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Article

Performance Analysis Using the Classification Composition and Match Records in Wheelchair Basketball

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Abstract: This study analyzes groups about game performance elements and sport class composition in each country by utilizing official records provided by major international wheelchair basketball games. To achieve the objective of this study, major game factors were explored by analyzing descriptive statistics in each year regarding the latest trend of sport class composition and playing time of each sport class and conducting the difference test between the groups. To analyze performance details of international wheelchair basketball games, this study selected official records of 209 games of 24 teams that participated in major international wheelchair basketball games. A test for difference also was conducted to examine the sport class composition, playing time, and game details of each group. First, scoring factors directly affecting the game results were compared between the groups. The result of this difference test shows that the success rate of 2-point and 3-point shots was significantly different except for the free throw success rate. The numbers of assists, defense rebounds, and steals were significantly different. Second, the medal group was compared with the other group, the average class of the other group's participation in quarters was higher than that of the medal group and the difference was significant. Regarding the difference between groups in terms of game performance, the difference in playing time between the medal group and the other group was in the order of 2.5 points, 4.0 points, 3.0 points, and 1.5 points. Third, given the general trend in 2012 to 2022 international events, the sport class composition and para-athlete played minutes in quarterly participation changes.

Keywords: wheelchair basketball; classification; performance; trend analysis

1. Introduction

Wheelchair basketball is one of the most popular official events in the paralympic games. Since 1964 when it was selected as an official game event at Tokyo Paralympic Games, wheelchair basketball has been spread all over the world for more than 60 years. Furthermore, the paralympic games held quadrennially, world championship games and regional international competitions continue to be held under the supervision of the IWBF (International Wheelchair Basketball Federation) for encouraging para-athletes to participate and compete in order to achieve their potential. From 2012 to 2022, about 27 countries participated in world championship games and Paralympic Games of wheelchair basketball, and as of 2024, member countries of the IWBF (International Wheelchair Basketball Federation) include 24 in Africa, 21 in America, 28 in Asia and Oceania, and 36 in Europe, about 289 players from 109 countries in total. From 2020, 10 international competitions are held annually. Wheelchair basketball leagues are actively conducted around the globe including Europe, North America, Asia, and so forth (17). As wheelchair basketball events have become common and grown so far, para-athlete's personal skills and team performances in world championships and Paralympic Games have been improved significantly. As a result, the global competitiveness is intense with more diversified strategies required than ever before in preparation for each competition (7). Basketball games have the fast transition between offense and defense, requiring fast and delicate judgment because the game result may be changed within seconds. To

secure winning and outstanding performance of the team, the optimized team of players is organized for each game (13). Particularly in contemporary basketball, roles are specifically divided among 5 players for certain strategies and tactics, which certainly decide the victory and defeat of the game. In team sports, an athlete's individual skill is an important factor, but the team's organization and tactics are also key to winning (20,21,25). Similarly, in wheelchair basketball, player selection can be a factor for winning, but due to the 'Sport Classification System', it has to be organized in a different way than in basketball. In particular, due to the decreasing number of international competition games and changes in the classification of para-athletes, the major national teams(United Stated America, Great Britain, Australia, etc.) are no longer relying on individual performance, but on team cohesion and tactics to win matches. Furthermore, the overall trend of major countries is to select the national team by identifying the appropriate combination of players and the sum of their classifications to maximize the performance and teamwork. In other words, in order to formulate a strategy, match analysis of wheelchair basketball needs to analyze not only the match factors that affect the match results, but also the factor analysis related to each player's sport class points as a major part of the team performance characteristics (21).

In general, basketball playing styles and roles change depending on the international trend, and training methods also change accordingly (10). For example, Štrumbelj et al. (29) points out that ever since 2001 when the shot clock changed from 30 seconds to 24 seconds, the numbers of team offenses, earning scores, and two-point shots increased during the 10 seasons, whereas the number of 3-point shots decreased. As the number of three-point attempts in international basketball has increased over time since 2010, and as offensive and defensive transitions have become faster, teams have demanded players to attack using a space and defend in various patterns (23). Like that, players are given various roles and many different training methods also are applied flexibly in line with the international trend.

