

Review

# Determinants of Basketball Match Outcome Based on Game-related Statistics: A Systematic Review and Meta-Analysis

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**Abstract:** This study aimed to systematically review the current scientific literature on game-related statistics (GRS) that better discriminate between basketball winning and losing teams, and to identify the magnitude of the difference of the most frequently cited GRS between winning and losing teams via meta-analysis. A systematic search of the databases Web of Science, Scopus, SPORTDiscus, PubMed, Science Direct, Latindex, Scholar Google, and Scielo was performed. Keywords addressed discriminant analysis, game-related statistics, discriminant factors, determinant factors, game outcome, match analysis, winning and losing, and basketball. Data from 20 out of 533 articles were eligible to be extracted. Structural Coefficients (SC) values were considered relevant for analysis when  $\geq 0.32$ . Results indicated that defensive rebounds and assists were classified as good ( $SC \geq 0.46$ ) or very good ( $SC \geq 0.56$ ) discriminant factors. Both were the most frequently GRS cited as discriminant factors, regardless of location, phase of the competition, or opponent's level. Based on these indicators, eight studies were included for meta-analysis. Meta-analyses showed that winning teams have at least six more defensive rebounds (95% CI = 4.22 - 7.99;  $p < 0.0001$ ) and around four more assists than losing teams (95% CI = 3.14 - 4.50;  $p < 0.0001$ ). Coaches should emphasize defensive rebounding and assisting drills in their practice planning to improve the likelihood of winning games.

**Keywords:** Discriminant analysis; basketball; game-related statistics



## 1. Introduction

According to FIBA, basketball is the second most popular team sport in the world, currently practiced in over 200 countries on five continents (<http://www.fiba.basketball/national-federations>). Its popularity can be explained by being an extremely dynamic and attractive sport (Gottlieb et al., 2021; Stojanović et al., 2018), that can be practiced either in the largest and most modern sports arenas in the world (Downs and Seifried, 2021) as well as in public squares and other less conventional places (Levicky and Busey, 2017; Santua, 2020), even at home (Santua, 2020). FIBA estimates that there are more than 450 million players (<http://www.fiba.basketball/presentation>) and 1.4 billion fans around the world (FIBA, 2019).

With all that hype around Basketball, coaches should find support in scientific studies conducted to analyze the variables linked to the success of these athletes and teams, which is essential for the preparation of training, game strategies, and tactics (Ibáñez et al., 2009). There are several determining factors of both individual and team performance in basketball, usually associated with body dimensions (García-Rubio et al., 2020; Zarić et al., 2020; Cui et al., 2019; Teramoto et al., 2018; Klapprodt et al., 2018) and athletic capability (Mancha-Triguero et al., 2020; Cui et al., 2019; Teramoto et al., 2018).

Moreover, on-court performance must also be analyzed. In this sense, a plethora of studies have investigated the predictive power of game-related statistics (GRS) on players' achievements (Zilinyi et al., 2022),

long-term career success (Lorenzo et al., 2019), and the outcome of matches at different levels of competition, countries, and age groups (Zhang et al., 2020; Paulauskas et al., 2018; Conte et al., 2018; Leicht et al., 2017; Lorenzo et al., 2010; Ibáñez et al., 2009; Angel Gómez et al., 2008; Gómez et al., 2008; Sampaio et al., 2004). Leicht et al. (2017) noted that shooting percentage and defensive rebounds are associated with higher winning frequency. Sampaio and Janeira (2003) found that during playoff close games, home teams are more prone to win if committing fewer fouls than their opposing team. Ibáñez et al. (2008) identified assists and steals as key GRS attached to winning. Dogan e Ersoz (2019) analyzed the performance of teams as they progressed through the EuroLeague phases and observed that during quarterfinals matches, 3-point % and assists were the main winning or losing differential, while during the Final Four matches, 2- and 3-point % and offensive rebounds better-discriminated match result.

As one can see, there is no consensus on which GRS represents the most important way of winning. Also, this conclusion may be context-dependent since analyses based on the opponent's level, game location, and competition phase seem to present different results. Understanding which of these GRS best discriminates between winning and losing teams can make coaches' training and game strategy planning easier and more evidence-based, as well as pointing out to performance analysts ways to better interpret the performance of athletes and teams.

Also, there have been reported differences in physical and physiological demands, the number of ball possessions, (Klusemann et al., 2013), playing style

(Klusemann et al., 2013; Zhai et al., 2020), and recovery time required between games (Kamarauskas et al., 2021; Fox et al., 2019) when the competition presents a more congested schedule, which is the case of short-term tournaments as compared to full-season ones. Those differences may partially explain the lack of consensus on GRS analysis.

Thus, to clarify these points, the objectives of our study were twofold. First, we conducted a systematic review of the current scientific literature to determine which GRS better discriminates between basketball winning and losing teams. After that, based on the most frequently cited GRS found throughout reviewed studies, we ran a meta-analysis to identify the magnitude of the difference of such GRS between winning and losing teams.

