DEAF AND HEARING BASKETBALL NATIONAL TEAMS AT THE 2019 WORLD CHAMPIONSHIPS: DISCRIMINANT ANALYSIS OF GAME-RELATED STATISTICS BETWEEN THE WINNING AND THE DEFEATED

Adam Michał Szulc[1], Elżbieta Sandurska[2]

[1]Institute of Physical Education, Kazimierz Wielki University, Bydgoszcz, Poland,
[2]Department of Genetics, Faculty of Natural Sciences, Kazimierz Wielki University, Bydgoszcz, Poland

DOI. 10.51371/issn.1840-2976.2021.15.S1.12 Original scientific paper

Abstract

The aim of the study was to identify the situational factors of a game which (a) might affect the victory or defeat in the game; (b) were common for matches played in a tournament for the hearing or deaf, including matches won or lost. The analysis included 37 matches of national deaf teams (5th World Deaf Basketball Championships, Poland) and 92 matches of national hearing teams (18th Basketball World Cup, China). During both tournaments, the matches played were divided into won and lost. We also presented analyses concerning 31 game situational variables related to the performance of national basketball teams at both events. All situational variables were subject to statistical analysis, including calculation of their means and standard deviations, and determination of minimum and maximum. Discriminant analysis was performed, too. The analyses showed no statistically significant differences in almost all game aspects between matches won by deaf and hearing basketball players. Statistically significant differences in situational variables were observed between matches won during the 5th World Deaf Basketball Championships and matches lost during the 18th Basketball World Cup. The discriminant analysis allowed to determine the situational variables that affected the winning or losing of a game: missed shots for 2 or 3 points, free throws, defensive and offensive rebounds, as well as assists, steals, and turnovers. A classification matrix indicated 21 results of direct match competitions achieved by deaf teams (winning and losing), which allowed to qualify these teams as hearing ones in terms of the values of game situational variables. Literature analysis revealed lack of scientific reports on deaf sport.

***Key words**:* Deaflympics sport, *deaf basketball, elite national teams, win-loss analysis, game-related statistics*

Introduction

There are many scientific publications in the world literature that comprehensively describe the development of basketball worldwide. Numerous reports concern statistics and analyses of basketball matches played during international competitions at the level of European Championships, World Cup, Olympic Games, NBA, or others (Bajgorić et al., 2015; Conte et al., 2018; García et al., 2013; Milanović et al., 2016; Paulauskas et al., 2018; Simović and Komić, 2008). These studies frequently focus on comparing match statistics of winning and losing teams (Dias Neto, 2007; Pojskić et al., 2009; Trninić et al., 2002). Other reports cover the statistics of individual players depending on their position on the court (Escalante et al., 2010; Ghe and Petreanu, 2018; Ibáñez et al., 2018; Jeličić et al., 2010; Pluta and Andrzejewski, 2011; Sampaio et al., 2006). Advanced computer software is applied in match analysis to enable time and space game analysis (Abdelkrim et al., 2007; Erčulj et al., 2008; Hulka et al., 2013). Stojanović et al. (2018) have reviewed the motor and physiological variables that occur during basketball games at different levels of male and female competitions. Petway et al. (2020) reported on the motor and physiological indicators in national, sub-elite, and junior basketball players, taking into account their position on the court and the match duration (divided into quarters). Much attention has also been paid to the body build and body composition of basketball players and their somatotype (Buśko et al., 2017; Gerodimos et al., 2005; Raymond-Pope et al., 2020; Viswanathan et al., 2010).

Almost all studies in the scientific literature are related to tournaments for hearing competitors. Some times for Paralympics competitors. A review of databases of scientific journals has identified only several publications concerning hard-of-hearing players and teams (Milašius et al., 2014; Palmer et al., 2006; Steward et al., 1991; Szulc, 2017, 2019; Szulc et al., 2017).

It can be argued that this is the first attempt to determine the level of situational variables associated with the play of deaf basketball competitors at the level of national teams. National team players may include athletes with a minimum level of hearing loss of 55 dB in the better ear. They are most often amateur basketball players, mainly from clubs associating deaf people. It is rare to encounter hard-of-hearing competitors playing in clubs together with hearing athletes. Only athletes representing the highest basketball level, with a minimum degree of hearing loss, play in higher league hearing teams. During competitions, deaf athletes are not allowed to use hearing aids, cochlear implants, etc., which results from the principle of fair play in deaf sport. In the history of the Olympic Games between 1908 and 2018, the Summer and Winter Games involved around 20 players with a hearing impairment representing different sports disciplines (when participating in hearing sports competitions, deaf athletes can use hearing aids and cochlear implants).

The international sport of the deaf has a nearly 100-year-old tradition, which began in 1924 in Paris with the event called International Silent Games. (Until 1965, this name was used interchangeably with the International Games for the Deaf. In 1966, the former name was changed into World Games for the Deaf, and in 2000, the current name Deaflympics was introduced). These competitions were to be equivalent to the Olympic Games for athletes with severe hearing loss. The first International Silent Games in 1924 involved 148 competitors (including 1 woman) from 9 European countries. Team games were represented there by football. The second team game that became a permanent feature of the International Silent Games was basketball. In 1949, two male basketball teams took part in the tournament in Copenhagen (Denmark): Belgium (gold medal) and Switzerland. In total, since 1949, the Deaf Games have been held 18 times; during the basketball tournament, US players have triumphed 14 times. Most recently, the 23rd Summer Deaflympics in 2017 in Samsun, Turkey, involved 135 basketball players from 14 countries. The first three places were won by teams from Lithuania, Venezuela, and Ukraine.

