Original article
DOI: 10.14529/hsm240318

THE EFFECT OF ACL INJURY ON POST-RECOVERY BASKETBALL PERFORMANCE IN THE NBA LEAGUE

I. Ranisavljev[1], *igor.ranisavljev@fsfv.bg.ac.rs, https://orcid.org/0000-0002-5784-2917*
F. Kojic[1], *kojic.fi@gmail.com, https://orcid.org/0000-0001-6740-3347*
M. Cosic[1], *marko.cosic@fsfv.bg.ac.rs, https://orcid.org/0000-0001-6780-6517*
N. Todorovic[1], *todorsnajder@gmail.com*
F. Kukic[2], *filip.kukic@gmail.com, https://orcid.org/0000-0002-8625-5375*
[1] *University of Belgrade, Belgrade, Serbia*
[2] *University of Banja Luka, Banja Luka, Serbia*

Abstract. **Aim.** This study investigated whether Anterior cruciate ligament (ACL) reconstruction affects the post-recovery performance in National Basketball Association (NBA) players. **Materials and Methods.** Quantitative analysis of retrospective data from the NBA players' game performance and injuries was performed. Data for 44 consecutive NBA seasons (Seasons 1976/1977 to 2019/2020) were analyzed. All male NBA players who sustained an ACL injury, followed by ACL reconstruction, and return to play (RTP) in the NBA during their career (n = 71) were included in the study. Their age at the time of injury, playing position, number of season pre- and post- injury, number of games played per season, points per game, rebounds per game, and assists per game. **Results.** Players played around 4 seasons before ACL injury and around 5 seasons after injury. After the ACL reconstruction, point guards showed a significant decline in minutes played per game ($p = 0.04$). A decline in number of games as well as in the minutes played per game could be observed in small forwards ($p = 0.03$). In average, power forwards played fewer seasons before the injury compared to after the injury (3.5 seasons pre- vs 6.2 seasons post-injury, $p < 0.05$). The number of games per season and minutes per game did not differ significantly prior and post ACL injury in Centers. The univariate ANOVA showed a 27.3 % general difference in game performance when the whole sample was analyzed. **Conclusions.** Several performance variables in absolute values, which decreased after RTP, indicate that NBA players' performance unquestionably changed after the ACL reconstruction.

Keywords: Ligament reconstruction, return to play, player performance, athlete health

For citation: Ranisavljev I., Kojic F., Cosic M., Todorovic N., Kukic F. The effect of ACL injury on post-recovery basketball performance in the NBA league. *Human. Sport. Medicine*. 2024;24(3):152–161. DOI: 10.14529/hsm240318

Научная статья
УДК 796.323.2
DOI: 10.14529/hsm240318

ВЛИЯНИЕ ТРАВМЫ ПЕРЕДНЕЙ КРЕСТООБРАЗНОЙ СВЯЗКИ НА РЕЗУЛЬТАТИВНОСТЬ ИГРОКОВ НБА ПОСЛЕ ВОЗВРАЩЕНИЯ В СПОРТ

И. Ранисавлев[1], *igor.ranisavljev@fsfv.bg.ac.rs, https://orcid.org/0000-0002-5784-2917*
Ф. Коич[1], *kojic.fi@gmail.com, https://orcid.org/0000-0001-6740-3347*
М. Цосич[1], *marko.cosic@fsfv.bg.ac.rs, https://orcid.org/0000-0001-6780-6517*
Н. Тодорович[1], *todorsnajder@gmail.com*
Ф. Кукич[2], *filip.kukic@gmail.com, https://orcid.org/0000-0002-8625-5375*
[1] *Белградский университет, Белград, Сербия*
[2] *Баня-Лукский университет, Баня-Лука, Сербия*