## 2. Materials and Methods

**Data and Research Sources** - This systematic review was conducted based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021), and considered complete articles published between 1970 and 2021, in English, Spanish and Portuguese, using the databases Web of Science, Scopus, SPORTDiscus, PubMed, Science Direct, Latindex, Scholar Google, and Scielo. In all databases (except when not available), the search was performed in the options "title", "title/abstract" and "keywords", using the following terms: discriminant analysis, game-related statistics, discriminant factors, determinant factors, game outcome, match analysis, winning and losing, combined with the term basketball (Boolean operator AND). The

search for studies was conducted from November 2020 to March 2022. All search procedures were performed by a single author (S.C.), and the results were later uploaded to EndNote™ software version X8.0.1 (Bld 10444) for source storage and duplicate removal. After the initial screening phase of titles and abstracts, the full versions of the studies were screened to identify those that were potentially relevant for this analysis. At this stage, the studies were independently assessed by two authors (S.C. and M.A.) using the eligibility criteria presented below.

*Eligibility Criteria* - To be preliminarily considered eligible, the studies should have aimed to investigate basketball GRS that discriminate between winning and losing teams, based on the discriminant analysis, a multivariate statistical approach used to discriminate and classify group membership. Plus, to avoid interferences in the rhythm of the game due to a greater or lesser number of ball possessions in each game (Mandić et al., 2019), the GRS should be standardized to an equivalence of 100 possessions. The results should mandatorily show structural coefficients (SC) values. Thus, studies that were limited to making comparisons of means (t-test or equivalent) or other kinds of analysis were disregarded. In each study, the sample consisted of the number of games played. Hence, studies whose competitions took place in short duration (tournaments) were excluded, as is the case in Olympic Games, FIBA World Cups, Universiade, and other tournaments with a similar competition system and in which participating teams play only three to six or eight matches.

The age group of interest was the adult category, regardless of gender. Therefore,

studies with the competitions' age group up to 19 years old were excluded (e.g.: Sub16, Sub17, Sub19). Finally, studies about NBA, WNBA, NCAA, 3x3 basketball, and wheelchair basketball competitions were also discarded, due to rules differences from those applied by FIBA, which could compromise the analyses.

The investigation protocol used in studies that perform this type of analysis is quite similar, with very rare exceptions. In this sense, we believe that the quality analysis of the studies is not necessary, as it was indirectly covered by the application of all eligibility criteria described above.

*Data Extraction and Analysis* - From the studies selected for the sample, the following data were extracted: competition, gender, year, country, number of games played, discriminant GRS, SC value, and model reclassification percentage. Data extraction was performed by a single author (S.C.), with another author (M.A.) independently responsible for verifying the accuracy of the extracted data.

*Statistical analysis* - To be interpreted as a discriminating factor between winning and losing, any given GRS SC value had to be 0.32 or higher (Tabachnick & Fidell, 2019), with cut-off points set as 0.71 (excellent), 0.63 (very good), 0.55 (good), 0.45 (fair), and 0.32 (poor) (Comrey & Lee, 1992).

Additionally, the most frequently GRS that differentiated winning from losing teams were identified. Based on these results, the studies that showed such GRS and presented mean  $\pm$  standard deviation values were selected to run a meta-analysis using Review Manager software (RevMan Version 5.4, The Cochrane Collaboration, 2020). Meta-analyses were conducted only if there

was a minimum of four studies with all required data available. Differences in means, as well as the 95% confidence interval (95%CI), were calculated using a continuous random effect model, to incorporate the degree of heterogeneity between studies.

