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Effect of Intellectual Impairment on Basketball Game-Related Statistics

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ABSTRACT

The purpose of this study was to analyze the influence of intellectual impairment (II) on game-related statistics which best contribute to success in basketball. Official game-related statistics were gathered from 6 male teams (n = 63 players) during the 13 games played in the World II-Basketball Championships (Ankara 2013). Variables were normalized to 100 ball possessions and descriptive statistics were calculated. To identify which variables contributed best to success, a discriminant analysis was performed. The obtained structural coefficients (SC) from this analysis indicated 2-pt successful $|SC = -0.65|$, assists $|SC = -0.61|$, steals $|SC = -0.41|$ and offensive rebounds $|SC = -0.32|$ as variables which best contributed to success. Results were compared with previous studies in able-bodied (AB) basketball. Assists and 2-point successful were discriminant variables to success in II and AB-competitions; however, defensive rebounds discriminated in many AB but not in II-competitions. In addition, steals and offensive rebounds were only discriminant in II-competitions. Relevancy of assists reflected the importance of teamwork in both AB and II-competitions; however, the lower shooting efficiency of II-players suggests possible limitations on decision making capacity or offensive tactics. Consequently, second opportunities to score (offensive rebounds) and scoring under low defensive pressure (fast-break after a steal); seem to take relevance to increase 2-point successful in II-players. These findings confirm the negative influence of II on basketball game-related statistics. This is a first step needed to develop evidence-based eligibility systems for this sport according to the position of the International Paralympic Committee regarding classification.

Key words: *intellectual disability, eligibility, classification, para-sport*

Introduction

Sports for athletes with intellectual impairment (II) were removed from the Paralympic program after it was revealed that during the Paralympic Games in Sydney 2000, 10 of the 12 basketball players from the gold winning Spanish team did not present any kind of impairment[1]. The lack of reliable eligibility systems at that moment made it possible for athletes to misrepresent their abilities. However, given the positive effect of Paralympic status on grassroots' development in sport, it is important for II-athletes to be able to participate at the highest level. For this, it is needed to develop evidence-based sport-specific eligibility systems which guarantee that only athletes with II having a significant activity limitation to perform a sport (e.g., basketball), will participate in this sport[2]. According to the International Paralympic Committee (IPC) classification code, athlete´s eligibility to participate in Paralympic sport is determined by the type of impairment and the impact of impairment on sport performance[3]. Hence, a first step to develop basketball-specific eligibility systems is to determine the impact of II on basketball performance[2].

Recent studies have already demonstrated that II do influence negatively on performance factors in different sports. One of these studies[4] identified a reduced length of the accelerative path and release speed in shot put in II-athletes when compared with a sample of able-bodied (AB) athletes matched by training volume. Other study[5] observed that II-swimmers in 200m freestyle race had more decline in their stroke length during the race than AB-swimmers. In this line, it was also observed that in 100m freestyle race, II-swimmers lost significantly more speed in the middle of the race than international AB-participants[6]. When elite II-table tennis players were compared with AB-table tennis players, results showed that II-athletes were significantly less proficient adapting their service/return to specific ball spin characteristics[7]; technical proficiency was lower when they played 10 sets of five basic and five advanced technical skills[8] and also tactical

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proficiency was lower playing 60 semi-standardized rallies against the same opponent[9]. These studies reported negative effects of II on sports performance, especially on technical and tactical components. Both components are also necessary to perform basketball[10].

Basketball performance is a complex product of multiple variables[11] in which technical and tactical knowledge are needed to solve a great number of open tasks externally regulated[10]. Also, cognitive abilities such as perceptive analysis, logical conclusions and general intelligence have been demonstrated to be significantly related with basketball success in AB-athletes[12]. Otherwise, the World Health Organization[13] manifested that an impaired intelligence is considered when the ability to understand new or complex information and to learn and apply new skills are significantly reduced; consequently, II might influence negatively basketball performance.