Аннотация. **Цель:** изучить, влияет ли реконструкция передней крестообразной связки (ПКС) на результативность игроков Национальной баскетбольной ассоциации (НБА) после восстановления и возвращения в большой спорт. **Материалы и методы.** Проведен количественный анализ ретроспективных данных результативности игроков НБА и полученных ими травм. Для анализа использовали данные за 44 последовательных сезона НБА (сезоны с 1976/1977 по 2019/2020 гг.). В исследование вошли данные всех игроков НБА мужского пола, получивших травму ПКС с последующей ее реконструкцией и возвращением в НБА в течение своей карьеры (n = 71). В ходе анализа учитывали возраст игроков на момент травмы, игровую позицию, количество сезонов до и после травмы, количество сыгранных игр за сезон, очки за игру, подборы за игру и передачи за игру. **Результаты.** На основании полученных данных установили, что игроки отыграли около 4 сезонов до травмы ПКС и около 5 сезонов после травмы. После реконструкции ПКС у разыгрывающих защитников обнаружили значимое снижение минут, сыгранных за игру ($p = 0,04$). Снижение количества игр, а также минут, сыгранных за игру, обнаружили у легких форвардов ($p = 0,03$). В среднем, тяжелые форварды играли меньше сезонов до травмы, чем после травмы (3,5 сезона до и 6,2 сезона после травмы, $p < 0,05$). По результатам оценки количества игр за сезон и минут за игру у центровых игроков до и после травмы ПКС статически значимых различий не обнаружили. В результате одномерного дисперсионного анализа данных всей выборки установили общую разницу в результативности игры в 27,3 %. **Заключение.** С учетом снижения абсолютных значений нескольких переменных, связанных с игровой результативностью, сформулирован вывод об однозначности влияния реконструкции ПКС на игровую результативность.

Ключевые слова: реконструкция связки, возвращение к игре, игровая результативность, здоровье спортсмена

Для цитирования: The effect of ACL injury on post-recovery basketball performance in the NBA league / I. Ranisavljev, F. Kojic, M. Cosic et al. // Человек. Спорт. Медицина. 2024. Т. 24, № 3. С. 152–161. DOI: 10.14529/hsm240318

Introduction. Basketball is a game where players need to score or defend the basket positioned at the height of 3.05 m. To get in a position to score, players must be able to run fast, jump, change direction rapidly, side shuffle, resist or overcome opponent's actions, and resist fatigue [14, 22, 28] Given that two teams are competing to score more points, players from the opposing teams frequently make strong physical contacts [21], while the intensity at which players perform is frequently very high and maximal [4, 11]. Considering this, lower body injuries are the most frequent among basketball players, with knee internal derangement resulting in 10+ days of activity loss and games missed composing the largest portion [7, 21].

Anterior cruciate ligament (ACL) ruptures are one of the most common knee injuries in basketball [2, 21]. Due to pronounced running, jumping, and cutting movements, basketball has been recognized as a sport with a high relative incidence rate for ACL injuries [16] Almost 14% of all notable injuries among National Basketball Association (NBA) players were related to knee joint trauma [13, 20]. Specifically, during a six-year period, overall 0.8% of NBA players sustained an ACL injury, with a relatively high return-to-play ratio (between 76–80% of all injured

players) [6, 12]. In addition, the cost of recovery was found to be $2.9 million per player for the NBA seasons 2010 to 2015 [25]. Although the prognosis for return-to-play (RTP) is likely positive, ACL reconstruction could be followed by a decrease in statistical performance as well as an inability to return to prior levels of play [8, 12].

For instance, Busfield et al. (2009) [5] compared the performance outcomes before and after ACL reconstruction in male NBA players during a 10-years period (from season 1993/94 through 2004/05). They noticed a significant decline in performance parameters such as field goals percentage, total rebounds, and games played after ACL trauma, compared to the pre-injury period. Similarly, Harris et al. (2013) [8] analyzed the period from 1975 to 2012 and identified 58 NBA players who underwent the ACL treatment and found a significant decrease in parameters such as minutes per game, points per game, and rebounds per game. Nwachukwu et al [12] investigated RTP and functional performances in NBA players between 2008 and 2014 year and found a decline minutes, points, rebounds, assists, steals, blocks, and turnovers after the ACL reconstruction.

While previous studies focused on basketball players in general, tasks and corresponding activity demands and physiological responses during basketball match-play vary according to the playing position [22]. Guards tend to display a higher percentage of live playing time sprinting and performing high-intensity shuffling compared to the forwards and centers [3, 19], Furthermore, differences were noted in distance covered, where point guards and centers covered shorter distances than shooting guards, small forwards, and power forwards [26]. In addition, players at different positions differ in anthropometric and body composition characteristics [24], which provides them with specific locomotion capabilities, thereby resulting in different potential and kinetic energy and inertia. Considering this, the susceptibility for ACL injury may vary between playing positions.