The 1st World Deaf Men Basketball Championships were held in 2002 in Athens (19–27.07.2002, Greece). The event involved 12 teams: Greece, Slovenia, Italy, Ukraine, Chinese Taipei, USA, Lithuania, Poland, Great Britain, Venezuela, Russia, and Turkey, with a total of 140 competitors. In the 1st World Deaf Men Basketball Championships, the first three places were taken by basketball players from Greece, USA, and Slovenia.

The 2nd World Deaf Men Basketball Championships took place in Guangzhou (22–30.06.2007, China). Overall, 192 basketballers participated from 16 countries: Chinese Taipei, Australia, China, Greece, Japan, Lithuania, Ukraine, USA, Hong Kong, Ghana, Belarus, India, Israel, Italy, Slovenia, and Russia. Lithuanian players became world champions, the second place was won by competitors from Greece, and USA took the third place.

The 3rd World Deaf Basketball Championships were held in Palermo (16–24.09.2011, Italy). The event involved 192 players from 16 national teams: Chinese Taipei, Russia, Spain, Greece, Japan, Lithuania, Ukraine, USA, Turkey, Venezuela, Sweden, Italy, Slovenia, Poland, Israel, and Canada. The teams from Lithuania (gold), Venezuela (silver), and Ukraine (bronze) stood on the podium.

The 4th World Deaf Basketball Championships took place in Taoyuan (4–12.07.2015, China). Overall, 17 teams declared their participation. Finally, the following countries were involved: Russia, Japan, Ukraine, Argentina, Chinese Taipei, Lithuania, Poland, USA, Greece, Australia, Korea, Israel, and Turkey. Venezuela, Mexico, Slovenia, and Great Britain did not take part. The Taoyuan event was the first professionally organized World Deaf Basketball Championship. A website dedicated to the Championships was created, official match statistics were published, and there were live broadcasts of the competition over the Internet; match videos are still available on YouTube.

The 5th World Deaf Men Basketball Championships were held in Lublin (27.06–06.07.2019, Poland). A total of 14 teams participated: Belarus, Poland, Ukraine, Turkey, Argentina, Russia, Italy, Israel, Spain, Venezuela, Lithuania, USA, Greece, and Japan. The Kenyan team withdrew from the tournament at the last minute. The US team became world champions, the Lithuanians won the title of vice-champions. The third place was taken by the team from Ukraine.

During the 5th World Deaf Basketball Championships, official match statistics included 36 situational variables related to basketball play; the variables were comparable with the statistics describing the 18th FIBA Basketball World Cup of 2019. In the case of deaf championships, however, organizers do not specify the competitors' body height, their club, their position in the play, or the graphical representation of the score evolution in a match, which informs how many times the lead changed.

The aim of the study was to identify the situational factors of a game which (a) might affect the victory or defeat in the game; (b) were common for matches played in a tournament for the hearing or deaf, including matches won or lost.

1. 5th World Deaf Basketball Championships (abbreviated as 5WDBC) (Lublin, Poland, 2019), during which 14 national teams played 37 matches and the competitors played 820 times (they took a DNP ['did not play'] 40 times in the matches played);

2. 18th FIBA Basketball World Cup (abbreviated as 18BWC) (China, 2019), during which 32 national teams played 92 matches and the competitors played 1934 times (they took a DNP 238 times in the matches played).

For the purposes of the statistical analyzes, the national teams taking part in the events were divided into two groups. The winner of a match was qualified to group one (1), and the team that lost a match was classified to group two (2). Therefore, the following abbreviations were assumed:

1. 5WDBC1 - a set of teams that won a match during 5WDBC;

2. 5WDBC2 - a set of teams that lost a match during 5WDBC;

3. 18BWC1 - a set of teams that won a match during 18BWC;

4. 18BWC2 - a set of teams

Table 1 contains descriptions of the situational variables used in the statistical analyses. The analyses were based on the match statistics from the official 5WDBC match protocols and from the official FIBA website (www.fiba.com).

Table 1. The situational variables and their description

No.	Variables	Description
1	PTS	Number of points scored by the team
2	FG_M	Number of field goals made for 2 or 3 points (without free throws)
3	FG_A	Number of field goal attempts for 2 or 3 points (without free throws)
4	2PTS_M	Number of field goals made for 2 points (without free throws)
5	2PTS_A	Number of field goal attempts for 2 points (without free throws)
6	3PTS_M	Number of field goals made for 3 points (without free throws)
7	3PTS_A	Number of field goal attempts for 3 points (without free throws)
8	FT_M	Number of free throws made for 1 point
9	FT_A	Number of free throw attempts for 1 point
10	OREB	Number of offensive rebounds
11	DREB	Number of defensive rebounds
12	AST	Number of assists, i.e. passes that led to a score
13	PF	Number of personal fouls
14	TO	Number of turnovers (of any cause)
15	STL	Number of steals
16	BLK	Number of blocked shots
17	PFT	Number of points from turnovers
18	PIP	Number of points in the paint (points scored in the restricted area)
19	SCP	Number of second chance points (points scored after a putback as a continuation of action immediately after a missed shot)
20	FBP	Number of fast break points (points scored after a fast break, e.g. when the opponent does not manage to return to the defence, or by a long pass or a very fast run and dribbling)
21	BP	Number of points scored by backup players
22	FG_%	$FG\_\% = \frac{FG\_M \cdot 100\%}{FG\_A}$ – player's effective field goal percentage
23	2PTS_%	$2PTS\_\% = \frac{2PTS\_M \cdot 100\%}{2PTS\_A}$ – player's effective 2-point field goal percentage
24	3PTS_%	$3PTS\_\% = \frac{3PTS\_M \cdot 100\%}{3PTS\_A}$ – player's effective 3-point field goal percentage
25	FT_%	$FT\_\% = \frac{FT\_M \cdot 100\%}{FT\_A}$ – player's effective free throw percentage
26	REB	$REB = OREB + DREB$ – general number of rebounds
27	TS_%	$TS\_\% = \frac{PTS \cdot 100\%}{(2 \cdot FG\_A + 0.88 \cdot FT\_A)}$ – true shooting percentage (index of shooting efficiency)
28	FT_missed	FT_missed = FT_A – FT_M
29	FG_missed	FG_missed = FG_A – FG_M
30	2PTS_missed	2PTS_missed = 2PTS_A – 2PTS_M
31	3PTS_missed	3PTS_missed = 3PTS_A – 3PTS_M

