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Relationship between Elite Women's Wheelchair Basketball Skills Testing and Future Success in the Sport

Judy R. Wilson, PhD[1*]; Angela Liegey-Dougall, PhD[2]; Douglas Garner, MS[3]

[1]*Department of Kinesiology, The University of Texas at Arlington, Arlington, Texas 76019, USA*
[2]*Department of Psychology, The University of Texas at Arlington, Arlington, Texas 76019, USA*
[3]*Department of Student Affairs, The University of Texas at Arlington, Arlington, Texas 76019, USA*

[*]***Corresponding author***
Judy R. Wilson, PhD
Associate Professor, Department of Kinesiology, The University of Texas at Arlington, Arlington, TX 76019, USA; Tel. 817.272.3128; Fax: 817.272.3128;
E-mail: jrwilson@uta.edu

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ABSTRACT

Introduction
Wheelchair basketball practices are built around developing technical and tactical skills required in game situations. To assess the performance of these skills, testing protocols have been developed. This allows both player and coach to determine improvements. However, will those who achieve high scores on skills tests be the most successful players on the basketball court during competition?

Purpose
The purpose of this analysis was to determine the relationship between skills test results and performance during competition as determined by the average efficiency scores obtained from box scores from eight basketball games.

Methods
In April 2013, 50 women of the wheelchair basketball teams around the United States, were recommended by their local coaches for consideration for the National Women's Wheelchair Basketball team. Out of which, 25 female wheelchair basketball players were invited to compete for positions on the United States 2014 National Wheelchair Basketball Association (NWBA) Senior Women's National Team. Skills tests were similar to those used at NWBA/PVA (National Wheelchair Basketball Association/Paralyzed Veterans of America) National Wheelchair Basketball Camps. Strength testing assessments were developed by a panel of NWBA Coaches with a history of national and international coaching experience. Nine (of 25) women were chosen for the International Wheelchair Basketball Federation (IWBF) Women's World Wheelchair Basketball Championship in Toronto, June 2014. Descriptive statistics and effect sizes provided preliminary information about the nature of the relationships between skills tests and player game efficiency scores.

Results
Players' rankings on efficiency per minute played at the championship games were compared to each player's respective ranking on the skills tests. A player's rank varied across the skill tests; however, there was consistency between the players' rankings on efficiency per minute played and the passing skills tests. Large effect sizes were found for higher player efficiency ratings per minute played and better dominant (stationary distance r=0.75; moving distance r=0.57) and non-dominant passing (accuracy r=0.70; stationary distance r=0.82; moving distance r=0.87).

Conclusion
Findings may represent that differential skill sets are needed for game performance. Passing, in particular, non-dominant passing skills, may give players an advantage on the court. In contrast, wheelchair basketball players on the court have large variability in the shooting, speed/agility, and strength skills, and these skill sets may be less predictive of court performance.

Keywords
Wheelchair basketball; Competition; Skills tests.

Abbreviations
NWBA: National Wheelchair Basketball Association; IWBF: International Wheelchair Basketball Federation.

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INTRODUCTION

Wheelchair basketball has enjoyed enormous success from its humble beginnings as a means of rehabilitation for World War II veterans who had suffered paralyzing injuries to one of the fastest growing sports for athletes with a disability.[1(p.5-7)] As participation in and the popularity of this sport has grown, so have the coaching techniques and curriculum. As more and more participants of varying levels of skill and aptitude become involved in the sport, it has become apparent that a "standardized comprehensive curriculum would have to be developed" and "a cadre of competent coaches to teach concepts and techniques to participants would have to be identified".[2(p.7)]

Participation in a regular physical activity is important for everyone but is an essential part of the rehabilitation process and certainly for participation in sports competition. This has been seen in an increase in the number of publications involving physical performance and the disabled. Included are measures of aerobic and anaerobic capacities as they relate to functional capacity or classification.[3-6] The International Wheelchair Basketball Federation (IWBF) classification system of eight classes (1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5). The groupings are "based on the player's physical capacity to execute fundamental basketball movements: pushing the wheelchair, dribbling, shooting, passing, catching, rebounding, and reacting to contact." This functional classification system allows even levels of competition on the court for wheelchair basketball based on functional mobility. The higher the player's classification on the court the greater the player's functional ability. The National Wheelchair Basketball Association (NWBA) teams are allowed to play a maximum of 15 points on the court at any given time among the five players.[7]