Indeed, previous studies showed that the players' performance declines after the ACL injury. However, to our knowledge, there is a scarcity of information on the performance at players at different positions (i.e., point guards, shooting guards, small forwards, power forwards, and centers). This position specification of post-injury reality is of importance for trainers (both head and strength and conditioning coach), players, and stakeholders. Therefore, the main goal of this study was to determine the game performance after the ACL reconstruction in NBA players. The main hypothesis was that different parameters of game performance will be affected at different playing position. The second hypothesis was that the decline in performance will vary between positions.

Materials and Methods. This study used retrospective injury data from the official NBA electronic medical record database (*Official NBA Stats | Stats | NBA.Com*). This approach was used in previous studies [7, 18, 23]. The study analyzed the period of 44 consecutive seasons, from 1976/1977 (when ABA and NBA were officially integrated) until 2019/2020. The players were identified throughout players' profiles and biographies, and Internet-based news releases, precluding formal institutional review board approval. Searches were performed for all NBA teams and players during the mentioned period. The data was manually collected by a sports medicine fellow and validated by senior author.

Sample. The final sample included 71 players who matched the inclusion criteria (Fig. 1). The inclusion criteria were: male NBA player who played at least 1 game in NBA prior to acute ACL injury; occurrence of ACL injury followed by ACL reconstruction; and RTP during after the ACL reconstruction. The RTP meant that a player played at least one NBA game after the ACL reconstruction. Subject exclusion criteria were: playing the National Collegiate Athletic Association (NCAA) or National Development League (NBDL); bi-cruciate injuries (i.e., ACL and complete posterior cruciate ligament); combined ACL and bi-collateral ligament injury; and the occurrence of ACL injury but the RTP data could be found.

Procedures. Obtained variables included player information such as age at the time of injury, playing position, number of season pre- and post- injury, and number of games played per season. According to reported playing position players were assigned as point guards, shooting guards, small forwards, power forwards, and center.

The in-game performance data were used to analyze their game performance before and after the injury. Variables of game performance were minutes per game, points per game, rebounds per game, and assists per game. Game performance variables were extracted separately for the pre- and post-injury period and compared between

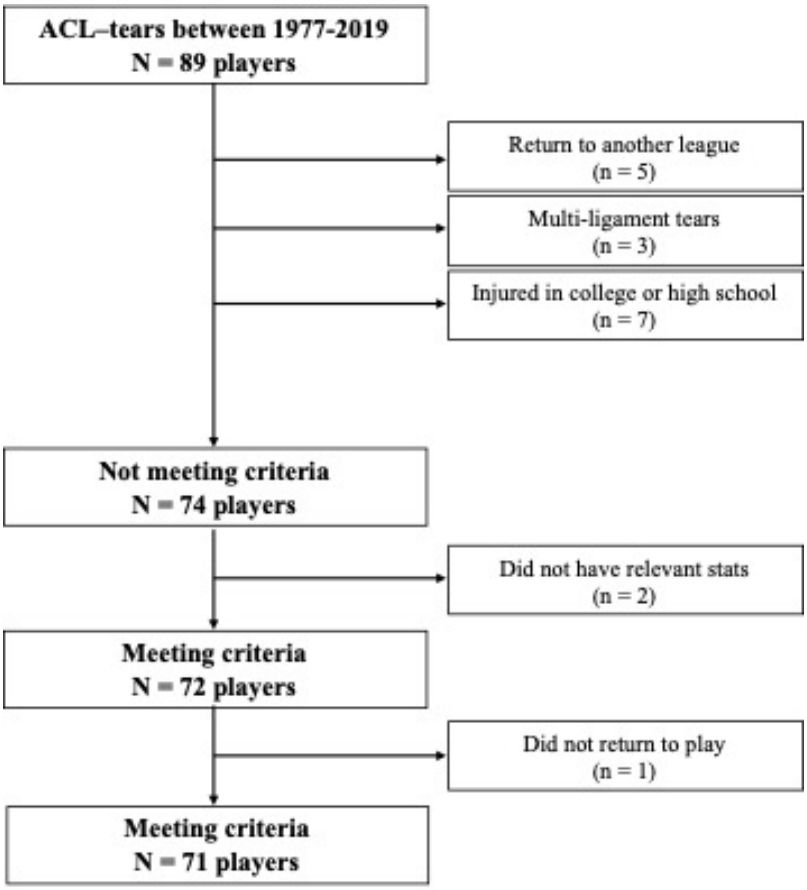

Fig. 1. Participant selection flow

these two periods. The research was approved from the Institutional Research Review Board (no 484-2). 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.

