durations of more than 20 minutes each. In accordance with IWBF classification ratings, players were classified into three groups: low (1.0–2.0 points, 144 players, playing time: 26.5 ± 5.5 mins), middle (2.5–3.5 points, 158 players, playing time: 30.3 ± 6.7 mins), and high (4.0–4.5 points, 101 players, playing time 29.2 ± 6.5 mins).

We conducted one-way analysis of variance to investigate differences in each statistic among the three groups using SPSS version 24. We also created models of how each group contributed to the score by covariance structure analysis using AMOS version 25. Observational variables used in covariance structure analysis were TS and individual statistics (FGM, FGA, FTM, FTA, OR, DR, AS, TO, ST, BS, PF, FD). These items were divided into three major categories: 1) items directly connected to the score (FGM, FGA, FTM, FTA, FD), 2) items related to increasing score opportunities (OR, DR, ST, BS), and 3) items related to reducing opponents’ score opportunities (TO, PF).

Using the comparative fit index (CFI), Root Mean Square Error of Approximation (RMSEA), and Akaike’s Information Criterion (AIC), a properly fit model must have the following fit characteristics: CFI=0.9, RMSEA=0.08\(^9\). In addition, all path coefficients were indicated by standardized estimated values.

**RESULTS**

The descriptive statistics for the individual statistics are summarized in Table 1. PTS, FGM, FGA, FTM, FTA, FT%, DR, and FD were significantly higher in the high group than in the other two groups, and were significantly higher in the middle group than in the low group. There were no significant differences in FG%, OR, AS, TO, ST, and BS between the middle and high groups, but these items were significantly higher in these two groups than in the low group. There were no significant differences in PF among the groups.

**Figures** 1 shows the play model for the high group. In the high group, FGM, FGA, and AS had significant causal relationships with TS. In addition, players with more FGA also had more AS. In category 2, no item had a causal relationship with TS. In the high group, there was a causal relationship between TO and TS. The model fit indices indicated that the model was a good fit (CFI=0.908, RMSEA=0.048, AIC=107.628).

**Figure 2** shows the play model for the low group. In the low group, FGM had significant causal relationship with TS. In addition, players with more FGA also had more AS. In category 2, ST showed a causal relationship with TS. In addition, increased ST resulted in an increase in FGM and AS. In category 3, TO showed a causal relationship with TS. The model fit was also good (CFI=0.922, RMSEA=0.050, AIC=121.852).

DISCUSSION

High scores were recorded for most statistics for players in the high group. This result is similar to our previous finding.
among female players. It can be said that male is also great reliance on players in the high group (who have more trunk function and freedom of movement). However, as mentioned above, it is important what kind of contribution each competitor will make. Therefore, we developed models of play for each group using covariance structure analysis, and we analyzed each group’s contribution to the team’s TS.

FGM and AS were directly linked to the TS; in the high group, there was significant causal relationship between these items and TS. This shows that players in the high group are required to have high scoring ability. However, because the standardized estimation value of FGA was negative, we can conclude that players only took shots with a good probability of

| Table 1. Descriptive statistics for individual game statistics |
|----------------|----------------|----------------|
|                | Low (n=144)   | Middle (n=158) | High (n=101) |
| Points (PTS)   | 3.2 ± 3.8     | 11.5 ± 7.0*    | 14.5 ± 7.3*+  |
| Field goals made (FGM) | 1.4 ± 1.8  | 5.0 ± 3.0*    | 5.9 ± 3.0*+  |
| Field goals attempted (FGA) | 3.5 ± 3.0  | 10.5 ± 5.6* | 13.2 ± 5.2*+ |
| Field goal percentage (FG%) | 32.7 ± 31.6 | 47.38 ± 19.3* | 45.5 ± 18.9* |
| Free throws made (FTM) | 0.3 ± 0.6    | 1.2 ± 1.5*    | 2.0 ± 2.0*+  |
| Free throws attempted (FTA) | 0.6 ± 1.0    | 2.0 ± 2.3*  | 3.2 ± 2.8*+  |
| Free throw percentage (FT%) | 11.8 ± 27.2  | 35.7 ± 39.1* | 48.7 ± 37.4*+ |
| Offensive rebounds (OR) | 0.6 ± 0.8     | 1.3 ± 1.4*   | 1.1 ± 1.2*   |
| Sefensive rebounds (DR) | 1.1 ± 1.1     | 4.0 ± 2.4*   | 6.3 ± 2.8*+  |
| Assists (AS)    | 1.2 ± 1.5     | 3.9 ± 3.4*   | 4.7 ± 3.9*   |
| Turnovers (TO)  | 1.0 ± 1.2     | 2.0 ± 1.5*   | 2.5 ± 2.3*   |
| Steals (ST)     | 0.5 ± 0.8     | 0.9 ± 1.2*   | 1.1 ± 1.2*   |
| Block shots (BS) | 0.1 ± 0.2     | 0.3 ± 0.6*   | 0.3 ± 0.5*   |
| Personal fouls (PF) | 1.9 ± 1.3     | 1.9 ± 1.3   | 2.1 ± 1.2   |
| Fouls drawn (FD) | 0.9 ± 1.1     | 2.8 ± 2.3*   | 4.2 ± 2.7*+  |