### 3. Results

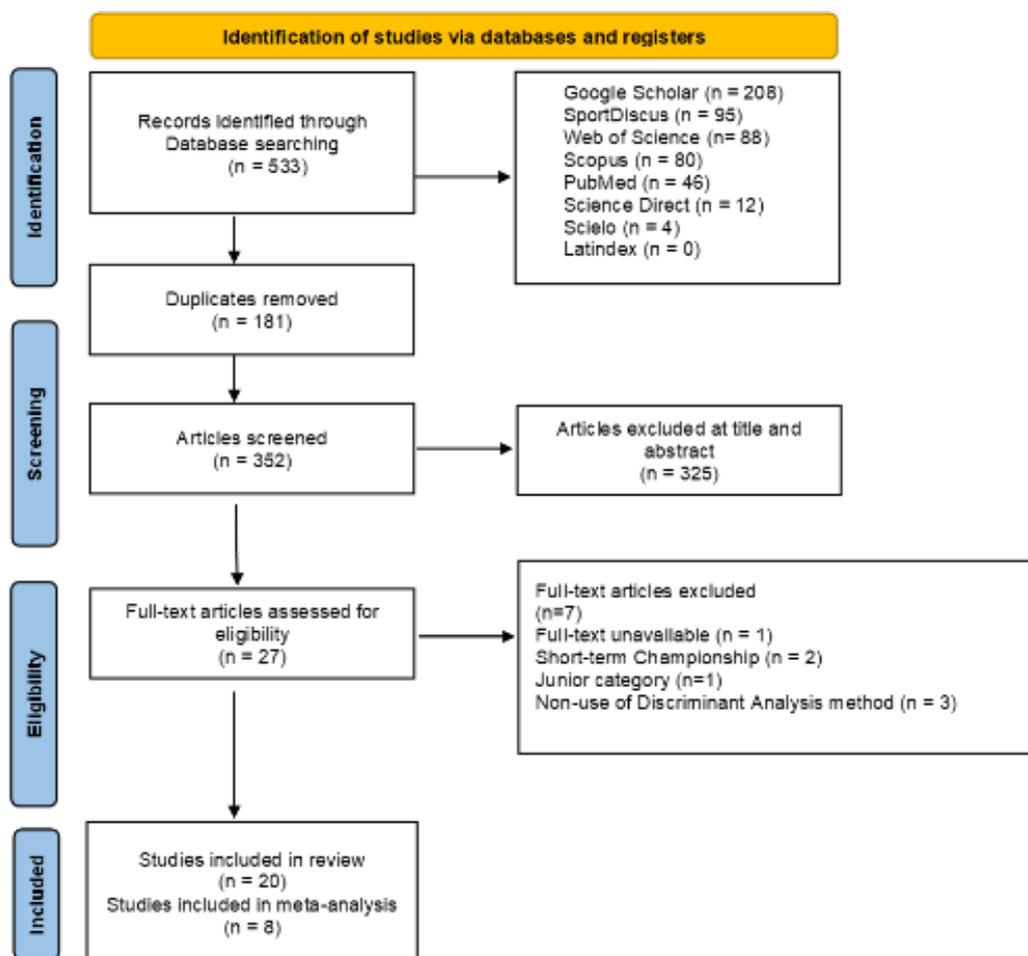
A total of 533 articles were identified through the database search. Of these, 181 were duplicates. Title and abstract screening were performed on the remaining 352 articles, of which 325 were determined to be irrelevant to the study aims. Twenty-seven articles were assessed for eligibility with the full-text review. After excluding seven studies for study design issues, 20 studies were included for data extraction (figure 1).

*Overview* - After reviewing the 20 articles, we observed a substantial increase in performance analysis research published over the last 15 years. Altogether, there were 45 discriminant analyses. One study conducted separate analyses for Asian and European teams (Maradame, 2017). Studies analyzed all games, close/balanced and unbalanced/very unbalanced games, home and away games, regular season, and playoffs games. Studies that used a male sample and the Spanish Leagues as the main competitions were predominant. Defensive rebounds and assists were the more prevalent winning/losing discriminant factors classified as good ( $SC \geq 0.46$ ) or very good ( $SC \geq 0.56$ ). In only one study, reclassification was not available. In the remaining 44 analyses, 32 (73%) showed reclassification above 80% (Table 1). Analyses result in 122  $SC > 0.32$ , being 35% relative to defensive actions and 65% to offensive actions. Considering that several different analyses were identified, we presented in this section solely the most prominent data among the results. For more detailed and complete data, please refer to table 1 and the following sections.

Balanced and Unbalanced Games Analyses - Four studies stratified games exclusively by final score differential and found discriminant factors in balanced games (Gómez et al., 2008; Gómez et al., 2006; Madarame, 2017; Mikic et al., 2018). Except for Mikic et al. (2018), all identified defensive rebound as a winning factor, and assists and 3-point shots made were cited in two studies each. Defensive rebounds and 2-point shots were responsible for differentiating winning and losing teams on four occasions, while

assists were responsible on three occasions in unbalanced games (Table 1).

Regular Season versus Playoffs Games Analyses - Only two studies analyzed exclusively competition phases. Dogan e Ersoz (2019) showed that 2- and 3-point shot % discriminated between winning and losing teams in seven consecutive EuroLeague seasons, throughout competition phases, but especially for the final four. According to Garcia et al. (2013) data, defensive rebound seems to be a winning factor during the regular season, but not in playoffs (table 1).