Statistical analyses. The players were assigned into five groups according to basic basketball playing positions (point guard, shooting guard, small forward, power forward, and center). One-sample Kolmogorov – Smirnov goodness-of-fit tests for Gaussian data distribution were performed and confirmed the normality of all data. As a first step all data were analyzed by descriptive statistical procedures where mean values, standard deviations, lower and upper bound confidence intervals were calculated. To determine the general differences between the analyzed variables in terms of pre-and post-injury period, MANOVA was used, while ANOVA with Bonferroni corrections was used to determine the differences between pairs of variables. All data were analyzed using the statistical package for social sciences SPSS (20.0).

Results. All pre- and post-injury data, according to specific playing positions, are presented in Table 1. Overall, seventy-two NBA players were identified with RTS following ACL reconstruction, with appropriate game performance data pre-and post-injury.

Generally, on average players played around 4 seasons before ACL injury and around 5 seasons after injury, with large inter-individual lower and upper bound intervals. Point guards showed a significant decline in minutes played per game after ACL injury ($p = 0.043$), while also a decline in the number of games played per season was on the border of significance ($p = 0.057$). In the shooting guard position, where only 8 players were part of the sample, the number of games per season was also smaller after the RTP, close to the statistical significance ($n = 54.7$ vs 42.9, $p = 0.069$). Small forwards also showed a significant decline in parameters number of games, as well as in the minutes played per game ($p < 0.05$), while also decline in rebounds per game after the RTP was on the border of significance ($p = 0.051$). Power forwards mainly sustained injury in the first part of their career and played