All situational variables were subject to preliminary statistical analysis, including calculation of their means and standard deviations, and determination of minimum and maximum. For the majority of the considered variables, results were found to be inconsistent with normal distribution (as verified with the Shapiro-Wilk test); therefore, statistically significant differences between the 5WDBC1, 5WDBC2, 18BWC1, and 18BWC2 groups were calculated with the use of the non-parametric Kruskal-Wallis test and Dunn's multiple comparison test.

Discriminant analysis served to indicate the variables that significantly differentiated one group from another. The statistical analysis of the data aimed to answer the following questions:

1. Which situational variables are statistically significantly different between the teams of 5WDBC1, 5WDBC2, 18BWC1, and 18BWC2?

2. Which national teams played matches at the level of the 5WDBC1, 5WDBC2, 18BWC1, or 18BWC2 match statistics?

3. Which match variables affect the victory and which affect the defeat in a match?

Results

Tables 2 and 3 present the values of arithmetic means with standard deviations, minimum and maximum values, as well as statistically significant differences obtained with the non-parametric Kruskal-Wallis test and Dunn's multiple comparison test for situational variables of the winning teams of 18BWC1 and 5WDBC1 and for the losing teams of 18BWC2 and 5WDBC2.

No statistically significant differences were observed between the winning teams of 18BWC1 and 5WDBC1 for PTS, FG_M, FG_A, FG_%, 2PTS_M, 2PTS_A, 2PTS_%, 3PTS_A, 3PTS_missed, FT_M, OREB, DREB, REB, PF, AST, BLK, PIP, SCP, or BP. In the majority of the considered variables, the winning teams of 18BWC1 differed statistically significantly from the losing teams, i.e. 18BWC2 (marked b in Table 2) and 5WDBC2 (marked c in Table 2). Winning deaf teams (5WDBC1) were generally characterized by better play indicators than defeated teams (18BWC2). These differences were statistically significant for most considered variables (marked d in Table 2). When comparing the losing teams of 18BWC2 and 5WDBC2, one can notice that hearing teams represented a different sports level than deaf teams, as confirmed by statistically significant differences (marked f in Table 3).

The performed discriminant analysis allowed to identify variables with the highest impact on the discrimination between teams into the 4 mentioned groups and, at the same time, to recognize the winning (5WDBC1) and defeated (5WDBC2) deaf teams that scored closest, with regard to the match statistics, to the winning (18BWC1) and defeated (18BWC2) hearing teams. At the beginning, all the variables describing the teams' playing efficiency were subjected to a detailed analysis examining the occurrence of correlations between them and checking whether these variables met the discriminant analysis assumptions. Finally, a set of 12 variables were selected for analysis: 2PTS_M, 2PTS_missed, 3PTS_M, 3PTS_missed, FT_M, FT_missed, OREB, DREB, AST, STL, TO, and BP.

Table 4 shows the values of discriminant function coefficients and canonical averages, as well as own values and the associated cumulative proportion of variance. The first function was responsible for 64% of the explained variance, i.e. it explained 64% of all discriminatory power. The second function explained about 34% of discriminatory power, while the third function explained only 2% of variance and it turned out to be not statistically significant (chi-squared test, Table 5).

The extreme (negative and positive) values of canonical averages of the first function for the 18BWC1 and 5WDBC1 groups implied that the first function best discriminated between these two groups, although the values of the remaining canonical averages suggested that the main division was between the hearing and deaf groups. The second function discriminated mainly between winning and losing teams, giving extreme canonical averages for the 5WDBC1 and 18BWC2 groups. The canonical averages calculated for the third discriminant function were comparable and did not differ much, which additionally indicated its weak discriminatory value (Table 4).

By observing the values of discriminant function coefficients, one can determine the variables that had the greatest impact on case discrimination. For the first discriminant function, the following variables presented the highest negative values: FT_missed, TO, 3PTS_missed, and 2PTS_missed; these had the greatest influence on the inclusion of a given match in the group of matches played by deaf players. Positive values, in turn, were assumed by the coefficients for the OREB, DREB, and AST variables, which suggests their greater impact in the allocation to the group of hearing players. The coefficients of the second discriminant function, whose canonical averages indicated greater discrimination between winning and losing teams, turned out to be highest for the 3PTS_missed and 2PTS_missed variables, classifying teams into the group of defeated ones. Assigning competitors to the winning team was influenced by the variables of STL, DREB, and FT_missed (Table 4).

Table 2. Descriptive parameters of the situation-related efficiency of the winning hearing and deaf teams

