Original Article

NBA Pre-Draft Combine is the weak predictor of rookie basketball player's performance

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ABSTRACT

The goal of the study was to assess the relationship between rookie player's Pre-Draft Combine physical abilities and basketball performance in the first NBA season. In strictly homogenized sample of players (N = 58) who matched the inclusion criterion of average playing time and number games in the period 2012-2015, the results indicate that Pre-Draft Combine testing procedures show low to moderate correlations with only few observed basketball performance variables in the first NBA season. The highest correlation was found between upper body strength and number of rebounds (r = .403, p = .002) and blocked shots (r = .333, p = .011). Regression model of Combine performance explained 24.7% of basketball performance with three physical performance tests. Practical application might suggest that some parts of the Combine might be restructured in order to include some other tests more informative tests for the future player performance and player selection.
Keywords: Sport performance; NBA; Statistics; Speed; Vertical jump; Regression.

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INTRODUCTION

Modern NBA basketball is a very dynamic sport which requires fast, aggressive and diversiform plays in the offense and defence. Most activities are short high intensity movements like sprinting, passing, jumping, shuffling and dribbling, with many physical contacts between players. Importance of the physical abilities in NBA basketball is well documented and teams regularly search for the players who can meet physical demands of the game (Hoffman et al., 1996; Page et al., 2013).

Previous studies showed that explosive power, agility, isokinetic strength of knee muscles and the absolute strength of upper body makes difference between elite and non-elite basketball players (Delextrat and Cohen, 2008). There are differences in physical abilities between players of different skill levels, whereas players with better skills are faster, more agile and have better performance in vertical jump tests (Hoffman et al., 1996; Page et al., 2013). In addition, some previous reports indicated the importance of physical abilities for the overall of playing time and on-court performance suggesting that better skilled players play more and have better game performance (Hoffman et al., 1996; McGill et al., 2012).

In that sense, assessment of the physical abilities is widely used to evaluate athletes in terms of their potential success in sport especially in basketball (Hoffman, 2006). In order to pick the best available players on the NBA draft, the whole monitoring system has been developed and every NBA team has its own scout network. In particular, National Basketball Conditioning Coaches Association (NBCCA) developed specific Pre-Draft Combine testing protocol for the future NBA players, which assumes valid and reliable tests, which supposed to be highly related to physical qualities important for basketball performance (Foran and Pound, 2007). It is conducted every summer and, inter alia, the protocol includes testing of speed, change of direction, vertical jump and upper body strength endurance.

While it has been verified that a limited number of factors, mainly offensive, determines performance in the NBA (Mikołajec, Maszczyk and Zając, 2013), very few studies analysed the significance and validity of Pre-Draft Combine tests for player selection and future game performance. Researches about game performance analysis were mainly devoted to evaluation of different game performance indexes (Martinez & Martinez, 2011; Marmarinos et al., 2019) or different mixed performance models (Casals and Martinez, 2013) while the only one research about predictive value of the Pre-Draft Combine in game performance, which included all rookie players regardless of playing role, indicated that the majority of individual Pre-Draft Combine tests are not related with future on-court performance (Teramoto et al., 2018). The lack of high significance between many physical tests and future on-court performance in the regression models, suggest that these parameters might be overestimated or that some test might be missing in Pre-Draft testing procedures. Furthermore, there are no published studies which evaluated the relationship between basic physical abilities measured on the Pre-Draft Combine and level of game performance of the rookie players, who had significant playing role during the rookie season.

It was hypothesized that some Pre-Draft combine tests will show moderate to strong relationship with on-court performance. Therefore, the goal of the study was to assess the relationship between rookie player's physical abilities on the Pre-Draft combine testing and their basketball performance in the first NBA season in the sample of players who had important playing role in the game.

MATERIALS AND METHODS

This study used a descriptive design research model (Thomas et al., 2015). We conducted a secondary analysis from archival data obtained from open-access official NBA records in period from 2012–2016 regular season (all stats used in study are available at https://stats.nba.com/) according to previously published studies (Teramoto et al., 2018; Zhang et al., 2018).