Similar to the changes in Basketball mentioned above, wheelchair basketball has also seen changes to the rules and the way the game gets played. For example, the sport classification in wheelchair-basketball was changed into the form of evidence-based in 2016 Rio Paralympic Games and the new minimum impairment criteria were applied in 2021 Tokyo Paralympic Games. Factors affecting sport performance in para sports include participants classification, health condition, training method among which classification factors vary significantly by player's function. Therefore, understanding the sport classification factors and playing time among countries known for major team's performance will be a vital factor in deciding strategies.

Although such research is not relatively active in the scope of wheelchair basketball, the game operation is similar to that of ordinary basketball and thus strategies may be established based on similar analytic approaches for game performance improvement. Previous studies in wheelchair basketball have been mainly about focusing on physical abilities (12, 18, 26, 34) and analyses of victory and defeat based on team records (9, 32).

Additionally, sport class factors which are a deciding characteristic when it comes to wheelchair basketball are major elements in analytic approaches for game performance improvement. However, previous studies on the sport class of wheelchair basketball focused on kinematics, and differences in skills and physical functions related to each player's points in terms of sports medicine (3, 6, 11, 31, 33). Such analyses merely on individual players' physical functions and abilities as in previous studies have limitations in understanding major factors affecting wheelchair basketball game performance.

Given the limitations of previous research, as mentioned earlier, the association among sport performance, sport-class composition(classification) and match results needs to be investigated. Additionally, considering the difference results between groups, it may potentially approach to new factors such as specific player rating and playing time of each player depending on their points in this rating.

2. Materials and Methods

2.1. Data Collection

To analyze performance details of international wheelchair basketball games, this study selected official records of 209 games of 24 teams that participated in major international wheelchair basketball games from August 30, 2012, to June 20, 2023 (n=418). This study collected data mainly from official records available at the IWBF's website (https://iwbf.org/, accessed on 12 March 2024). Furthermore, we obtained the sport class composition of each quarter through videos in the official websites of the IWBF and FIBA as well as YouTube. However, as shown in Table 1, we removed those that did not have uploaded videos or did not accurately display the official results.

Table 1. The number of 2012-2022 World Championships and Paralympic Games.

Event	Number	Remark
2012 London Paralympics	38	Not uploaded 6 games
2016 Rio Paralympics	42	
2018 Hamburg World Championships	41	Not uploaded 7 games
2020 Tokyo Paralympics	41	Not uploaded 1 game
2022 Dubai World Championships	47	Data missing 6 games
Total	209	

2.2. Data Varables and Processing

First, descriptive statistics analysis was performed on collected match records with the average and standard deviation calculated. Second, the non-parametric statistics technique "Mann-Whitney U Test" was performed to verify differences in the match results, sport class composition, and playing time (see Table 2) using IBM SPSS 27.0 program.   The current study used the acquisition medal in each event to determine the sport level. Since the difference in number between the medal group and the other group was significant and the basic assumption of parametric statistics (normality test) failed, the non-parametric statistics method was applied instead. The statistical significance level was set to .05. Third, trends were analyzed on international wheelchair basketball games in each year. Game trends were analyzed based on descriptive statistics of annual match records. To be specific, trend analysis is used to identify the records and para-athletes and teams for checking the performance contents of national athletes, and to set target standards to promote performance in international sports competitions (22). Therefore, the trend information applied in this study can be used as a basis for composing the wheelchair basketball to line-up and training by checking trends in the performance of major countries in international wheelchair basketball competitions.

Step 1	Understanding of general game results based on descriptive statistics

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Step 2	Understanding of international wheelchair basketball game trends based on annual game results

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Step 3	Understanding of major factors based on a non-parametric difference test between groups

Figure 1. Data processing structure.

Table 2. Research subjects and variables.