Variables	*N_18BWC*[1]	$\bar{X}$	Min	Max	SD	*N_5WDBC*[1]	$\bar{X}$	Min	Max	SD
PTS	*92*	87.4^{b,c}	67.0	126.0	11.9	*37*	86.0^{d,e}	59.0	118.0	13.3
FG_M	*92*	31.4^{b,c}	19.0	48.0	5.1	*37*	30.2^{d,e}	20.0	47.0	6.4
FG_missed	*92*	33.5^{a,b,c}	16.0	51.0	6.5	*37*	37.5^{e}	18.0	62.0	7.9
FG_A	*92*	65.0	48.0	82.0	7.0	*37*	67.7	47.0	91.0	10.1
FG_%	*92*	48.6^{b,c}	33.9	75.0	7.2	*37*	44.6^{e}	31.9	62.1	7.5
2PTS_M	*92*	21.9^{b,c}	13.0	36.0	4.5	*37*	22.8^{d,e}	9.0	40.0	7.4
2PTS_missed	*92*	17.9^{a,b,c}	6.0	33.0	5.1	*37*	21.1	4.0	35.0	6.1
2PTS_A	*92*	39.8	30.0	54.0	5.9	*37*	43.9	28.0	61.0	10.2
2PTS_%	*92*	55.2^{b,c}	34.8	85.7	9.5	*37*	51.7^{e}	27.3	85.7	10.9
3PTS_M	*92*	9.5^{a,b,c}	1.0	24.0	3.7	*37*	7.4	0.0	13.0	2.9
3PTS_missed	*92*	15.6	7.0	27.0	4.4	*37*	16.4	5.0	27.0	4.6
3PTS_A	*92*	25.1	10.0	44.0	6.5	*37*	23.8	7.0	33.0	6.2

3PTS_%	*92*	$37.5^{a,b,c}$	10.0	65.0	9.7	*37*	30.7^{e}	0.0	44.4	8.9
FT_M	*92*	15.0	1.0	35.0	6.8	*37*	$18.3^{d,e}$	5.0	33.0	7.1
FT_missed	*92*	$4.8^{a,c}$	0.0	11.0	2.3	*37*	9.9^{d}	3.0	19.0	4.2
FT_A	*92*	19.8^{a}	2.0	38.0	7.8	*37*	28.2^{d}	11.0	52.0	9.9
FT_%	*92*	$74.6^{a,c}$	25.0	100.0	11.6	*37*	64.6^{d}	45.5	82.6	9.3
OREB	*92*	10.8	4.0	22.0	3.9	*37*	12.1	3.0	25.0	4.4
DREB	*92*	$28.5^{b,c}$	18.0	42.0	4.7	*37*	$31.6^{d,e}$	19.0	49.0	6.0
REB	*92*	$39.3^{b,c}$	25.0	58.0	5.9	*37*	$43.9^{d,e}$	25.0	61.0	8.3
AST	*92*	$21.7^{b,c}$	12.0	37.0	5.3	*37*	$19.4^{d,e}$	11.0	41.0	6.4
PF	*92*	$18.7^{b,c}$	11.0	30.0	4.1	*37*	20.4	8.0	36.0	6.5
TO	*92*	$12.6^{a,b,c}$	5.0	19.0	2.9	*37*	18.3^{d}	10.0	30.0	5.3
STL	*92*	7.8^{a}	2.0	16.0	3.0	*37*	13.4^{d}	2.0	30.0	6.8
BLK	*92*	$3.6^{b,c}$	0.0	10.0	2.2	*37*	2.6	0.0	9.0	2.0
TS%	*92*	$59.5^{a,b,c}$	46.1	85.5	7.6	*37*	53.8^{e}	41.5	70.6	6.7
PFT	*92*	$17.3^{a,b}$	3.0	34.0	6.6	*37*	$24.5^{d,e}$	5.0	49.0	11.2
PIP	*92*	$37.5^{b,c}$	16.0	70.0	9.3	*37*	$41.4^{d,e}$	12.0	74.0	14.6
SCP	*92*	10.4	2.0	23.0	5.2	*37*	12.1^{e}	4.0	24.0	5.7
FBP	*92*	$11.3^{a,b}$	2.0	25.0	4.9	*37*	$22.7^{d,e}$	5.0	50.0	11.2
BP	*92*	$31.7^{b,c}$	2.0	78.0	12.7	*37*	26.8	4.0	57.0	13.0

a, b, c, d, e – statistically significant differences, p<0,05; a 18BWC1 vs. 5WDBC1; b 18BWC1 vs. 18BWC2; c 18BWC1 vs. 5WDBC2; d 5WDBC1 vs. 18BWC2; e 5WDBC1 vs. 5WDBC2; N_18BWC1 – number of matches won by hearing teams; N_5WDBC1 – number of matches won by deaf teams

Table 3. Descriptive parameters of the situation-related efficiency of the defeated hearing and deaf teams

Variables	*N_18BWC*^{2}	$\bar{X}$	Min	Max	SD	*N_5WDBC*^{2}	$\bar{X}$	Min	Max	SD
PTS	*92*	71.6^{f}	45.0	101.0	11.2	*37*	60.8	35.0	96.0	14.3
FG_M	*92*	25.9^{f}	17.0	38.0	4.3	*37*	21.2	13.0	38.0	5.4
FG_missed	*92*	38.5^{f}	26.0	58.0	6.6	*37*	42.9	23.0	61.0	7.8
FG_A	*92*	64.4	51.0	87.0	7.2	*37*	64.1	50.0	79.0	7.6
FG_%	*92*	40.3^{f}	26.6	56.9	6.2	*37*	33.2	19.7	55.8	8.1
2PTS_M	*92*	18.7^{f}	10.0	30.0	4.2	*37*	15.6	8.0	33.0	5.4
2PTS_missed	*92*	21.8	10.0	34.0	5.1	*37*	25.2	12.0	38.0	5.9
2PTS_A	*92*	40.5	25.0	61.0	6.5	*37*	40.8	20.0	58.0	7.6
2PTS_%	*92*	46.3^{f}	27.5	66.7	8.1	*37*	38.1	20.0	60.0	9.6
3PTS_M	*92*	7.1^{f}	0.0	12.0	2.7	*37*	5.6	0.0	11.0	2.6
3PTS_missed	*92*	16.7	8.0	36.0	5.1	*37*	17.7	5.0	28.0	5.9
3PTS_A	*92*	23.8	13.0	46.0	6.3	*37*	23.3	11.0	39.0	7.7
3PTS_%	*92*	30.7^{f}	0.0	70.0	10.8	*37*	24.0	0.0	61.5	10.1
FT_M	*92*	12.8	3.0	24.0	5.3	*37*	12.8	0.0	27.0	6.5
FT_missed	*92*	4.5^{f}	0.0	12.0	2.6	*37*	9.1	0.0	23.0	4.8