Table 1

Descriptive statistics of the game statistics pre- and post-injury

Position	Variable	Pre/Post injury	MEAN±SD	95% Confidence Interval		Univariate Test – ANOVA		
				Lower Bound	Upper Bound	F_{ANOVA}	P value	Part. Eta^2
Point Guard (PG, N = 21)	Seasons	Pre_INJ	5.0 ± 3.4	3.5	6.5	0.367	0.548	0.009
		Post_INJ	5.7 ± 4.2	4.2	7.2			
	Games	Pre_INJ	57.9 ± 15.2	50.7	65.0	3.849	0.057	0.088
		Post_INJ	47.8 ± 17.9	40.7	54.9			
	Minutes	Pre_INJ	26.3 ± 7.5	22.8	29.8	4.363	0.043*	0.098
		Post_INJ	21.7 ± 6.8	18.2	25.1			
	Points	Pre_INJ	11.2 ± 5.2	9.0	13.4	2.597	0.115	0.061
		Post_INJ	8.8 ± 4.6	6.6	11.0			
	Rebounds	Pre_INJ	2.9 ± 1.1	2.0	3.5	0.237	0.629	0.006
		Post_INJ	2.6 ± 1.6	1.8	3.3			
	Assists	Pre_INJ	4.71 ± 2.4	4.1	5.3	3.504	0.069	0.081
		Post_INJ	3.5 ± 1.9	2.9	4.0			
Shooting Guard (SG, N = 8)	Seasons	Pre_INJ	4. ± 2.6	1.7	6.5	0.505	0.489	0.035
		Post_INJ	5 ± 2.3	2.6	7.3			
	Games	Pre_INJ	54.7 ± 12.5	43.2	66.3	3.113	0.069	0.182
		Post_INJ	42.9 ± 14.4	31.3	54.5			
	Minutes	Pre_INJ	24.6 ± 5.8	19.0	30.1	2.587	0.130	0.156
		Post_INJ	19.6 ± 6.6	14.0	25.3			
	Points	Pre_INJ	11.8 ± 4.3	8.3	15.4	1.326	0.269	0.087
		Post_INJ	8.9 ± 5.9	5.3	12.5			
	Rebounds	Pre_INJ	2.9 ± 0.8	1.6	4.0	1.212	0.290	0.080
		Post_INJ	2.3 ± 1.2	1.1	3.5			
	Assists	Pre_INJ	2 ± 0.8	1.1	3.0	0.698	0.417	0.048
		Post_INJ	1.6 ± 1	0.7	2.6			
Small Forward (SF, N = 11)	Seasons	Pre_INJ	4 ± 2.7	2.0	6.0	0.945	0.343	0.045
		Post_INJ	5.4 ± 3.8	3.3	7.4			
	Games	Pre_INJ	62.6 ± 11.8	52.8	72.5	5.636	0.028*	0.220
		Post_INJ	47.3 ± 17.9	37.4	57.1			
	Minutes	Pre_INJ	27.2 ± 5.8	22.4	32.0	5.223	0.033*	0.207
		Post_INJ	20.8 ± 7.3	16.0	25.6			
	Points	Pre_INJ	13.1 ± 5.4	10.1	16.1	2.189	0.155	0.099
		Post_INJ	9.4 ± 6.3	6.4	12.5			
	Rebounds	Pre_INJ	4.2 ± 1.5	3.1	5.2	4.000	0.051	0.167
		Post_INJ	3.1 ± 1.1	2.0	4.1			
	Assists	Pre_INJ	2.2 ± 0.9	1.4	3.0	2.550	0.126	0.113
		Post_INJ	1.5 ± 1.0	0.7	2.3			
Power Forward (PF, N = 20)	Seasons	Pre_INJ	3.5 ± 2.9	2.1	5.0	6.315	0.016*	0.142
		Post_INJ	6.2 ± 3.8	4.7	7.7			
	Games	Pre_INJ	54.6 ± 17.3	47.3	62.0	3.442	0.071	0.083
		Post_INJ	45.2 ± 14,6	37.9	52.5			
	Minutes	Pre_INJ	22.6 ± 8.8	19.0	26.1	0.585	0.449	0.015
		Post_INJ	20.2 ± 10.8	16.6	23.8			
	Points	Pre_INJ	9.8 ± 5.4	7.5	12.2	1.822	0.185	0.046
		Post_INJ	7.6 ± 4.8	5.3	9.8			
	Rebounds	Pre_INJ	5.1 ± 2.2	4.3	5.8	3.033	0.080	0.074
		Post_INJ	3.9 ± 1.9	3.2	4.7			
	Assists	Pre_INJ	1.2 ± 0.9	0.6	1.8	0.408	0.527	0.011
		Post_INJ	1.1 ± 0.8	0.4	1.7			

Table 1 (end)

Position	Variable	Pre/Post injury	MEAN±SD	95% Confidence Interval		Univariate Test – ANOVA		
				Lower Bound	Upper Bound	F_{ANOVA}	P value	Part. Eta^2
Center (C, N = 12)	Seasons	Pre_INJ	3.7 ± 3.4	1.7	5.6	0.607	0.444	0.027
		Post_INJ	4.7 ± 2.8	2.7	6.6			
	Games	Pre_INJ	45.5 ± 23.1	36.0	54.9	0.008	0.928	0.000
		Post_INJ	44.8 ± 16.4	35.3	54.2			
	Minutes	Pre_INJ	18.1 ± 9.9	13.4	22.6	0.383	0.543	0.017
		Post_INJ	15.9 ± 6.8	11.3	20.5			
	Points	Pre_INJ	7.3 ± 4.8	4.4	10.2	0.871	0.361	0.038
		Post_INJ	5.6 ± 3.9	2.7	8.5			
	Rebounds	Pre_INJ	4.5 ± 2.7	3.6	5.5	0.417	0.525	0.019
		Post_INJ	3.9 ± 2.0	2.9	4.9			
	Assists	Pre_INJ	0.7 ± 0.5	0.1	1.5	0.210	0.651	0.009
		Post_INJ	0.6 ± 0.5	0.2	1.4			