Subject	Variable	Subject	Variable
1QSC	1st quarter Sport Class Composition	2PA	2-Points Attempt
2QSC	2nd quarter Sport Class Composition	2P%	2-Points Shooting Percentage
3QSC	3rd quarter sport class Composition	3PM	3-Points Made
4QSC	4th quarter sport class Composition	3PA	3-Points Attempt

1.0 played minutes	1.0-point player played minutes	3P%	3-Points Shooting Percentage
1.5 played minutes	1.5-point player played minutes	FTM	Free Throw Made
2.0 played minutes	2.0-point player played minutes	FTA	Free Throw Attempt
2.5 played minutes	2.5-point player played minutes	FT%	Free Throw Percentage
3.0 played minutes	3.0-point player played minutes	OR	Offensive Rebounds
3.5 played minutes	3.5-point player played minutes	DR	Defensive Rebounds
4.0 played minutes	4.0-point player played minutes	TOT	Total Rebounds
4.5 played minutes	4.5-point player played minutes	AS	Assists
PTS	Points	TO	Turnovers
FGM	Field Goals Made	ST	Steals
FGA	Field Goals Attempt	BS	Block Shots
FG%	Field Goals Shooting Percentage	PF	Personal Fouls
2PM	2-Points Made		

3. Results

3.1. Descriptive Statistics

Descriptive statistics are presented in Table 3. As for results depending on the sport class, sport classes competing in each quarter were given almost 14 points. The playing time of each sport class was 17:44 minutes for players of 1.0 points, 18:53 minutes for players of 1.5 points, 17:46 minutes for players of 2.0 points, 18:47 minutes for players of 2.5 points, 21:12 minutes for players of 3.0 points, 15:02 minutes for players of 3.5 points, 16:52 minutes for players of 4.0 points, and 17:55 minutes for players of 4.5 points. In general, players of 1.5 points, 2.5, points, and 3.0 points were given longer playing time than others. In review of game results, the average score of each game was 61.94. The numbers of successful field shots and attempts were 26.50 and 59.94 respectively. The numbers of successful 2-point shots and attempts were 24.64 and 52.35 respectively. The numbers of successful 3-point shots and attempts were 1.86 and 7.61 respectively. The numbers of successful free throws and attempts were 7.09 and 12.35 respectively. The numbers of offense rebounds and defense rebounds per game were 8.22 and 26.22. The numbers of assists, steals, block shots, turnovers, and errors were 19.61, 5.13, 0.85, 12.25, and 15.60 respectively.

Table 3. Descriptive statistics on games.

Variables	N	Mean	SD	Variables	N	Mean	SD
1QSC	418	13.92	0.224	2PA	418	52.35	7.353
2QSC	418	13.91	0.228	2P%	418	46.71	9.127
3QSC	418	13.88	0.280	3PM	418	1.86	1.637
4QSC	418	13.90	0.280	3PA	418	7.61	4.344
1.0 played minutes	408	17:44	7:44	3P%	418	24.24	20.229
1.5 played minutes	250	18:53	8:53	FTM	418	7.09	4.284
2.0 played minutes	291	17:46	9:25	FTA	418	12.35	6.627
2.5 played minutes	290	18:47	9:43	FT%	418	55.74	19.522
3.0 played minutes	347	21:12	9:27	OR	418	8.22	3.719
3.5 played minutes	264	15:02	9:54	DR	418	26.22	5.440
4.0 played minutes	356	16:52	9:08	TOT	418	34.44	6.790
4.5 played minutes	339	17:55	8:44	AST	418	19.61	6.025
PTS	418	61.94	15.034	STL	418	5.13	3.162
FGM	418	26.50	6.585	BLK	418	0.85	1.140
FGA	418	59.94	6.544	TO	418	12.25	5.397
FG%	418	43.99	9.000	PF	418	15.60	4.602
2PM	418	24.64	6.511				