For athletes participating in any type of competition, it is important to evaluate performance-related components of their particular sport. Skills tests, if they are valid and reliable in reflecting the skills needed, should provide coaches with the ability to assess their players' standard of performance and then individualize instruction and practice.[8] Early efforts by Brasile[9] modified skills tests developed for able-bodied basketball players so they could be used for wheelchair basketball players. Brasile found these acceptable as he consistently found that the top five scorers on the skills tests were the top five athletes and usually composed the starting lineup. Others have adapted these tests in various other research projects[6,10]; however, most studies have evaluated wheelchair basketball skills proficiencies as they relate to disability classification.[6,11,12]

Another research focus has been to link the players' performance to their functional potential. Schmidt et al analyzed elite female wheelchair athletes during a competitive basketball game. After evaluating points scored and other performance measures (rebounds, points, forced turnovers) they were able to demonstrate that athletes reached game level performances in accordance with their functional ability.[13] Further support for this finding came from the evaluation of game-related statistics that differentiated players' classification and their playing positions. Vanlandewijck et al found that high point players performed better than low point players in most of the game-related statistics. Game performance analysis included offensive rebounds, assists and last pass, as well as the number of successful and unsuccessful 2-point field goals and it was concluded that the performance of elite female wheelchair basketball players were dependent on their classification.[14]

Wheelchair basketball is a high intensity, intermittent activity that requires the player to maneuver the chair (propulsion, start, stop and change direction) and handle the basketball by shooting, passing, dribbling, or rebounding.[15] Performance analysis has been suggested as a way to provide the coaches of wheelchair basketball teams with findings to improve training plans and competition management.[16] Gomez et al used game-related statistics from the official box scores for games played during the Beijing Paralympics 2008 and the World Wheelchair Basketball Championship 2010. In the final analysis, field-goals percentage and free throws rate were the most important factors in men's games while field-goals percentage and offensive rebounding percentage were important in women's games. While the quality of the opponent has a great effect in the final point differential, performance analysis provides information to improve training sessions and prepare players for competition.

The purpose of this project was to understand relationships between training, current use of skills testing and success in wheelchair basketball during competitive game situations. By understanding which skills translate to successful performance during competition, coaches will be aware of the best skills to focus on during practices. Essentially, are current training methods to improve skills and physical capacity related to success in a wheelchair basketball game?

METHODS

Fifty women, who were members of wheelchair basketball teams (with an average of 10 years of experience) around the United States, were recommended by their local coaches for consideration for the National Women's Wheelchair Basketball team. These recommendations were evaluated by the coaches for the National Women's Wheelchair Basketball team and 25 women were selected and invited to the Lakeshore Foundation/USA Olympic and Paralympic Training Center, Birmingham, AL, USA to attend and participate in skills tests and training camps to compete for a position on the 2014 National Women's Wheelchair Basketball team.

The wheelchair athletes were grouped according to the International Wheelchair Basketball Federation classification system (1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5).[7] These women went through a series of skills tests similar to those published by Brasile and Hedrick[17] and included tests to evaluate strength, speed and agility, shooting and passing, the validity of which have been established previously. Each player was ranked according to the results of their skills tests as well as value points. The "value points" were based on the efficiency ratings that the athletes achieved in scrimmages, received from coaches voting in the selection committee meetings and number of wins during scrimmages. The coaching staff of the National team and coaches from around the country who had been invited to be part of the selection committee, made

the final decision as to which players would make the National Women's Wheelchair Basketball team.

These tests consisted of measurements of strength and conditioning [12 min push (# or laps), bench press – the maximum weight that can be lifted one time or 1 repetition maximum (1 RM), 75% body weight, chin-ups, dips, Medicine Ball (distance ft)], speed [Star drill, initial 15', after initial 50', ¼ court dribbling (agility, no hands)], passing (accuracy in passing – dominant and non-dominant, Lob passing-L, Lob passing-R, distance passing (Stationary dominant and non-dominant) distance passing (moving dominant and non-dominant), and shooting [12' shot (A,B,C,D,E), 12' shot/total made, 12' shot/total taken, 12" shot %, 3 pt shot, free throws, free throws %, Lay ups (R&L), left side layups made/taken, non-dominant shooting/made].