Participants

The subjects of the study were rookie NBA players in four consecutive seasons, in the period from 2012/13 until 2015/16. In order to increase the reliability of basketball data (Kubatko et al., 2007) the inclusion criteria for participation in the study were: number of games played in the first season (more than 30 games), and average time on court in the first season (minimum 16 minutes played per game) (Abdelkrim et al., 2007). From total number of 240 rookie players drafted in these four seasons, after stratification the sample included 58 players who matched the inclusion criterions.

Design and Procedures

The sample of physical ability variables included data from the following standardized Pre-Draft Combine tests:

- Lateral agility: test measures how fast a player moves laterally around the key measured in seconds (lane agility),
- Shuttle run agility: The players start in the middle of the key and run to each side of the key before returning to the centre, measured in seconds (shuttle run),
- Speed: sprint over the distance of three quarters of the court is measured in seconds (¾ sprint),
- Power: measured by the vertical jump from spot (VJ from spot) and from running (VJ from running),
- Strength endurance: maximal number of reps on bench press with 185 lbs (bench press).

The sample of basketball performance variables included the following game data variables:

- PTS (number of points),
- 2PTS FG% (efficiency of shot for 2 points),
- 3PTS FG% (efficiency of shot for 3 points),
- FT% (free throw efficiency) ,
- OFF REB (number of offensive rebounds),
- DEF REB (number of defensive rebounds),
- TOTAL REB (total number of rebounds),
- ASIST (number of assists),
- TOV (number of turnovers),
- STL (number of steals),
- BLK (number of blocked shots),
- PF (number of personal fouls),
- DD (number of double doubles).

The research has formal approval of all procedures from the Institutional of Research Review Board. This study was conducted as non-human subjects research by the Institutional Review Board as we conducted a secondary statistical analysis of data available through web-based public access with no individual health information.

Statistical Analysis

All row data were collected using official NBA league web site (nba.com/stats). As a first step all data were analysed by descriptive statistical procedures where mean values and standard deviations were calculated. The ranges between single variables were defined with minimal (MIN) and maximal (MAX) values. Correlation between variables physical test and basketball performance were calculated using by Pearson's correlation product analyses, while Multiple Regression Analyses with backward criteria were used for calculation prediction relation between Game Performance Score (GPS), as criteria, with physical performance tests, as predictive variables. Game Performance Score was calculated using methods of mathematical modelling by applying procedures of multidimensional scaling where GPS was representing a general factor score calculated by Principal Component Analyses I.e. Factor Analysis according to the procedures described before (Kukic et al. 2018). As per Cohen's effect size criteria for correlation coefficients (small: r = .10 – .29, medium: r = .30 – .49, and large: r ≥ .50. All data were analysed using the statistical package for social sciences SPSS (20.0).

RESULTS

Descriptive statistics of the sample is presented in Table 1.

Table 1. Descriptive statistics of physical abilities and game performance.

Variable	Mean ± SD	MIN - MAX
Age (yrs.)	21.12 ± 1.27	19.00 - 24.00
Body height (cm)	197.43 ± 8.29	178.00 - 215.00
Body mass (kg)	97.34 ± 11.63	75.00 - 126.00
BMI (kg/m2)	24.91 ± 1.80	21.75 - 29.61
Lain agility (s)	11.15 ± 0.52	10.27 - 12.85
Shuttle Run (s)	3.01 ± 0.20	2.69 - 3.71
¾ sprint (s)	3.30 ± 0.13	3.08 - 3.81
VJ from spot (cm)	77.68 ± 7.31	62.23 - 96.52
VJ from running (cm)	92.51 ± 7.86	73.66 - 111.76
Bench press (number of repetitions)	9.10 ± 4.45	1.00 - 19.00
PTS	9.40 ± 4.10	3.40 - 22.10
2PTS FG%	44.66 ± 5.75	33.20 - 62.30
3PTS FG%	29.72 ± 15.22	0.00 - 100.00
FT %	71.63 ± 10.53	41.80 - 87.10
OFF REB	1.12 ± 0.95	0.10 - 5.40
DEF REB	3.04 ± 1.43	1.00 - 8.10
TOTAL REB	4.15 ± 2.28	1.10 - 13.20
ASIST	1.86 ± 1.44	0.20 - 6.70
TOV	1.28 ± 0.68	0.50 - 3.80
STL	0.75 ± 0.35	0.20 - 1.70
BLK	0.41 ± 0.40	0.00 - 2.30
PF	2.09 ± 0.60	0.80 - 3.40
DD	5.03 ± 9.79	0.00 - 57.00