3.2. Difference Test

The second set of research findings is about the difference in match records from 2012 to 2023 between the groups. In view of the difference test results between groups particularly regarding the sport class, the medal group showed a higher level of points in the average quarterly rating (1Q: 14 points, 2Q: 13.96 points, 3Q: 13.98 points, 4Q: 13.96 points) than the other group (1Q: 13.89 points, 2Q: 13.89 points, 3Q: 13.85 points, 4Q: 13.88 points), and the difference was significant. In addition, the playing time depending on the points of the medal group was as follows: 2.5 points (22:21), 3.0 points (19:05), 2.0 points (17:51), 4.5 points (17:34), 1.0 points (16:37), 1.5 points (16:15), 3.5 points (14:55), and 4.0 points (14:46) in order. That of the other group was as follows: 3.0 points (22:04), 1.5 points (19:21), 1.0 points (18:08), 4.5 points (18:03), 2.0 points (17:45), 4.0 points (17:38), 2.5 points (16:49), and 3.5 points (15:05) in order. The difference in playing time between the medal group and the other group was in the order of 2.5 points (p=.001), 4.0 points (p=.001), 3.0 points (p=.002), and 1.5 points (p=.025). This shows that the difference in playing time was significant.

Table 4. Difference test depending on the quarterly sport class composition, playing time in groups.

Variables	Medal group		Non-Medal group		Mann-Whitney U	Sig
	Mean	SD	Mean	SD		
1QSC	14.00	.001	13.89	.255	13788.500	**.001**[*]
2QSC	13.96	.183	13.89	.241	14873.500	**.003**[*]
3QSC	13.98	.118	13.85	.310	13382.000	**.001**[*]
4QSC	13.96	.155	13.88	.309	14841.000	**.004**[*]
1.0 played minutes	16:37	7:53	18:08	7:39	14693.500	.152
1.5 played minutes	16:15	7:11	19:21	9:05	3106.000	**.025**[*]
2.0 played minutes	17:51	8:59	17:45	9:36	8193.000	.858
2.5 played minutes	22:21	9:21	16:49	9:24	6620.500	**.001**[*]
3.0 played minutes	19:05	11:19	22:04	8:27	9704.000	**.002**[*]
3.5 played minutes	14:55	8:08	15:05	10:29	6499.000	.522
4.0 played minutes	14:46	10:09	17:38	8:37	9652.500	**.001**[*]
4.5 played minutes	17:34	7:32	18:03	9:08	10748.500	.503

In view of match records, the success rates of 2-point shots and 3-point shots showed a significant difference except the free throw success rate. The most significant difference was observed in the 3-point shots success rate (p=.001): that of the other group was 1.83 out of 8.01 attempts while that of the medal group was 1.93 out of 6.49 attempts. This means that the success rate of the medal group (31.41%) was 9.69% higher than that of the other group (21.72%). As for the success rate of 2-point shots (p=.001), that of the other group was 23.46 out of 51.30 attempts while that of the medal group was 28.07 out of 55.35 attempts. This means that the success rate of the medal group (50.73%) was 5.4% higher than that of the other group (45.33%). In contrast, the free throw success rate of the other group was 6.86 out of 12.17 attempts while that of the medal group was 7.79 out of 12.95 attempts. Thus, the success rate of the medal group (57.64%) was 2.47% higher than that of the other group (55.17%), which means that the difference is statistically insignificant. In each wheelchair basketball game, the average numbers of offense rebounds, defense rebounds, steals, and block shots were 8.22, 26.22, 19.61, 5.13, and 0.85 respectively. As these records were comparatively analyzed regarding game performance between the medal group and the other group, the difference in terms of assist, defense rebound, and steal was significant. First, the number of assists (p=.001) in the medal group (22.94) was 4.47 more than that in the other group (18.47), which is a significant difference. The number of defense rebounds (p=.008) in the medal group (27.38) was 2 more than that in the other group (25.38), which is a significant difference. The number of steals (p=.016) in the medal group (5.95) was 1.11 more than that in the other group (4.84), which is a significant difference. The number of turnovers (p=.001) in the medal group (9.40) was 3.82 less than that of the other group (13.22), which is a significant difference. The number of fouls (p=.001) in the medal group (13.98) was 2.19 less than that of the other group (16.17), which is a significant difference.