**Figure 1.** The screening process for selecting performance analysis studies.

**Table 1.** Championship characteristics of the included studies and discriminant analysis outcomes.

Study	Championship	Sex	Local	n	Discriminant Factors (SC value)	Reclassification
Sampaio and Janeira (2003)	Portuguese National League 1997/1998 and 1998/1999	M	Portugal	409	Regular Season (Close Games):	100%
					Home Games: Fouls (-.40), Missed 2P (-.33)	100%
					Away Games: FTM (.43), 3PM (.33)	
					Playoffs (Close Games):	100%
					Home Games: Fouls (-.51)	100%
					Away Games: FTM (.41), Off Reb (-.33)	100%
Gómez et al. (2006)	Spanish League 2004/2005	F	Spain	178	All Games: Def Reb (.40), 2PM (.38), Ast (.33)	83%
					Balanced Games: FTM (.46), Def Reb (.40), 3PM (.37), Ast (.36)	76%
					Unbalanced Games: 2PM (.49), Def Reb (.49)	96%
García et al. (2007)	Amateur Spanish League	M	Spain	182	Fouls (.38), Ast (.34)	N/A
Ruano et al. (2007)	Spanish National League 2004/2005	F	Spain	182	All Games: Def Reb (.40), 2PM (.38), Ast (.33)	83%
					Home Games: Def Reb (.40), 2PM (.36)	82%
					Away Games: 2PM (.35), Def Reb (.34)	83%
Gómez et al. (2008)	ACB Spanish League 2004/2005	M	Spain	306	All Games: Def Reb (.42), Ast (.38)	87%
					Home Games: Ast (.41), Def Reb (.40)	88%
					Away Games: Def Reb (.44), Missed 3P (-.35)	87%
Ibáñez et al. (2008)	Spanish League 2000/2001 to 2005/2006	M	Spain	870	Ast (.47), Steals (.34)	82%
Gómez et al. (2008)	Spanish League 2004/2005	M	Spain	306	All Games: Ast (.42), Def Reb (.38)	87%
					Balanced Games: Def Reb (.37)	81%
					Unbalanced Games: Ast (.39), Def Reb (.37) e 2PM (.33)	99%

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Garcia et al. (2009)	ACB Spanish League 2007/2008	M	Spain	306	2PM (.49), Bked Shots (-.47), Blk (.42), Dunks (.35), Def Reb (.33)	58%
Dimitrus et al. (2013)	Greek League 2010/2011	F	Greece	121	Missed FT (-.59), Ast (.58) e 3PM (.50)	57%
Garcia et al. (2013)	ACB Spanish League 2007/2008	M	Spain	323	Regular Season: Ast (.45), Def Reb (.38), 2PM (.36) Balanced Games: Ast (.35), 2PM (.35), Def Reb (.35) Unbalanced Games: Ast (.32)	87% 81% 81%
Almas (2015)	NBB 2013/2014	M	Brazil	316	Regular Season: Balanced Games: Def Reb (.49), FTM (.33) e 3PM (.33) Unbalanced Games: Ast (.45), Def Reb (.40) e 3PM (.39)	79% 97%
Marmarinos et al. (2016)	EuroLeague 2012/2013 to 2014/2015	M	Several Countries	1514	Playoff: Balanced Games: Def Reb (.44) e 3PM (.42)	72%
Dogan et al. (2016)	Turkish League 2014/2015	M	Turkey	263	Def Reb (.66), PPos (.66), Def PPos (-.56), Ast (.54), Steals (.39)	81%
Maradame (2017)	FIBA Asia 2011, 2013 and 2015	M	Several Countries	179	Ast (.55), Steals (.53), Def Reb (.48), TO (.47) e Off Reb (.33)	59%
Maradame (2017)	FIBA Europe 2011, 2013 and 2015	M	Several Countries	259	Balanced Games: Def Reb (.36), Ast (.35) Unbalanced Games: Ast (-.42), Def Reb (.39), 2PM (.37)	81% 100%
Maradame (2017)	FIBA Europe 2011, 2013 and 2015	M	Several Countries	259	Unbalanced Games: 2PM (.33), Def Reb (.33)	99%

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Prochnow et al. (2017)	NBB 2008/2009 to 2014/2015	M	Brazil	1912	Ast (.39), Def Reb (.38)	82%
Ibáñez et al. (2018)	Copa del Rey 1995/1996 to 2104/2015	M	Spain	140	2PM (-.43), 2PA (.41), TO (.40), Steals (.36), Fouls Drawn (.34)	70%
Mikic et al. (2018)	EuroLeague 2007/2008 to 2008/2009	M	Several Countries	251	All Games: Ast (.41), Def Reb (.39), 2PM (.35) Balanced Games: 2PM (.38), 3PM (.34) Unbalanced Games: Ast (.43), 3PM (.35)	83% 80% 97%
Cene (2018)	EuroLeague 2016/2017	M	Several Countries	259	TS% (.43), FG% (.41) e eFG% (.41)	71%
Dogan and Ersoz (2019)	EuroLeague 2010/2011 to 2016/2017	M	Several Countries	N/A	Group Phase: 2P% (.50), Def Reb (.49), Fouls Drawn (.48), Blk (.46), Ast (.34) Top 16: 2P% (.46), Blk (.45), TO (-.40), 3P% (.37), Def Reb (.36) Quarterfinals: 3P% (.49), Ast (.33) Final Four: 3P% (.54), Off Reb (-.37) e 2P% (.35)	75% 85% 82%
Giovanini et al. (2021)	NBB 2014/2015 to 2018/2019	M	Brazil	1271	Regular Season: Close Games: Def Reb (.40) Balanced Games: Ast (.34), Def Reb (.34) Unbalanced Games: Ast (.47), 3PM (.37), Def Reb (.36), 2P% (.36), 3P% (.35) Playoff: Close Games: Def Reb (.41) Balanced Games: Def Reb (.37), Ast (.37), 2P% (.33)	71% 91% 99% 76% 90%