Nine of the 25 players were selected for the National Women's Wheelchair Basketball team and competed in the Women's World Wheelchair Basketball Championship held in Toronto, Ontario, Canada in June 2014. Team USA came in fourth place. Player efficiency ratings and minutes played from each of the eight championship games were obtained from the official score report. Efficiency ratings were totalled and then divided by the sum of minutes played to create the final "efficiency per minute played." Players who completed the skills tests during the training camp were then ranked based on their respective "efficiency per minute played" values and these rankings were visually compared to each player's respective ranking on each of the skills tests. For presentation purposes, the team was divided into two groups by classification (players with the functional classifications of 1.0, 1.5 and 2.0 represented Group 1 and players with the functional classification of 2.5, 3.0, 3.5, 4.0 and 4.5 represented Group 2) because there were not enough participants in each classification to conduct analyses. Finally, Spearman rho correlation coefficients were calculated as preliminary indicators of effect size for the relationships between each of the skills tests rankings and the rankings on efficiency per minute played.

Player efficiency ratings are based on playing performance during their minutes of playing time. The various skills have been given point values that can be either positive or negative and are similar to those developed by Byrnes and Hedrick.[18(p.79)] Examples would be 2-point field goal made (+2); a 3-point field goal made (+6); personal fouls (-2), etc. Basketball spotters keep track of each player's performance and the results are then analyzed by standard Basketball Analytical software which provides the player efficiency ratings. The player efficiency ratings were included in the Box Scores in the official results book from the June 20-28, 2014 Women's World Wheelchair Basketball Championship.

Data analyses focused on describing the relationships between the skills tests and player efficiency ratings rather than significance levels due to the small sample size in the analyses (n=9). There was not sufficient power to perform statistical significance tests (e.g., interpret significant correlation coefficients or perform multivariate regression analyses). However, a preliminary indication of the magnitude of these effects was examined by evaluating the effect size using Spearman correlation coefficients as indicators of effect size with Cohen's guidelines for interpreting small (r=0.10), medium (r=0.30), and large (r=0.50) effect sizes.[19] Spearman correlation coefficients were used instead of Pearson because of the small sample size and non-normal distributions.

RESULTS

In order to examine whether there were any patterns in the data suggesting that players who ranked high on certain skills tests also ranked high on efficiency per minute during the championship games, we examined players' relative rankings on these variables (Tables 1-4). While a player's rank fluctuated from skill to skill, it was notable that the most consistency in rankings appeared between efficiency per minute played and the passing skills tests.

Table 1. *Responses of Coaches, Administrative Officials and Trainees about Scouting and Developmental Pathways of Coaches and Trainees*

	Strength Skills Tests Rankings						
Classification	**Efficiency Per Minute Ranking**	**12 min push-laps**	**Bench Press 1-Rep Max**	**75% Body Weight**	**Chin ups reps**	**Dips reps**	**Med ball distance(ft)**
Class: ≥2.5							
Player A	1.0	8.0	6.5	2.0	9.0	8.0	2.0
Player B	2.0	2.0	2.0	3.0	4.0	7.0	3.5
Player C	3.0	4.0	6.5	1.0	8.0	9.0	1.0
Player D	5.0	6.5	1.0	7.0	1.0	1.0	3.5
Player E	6.0	4.0	4.0	4.0	2.0	2.0	5.5
Class: ≤ 2							
Player F	4.0	1.0	6.5	8.5	6.0	5.0	9.0
Player G	7.0	9.0	6.5	8.5	5.0	6.0	8.0
Player H	8.0	4.0	3.0	6.0	3.0	3.0	5.5
Player I	9.0	6.5	9.0	5.0	7.0	4.0	7.0

Table 2. *Rankings on Efficiency per Minute Played Compared To Rankings on the Speed and Agility Skills Tests*

	Strength Skills Tests Rankings					
Classification	**Efficiency Per Minute Ranking**	**Initial Speed 15'**	**Max Speed 15' after initial 50'**	**Overall Speed 20M**	**1/4 Court Dribbling**	**Star Drill**
Class: ≥2.5						
Player A	1.0	5.0	8.0	6.0	6.0	6.0
Player B	2.0	3.0	2.0	1.0	1.0	2.0
Player C	3.0	6.0	5.0	7.0	7.0	7.0
Player D	5.0	4.0	3.0	2.0	3.0	8.0
Player E	6.0	1.0	6.0	4.0	5.0	4.0
Class: ≤ 2						
Player F	4.0	7.0	1.0	3.0	4.0	9.0
Player G	7.0	2.0	7.0	5.0	2.0	1.0
Player H	8.0	8.0	9.0	9.0	8.0	3.0
Player I	9.0	9.0	4.0	8.0	9.0	5.0