Table 5. Difference test on game result in groups.

Variables	Medal group		Non-Medal group		Mann-Whitney U	Sig
	Mean	SD	Mean	SD		
PTS	69.75	10.490	59.28	15.453	9700.500	**.001***
FGM	30.01	4.715	25.29	6.725	9409.000	**.001***
FGA	61.83	5.918	59.28	6.645	13034.500	**.001***
FG%	48.58	6.293	42.42	9.278	9858.500	**.001***
2PM	28.07	4.852	23.46	6.612	9464.500	**.001***
2PA	55.35	6.102	51.30	7.462	11582.000	**.001***
2P%	50.73	6.747	45.33	9.462	10927.000	**.001***
3PM	1.93	1.500	1.83	1.687	15951.000	.401
3PA	6.49	3.697	8.01	4.482	13514.000	**.002***
3P%	31.41	23.393	21.72	18.399	12586.500	**.001***
FTM	7.79	4.436	6.86	4.210	14804.000	.060
FTA	12.95	6.536	12.17	6.660	15681.000	.284
FT%	57.64	17.788	55.17	20.061	15149.000	.118
OR	8.35	3.550	8.16	3.781	16398.000	.682
DR	27.38	5.286	25.83	5.456	13988.000	**.008***
TOT	35.73	5.952	33.99	7.031	13906.000	**.007***
AST	22.94	4.956	18.47	5.948	9525.000	**.001***
STL	5.95	3.937	4.84	2.806	14242.000	**.016***
BLK	1.04	1.380	.79	1.040	15390.000	.148
TO	9.40	3.701	13.22	5.552	9958.500	**.001***
PF	13.98	4.937	16.17	4.343	12346.000	**.001***

3.3. Trend Analysis

The third set of research findings is about the trend in descriptive statistics of match records from 2012 to 2022. As to changes depending on the sport class, the quarterly sport class composition tended to decrease. As to the playing time depending on the range of points, that of 1.0 points, 2.5 points, 3.0 points, and 4.5 points decreased while that of 1.5 points, 2.0 points, 3.5 points, and 4.0 points increased. As to the playing time depending on the range of points, that of 1.0 points, 2.5 points, 3.0 points, and 4.5 points decreased while that of 1.5 points, 2.0 points, 3.5 points, and 4.0 points increased. Particularly, the playing time of wheelchair basketball players of a mild case (4.5 points) decreased as much as about 5:07 minutes. In contrast, that of players of 3.5 points and 4.0 points increased as much as 3:09 minutes and 3:47 minutes respectively.

Table 6. Trend of quarterly sport class composition and playing minutes in 2012 to 2022.

Variables	2012		2016		2018		2020		2022	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1QSC	13.95	.247	13.92	.187	13.89	.261	13.96	.141	13.89	.253
2QSC	13.99	.081	13.92	.198	13.90	.269	13.90	.219	13.87	.286
3QSC	13.94	.182	13.91	.193	13.85	.280	13.90	.228	13.83	.412
4QSC	13.95	.193	13.90	.277	13.92	.215	13.90	.214	13.83	.405
1.0 played minutes	20:09	6:44	17:49	6:20	13:48	6:09	20:56	10:45	16:28	5:38
1.5 played minutes	17:56	8:20	17:54	6:56	15:59	10:07	21:15	9:11	21:25	8:36
2.0 played minutes	15:59	9:43	19:35	8:03	18:37	10:44	17:50	9:22	16:45	8:50
2.5 played minutes	18:02	7:07	20:11	7:29	16:35	10:06	21:31	10:34	17:25	10:48
3.0 played minutes	21:32	8:36	23:08	7:34	21:35	11:12	20:38	10:05	19:04	8:53
3.5 played minutes	11:31	6:39	16:44	9:11	16:36	14:01	16:08	8:37	14:10	7:35
4.0 played minutes	15:30	7:33	17:38	7:45	13:53	8:54	17:58	8:43	19:17	8:17
4.5 played minutes	22:16	7:37	18:03	8:24	13:24	7:21	19:22	8:34	17:09	9:13

As time passed, one competition after another, the general scores and numbers of field shots, 2-point shots, free throws, rebounds, assists, block shots, and personal fouls decreased in general while 3-point shot success rates and numbers of attempts, steals, and turnovers increased.