Table 2

Difference in game parameters pre- and post-injury at the level of whole sample

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta^2	Observed Power[d]
Position_Play * Pre-Post_Injury_Period	Pillai's Trace	1.303	4.130	54.000	804.000	.000	.217	1.000
	Wilks' Lambda	.147	5.598	54.000	662.368	.000	.273	1.000

more season after injury (n = 3.5 pre-injury vs 6.2 post-injury, $p < 0.05$). However, as well as the players in other positions, they played less game per season after RTP ($p = 0.071$) and showed a decline in rebounding performance per game ($p = 0.08$). Interestingly, the smallest amount of difference in performance before the injury and after RTP was found in players in the center position. Although there is slight insignificant decline in some game performance, they generally played an almost equal volume of games and minutes per game before the injury and after RTP.

Univariate Test ANOVA showed a slight but mainly insignificant decline in almost all game performance parameters on individual playing positions. However, when the whole sample was analyzed, general difference in the game parameters was 27.3 % (Table 2).

Discussion. The study was conducted with the aim to compare basketball performance of the NBA players before and after ACL reconstruction, according to the specific playing position. The main findings revealed that, although the trend for a general decline in sporting performance was observed, only a few parameters (i.e., games played, minutes per game, number of seasons) reached statistical significance for some positions (Point Guard, Small Forward and Power Forward). Overall, when performance data from all positions together is analyzed, there is a 27 % of the difference in game parameters following ACL injury.

Generally, from 30 pre-to-post injury-related variables (6 for each of the 5 positions), only 4 showed a significant decline ($p < 0.05$). Still, note that there is also a several other parameters with the rate of decline after RTP, close to the level of significance. Conversely, the only parameter that is significantly increased after RTP is the number of seasons for the Power Forward position. This may be attributed to the fact that players from the Power Forward position, due to high versatility, often end their careers at the Center position, which might further prolong their careers [17]. Players on guard position are limited in that sense, due to certain physical and anthropometric characteristics and pronounced physiological demands during the match [22]. This is supported by previous data which showed that up to 2013, 100 % of all centers (12/12; 100 %) returned to the NBA after ACL reconstruction compared to 95 % of forwards and 71 % (17/24) of guards [8].

The volume of minutes per game for Point Guard and Small Forward positions is significantly reduced following injury, while for the Small Forward position there is also a significant

decline in the number of games after RTP. The Point Guard position is specific and important, and the team with an unprepared playmaker will be very vulnerable and mild offensively. While this is one of the most intense playing positions in terms of change of direction in both offense and defense [15], potential hesitation to return to a highly aggressive style of play following injury might be an important factor, especially for point guards [9].

Also, if we look at the absolute values of minutes played by positions, it is visible that the Point guard and Small Forward are more engaged than other players, so the significant difference in minutes before and after RTP can be attributed, not so much to the fact that they played less after injury, but that they played more before the injury. Specifically, those two positions are polyvalent and it happens that a player from the Point guard position and Small forward position switch to the Shooting guard position, which prolongs players' time in the game [3]. When the player is not ready to cover both positions after the injury, he remains at his primary position, with decreased volume in the game.

The reason for the decline in the Number of games and Minutes spent in the game after RTP lies in the fact that a gradual return to the competitive games is a necessary part of the RTP process. Therefore, a decrease in volume of games and minutes per game is the consequence of the final part of the entire rehabilitation process. The principle of gradual increase in training load after injury should be respected here and a decrease in volume can be mainly attributed to the methodology of recovery in RTP process [27].

Although there are not many significant differences in the game performance before and after RTP, in the absolute values there is a solid rate of decline in performance after RTP. The total number of points, rebounds, and assists in absolute values is lower for all players after RTP, regardless of playing position. In line with the present data, previous report by Busfield et al. [5] from limited time frame (10 NBA seasons) showed a decline in absolute values of all statistical parameters after RTP and that player efficiency rating (the sum of positive performance measures subtracted by negative measures) decreased in 44 % of players after RTP. The possible reason why many of those parameters are below the level of statistical significance is the number of obtained players' data (i.e., sample size).