Table 3. *Rankings on Efficiency per Minute Played Compared To Rankings on the Shooting Skills Tests*

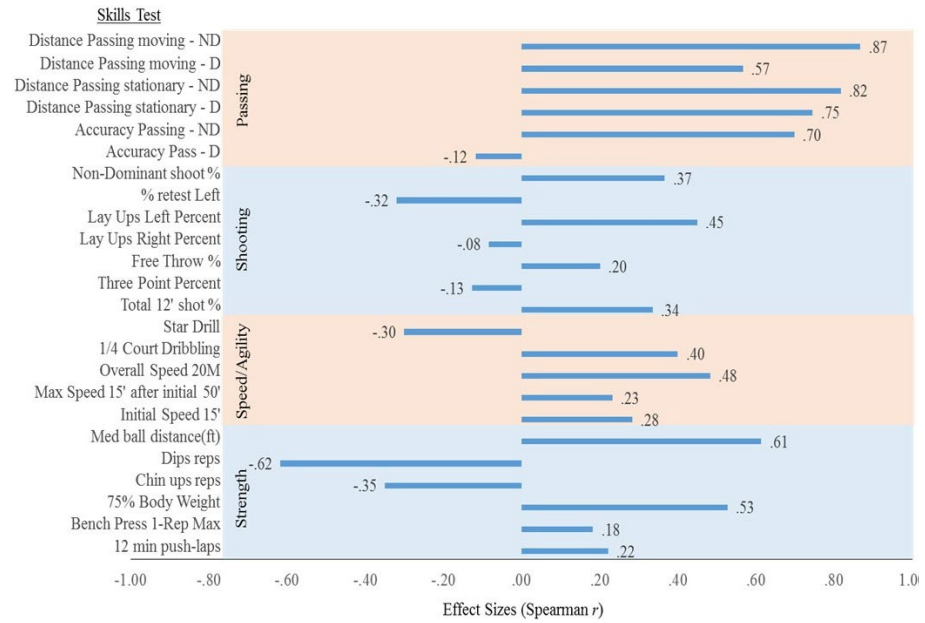
	Strength Skills Tests Rankings							
Classification	**Efficiency Per Minute Ranking**	**Total 12' shot %**	**Three Point Percent**	**Free Throw %**	**Lay Ups Right Percent**	**Lay Ups Left Percent**	**% retest Left**	**Non-Dominant shoot %**
Class: ≥2.5								
Player A	1.0	1.0	2.5	1.0	6.0	7.0	4.0	4.0
Player B	2.0	3.5	9.0	2.5	4.0	1.0	7.0	5.0
Player C	3.0	9.0	6.5	6.0	7.0	6.0	3.0	2.0
Player D	5.0	6.5	5.0	8.0	3.0	4.0	9.0	6.0
Player E	6.0	5.0	1.0	9.0	1.0	3.0	8.0	3.0
Class: ≤ 2								
Player F	4.0	3.5	4.0	7.0	8.0	2.0	5.5	7.0
Player G	7.0	6.5	8.0	5.0	5.0	5.0	5.5	1.0
Player H	8.0	2.0	6.5	2.5	2.0	9.0	1.5	9.0
Player I	9.0	8.0	2.5	4.0	9.0	8.0	1.5	8.0

Table 4. *Rankings on Efficiency per Minute Played Compared To Rankings on the Passing Skills Tests*

	Strength Skills Tests Rankings						
Classification	**Efficiency Per Minute Ranking**	**Accuracy Pass (D)**	**Accuracy Passing (ND)**	**Distance Passing stationary (D)**	**Distance Passing stationary (ND)**	**Distance Passing moving (D)**	**Distance Passing moving (ND)**
Class: ≥2.5							
Player A	1.0	1.0	1.5	1.0	1.0	4.0	1.0
Player B	2.0	5.0	4.0	4.0	5.0	2.0	2.0
Player C	3.0	9.0	5.0	2.0	2.0	5.0	5.0
Player D	5.0	7.5	1.5	5.0	3.0	3.0	3.0
Player E	6.0	7.5	3.0	3.0	4.0	1.0	4.0
Class: ≤ 2							
Player F	4.0	6.0	6.5	7.5	6.0	6.0	6.0
Player G	7.0	2.0	6.5	7.5	7.0	9.0	7.0
Player H	8.0	3.5	8.0	6.0	8.0	7.0	8.0
Player I	9.0	3.5	9.0	9.0	9.0	8.0	9.0

D=Dominant, ND=Non-dominant.