Particularly, the numbers of 3-point shot successes and attempts increased as much as 0.74 and 3.64 respectively in 2023 compared to those in 2012. The 2-point shot success rate also increased. The number of steals increased as much as 1.75 and that of turnovers 0.22 in 2023 compared to those in 2012 respectively.

Table 7. Trend of game results in 2012 to 2022.

Variables	2012		2016		2018		2020		2022	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
PTS	62.79	12.596	61.62	14.702	62.62	11.847	61.65	12.080	61.18	21.011
FGM	26.63	5.396	26.32	6.632	26.94	5.201	26.56	5.444	26.11	9.055
FGA	59.68	5.951	58.94	6.489	60.09	5.782	62.13	6.061	58.99	7.656
FG%	44.67	8.211	44.38	8.782	44.83	7.782	42.68	7.491	43.49	11.641
2PM	25.41	5.315	24.23	6.751	25.11	5.214	24.45	5.416	24.15	8.736
2PA	54.63	5.501	50.62	7.832	52.63	5.929	53.95	6.350	50.40	9.187
2P%	46.49	8.488	47.38	8.918	47.66	8.386	45.17	7.954	46.79	11.169
3PM	1.22	1.184	2.10	1.767	1.83	1.464	2.11	1.757	1.96	1.759
3PA	5.05	3.233	8.32	4.443	7.45	3.411	8.18	3.676	8.69	5.420
3P%	24.17	26.033	24.45	17.171	24.35	18.666	24.46	16.862	23.81	21.769
FTM	8.30	4.336	6.88	3.698	6.91	4.284	6.44	4.006	7.01	4.827
FTA	14.61	6.999	12.01	6.083	11.77	6.270	11.34	6.149	12.20	7.191
FT%	56.40	16.559	58.31	18.699	55.27	21.607	53.97	20.536	54.85	19.791
OR	8.74	3.616	7.94	3.316	8.71	3.707	8.18	3.775	7.68	4.062
DR	26.71	5.659	26.44	5.389	26.12	4.623	28.67	5.159	23.55	5.140
TOT	35.45	6.898	34.38	6.577	34.83	5.370	36.85	6.466	31.23	7.191
AST	19.36	5.174	20.58	6.334	19.30	5.298	21.44	5.200	17.64	7.034
STL	3.53	2.306	5.67	3.469	5.66	3.183	5.39	2.792	5.28	3.390
BLK	1.11	1.014	1.30	1.612	0.67	1.101	0.72	0.836	0.51	0.786
TO	11.54	4.374	13.56	5.613	12.84	5.290	11.54	4.606	11.76	6.422
PF	17.63	4.738	16.08	4.314	14.60	3.820	15.23	4.392	14.73	5.038

4. Discussion

The main objective is to provide basic data for game performance improvement by examining the recent trend of sport class composition as well as deciding factors of wheelchair basketball. To achieve the objective of this study, official records and game videos of 209 Paralympic Games and wheelchair basketball world championship games were collected, and 418 match records in total were analyzed including the rating in each country.
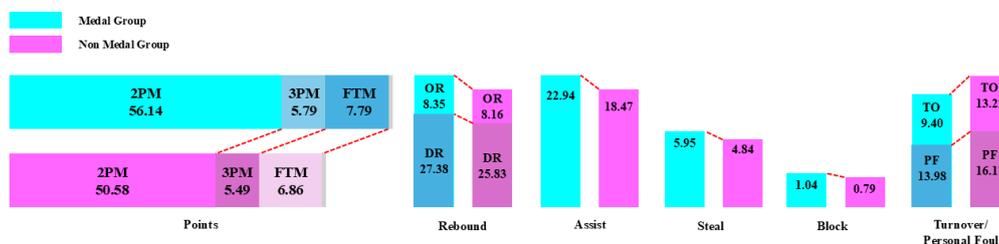

Figure 2. Comparison of game results between groups.