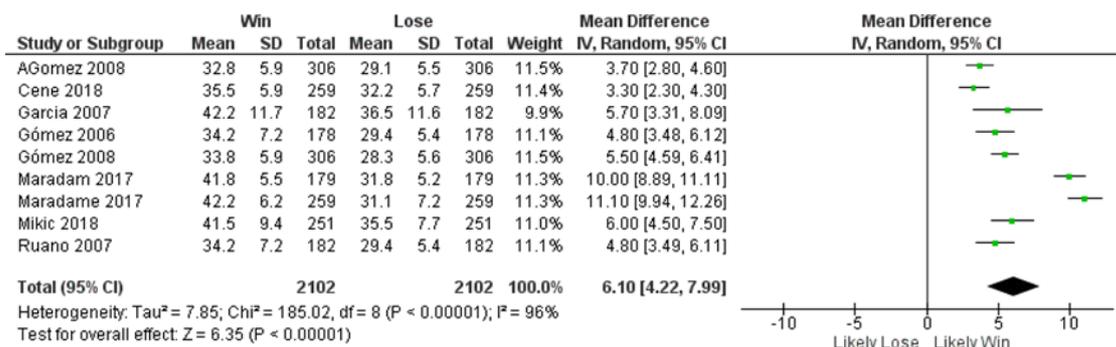
PM: 2 or 3 point-shots made; PA: 2 or 3 point-shots attempted; FTM: free throw made; FTA: free throw attempted; Def Reb: defensive rebounds; Off Reb: Offensive rebounds; Ast: assists; TO: turnovers; Blked: blocked shots; PPos: points per ball possession; Def PPos: defensive points per ball possession.

**Home versus Away Games Analyses -** Two studies analyzed home and away games of the same season of men’s (Gómez et al., 2008) and women’s (Ruano et al., 2007) Spanish Basketball National Championship. Defensive rebounds discriminated game outcome no matter the sex or the location of the game. However, men’s competition showed that more assists (home games) and fewer missed 3-point shots favored winning odds, while women’s winning teams made more 2-point shots in both home and away games (table 1).

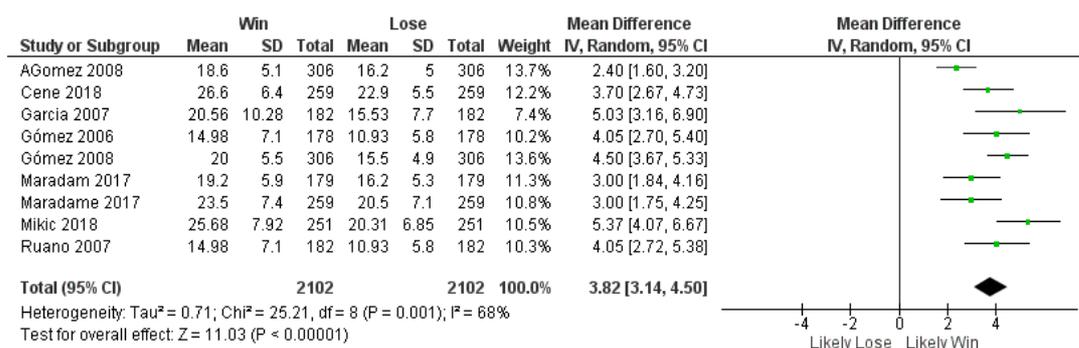
**Miscellaneous Analyses -** Some studies benefited from the high number of games analyzed and performed subgroup analyses. Almas (2015) found the defensive rebound and 3-point shots made performance determinants for winning in balanced games (up to 15 points) in both the regular season and playoffs. Giovanini et al. (2021) extended this analysis to the next five seasons of the same competition and identified that only defensive rebounds characterized winning teams in close matches (up to 7 points). In balanced games, defensive rebounds and assists were determinants for winning in the regular season as well as in playoffs. At last, Sampaio and Janeira (2003) analyzed home and away games stratified by final score

differential during the regular season and playoffs of the Portuguese National League and found discriminant factors only for closed games (up to 8 points). Their results showed that fouls were a negative factor for home teams and that free throws made were a positive factor for away teams, regardless of the competition phase (table 1).