Specific research in II-basketball has demonstrated the benefits of basketball practice on maladaptive behavior[14], overall physical fitness[15], strength[16] and cardiovascular endurance[17]. Also, some studies have assessed how a specific training can improve II-athlete's basketball skills[15,18]. In these studies, basketball skills were divided into four categories[19]: ball handling, reception, passing and shooting; and these categories were used to assess athlete´s improvement and to classify II-athletes according to their skills[20,21]. These studies found a correlation between level of impairment and basketball skills, which suggests that cognitive abilities affected by II are involved in these skills. However, when II-basketball coaches were asked which basketball variables they considered most affected by II, coaches pointed out individual and collective offensive tactics instead of basketball skills[22]. Nevertheless, to assess basketball performance and consequently, the impact of II on it; it is recommended to analyze performance directly from competition because it represents the real competition context and it guarantees ecological validity, as tasks and demands are sport specific[23]. In this line, a recent study[24] described game-related statistics in high-level II-basketball teams and identified that successful teams performed significantly better than unsuccessful teams in the variables: steals, assists, successful 2-points shots and 2-points shot percentage. These results provided reference values to better understand how II-athletes perform basketball. However, to develop basketball-specific eligibility systems for II-players, it is still necessary to demonstrate how II impact on basketball performance. For this, the comparison between II and AB-players performing basketball is needed. To address this need, the present study aimed to analyze how intellectual impairment can influence on game-related statistics which best contribute to success in high-level basketball competitions.

The hypothesis of the present study is that II will negatively affect on game-related statistics which best contribute to success comparing with AB-basketball, especially in those variables directly related with tactical factors and decision making.

Method

Sample and variables

Data were collected from all the games played (n = 13) during the World Basketball Championships for II-players (Ankara) in 2013, organized by the International Sports Federation for Para-athletes with an Intellectual Disability (INAS). Six teams participated in the Championships (Portugal, France, Australia, Greece, Poland and Turkey) with a total of 63 male players. The following absolute game-related statistics were gathered in each game: 2- and 3-point field-goals (both successful and unsuccessful), free-throws (both successful and unsuccessful), offensive and defensive rebounds, steals, turnovers, assists, blocks, and personal fouls. Definitions are according to the basketball statistics manual of the International Basketball Federation[25]. Game variables were collected per team in each match (40 min played) and they were normalized to 100 ball possessions to account for game rhythm contamination[26]. Oliver´s equation[27] was used to calculate ball possessions (BP): BP = (field-goals attempted) – (offensive rebounds) + (turnovers) – 0.4 x (free-throws attempted).

Procedures

Professional statisticians from the Championship´s organization gathered all the data, however, a sub-sample of 10% of the sample were randomly selected and checked by two basketball experts at least 5-years experienced. Results showed Intraclass Correlation Coefficients higher than 0.94 in all variables.

Statistical analyses

Descriptive statistics (mean and standard deviation) were calculated for each game variable from all teams, successful and unsuccessful teams. The Shapiro-Wilk test was used to confirm normal distribution of the sample and a discriminant analysis using the game-related statistics was carried out to identify the variables which best contributed to success during the championships[28]. The structural coefficients (SC's) obtained from the discriminant function were used to identify these variables. Relevant for the discrimination between both groups was the SC above $|0.30|$[29]. Leave-one-out classification was conducted to validate the discriminant models[30]. All statistical analyses were performed using PASW statistics 20 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at $P<0.05$.

Ethics approval

The present study was approved by the KU-Leuven ethical committee and it was supported by INAS and IPC. All the participants were given an informed consent which was signed by them, approving participation in this research.

Results

Descriptive game-related statistics from all teams participating in the II-Ankara are presented and compared in table 1 with previous studies in different AB World Basketball: Under 18 (U-18) years old-1999, senior-2002[31] and both U-18 and senior in 2006[32]. Main differences pointed out lower shooting effectiveness in all kind of shots in II-players, more number of turnovers and more offensive and defensive rebounds except when compared with U-18 Championships in 2006. The distribution of field shots attempted indicated that in II-Ankara 3-pt shots represented 22.2% of all field shots attempted, in AB-junior competitions it represented 28.1% in 1999 and 28.9% in 2006; and in senior competitions it was 34.4% in 2002 and 31.6% in 2006. (Table 1)

A first discriminant analysis which included all game-related statistics to identify the variables which best contributed to success in II-Ankara was not significant ($p > 0.05$). However, when the variables 3-pt successful, 3-pt unsuccessful and blocks were excluded from the discriminant analysis, the second obtained function was significant ($p < 0.05$) and classified correctly 96.2% of the teams into successful and unsuccessful teams. Results indicated that 2-point successful (SC = –0.65), assists (SC = –0.61), steals (SC = –0.41) and offensive rebounds (SC = –0.32) were the variables which best contributed to success in II-basketball (Table 2).