Firstly, match records of IWBF games from 2012 to 2022 were analyzed, and the results are as below: Scoring factors directly affecting the game results were compared between the groups. The result of difference shows that the success rate of 2-point and 3-point shots was significantly different

except the free throw success rate. and the numbers of assists, defense rebounds, and steals were significantly different. This result shows that the medal group used various offensive tactics contributing to scoring and hindered the other team from opportunities of secondary scoring through defense rebounds and quick transition. Prior research in basketball game analysis has shown that modern basketball prefers to play a fast-paced, aggressive style, and that play is strongly associated with higher success rates in three-pointers, steals, and rebounds (4, 15). As suggested by the results of this study, the international wheelchair basketball events show similar trends to those of basketball. Furthermore, the game performance showed differences terms of defense rebound and steal, which contribute to switching the other team's scoring attempts into our team's offense opportunities as well as assists that are directly related to scoring just as in basketball games (2, 5, 27). The difference in turnovers and fouls was also significant between the outstanding group and the other group. In addition, the medal group recorded less turnovers and fouls than the other group. According to the research, turnovers increase the probability to give the other team opportunities to win a score and it is known that turnovers increase the probability for the other team to win a score and cut off the flow of our team's offense on turnovers (14, 28, 30). If a certain player is with many fouls and not thoroughly prepared for free throw opportunities, the player can be an easy target for the other team to score. The result of this study as well shows that the medal group recorded smaller numbers of turnovers and fouls than the other group. Thus, compared to the non-medal group, the performers are making and attempting more shots that directly affect scoring (2-points, 3-points, and free throws), and they have a higher frequency of defensive rebounds and steals that contribute to taking control of the game. They also have fewer turnovers and mistakes, which is a sign of a team that plays a steady game and performs well.

Second, as for the difference between the groups depending on the sport class and game performance, the para-athlete's composition in each quarter depending on the sport class was as follows: the class of 13.92 points for 1 quarter, 13.91 points for 2 quarters, 13.88 points for 3 quarters, and 13.90 points for 4 quarters. As the medal group was compared with the other group, the average composition of the other group in relation to para-athlete in quarters was higher than that of the medal group (1Q: 14 points, 2Q: 13.96 points, 3Q: 13.98 points, 4Q: 13.96 points) than the other group (1Q: 13.89 points, 2Q: 13.89 points, 3Q: 13.85 points, 4Q: 13.88 points), and the difference was significant. As to the difference between groups in sport performance, the difference in playing time between the medal group and the other group was in the order of 2.5 points (p=.001), 4.0 points (p=.001), 3.0 points (p=.002), and 1.5 points (p=.025). This shows that the difference in playing time was significant. In the medal group, the participation rate of players was even among different points. The class of 2.5 points participated in games about 4:30 minutes longer than in the other group. The class of 2.5 points is regarded as a major class since it can maintain the most stable posture among low classes of points and is highly capable of passing and shooting (1, 24).