Table 2. Correlation between physical abilities and basketball performance.

Performance/Test	Lain agility		Shuttle run		3/4 Sprint		VJ from spot		VJ from running		Bench press	
	r	p	r	p	r	p	r	p	r	p	r	p
PTS	.260*	.049	.042	.753	-.049	.715	.139	.299	.161	.227	-.025	.853
2PTS FG%	.179	.180	.016	.905	.349**	.007	-.204	.125	-.212	.109	.221	.096
3PTS FG%	-.031	.818	-.307*	.019	-.065	.627	.030	.825	.243	.067	-.180	.177
FT%	-.054	.685	-.099	.460	-.175	.189	.137	.306	.270*	.048	.052	.699
OFF REB	.152	.256	.221	.096	.247	.062	-.157	.239	-.306*	.020	.304*	.020
DEF REB	.089	.508	.234	.077	.194	.145	.039	.770	-.059	.660	.401**	.002
TOTAL REB	.103	.441	.231	.081	.221	.095	-.034	.802	-.152	.256	.403**	.002
ASIST	-.364**	.005	-.131	.329	-.352**	.007	.221	.095	.266*	.043	-.261*	.048
TOV	-.263*	.046	.004	.973	-.151	.257	.213	.109	.117	.380	.016	.907
STL	-.345**	.008	.040	.764	-.244	.065	.244	.065	.270*	.040	-.207	.119
BLK	.080	.549	.077	.566	.239	.071	-.023	.866	-.165	.215	.333*	.011
PF	-.062	.646	.155	.247	.088	.510	.167	.209	-.015	.913	.236	.075
DD	.131	.328	.110	.412	.184	.166	.036	.788	-.187	.159	.207	.120

Table 2 shows the correlation coefficients between physical abilities and basketball performance. From 78 possible correlation pairs, there was only 16 significant correlations (20.51% of correlation's $p < .05$), generally low to moderate level (from $r = .26$ till to $r = .403$, $p < .05$). It can be observed that according to the number of realized correlations ($p = .01$; $p = .05$), that parameter Bench press test shows the highest number of correlations with game performance variables (5 correlation). As well, looking from game performance perspective, parameter ASIST is ahead with number of correlations with physical performance (4 correlations).

Table 3. Regression model of game performance based on physical abilities.

Model	R	R^2	Adjusted R Square	Std. Error
4	.497d	.247	.205	.892

Regression model with the smallest error and the highest variance prediction was model number 4 ($F = 5.893$, $p < .001$). The model equation includes three physical predictors of basketball performance i.e. GPS: lane agility, VJ from running and bench press.

Game Performance Score = 1.43934 - (.43008 x Lane agility) + (.04234 x VJ from running) - (.06169 x Bench press)

DISCUSSION

The present study is designed to address the importance of Pre-Draft Combine results for player's game performance in the rookie NBA season. The present study suggests that Pre-Draft Combine testing procedures show low to moderate correlations with only few observed basketball performance variables in the first NBA season. Generally, according to the results the highest correlation was found between upper body strength in bench press and number of rebounds and blocked shots (TOTAL REB - $r = .403$, $p = .002$ and BLK - $r = .333$, $p = .011$, Table 2). Regression model of pre-draft combine performance explained 24.7% of basketball performance in game. In this context, the value of Pre-Draft Combine represents ¼ of overall rookie performance score variability i.e. it is just part of the puzzle for basketball performance appraisal.