FT_A	*92*	17.3^{f}	4.0	33.0	6.3	*37*	21.9	0.0	50.0	10.0
FT_%	*92*	73.5^{f}	40.0	100.0	13.1	*37*	55.7	0.0	81.0	16.3
OREB	*92*	10.8	2.0	20.0	4.1	*37*	9.8	2.0	19.0	3.9
DREB	*92*	23.9	12.0	37.0	4.9	*37*	24.1	13.0	38.0	5.7
REB	*92*	34.7	19.0	57.0	6.8	*37*	34.2	19.0	53.0	7.2
AST	*92*	15.3^{f}	6.0	23.0	3.8	*37*	11.5	6.0	23.0	4.9
PF	*92*	20.5	10.0	32.0	4.5	*37*	23.2	13.0	37.0	5.5
TO	*92*	14.4^{f}	3.0	23.0	4.1	*37*	21.8	8.0	41.0	8.2
STL	*92*	6.8^{f}	3.0	13.0	2.4	*37*	10.0	3.0	22.0	4.3
BLK	*92*	2.2	0.0	10.0	1.8	*37*	1.6	0.0	5.0	1.4
TS%	*92*	49.9^{f}	32.0	66.8	6.8	*37*	41.2	24.9	60.2	8.3
PFT	*92*	12.5	2.0	26.0	4.7	*37*	15.3	6.0	38.0	7.1
PIP	*92*	30.4	14.0	50.0	7.8	*37*	26.6	8.0	64.0	11.1
SCP	*92*	9.0	0.0	19.0	4.3	*37*	8.1	0.0	19.0	4.4
FBP	*92*	8.2^{f}	0.0	30.0	5.6	*37*	13.5	3.0	41.0	7.6
BP	*92*	26.4^{f}	8.0	55.0	9.7	*37*	20.3	3.0	44.0	10.3

f – statistically significant differences, p<0,05; f 18BWC2 vs. 5WDBC2; N_18BWC2 – number of matches lost by hearing teams; N_5WDBC2 – number of matches lost by deaf teams

The classification of matches with the use of such a discriminant function was correct, on average, in 79.84% of cases, with the largest number of correctly classified matches in the group of hearing winning players (85.87%). An equally high result was recorded for the hearing losing teams (83.7%). Fewer correct assignments were observed in the deaf group: 72.97% for the losing teams and 62.16% for the winning teams (Table 6). (Table 6. Classification matrix of the 18BWC1, 5WDBC1, 18BWC2, and 5WDBC2 teams based on the obtained discriminant function)

In other words, when analysing the matrix of team classification to the 18BWC1, 5WDBC1, 18BWC2, and 5WDBC2 groups (Table 6), one can conclude that in 52 cases (out of 258 matches played) the teams were assigned to wrong groups.

Table 4. Raw values of discriminant function coefficients, own values, and canonical averages for the applied variables, with the grouping variable including the 18BWC1, 5WDBC1, 18BWC2, and 5WDBC2 groups.

Variables	DF 1	DF 2	DF 3
2PTS_M	0.020	−0.024	0.080
2PTS_misssed	0.109*	0.045*	−0.024*
3PTS_M	−0.011	−0.073	−0.084
3PTS_missed	0.116*	0.056*	−0.018*
FT_M	−0.023	−0.018	0.052
FT_missed	0.176*	−0.103*	−0.108*
OREB	−0.154*	−0.035*	0.153*
DREB	−0.067*	−0.110*	0.006*
AST	−0.052	−0.009	−0.119
TO	0.146*	−0.008*	−0.060*
STL	0.013*	−0.186*	0.079*
BP	0.004	0.024	−0.017
CONSTANT	*−3.320*	*4.609*	*0.763*
OWN VALUE	*1.798*	*0.960*	*0.052*
CUMULATIVE PROPORTION	*0.640*	*0.982*	*1.000*
Canonical averages			
5WDBC^1	0.555	−2.035	0.268
18BWC^1	−1.351	−0.204	−0.192
5WDBC^2	2.737	0.138	−0.296
18BWC^2	0.028	0.967	0.203

* Statistically significant variables in the discriminative model; DF – discriminant function

The analysis of the detailed case classification revealed a mistaken allocation of 24 matches of deaf national teams. The discriminant function assigned the following high-level deaf winning teams to the 18BWC1 group: USA in 3 cases (matches: JPN–USA 41:93; USA–ESP 105:55; RUS–USA 76:91), Ukraine in 2 cases (matches: BLR–UKR 55:85; UKR–RUS 73:64), Russia in 2 cases (matches: RUS–POL 84:71; ARG–RUS 76:83). The lost match of Argentina with Russia was also classified as a match of Argentina at the team level of 18BWC1 (bold denotes teams with changed classification). In four cases, winning deaf teams were wrongly assigned by the discriminant function to the hearing but losing teams. These were: Italy in 2 matches (ITA–TUR 66:58; ITA–JPN 61:58), Japan (TUR–JPN 78:91), and Ukraine (UKR–ARG 90:69).

Incorrect assignment of winning teams to a group of losing teams shows a weaker determination of the discriminant function in the case of deaf teams. The team of Argentina was classified to the 5WDBC2 group twice (TUR–ARG 66:75; ARG–GRE 84:83), while the Lithuanian team was wrongly assigned to this group on the basis of the match with Greece (LTU–GRE 76:66).