Lastly, in view of the general trend in 2012 to 2022 international competitions, the sport class consideration in quarterly participation decreased. As to the playing time depending on the range of points, that of 1.0 points, 3.0 points, and 4.5 points decreased while that of 1.5 points, 2.0 points, 3.5 points, 4.0 points increased. Particularly, the playing time of wheelchair basketball players of a mild case (4.5 points) decreased as much as about 4:21 minutes. In contrast, that of players of 3.5 points and 4.0 points increased as much as 2:39 minutes and 3:47 minutes respectively. Particularly, the playing time of the classes of 4.5 points and 1.0 points significantly decreased (see Figure 3).
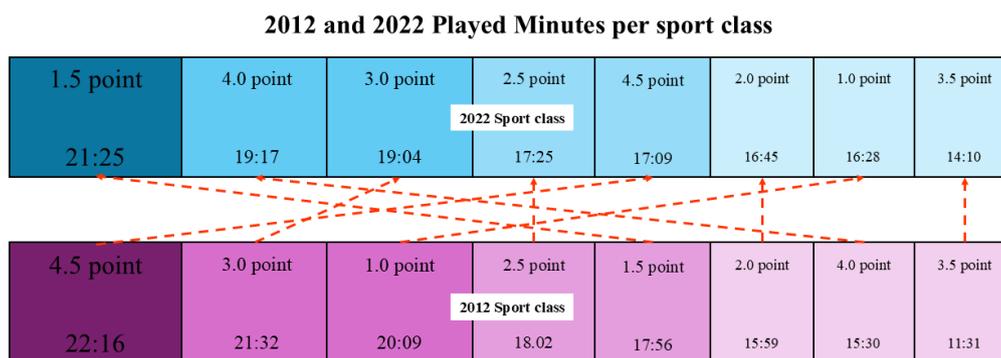
2012 and 2022 Played Minutes per sport class

1.5 point	4.0 point	3.0 point	2.5 point	4.5 point	2.0 point	1.0 point	3.5 point
			2022 Sport class				
21:25	19:17	19:04	17:25	17:09	16:45	16:28	14:10

4.5 point	3.0 point	1.0 point	2.5 point	1.5 point	2.0 point	4.0 point	3.5 point
			2012 Sport class				
22:16	21:32	20:09	18.02	17:56	15:59	15:30	11:31

Figure 3. Comparison of playing time depending on the sport class between 2012 and 2022.

In wheelchair basketball, players of 4.5 points are of the mild case and play various roles in the team with the relatively high motor ability such as scoring, dribbling (1, 8). The playing time of players of 4.5 points decreased probably because the IWBF criteria of minimum disability was revised in application of proof-based sport classification as directed by the IPC after the year of 2016 (8, 19). Among wheelchair basketball players attending the Tokyo Paralympic Games held in 2021, sport classification was conducted again among players of 4.0 points and 4.5 points. Except 75% who proved to be qualified among 134 players, the rest had to take the reexamination. Some players of 4.5 points failed to meet the revised criteria of minimum disability and thus could not attend Tokyo Paralympic Games (16). Besides, players of 1.0 points are of the most severe disability among wheelchair basketball players and thus have limitations in wheelchair manipulation and moving speed. It seems that as wheelchair basketball advances recently, the trend of pursuing a fast-playing pace led to the revision. Roles of players of low points who had to play for a less time were transferred to players of relatively high points, and the sport class of participant players was affected as a result.

2022 IWBF World Championships

3.0 point	2.5 point	4.5 point	2.0 point	1.0 point	4.0 point	3.5 point	1.5 point
			Medal Group				
23:55	23:50	23:11	16:00	15:31	14:37	13:36	12:59

1.5 point	4.0 point	3.0 point	2.0 point	1.0 point	4.5 point	3.5 point	2.5 point
			Non Medal Group				
22:13	20:57	18:12	17:07	16:49	15:15	14:16	13:12

Figure 4. Comparison of playing time depending on the sport class in each group in 2022.

This study is of significance in that as it examines characteristics of wheelchair basketball games and analyzes trends in major game performance factors and sport class composition among major countries of excellent game performance, visualized data are made available in an easier and faster way. It is expected that findings of this study can be utilized effectively for game performance strategies in line with the largest trend. In addition, this study is expected to contribute to future studies on the game performance in wheelchair basketball games.

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curation, Kim., Lee.; writing—original draft preparation, Lee.; writing—review and editing, Kim., Lee.; visualization, Kim.; supervision, Kim.; project administration, Kim., Lee".

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