This is the first study that includes strictly homogenized sample of rookie NBA players who played significant playing time in the game (more than 1/3 of total game time) and significant number of games (more than 1/3 of total games in season) in order to assess the importance of pure physical qualities in game performance. Considering that all rookie players don't play so many minutes at the start of NBA career, the present stratification was used in order to increase the validity of presented relationships. The majority of previous studies explored the relationships in junior male or female players (Marcolin et al., 2018), while sample of NBA players was used in very few studies (Fearnhead and Taylor, 2011; Maymin, 2013; Page et al., 2013). Only one study up to date assessed the relationships between game statistics and physical performance (Teramoto et al., 2018).

Speed and lane agility tests showed low correlation with the number of points, number of assists, turnovers and steals in game (from Lain Agility vs. PTS, r = .260, p = .049 till to ASIST, r = -.364, p = .005, Table 2). It should be noted that the negative coefficients between speed and agility tests indicated that faster players tend to have better game performance. Other researchers also reported that agility is connected with number of points, assists, and steals (McGill et al., 2012). The number of correlations between these tests and statistic parameters shows that lane agility test is more specific to NBA basketball due to lateral movements in compare to shuttle run test which includes only forward running and change of direction. The high interrelation between tests indicates that they measure the generally the same ability, which was the also the case in NFL combine testing battery (Mcgee and Burkett, 2003). This indicates that lane agility alone might be utilized in testing battery. Unlike agility, linear running velocity in ¾ courts as an assessment of basic speed potential was in correlation only with the number of assists. Having on mind that assists and turnovers are not only related with the technical or physical skills of players, but also with the perception and action process in the game (Paulauskas et al., 2018) it is natural that faster players have potential to more often come in position to get and to make an assist.

Vertical jump from running showed low correlation with number of assists, steals and number of offensive rebounds (r = .266, p = .043; r = .270, p = .040; r = -,306 p = .020; respectively, Table 2). It might be particularly surprising that VJ from spot does not seem to be significant factor for number of rebounds during the game, as well as that vertical jump from spot is not related to any of the statistical data which is in line with previous report of McGill and colleagues (McGill et al., 2012). This might amplify from tactical aspect the importance of body positioning for executing the rebound rather that level of vertical jump per se. Considering that basketball players in average execute between 44 ± 7 and 46 ± 12 jumps per game (Abdelkrim et al., 2007;McInnes et al., 1995), it can be assumed that in game situations, basketball players does not necessarily perform countermovement drop which will allow them to execute maximum VJ height (Mandic et al., 2015), but rather utilize optimal speed and timing of movement for making the efficient rebound. Therefore, vertical jump from spot represent measure of explosive strength for basketball game in sport non-specific or so-called static conditions, but definitely vertical jump from running is more specific informative test for basketball rebounding performance. Considering that rebounds in offense and defence can be the determining factor for winning the game (Csataljay et al., 2009;Madarame, 2017), huge importance of offensive and defensive rating in the outcome of the game (Malarranha et al., 2013)vertical jump from running seems to be the most appropriate sports-specific jumping test for basketball players.

Even though upper body strength endurance in bench press showed low to medium correlation with number of rebounds both in offense and defence and blocked shots (from r = -.261, p = .048 till to r = .403, p = .002, Table 2), this is the physical test with the highest number of correlations with basketball performance variables. Only one earlier investigation on this topic reported significant correlation between the bench press and the number of blocks (Gomes et al., 2013). Although bench press represents a basic upper body strength test and it is not similar with basketball moves other that passing, it is possible that the relation of arm strength is primarily due to importance for contact positioning before rebounding, which is in line with the previous paragraph. As well, bench is the most utilized upper body exercise and players who make extra workouts surely have bench press in their strength program. Bearing this in mind, it is obvious that bench press per se is not a represent of basketball success but it seems that it has high connection with degree of overall training level and therefore with performance.