Table 5. Chi-squared test of discriminant functions

Roots removed	Values	Canonical value of the R model	Wilks' lambda	Chi-square	Df	p
0	1.798	0.802	0.173	436.30	36	≤ 0.001
1	0.960	0.699	0.485	180.13	22	≤ 0.001
2	0.052	0.222	0.951	12.54	10	0.25

In 7 cases, losing deaf teams, according to the classification analysis, played matches at a level comparable with that of hearing defeated teams. Two such matches were played by the Russian team (RUS–USA 76:91; UKR–RUS 73:64). The remaining cases were single matches of various nationalities (POL–UKR 62:68; LTU–USA 77:105; VEN–ITA 85:71; GRE–USA 53:69; TUR–ITA 58:66). The lost matches of Argentina and Greece were classified at the level of 5WDBC1 (ARG–POL 96:106; ARG–GRE 84:83).

Winning hearing teams were correctly allocated in as many as 79 cases; the most frequent mistakes consisted in assigning them to losing, but still hearing groups. This was the case in 11 matches of various national teams: Argentina (ARG–FRA 80:66), Nigeria (CHN–NGR 73:86), France (FRA–LTU 78:75; FRA–AUS 67:59), Poland (CHN–POL 76:79), Puerto Rico (IRI–PUR 81:83; PUR–TUN 67:64), Dominican Republic (DOM–JOR 80:76), Jordan (JOR–SEN 79:77), and Spain (ESP–ITA 67:60; ESP–IRI 63:73). These teams were assigned to the 5WDBC1 group in 2 wrong classifications only; specifically, these were matches played by Argentina (RUS–ARG 61:69; POL–ARG 65:91).

Table 6. Classification matrix of the 18BWC1, 5WDBC1, 18BWC2, and 5WDBC2 teams based on the obtained discriminant function

Hearing / deaf	Correct classification percentage	Classified as 5WDBC^1 teams	Classified as 18BWC^1 teams	Classified as 5WDBC^2 teams	Classified as 18BWC^2 teams
5WDBC$_1$	62.16	23	7	3	4
18BWC^1	85.87	2	79	0	11
5WDBC$_2$	72.97	2	1	27	7
18BWC^2	83.70	1	11	3	77
Total	**79.84**	**28**	**98**	**33**	**99**

A similarly high number of correct allocations were observed among hearing defeated teams. Also, as in the previous case, wrong assignments consisted mainly in changing the group from losing to winning, but still within the group of hearing competitors. The 18BWC1 involved the following matches: IRI–PUR 81:83; GRE–NZL 103:97; NZL–BRA 94:102; POL–CZE 84:94; ANG–PHI 84:81; BRA–GRE 79:78; ESP–IRI 73:65; FRA–LTU 78:75; MNE–NZL 83:93; TUR–CZE 76:91; USA–BRA 89:73. The remaining mistakes of the classification analysis, allocating these teams among deaf groups, include a mere 1 case of classifying Nigeria in the 5WDBC1 group (NGR–ARG 81:94) and 3 cases of ascribing the 5WDBC2 group: Korea (KOR–NGR 66:108), Poland (POL–ARG 65:91), and Japan (USA–JPN 98:45).

Discussion

Deaf sport, including basketball, is absent in media and literature. The public is not aware of the existence of organizational structures and competitions for deaf sport separate from Paralympics and sport for hearing athletes. The lack of information on deaf people's sport increases the marginalization and social exclusion of this group.

The aim of the study was to identify the situational factors of a game which (a) might affect the victory or defeat in the game; (b) were common for matches played in a tournament for the hearing or deaf, including matches won or lost. The analyses were based on the most common game indicators encountered in the literature.

The winning deaf teams during 5WDBC in Poland (5WDBC1) achieved results comparable with those of the winning hearing teams during 18BWC in China (18BWC1). The 5WDBC1 teams obtained similar point/shot scores by performing more attempts than the 18BWC1 teams. The 5WDBC1 teams were characterized by higher play indicators and higher or comparable efficiency as compared with the 18BWC2 teams. Shot and point indicators were compared with those achieved by basketball players during the 2006 World Championships in Japan (WC_2006) and the 2008 Summer Olympics in Beijing (SO_2008). These statistics were similar to those presented in Tables 2 and 3. According to Dias Neto (2007), WC_2006 winners presented the following statistics: FG_M: 27.6; FG_A: 59.9; FG_%: 46.0; 2PTS_M: 19.7; 2PTS_A: 38.2; 2PTS_%: 51.4; 3PTS_M: 7.9; 3PTS_A: 21.7; 3PTS_%: 36.4; FT_M: 28.3; FT_A: 25.4; FT_%: 72.0; the values for the defeated teams were as follows: FG_M: 26.7; FG_A: 63.5; FG_%: 42.1; 2PTS_M: 19.9; 2PTS_A: 42.5; 2PTS_%: 46.9; 3PTS_M: 6.8; 3PTS_A: 21.0; 3PTS_%: 32.3; FT_M: 14.8; FT_A: 22.3; FT_%: 66.5. In turn, Pojskić et al. (2009) reported the following match statistics for SO_2008 basketball players of winning teams: 2PTS_M: 24.4; 2PTS_A: 40.6; 2PTS_%: 57.8; 3PTS_M: 9.2; 3PTS_A: 22.4; 3PTS_%: 41.1; FT_M: 16.1; FT_A: 22.4; FT_%: 73.5; the defeated teams presented the following statistics: 2PTS_M: 17.6; 2PTS_A: 37.9; 2PTS_%: 46.3; 3PTS_M: 7.5; 3PTS_A: 22.7; 3PTS_%: 32.9; FT_M: 14.3; FT_A: 19.3; FT_%: 72.7. Data presented by Milašius et al. (2014) concerning the Lithuanian national team participation in the Deaflympics of 2005 (Melbourne, Australia), 2009 (Taipei, Chinese Taipei), and 2013 (Sofia, Bulgaria) indicate the percentage shot indicators for deaf Lithuanian basketballers ranging 51.1–64.0% for 2-point goals, 32.6–33.4% for 3-point goals, and 56.0–69.4% for free throws. These values are similar to those provided in Table 2.