TABLE 2
DISCRIMINANT ANALYSIS STRUCTURE COEFFICIENTS (SC) II-ANKARA

Game-related statistics	SC
2-pt successful	–0.65*
2-pt unsuccessful	–0.13
Free-throws successful	–0.23
Free-throws unsuccessful	–0.26
Defensive rebounds	–0.26
Offensive rebounds	–0.32*
Assists	–0.61*
Steals	–0.41*
Turnovers	–0.11
Fouls	–0.15
Eigenvalue	1.8
Wilk´s Lambda	0.36
Canonical Correlation	0.80
Chi-squared	19.6
Significance	<0.05
Reclassification	96.2%

* SC discriminant value > 0.30

TABLE 1
GAME-RELATED STATISTICS FROM II-ANKARA, U-18 AND SENIOR WORLD BASKETBALL CHAMPIONSHIPS

Variable	II-Ankara 2013	U-18 1999	Senior 2002	U-18 2006	Senior 2006
2-pt successful	25.7 (10.4)	29.7 (0.8)	27.6 (0.8)	33.3 (10.2)	34.0 (9.2)
2-pt unsuccessful	52.6 (12.0)	31.1 (0.9)	32.2 (1.0)	43.7 (–)	37.3 (–)
2-pt percentage	32.3%	47%	46.2%	43.1%	47.5%
3-pt successful	4.6 (3.6)	7.5 (0.5)	11.4 (0.6)	9.3 (4.9)	11.1 (5.2)
3-pt unsuccessful	17.8 (8.3)	16.4 (0.8)	20.0 (0.8)	22.0 (–)	21.9 (–)
3-pt percentage	18.2%	31.4%	36.3%	29.8 (–)	33.7%
Free-throws successful	13.7 (9.1)	20.8 (1.1)	26.2 (1.2)	24.2 (13.3)	25.5 (11.8)
Free-throws unsuccessful	13.4 (9.5)	9.3 (0.6)	9.0 (0.6)	13.3 (–)	10.8 (–)
Free-throws percentage	52.9%	69.1%	74.4%	64.5%	70.3%
Offensive Rebounds	22.5 (10.4)	17.9 (0.7)	14.7 (0.8)	23.0 (10.4)	16.6 (7.1)
Defensive Rebounds	41.6 (16.1)	33.0 (0.8)	33.7 (0.9)	46.5 (12.3)	38.4 (9.3)
Assists	15.3 (9.8)	11.6 (0.6)	23.7 (0.7)	19.5 (7.3)	21.4 (7.8)
Fouls	25.5 (6.9)	28.8 (0.8)	34.0 (0.9)	34.5 (9.5)	34.3 (8.8)
Steals	16.5 (8.9)	15.8 (0.7)	17.6 (0.8)	(–)	(–)
Turnovers	32.6 (14.6)	21.2 (0.6)	9.5 (0.7)	29.6 (8.7)	26.8 (8.1)
Blocks	4.8 (4.4)	3.4 (0.3)	4.8 (0.3)	(–)	(–)

(–) Missing data from the reference.

Descriptive game-related statistics (means and standard deviations) from successful and unsuccessful teams and differences in the identified variables which best contributed to success are presented in Table 3.(Table 3)

In table 4, game-related statistics which best contributed to success in this study were compared with similar studies in the following AB-basketball competitions: European Championships Under-16 (U-16) years old (season 2004–2005)[33], European Championships Under-20 (U-20) years old (seasons 2005 to 2007)[34], Spanish Basketball Amateur League (EBA, season 2004–2005)[35], the Spanish Professional League (ACB) during the season 2004-2005[26], ACB league in the season 2007–2008 and the ACB´s playoff from this last season[36]. Defensive rebounds, assists and 2-point successful were the game-related statistics which best contributed to success in several AB-basketball competitions. However, defensive rebounds in II-basketball did not discriminate to success and steals and offensive rebounds were discriminant in II-basketball but not in any AB-basketball competition. (Table 4)

Discussion

The aim of the present study was to analyze how intellectual impairment can influence on game-related statistics which best contribute to success in high-level basketball competitions. The obtained results confirmed the hypothesis that intellectual impairment negatively influences on basketball game-related statistics which contribute to success. In addition, these results enhanced the relevancy of 2-point successful, assists, steals and offensive rebounds to success in high-level II-basketball competitions.