Regression analyse were calculated in order to determine influence of which physical fitness measures might be the most closely related to game performance in basketball. The results of the regression analyse are in line with previous findings of Teramoto et al. (Teramoto et al., 2018). As well, the present study is conducted on stratified sample which additionally indicates that individual Pre-Draft Combine measures are statistically significant but not highly associated with game performance. From regular six pre-draft combine tests, only three were part of our regression equation (Table 3 and regression model equation), with 24.7% of overall GPS variability explanation, where power influence of extracted variables is: Lane agility, Bench press and VJ from running, respectively. In view of strict sample stratification, the level of explained variance might be even more significant regarding those three tests and their influence in performance. In only one previous report about comparable problem in non-stratified sample of players, regardless of playing time, length-size parameters showed to explain 47.1% of basketball performance variance (Teramoto et al., 2018). The same authors showed that additional abilities covered with testing procedure showed total of 25.3% explained of variance (power-quickness 16.1% and upper-body strength 9.2%) which is in line with our regression modelling.

Considering equation of basketball success, the most important factors for success in basketball are: anthropometric characteristics - body height, wing span and body mass (Monson, 2018; Teramoto et al., 2018, Paulauskas et al., 2018), aerobic and anaerobic endurance (Padulo et al., 2016), physical abilities and basketball technique, cognitive abilities, tactical basketball thinking, sociological and objective factor, training factor and error factor (Karalejic and Jakovljevic, 2008). Value of an individual player can't be estimated by single measure (Page et al., 2013) and therefore physical abilities are important but not crucial factor for basketball success.

All of the factors from equation are in certain interrelation which makes them interdependent (Karalejic and Jakovljevic, 2008). It is well-known that even relatively stable categories (scoring, rebounding, and ball-handling), change in relation to the particular conditions during game and during the season. Considering the importance of teamwork, the impact of individual athletic abilities on game performance measures in basketball seems to be smaller than one might assume (Teramoto et al., 2018). Due to synergetic effect of different skills, player's performance is dependent on teammates as well as opponent players during the game (Maymin et al., 2013). Also, same authors find more than two hundred mutually beneficial trades between NBA teams, where the basketball skills of the traded players fit better in team of trading partner and level of player and team performance was increased, regardless the level of physical difference between the traded players.

It might be unexpected that NBA Pre-Draft combine results show low relation with game related statistics during the first NBA season. It is obvious that players who reach the NBA draft level have high level of physical performances. This physical level might allow them to become high-level basketball players in the following seasons, but physical performance per se does not guarantee that with better results on the pre-draft combine, the better they will be in the basketball game. As well, previous reports indicated that basketball players in general should be valued in terms of their offensive and defensive contribution in the game, while also taking into account intangible elements like leadership, intensity, intimidation and personality (Martinez & Martinez, 2011). Studies from other sports (football, rugby, and hockey) found that there is little support for many of the current preseason tests regarding relation with game performance (Kuzmits and Adams,2008; Mcgee and Burkett, 2003;Teramoto et al., 2018). Therefore, possible questions for the future studies is how the results from Pre-Draft combine might affect the player performance in the NBA during the later stages of career and is it possible that physically dominant athletes from the Combine will be developed into the best basketball players in the following years.

CONCLUSION

From regular six pre-draft combine tests, only three of them showed important influence on Game Performance Score, according to the following order: Lane agility, Bench press and VJ from running. It might be concluded that some of Pre-Draft Combine physical tests might not be so essential for test battery and that some more important factors might be included in the player evaluation as a regular part of selection process beside pure physical performance tests. Therefore, practical application of these results might suggest that some part of the Combine might be restructured in order to include some other tests which might be more informative for the future performance and player selection process.

AUTHOR CONTRIBUTIONS

Igor Ranisavljev and Marko Cosic: Research design, manuscript writing and preparation. Radivoj Mandic: Result interpretation and literature review. Predrag Blagojeic: Data acquisition. Milivoj Dopsaj: Statistic analysis and result interpretation.

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