**Meta-analyses —** The most featured discriminant GRS were assists (11 studies), defensive rebounds (9 studies), 2-point shot made (5 studies), and steals (4 studies). However, some studies did not present mean and standard deviation values for those variables. Thus, we conducted meta-analyses only for defensive rebounds and assists. Meta-analyses showed that winning teams have at least 6 more defensive rebounds (95% CI = 4.22 - 7.99;  $p < 0.0001$ ; figure 2) and around 4 more assists than losing teams (95% CI = 3.14 - 4.50;  $p < 0.0001$ ; figure 3). It is worth mentioning that the difference in the number of defensive rebounds between the winning and losing teams was large, between 3 and 11 (figure 2). In assists, the range of differences was narrower, ranging between 2 and 5 (figure 3).



**Figure 2.** Forest plot of studies comparing defensive rebounds performance in basketball winning and losing teams. The data shown are mean difference ± 95% CI.



**Figure 3.** Forest plot of studies comparing assists performance in basketball winning and losing teams. The data shown are mean difference ± 95% CI.

#### 4. Discussion

The purpose of this study was to systematically review the current scientific literature on GRS that better discriminate basketball winning and losing teams, and to identify the magnitude of the difference of the most frequently cited GRS between winning and losing teams via meta-analysis. Discriminant analysis interesting has grown in the last 15 years, which can be seen by the increase in published research throughout this period. Basketball discriminant analysis is essential to identify key indicators and effective coaching strategies that can be trained and improved to increase the chances of a better outcome. The main results indicate that defensive rebounds and assists are the game-related statistics that best discriminate between winning and losing teams, no matter the phase of the competition, game location, or opposing teams' level.

All included studies used Oliver's (2004) equation (BP = attempted field goals – offensive rebounds + turnovers – 0.4 x attempted free throws) to determine the number of ball possession and further normalize data by 100 ball possessions. This strategy was important to avoid misinterpretation of data due to differences in game pace. A faster-paced game (higher number of ball possessions) creates more opportunities to execute technical actions that would be recorded on the boxscore, and vice-versa. Thus, normalizing the number of

ball possessions makes teams comparisons more feasible (Csataljay, James, Hughes, & Dancs, 2011).

Moreover, short-duration tournaments like Olympic Games and World Cups present different physical, physiological, and tactical demands when compared to full-season competition formats (Klusemann et al., 2013; Kamarauskas et al., 2021; Zhai et al., 2020). We believe that these aspects could become confounding factors, and that is why we chose to select only studies that analyzed full-season, not short-term tournaments.

*Defensive Rebounds* - Defensive rebounds proved to be a key element in differentiating wins from losses (Sampaio et al., 2016), but to understand why it should be appreciated for its previous and subsequent events in the game. Defensive rebounding acts like a benchmark of the opponent team's ball possession ending after an unsuccessful field goal, plus it avoids the offensive team from having a second chance to score. Moreover, it is the basis for team play because allows more chances for fastbreaks and assists (Gómez et al., 2008; Ibáñez et al., 2009). In fact, 42% of fastbreaks start after a defensive rebound (Cárdenas et al., 2015), creating an opportunity for an easy scoring (Conte et al., 2017; Evangelos et al., 2005) and consequently turning the game's momentum in favor of the own team (Burke and Burke, 1999). Consequently, teams that cannot control the defensive rebounds have fewer chances of winning the game (Tsamourtzis

and Athanasiou, 2004), especially in close games (Giovanini et al., 2021).

Besides initiating the offensive transition, the favorable impact of defensive rebounds on winning odds can be explained by individual's and team's defensive effort. A well-organized, communicative, and aggressive defense can outplay the opposing team's offense by forcing it out of its comfort zone, not allowing enough time to execute set plays, which creates more pressure leading to adverse conditions for an open shot (Christmann et al., 2018; Ibáñez et al., 2008; Angel-Gómez et al., 2008). The most frequently used type of defense is quarter-court man-to-man (within the 3-point line limits) (Álvarez et al., 2009), which provides similar pressure on offensive players to full-court press defense (Sampaio et al., 2016). This kind of pressure tends to low shooting efficiency (Lucey et al., 2014; Csataljay et al., 2013), increasing the number of rebounds to be disputed. Plus, a more aggressive defense induces more contested passes which also impairs shooting efficiency (Bartholomew and Collier, 2011).

The disproportion between the number of defensive and offensive rebounds can be explained by the positioning and attitude of the players of both teams in the areas close to the rebound. Statistically, superiority situations enable more rebounds to be caught (Ribas et al., 2011), and usually the defensive team has numerical superiority inside the lane (restricted area) immediately after the shot is taken (Csataljay et al., 2017). This happens because part of the offensive players starts the defensive transition to promote defensive balance and try to prevent the opposing team an easy scoring (Moselhy, 2018). Additionally, Zarić et al. (2020) identified that point guards, shooting guards, and small forwards of the highest-ranked teams in the FIBA World Cups 2010, 2014, and 2019 were taller than those of the worst-ranked teams, which means more help on rebounding.