TABLE 3
GAME-RELATED STATISTICS IN SUCCESSFUL AND UNSUCCESSFUL TEAMS II-ANKARA

Variables	Successful Teams	Sig.	Unsuccessful Teams
2-pt successful *	32.4 (9.7)	>	19.0 (5.8)
2-pt unsuccessful	54.7 (12.6)		50.6 (11.4)
2-pt percentage	37.2 % (9.2)		27.3 % (5.4)
3-pt successful	5.2 (4.7)		3.9 (1.9)
3-pt unsuccessful	17.0 (10.2)		18.7 (6.2)
3-pt percentage	18.9 % (12.6)		17.4 % (9.5)
Free-throws successful	16.3 (10.5)		11.0 (6.9)
Free-throws unsuccessful	16.6 (9.8)		10.3 (8.5)
Free-throws percentage	48.4 % (14.4)		57.5 % (20.9)
Offensive rebounds *	26.6 (11.1)	>	18.4 (8.1)
Defensive rebounds	46.9 (18.8)		36.4 (11.1)
Assists *	21.4 (10.3)	>	9.3 (3.5)
Fouls	24.2 (7.2)		26.8 (6.7)
Steals *	20.8 (9.3)	>	12.3 (6.4)
Turnovers	30.5 (16.7)		34.6 (12.4)
Blocks	5.8 (5.3)		3.7 (3.3)

* SC discriminant value > 0.30 and direction of significance

Employing the normalization of game-related statistics to 100 ball possessions as it has been extended used in the literature, let us compare the results from this study with previous studies in AB-basketball[26,33–36] avoiding the influence of game rhythm on final outcome during competition[26]. This is relevant in order to make possible to compare results in terms of efficiency instead of general outcome. Not doing this, we might mistakenly conclude that two teams scoring 70 points during a game had similar final offensive outcome; however, a team that required 50 ball possessions would be less efficient than other that employed only 35 ball possessions. It would mean that the second team score more points per ball possession. Although game-related statistics from AB-competitions presented certain range of variance across different categories and championships[37], common differences were presented between II and AB-basketball in all competitions. Lower shooting percentages found in II-players (see Table 1) could indicate that they were too much basket oriented and they did not prepare the shot as much as AB-players by interacting with their team[38]. Also, higher defensive intensity, or II-players shooting under pressure of the opponent, even though they are not under time pressure, might underlay these differences. Also, lower technical skills[32] and concentration limitations could explain results in shooting efficiency[38]. Probably, as a consequence of lower shooting efficiency, offensive and defensive rebounds seem higher in II compared to AB-competitions, with the exception of U-18 competitions in 2006. This exception could be probably due to the increase of 3-pt attempts in this category[32]. Shots distribution indicated a stronger preference of 2-point shots in II-competitions instead of 3-point shots. The lower shooting efficiency and the higher number of turnovers committed by II-players could explain the increase in fast-breaks and consequently more opportunities for 2-point shots instead of 3-point. Furthermore, the lower 3-point-efficiency in II-players might explain their preference for 2-point shots. This preference might also indicate that II-basketball is played closer to the basket than AB-basketball. In addition, in 2010, the distance of the 3-point line was increased from 6.25 meters to 6.75 meters. Probably, this modification could also influence on II-players shooting preference; however, to the authors knowledge there are no previous studies in II-basketball that provide the possibility to compare if there was a modification in shooting preferences in II-players before and after this rule modification.

In all AB-senior competitions, assists were higher and turnovers were lower than in II and U-18 competitions. AB-senior players seem to have higher efficiency in collective actions and higher team tactical development[39] that might explain these differences. In addition, the lower number of turnovers can be related with better dribbling skills and experience of AB-senior players[38]. According to this, it seems that II-players' skills and collective actions

TABLE 4

VARIABLES WHICH DISCRIMINATE TO SUCCESS IN II-ANKARA AND AB-BASKETBALL COMPETITIONS

	II 2013	U-16 Close 04-05	U-16 Balance 04-05	U-20 05-07	EBA 05-06	ACB 04-05	ACB 07-08	ACB Playoff 2008
2-pt successful	X		X	X			X	
2-pt unsuccessful					X			
2-pt percentage								
3-pt successful							X	
3-pt unsuccessful								
3-pt percentage								
Free-throws successful					X			
Free-throws unsuccessful								
Free-throws percentage								
Defensive rebounds			X	X	X	X	X	X
Offensive rebounds	X							
Assists	X	X		X	X	X	X	
Fouls					X			
Steals	X							
Turnovers		X						
Blocks								

X – Discriminant variables (SC > 0.30).

are closer to U-18 players, who are under development of technical, tactical and fitness components[32].