This could mean that the 5WDBC1 teams, in terms of shot statistics, would be able to conduct a balanced sports competition with the 18BWC participants. This has been confirmed by the performed discriminant analysis that assigned the 5WDBC winning and losing teams (5WDBC1 and 5WDBC2) to team groups winning and losing during 18BWC. The analysis allowed to identify 21 matches that could be classified in the 18BWC1 group (8 matches) and in the 18BWC2 group (13 matches).

When comparing the game-related situational variables (defensive rebounds, assists) of 5WDBC and 18BWC, one can notice a pronounced increase in DREB as compared with the statistics of WC_1998 in Greece, WC_2002 in the USA (Simović and Komić, 2008), SO_2008 (Pojskić et al., 2009), and WC_2006 (Dias Neto, 2007). The number of rebounds during SO_2008 equalled 10.5 for OREB, 26.2 for DREB, 36.5 for REB in the winning group and 10.2 for OREB, 21.5 for DREB, 31.7 for REB in the defeated group. The OREB number for SO_2008 is comparable with the data presented in Tables 2 and 3, whereas for the DREB number, one can notice a rising trend (about 30 DREB rebounds; Table 2). Defeated teams (Table 3) are characterized by DREB statistics at the level of those for WC_2006 and SO_2008. The number of defensive rebounds of the Lithuanian team during the 2005, 2009, and 2013 Deaflympics equalled 31.8, 28.0, and 30.0, respectively (Milašius et al., 2014). There were 10.6, 17.0, and 12.2 offensive rebounds, respectively.

The statistics of assists imply a progress also in this game component. The players of the winning teams performed ca. 20–22 assists per match during 5WDBC and 18BWC, and 16.0 and 13.3 during WC_2006 and SO_2008, respectively. For the losing teams, similar numbers of assists were observed during the considered basketball events: 15.3 for 18BWC2, 11.5 for 5WDBC2, 12.0 for WC_2006, 10.7 for SO_2008. The Lithuanian deaf competitors (Milašius et al., 2014) presented the following results for this component: 16.2 (Melbourne 2005), 22.4 (Taipei 2009), 14.5 (Sofia 2013).

A literature review regarding the impact of situational game indicators on success or failure (World Championships in years 1998–2006 [Simović and Komić, 2008], Summer Olympics in 2008 [Pojskić et al., 2009] and 2012 [Milanović et al., 2016], as well as FIBA European Club Championships in years 1992–2000 [Trninić et al., 2002]) implies that the indicators determining victory or defeat varied among individual basketball events. One should emphasize that the most frequent winning indicators are free throw, 2-point goal, and 3-point goal efficiency, defensive and offensive rebounds, as well as assists, steals, and turnovers. The statistically significant variables concerning the success or failure in a match included in Table 4 (FT_missed, 2PTS_missed, 3PTS_missed, DREB, AST, TO, OREB, and STL) are consistent with the results provided by other authors, despite the slight differences in the way of presentation.

Conclusion

The presented study allowed to determine the sports level of deaf basketball teams participating in the 5th World Deaf Basketball Championships in 2019 in Lublin (Poland) in terms of match statistics and to compare it with the statistics of the best national teams competing in the 18th Basketball World Cup in China in 2019. Match indicator values demonstrate that deaf basketball is developing in a similar direction and pace as the basketball sport at the level of the World Cup and the Olympic Games for hearing teams. The survey can provide guidance for coaches and deaf players on many game aspects. Deaf basketball requires further research, essential for the development of this sport, especially in the area of biomechanical characteristics comparisons, which indicate differences or similarities in the motor performance of both basketball groups at various levels of sports competition, with similar results in match statistics. The article helps minimize the general public belief in the inferior sporting potential of deaf people, thus reducing barriers between the deaf and hearing communities.

Acknowledgments

The study was supported by the Ministry of Science and Higher Education (Grant of Kazimierz Wielki University No. BS-2017-N2).

References

Abdelkrim, N. B., El Fazaa, N., Ati, E. (2007). Time-motion analysis and physiological data of elite under-19 basketball players. British Journal of Sports Medicine, 41, 69–75.

Bajgorić, B., Deis Čaušević, D., Bašinac, I., Korjenic, A. (2015). Latent structure of standard indicators of competitive efficiency of teams on the world basketball championship of players up to 20 years. Sport Science 8(1), 31–34.

Buśko, K., Pastuszak, A., Lipińska, M., Gryko, K. (2017). Somatotype variables related to strength and power output in male basketball players. Acta of Bioengineering and Biomechanics, 19(2), 161–167. DOI:10.5277/ABB-00678-2016-02.

Conte, D., Tessitore, A., Gjullin, A., Mackinnon, D., Lupo, C., Favero, T. (2018). Investigating the game-related statistics and tactical profile in NCAA division I men's basketball games. Biology of Sport, 35(2), 137–143. DOI: 10.5114/biolsport.2018.71602.

Dias Neto, J. M. (2007). The stats value for winning in the World Basketball Championship for Men 2006. Fitness & Performance Journal, 6(1), 57–61.

Erčulj, F., Dežman, B., Vučković, G., Pers, J., Perše, M., Kristan, M. (2008). An analysis of basketball players' movements in the Slovenian basketball league play-offs using the SAGIT tracking system. Facta Universitatis. Series: Physical Education and Sport, 6(1), 75–84.

Escalante, Y., Saavedra, J. M., García-Hermoso, A. (2010). Game-related statistics in basketball by player position and final game score differences in European Basketball Championship 2007. Fitness & Performance Journal, 3, 37–42.