Figure 1. *Spearman Correlation Coefficients as Indicators of Effect Size for Relationships between Efficiency Ratings Per Minute Played and The Strength, Speed and Agility, Shooting, and Passing Tests.*



Spearman correlation coefficients were calculated using the ranked data to determine preliminary effect sizes to judge the magnitude of the relationship between these rankings (Figure 1). Large effect sizes were found for the relationship between higher efficiency ratings per minute played and better passing skills, particularly the passing skills that involved the use of the non-dominant hand. These relationships appeared to be driven by very strong relationships between non-dominant passing and player efficiency ratings per minute played among the players in Class 2 or below (Table 4).

Additional large effect sizes were found for higher efficiency per minute played and higher medicine ball distance and repetitions at 75% body weight rankings, but with lower ranking on dips repetitions.

DISCUSSION

The goal in conducting the analyses in the current study was to determine which skills evaluated during practices contributed the most to winning during actual game competition. If it can be determined which skills are most effective during the competition, then coaches could design practices that would emphasize the relevant skills. Our preliminary findings suggest that development of non-dominant passing skills, especially among players in Classes 1, 1.5, or 2, may improve overall player efficiency ratings during gameplay. This finding is supported by previous studies. Stockel and Weigelt found that skilled use of the non-dominant hand was crucial for successful play at higher competitive levels in the sport of basketball. As the level of competition increased, there was less reliance on the dominant hand.[20]

The current study suggested passing skills as possible mechanisms to explain the relationship between functional potential and field performance. This contrasted with previous analyses of player performance during wheelchair championship games that revealed that shooting skills were related to game performance and it was further determined that female wheelchair athletes from the "best" teams had higher shooting efficiency and significantly higher graded gameplay values when compared to players from the "weakest" teams.[16] Gomez et al[16] also found that field-goal percentage and free-throws rate were the most important factors in men's games while field-goals percentage and offensive rebounding percentage of women's games were the most important factors for winning. Together, these findings suggest that identifying relevant skills and trends toward success on the court will help wheelchair basketball coaches plan accurate practice sessions.

While these findings are illuminating, they should be viewed with caution. Due to the nature of basketball teams, our sample size was necessarily limited. It was limited further because three of the twelve national team members did not complete the skills testing. Although, we used rankings and effect sizes rather than statistical tests and p values, the power of the study was limited. It may be worthwhile to consider testing of specific skills throughout team practices to get a complete picture of the relationships between skills acquisition and game performance. This approach would allow also for a longitudinal assessment of the development of skills over the course of training and allow for examination of specific training approaches. Additionally, the skills tests may have been vulnerable to bias or low validity; however, most of the skills tests were derived from Brasile's original work and have been validated by Brasile and others.[8,10,11]

It is important to note the success of the NWBA Women's Wheelchair Basketball Team in the overall tournament. With a fourth place finish, three teams were able to successfully defend-

against the U.S. team thus decreasing their ability to score points and prevent the opposing team from scoring. These results are reflected in lower player efficiency ratings.

The results of this study indicate the importance of evaluating performance-related components of any sport. However, the question remains as to what are the best skills that can be tested that will correlate with success on the court during gameplay. There is a lack of longitudinal data on skills measured during junior programs that can be monitored through intercollegiate and international play. These data could be correlated to box scores and help determine which best represent success during gameplay. At any level, determining baseline measurements of wheelchair basketball skills can indicate the weaknesses and strengths of the players that then provide the basis for practice and training.

In addition to the skills of the players, rankings from the results of the skills tests are often adjusted based on the coaches' subjective rankings. Coaches evaluate the "intangibles" such as "court sense," "decision-making" in game situations, and communication between players for which no skills tests exist. Simply ensuring that a player is in the correct chair can optimize their capabilities and could make a difference in their performance. Future research in this area will allow coaches to individualize instruction and practices for each player to maximize their capabilities. However, we are still left with the question as to the best way to enhance gameplay performance.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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