The fact that assists and 2-point successful shots were discriminant variables in most AB-competitions and in II-competitions, seems logical due to the strong relationship of these variables with the final aim of the game[40]: »to score in the opponents´ basket«. However, success in these variables requires abilities such as anticipation, perception, decision making and execution and also with individual and collective tactical offense[36,39]; abilities which seem to be negatively influenced by the impact of II[13,22]. This could explain that offensive rebounds and steals take significant importance to success especially in II-basketball because these variables can provide more opportunities to score. Offensive rebounds let teams a second opportunity to success in the offensive phase and steals could generate more opportunities of fast-break with low defensive pressure. These variables also require to read and to anticipate the game; consequently, differences in cognitive abilities or experience in II-basketball players might also explain differences in game-related statistics between successful and unsuccessful teams (see Table 3).

These findings are a first step in the development of specific eligibility systems for II-basketball and indicated that II influences on basketball game-related statistics which contribute to success. Future research in the line followed in this study should statistically contrast differences between game-related statistics in II and AB-basketball players to discover which variables discriminate best between II and AB-athletes. Additional research is needed to identify which cognitive abilities are involved directly in basketball performance and which is the minimum impairment needed to negatively impact on it[3,24].

Conclusions

The results of this study have led to a deeper understanding of how II influences on basketball performance. This is a necessary step to develop evidence-based basketball-specific eligibility systems which are absolutely necessary for future inclusion of II-basketball in the Paralympic program. Although previous studies have demonstrated the impact of II in other sports, this study was the first to study this in basketball. This study confirms that II influenced negatively on game-related statistics which contribute to success. Limitations presented by II-players to reach similar shot efficiency levels than AB-players seem to be explained by difficulties to carry out individual and collective tactics in which cognitive abilities are required to perceive, decide and execute correctly.

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UTJECAJ INTELEKTUALNOG OŠTEČENJA NA STATISTIKU KOŠARKE

SAŽETAK

Svrha ovog rada bila je analizirati utjecaj intelektualnog oštećenja (II) na igračke statistike koji najbolje doprinose uspjehu u košarci. Službena statistika vezana za igru prikupljena je od 6 muških ekipa (n = 63 igrača) tijekom 13 odigranih utakmica na Svjetskom II-Košarka prvenstva (Ankara, 2013.). Varijable su normalizirane na 100 posjeda lopte i deskriptivne statistike su izračunate. Kako bi prepoznali koje varijable najbolje doprinose uspjehu provedena je diskriminacijska analiza. Dobiveni strukturni koeficijenti (SC) u diskriminacijskoj funkciji su istaknuli su poene za 2 koša $|SC = -0.65|$, *asistencije,* $|SC = -0.61|$, *ukradene lopte* $|SC = -0.41|$ *i napadačke skokove* $|SC = -0.32|$ *kao varijable koji najbolje pridonose uspjehu. Rezultati su uspoređeni s ranijim studijama u radno sposobnoj (AB) košarci. Asistencije i uspješni poeni za dva koša su diskriminantne varijable uspjeha u II i AB-natjecanjima; Međutim, obrambene skokova bili su diskriminacijska varijabla u mnogim AB, ali ne u II-natjecanjima. Osim toga, ukradene lopte i napadački skokovi se bili diskriminantnih varijable u II-košarci. Relevantnost asistencija odražava važnost timskog rada u oba: AB i II-košarku; Međutim, niža djelotvornost šutiranja prikazana je kod igrača (II) čini se da ukazuju na ograničenja na sposobnost donošenja odluka i taktike kako bi se došlo u optimalnu poziciju za šut. Prema tome, druge prilike za koš (napadački skokovi) i koševi pod niskim pritiskom obrane (kontre nakon ukradenih lopti) se Čine važnim za povećanje uspješnosti šutiranja za 2 poena. Ovi rezultati potvrđuju negativan utjecaj II na košarkašku statistiku povezanim s igrom i to je prvi nužan korak za razvoj sustava za ispunjavanje uvjeta za košarku specifične potrebne uključiti II-košarku u paraolimpijskog programa.*