García, J., Ibáñez, S. J., De Santos, R. M., Leite, N., Sampaio, J. (2013). Identifying basketball performance indicators in regular season and playoff games. Journal of Human Kinetics, 36, 163–170.

Gerodimos, V., Manou, V., Kellis, E., Kellis, S. (2005). Body composition characteristics of elite male basketball players. Journal of Human Movement Studies, 49(2), 115–126.

Ghe, A., Petreanu, M. (2018). Comparative analysis regarding men's basketball individual statistics from World Cup 2014. European Proceedings of Social and Behavioral Sciences, 26, 197–203. DOI: 10.15405/epsbs.2018.03.26.

Hulka, K., Cuberek, R., Svoboda, Z. (2013). Time-motion analysis of basketball players: a reliability assessment of Video Manual Motion Tracker 1.0 software. Journal of Sports Sciences, 32(1), 53–59.

Ibáñez, S. J., Mazo, A., Nascimento, J., García-Rubio, J. (2018). The relative age effect in under-18 basketball: effects on performance according to playing position. PLoS One, 13(7), e0200408. DOI: 10.1371/journal.pone.0200408.

Jeličić, M., Trninić, M., Jelaska, I. (2010). Differences between three types of basketball players on the basis of situation-related efficiency. Acta Kinesiologica, 4(1), 82–89.

Milanović, D., Štefan, L., Sporis, G., Vuleta, D., Selmanovic, A. (2016). Effects of situational efficiency indicators on final outcome among male basketball teams on the Olympic Games in London 2012. Acta Kinesiologica, 10(1), 78–84.

Milašius, K., Paulauskas, R., Dadeliene, R., Šatas, A. (2014). Body and functional capacity of Lithuanian deaf basketball team players and characteristics of game indices. Baltic Journal of Sport and Health Sciences, 4(95), 24–30.

Palmer, T., Katbeen, M., Weber, M. (2006). The deaf athlete. Current Sport Medicine Reports, 5, 323–326.

Paulauskas, R., Masiulis, N., Vaquera, A., Figueira, B., Sampaio, J. (2018) Basketball game-related statistics that discriminate between European players competing in the NBA and in the Euroleague. Journal of Human Kinetics, 65, 225–233.

Petway, A. J, Freitas, T. T., Calleja-González, J., Medina Leal, D., Alcaraz, P. E. (2020). Training load and match-play demands in basketball based on competition level: a systematic review. PLoS One, 15(3), e0229212.

Pluta, B., Andrzejewski, M. (2011). Characteristics of team leaders play as exemplified by the European Championships in Basketball. Journal of Human Kinetics, 27, 161–179.

Pojskić, H., Šeparović, V., Užičanin, E. (2009). Differences between successful and unsuccessful basketball teams on the final Olympic tournament. Acta Kinesiologica, 3(2), 110–114.

Raymond-Pope, C. J., Solfest, A. L., Carbuhn, A., Stanforth, P. R., Oliver, J., Bach, C. W., Bosch, T., Dengel, D. R. (2020). Total and regional body composition of NCAA Division I collegiate basketball athletes. International Journal of Sports Medicine, 41(4), 242–247. DOI: 10.1055/a-1073-7941.

Sampaio, J., Janeira, M., Ibáñez, S., Lorenzo, A. (2006). Discriminant analysis of game-related statistics between basketball guards, forwards and centres in three professional leagues. European Journal of Sport Science, 6(3), 173–178. DOI: 10.1080/17461390600676200.

Simović, S., Komić, J. (2008). Analysis of influence of certain elements of basketball game on final result based on differetiant at the XIII, XIV and XV World Championship. Acta Kinesiologica, 2(2), 57–65.

Steward, D., Robinson, J., McCarty, D. (1991). Participation in deaf sport: characteristics of elite deaf athletes. Adapted Physical Activity Quarterly, 8, 136–145.

Stojanović, E., Stojiljković, N., Scanlan, A. T., Dalbo, V., Berkelmans, D., Milanović, Z. (2018). The activity demands and physiological responses encountered during basketball match-play: a systematic review. Sports Medicine, 48(1), 111–135. DOI: 10.1007/s40279-017-0794-z.

Szulc, A. M. (2017). The report and analysis of the first U21 European Deaf Football Championship Men, Wroclaw, Poland 2016. Human Movement, 18(23), 44–48. DOI: 10.1515/humo-2017-0015.

Szulc, A. M. (2019). The report and analysis of the 2nd U21 European Deaf Football Championship Men, Stockholm, Sweden 2018. Human Movement, 20(3), 80–87. DOI: https://doi.org/10.5114/hm.2019.83990.

Szulc, A. M., Buśko, K., Sandurska, E., Kołodziejczyk, M. (2017). The biomechanical characteristics of elite deaf and hearing female soccer players: comparative analysis. Acta of Bioengineering and Biomechanics, 19(4), 127–133. DOI: 10.5277/ABB-00907-2017-02.

Trninić, S., Dizdar, D., Lukšić, E. (2002). Differences between winning and defeat top quality basketball teams in final tournaments of European Club Championship. Collegium Antropologicum, 26(2), 521–531.

Viswanathan, J., Nageswara, A. S., Baskar, S. (2010). Anthropometric assessment of youth national championship basketball players in relation to playing position. British Journal of Sports Medicine, 44(Suppl 1), i36–i37. DOI: 10.1136/bjsm.2010.078725.119.

www.FIBA.com: http://www.fiba.basketball/basketballworldcup/2019. accessed on 04.04.2020

Corresponding information:

Received:21.07.2020.
Accepted:04.12.2021.
Correspondence to: Adam Michał Szulc
University: Kazimierz Wielki University
Faculty: Institute of Physical Education
Phone: +48 793 085 314
E-mail:aszul@ukw.edu.pl