Hojo et al. (2019) demonstrated that defensive players who position themselves closer to the rim than opposing attackers are more likely to catch the ball. Another reason why defensive players should not spare effort to catch rebounds is that offensive performance starting with offensive rebounds is more efficient than those starting after ball possession change (Csataljay et al., 2017). Ionescu et al. (2020) and Christmann et al. (2018) made it clear that the main way to gain ball possession and to start offensive actions is defensive rebounding. Hence, positioning and boxing out are mandatory defensive actions (Csataljay et al., 2017).

*Assists* - After a loss in game 2 of the 2014 NBA Finals, San Antonio Spurs coach Gregg Popovich made a remarkable statement about the importance of ball movement: "either you move it or you die". Conte et al. (2018) verified that winning teams use more passing actions, such as ball reversal and post entries, intending to create better shooting opportunities.

Melnick (2001) compared NBA teams' performance based on assisted and unassisted team points. Win-loss record favored the assisted scoring, suggesting that "how a basketball team scores points is more important than the number of points it scores". Therefore, the other most frequently GRS able to discriminate between winner and loser teams were assists. According to FIBA Statisticians' Manual (2018), "An assist is a pass that leads directly to a team-mate scoring". So, it is associated with a successful team's offense, especially in away games (Mikołajec et al., 2021).

Christmann et al. (2018) revealed that individual plays, such as 1x1 with or without isolation, resulted in the lowest field goal efficiency of all play types, and that complex team play (various concatenated actions) showed the highest efficiency. This type of playing is often finalized with an assist. Interestingly, the only three studies included in this review analyzing women's competition presented assists as a game-

winning differential, at least when considering all games played (Dimitrus et al., 2013; Gómez et al., 2006; Ruano et al., 2007).

Assists represent an unselfish style of playing (Ibáñez et al., 2008; Melnick, 2001), and suggest a team's better overall passing skill, but it must not be assumed as a guards-only responsibility (Sindik and Jukić, 2011). Even though guards spent most of their live playing time in possession of the ball (Feroli et al., 2020), any playmaker plays a major role in assisting their teammates (Howard and Hoffman, 2018). However, one can argue that not every pass that precedes a scoring should be considered an assist. Perhaps, it is time for differentiating intentional from unintentional assists. Indeed, there is an understanding at NCAA that "an assist should be more than a routine pass that just happens to be followed by a field goal" (Isaacs et al., 2019). FIBA's current definition may split the accomplishment of an assist between the passer and the shooter, and that should be addressed in further analyses.

*Field Goals* - Field goals and steals were also found as discriminant factors in some studies. Since basketball aims to make more points than the opposing team, field-goal becomes one of the most significant skills of the game and reflects the offensive quality of winning teams (Sampaio, 1998). Gryko et al. (2018) analyzed FIBA EuroBasket 2015 field goals and found that the best-ranked teams hit more 2-point shots, whilst weaker teams were more dependent on hitting 3-point shots. Mikołajec et al. (2021) indicated that offensive-related statistics, such as field goals and free throws, were more likely to increase winning odds than any other variable in EuroLeague. As a close defender makes the shooter's accuracy decreases drastically (Rolland et al., 2020), teams must be prepared to play versus different defensive systems (Gómez et al., 2006), and be able to score more effectively, regardless of defensive actions (Csataljay et al., 2013).

The number of 3-point shot attempts has increased 10-fold since the early 1980s

(Rolland et al., 2020), but only six studies demonstrated that hitting 3-point shots is a way of winning games. It's worth highlighting that 11 of the 20 studies included in this review analyzed data from seasons played before 2010. The distance of the 3-point line was lengthened by 50 cm after the 2010 FIBA World Cup, and its immediate impact was to reduce 3-point shots attempt (Montero et al., 2013; Meneses et al., 2016; Pérez-Ferreirós et al., 2018).

Still, a closer look at the table 1 data reveals that that 2-point shot made was a winning factor in 12 different analyses before the 3-point line distance change, but after that only two analyses showed relevance, both on unbalanced games. The 3-point shots made seemed to be a differential mostly in Brazilian basketball. Moreover, 2- and 3-point % only discriminated teams after the 3-point line rule has changed, indicating that the quality of the shots overcomes the number of field goals (Çene, 2018). Reference values extracted from Brazilian's NBB data have established that hitting 42% of 3-point shots and 60% of 2-point shots correspond to a percentile 75 (Meneses et al., 2016), which means shooting at this level is not an easy task.

Besides, if a team can reach and maintain this level of 3-point shooting performance, the more they shoot, the more they miss. So, shooting selection is a key to increasing the chances to win games (Suárez-Cadenas et al., 2016).

In summary, there was a change in the scenario after 2010, with most analyses high-weighting the 2-pointers before the 3-point line rule has been changed, and the 3-pointers after that.

*Steals* - The last GRS frequently found as a discriminate factor is steals. FIBA considers a brief list of situations as a steal: if a defensive player intercepts or deflects a pass; if he or she takes the ball away from an opponent while holding or dribbling it; and if he or she picks up a loose ball originated by offensive player mishandling (FIBA, 2018).