*p<0.05 vs. low group, +p<0.05 vs. middle group.

**Fig. 1.** The high group’s scoring contribution model. CFI=0.908, RMSEA=0.048, AIC=107.628, *p<0.05. Paths shows the influence of the item. All path coefficients were indicated by standardized estimated values. Dotted lines shows no significant difference (p>0.05). Model fit was assessed using the comparative fit index (CFI), Root Mean Square, Error of Approximation (RMSEA), and Akaike’s Information Criterion (AIC).

A properly fit model must have the following fit characteristics: CFI>0.9, RMSEA<0.08.

TS: the team's total score; FGM: field goals made; FGA: field goals attempted; FTM: free throws made; FTA: free throws attempted; AS: assists; TO: turnovers; FD: fouls drawn.

**Fig. 2.** The low group’s scoring contribution model. CFI=0.922, RMSEA=0.050, AIC=121.852, *p<0.05. Paths shows the influence of the item. All path coefficients were indicated by standardized estimated values. Dotted lines shows no significant difference (p>0.05). Model fit was assessed using the comparative fit index (CFI), Root Mean Square, Error of Approximation (RMSEA), and Akaike’s Information Criterion (AIC).

A properly fit model must have the following fit characteristics: CFI>0.9, RMSEA<0.08.

TS: the team's total score; FGM: field goals made; FGA: field goals attempted; FTM: free throws made; FTA: free throws attempted; AS: assists; TO: turnovers; FD: fouls drawn.
succeeding. TO was also important, suggesting that players in the high group have to suppress TO to increase opportunities for scoring. These are the same roles required of female players in the high group\(^9\). With regard to the medium group, however, OR was important among female\(^9\), but not male. Thus, high-group players are required to have strong scoring ability among both female and male, but their other roles may differ due to team and individual differences.

Among females, there were no correlations between TS and other variables in the low group\(^8\), but FGM was significant among males. This shows that, although the male low group has fewer opportunities to shoot compared with the high group, these players are still important to the team’s score. We suppose that the difference between males and females in this respect is due to differences in tactics and male is superior to female in muscular strength. Furthermore, there was a significant difference in TS from ST and TO. From this finding, we can conclude that players in the low group are required to contribute to TS by increasing ST and decreasing TO, thereby increasing scoring opportunities. In addition, since ST is significantly related to FGM, stealing may also lead to situations where it is easy for the stealing player to score.

We could not develop a suitable model for the middle group. This result seems to be because the roles of the middle group differ depending on the team and the individuals.

This study had some limitations. We analyzed the statistics of male wheelchair basketball players in the 2016 Paralympic Games, and several important elements were revealed. However, the individual circumstances of players in each country and the resulting differences in play have not been clarified. Future analysis of the individual circumstances of players in each country and video analysis may elucidate more detailed roles and possibly new roles played by players in each capability group.

In conclusion, in male wheelchair basketball, plays more directly involving the ball were associated with players in the high group. These players are required to have high scoring ability and reduce TO. Players in the low group are important to increase FGM and ST, and suppress TO.

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**Conflict of interest**

None.

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