However, statisticians usually simplify these data as a single variable.

Like defensive rebounds, the impact of steals on winning must be understood according to their preceding and following events. Steals reflect the defensive quality of winning teams (Gómez et al., 2006) and perimeter defensive pressure (Sampaio et al., 2006). The defense's mission is to take the opposing team out of their comfort zone, trying to lessen offensive options. This situation trends to not only poor field goals efficiency, but also to bad pass angles and uncontrolled dribbling, which increases the chances of a steal (Ibáñez et al., 2008). Plus, steals interrupt the opposing team's ball possession before they have a chance to score, avoiding an eventual dependence on defensive rebounding to regain control of the ball.

To achieve this kind of pressure, players must be properly fit (Dežman et al., 2001), with a high level of agility performance (Gomes et al., 2017). Data presented in table 1 indicate that steals are more prevalent in European competitions, regardless of competition phase, game location, or game scoring differential. Whether this is due to the typical European playing style is something about to be established.

What happens after the steal may also impact the match outcome. Cárdenas et al. (2015) pointed out that all together steals and pass interceptions respond for 50% of fastbreak starting on winning teams. Ciampolini et al. (2017) showed that fastbreaks lead to passively guarded or even wide open (unguarded) shot opportunities and Evangelos et al. (2005) indicated that winner teams executed more fastbreaks and were more successful in this kind of offensive situation than loser teams, which was associated with a higher probability of winning.

*Other GRS Analyses* - Two aspects of the data analysis deserve attention, both based on popular sayings suggesting that "offense wins games, but defense wins

championships" and "free throw wins games". All the studies included in this review analyzed games, not competitions per se. So far, the data gathered here confirmed that offense wins games, since 65% of the game-related statistics associated with match-winning do refer to the offensive part of the game. As we did not investigate teams' final ranking in each competition, our analysis did not allow us to support the premise that defense wins championships. On the other hand, Kozar et al. (1994) analyzed free-throw performance in college basketball and showed free throws percentage is higher in the last 5 min than in the first 35 minutes of the game. Also, winner teams had a greater performance in free throws than loser teams. These results should be enough to anticipate a high impact of the free-throw shooting on win expectations. Surprisingly just a few studies in our review found free throws made as a typical GRS of winner teams, primarily in balanced and away games.

There is no predetermined value to classify games as close, balanced, or unbalanced games since stratification is based on scores clustering for each championship. Generally, close games' final score is no higher than 10 points apart. However, most studies define only balanced and unbalanced games, using cut-off points ranging from 8 (Fox et al., 2020) to 18 points (Madarame, 2018), making proper comparisons a hard task. Maybe this approach is statistically correct, but basketball-wise, one should discuss the determination of real-game reference values for classifying a game as close, balanced, unbalanced, and very unbalanced.

*Meta-Analyses* - To the best of our knowledge, this is the first study to perform a meta-analysis about GRS as winning/losing discriminating factors. These analyses presented high (defensive rebounds;  $I^2 = 96\%$ ) and moderate to high (assists;  $I^2 = 68\%$ ) heterogeneity levels, which makes the understanding of how much a team must

outplay its opponent in defensive rebounds or assists in favor to winning the game still unclear. We must highlight that due to the eligibility criteria, all included studies followed the same methodology, i.e., the same study design, the same data acquisition and analysis, and with no sample selection since all the matches in each championship were included. Hence, there is no reason to believe in methodological issues are responsible for this level of heterogeneity. On the other hand, as stated before, the basketball-playing style is not based on a single pattern all over the World. Therefore, pacing, shot selection, and defensive strategies may vary considerably not only within the championship, but amongst different leagues, countries, and continents. Future research should investigate whether these aspects could be responsible for these heterogeneity levels found in the present study.

## 5. Practical Applications

The present findings suggest that basketball coaches should emphasize defensive rebounding and assisting drills in their practice planning to improve the likelihood of winning games. Defensive rebounding leads to fewer opponent's second-chance opportunities, and a higher number of fastbreaks, besides indicating a more efficient defensive system. Assists are a benchmark of an unselfish and successful playing style. So, coaches should practice game-related situations that comprehend both GRS, not forgetting the actions that precede and succeed those GRS.

This kind of analysis based on GRS has proven to be a valid and reliable method to understand aspects of the game of basketball that may increase one's team's chances to win games and orient training and game preparation. However, it is crucial to highlight that by doing this approach, we are analyzing and debating strictly numbers, not people or even more complex contexts.

Likely, there are intangibles that numbers appreciation will not be able to reach. So, for more suitable performance analysis, we advise scouting staff not to restrict data to GRS.

## 6. Conclusions

In conclusion, our results indicate that defensive rebounds and assists are the most discriminant factors between winning and losing teams, regardless of game location, phase of the competition, or the opponent's level.

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