On the other hand, although the overall reduction in-game statistics is visible, it can't be ignored that in practice there are many cases where ACL reconstruction and RTP, players provide better game statistics (performances) and play more seasons, show better results, even become MVP players and win Euro-league titles. This fact may support the thesis that there are still no uniform rehabilitation protocols, and that the topic of ACL injury and RTP is probably still a kind of bugbear, both for coaches, trainers, and players, and for other professionals (therapists, psychologist, etc.) involved in the entire process of rehabilitation. In addition to the protocol and methodology of rehabilitation for returning players to competitive sport form, it is probably equally important to address some other questions. First, what was the age when player was injured; how the injury occurred, and what were the main reasons for ACL injury? We need to have on mind that high-level NBA players have access to the specific rehabilitation protocols, but the return to high intensity basketball is still associated with risk of re-tear, which happened to 9.3 % of NBA players in period 2007–2017 [1]. In which part of the season player was injured; when he returned to the court; as well as how much room for maneuver was available to the coaches during the rehabilitation process and during RTP process. Bearing in mind that a large number of variables can influence the conclusions in terms of whether the injury essentially leaves a mark on a player future performance or is it just our incapability to prove it numerically with the level of statistical significance, the present paper probably opens many questions.

Limitations. The present study tried to find all players who suffered an ACL injury and RTP to the NBA. All NBA teams implemented the NBA electronic medical record database from the start of 2012–2013 NBA season [10], so despite the search effort, there is a possibility that some players over the long period be might not be discovered due to the unavailability of the official medical records. As well, in addition to already mentioned issues concerning the manner of ACL injury and the rehabilitation protocols, it would be interesting above all to analyze how some other performance parameters such as total points (±), valorization of the game, or some other elements from advanced NBA statistics changed after RTP. However, advanced statistics is not available for the entire period of the NBA history, here so we were unable to analyze this data. We must bear in mind that this study covered

a relatively long period (from 1976 until the 2020 year), thus player preparation has changed a lot since 1976. Some basketball rules (3 points, shape of the paint, etc.) and the philosophy of the game have evolved, and everything has resulted in different abilities and characteristics of the players in the present.

Conclusions. The methodology used in the present study tried answer the important questions about the NBA player performance after ACL reconstruction, when all available players throughout the history of the NBA league are included. Existing results, using the most accurately controlled sample of NBA players with ACL injury since the beginning of the NBA league, demonstrate that there is an overall a 27 % of change in the game parameters following ACL injury, while variables number of played games and number of minutes per game are significantly decreased after RTP. Although some differences before and after RTP were significant and many other on the border of significance, it should be noted that basketball game performance is a multifactorial phenomenon, and generalization of conclusions should be taken with cautiousness. Considering the above, the absence of numerous significant performance differences may indicate that injuries are unfortunately an integral part of basketball and that ACL reconstruction procedures do not leave so big consequences on basketball player performance. Large number of performance variable decreased in absolute values, indicating that player performance undoubtedly changed after the ACL reconstruction.

References

1. Allahabadi S., Rubenstein W.J., Lansdown D.A. et al. Incidence of Anterior Cruciate Ligament Graft Tears in High-risk Populations: An Analysis of Professional Athlete and Pediatric Populations. *The Knee*, 2020, vol. 27 (5), pp. 1378–1384. DOI: 10.1016/j.knee.2020.06.013

2. Andreoli C.V., Chiaramonti B.C., Biruel E. et al. Epidemiology of Sports Injuries in Basketball: Integrative Systematic Review. *BMJ Open Sport & Exercise Medicine*, 2018, vol. 4 (1), e000468. DOI: 10.1136/bmjsem-2018-000468

3. Ben Abdelkrim N., Castagna C., El Fazaa S., El Ati J. The Effect of Players' Standard and Tactical Strategy on Game Demands in Men's Basketball. *Journal of Strength and Conditioning Research*, 2010, vol. 24 (10), pp. 2652–2662. DOI: 10.1519/JSC.0b013e3181e2e0a3

4. Bishop D.C., Wright C. A Time-motion Analysis of Professional Basketball to Determine the Relationship between Three Activity Profiles: High, Nedium and Low Intensity and the Length of the Time Spent on Court. *International Journal of Performance Analysis in Sport*, 2006, vol. 6 (1), pp. 130–139. DOI: 10.1080/24748668.2006.11868361

5. Busfield B.T., Kharrazi F.D., Starkey C. et al. Performance Outcomes of Anterior Cruciate Ligament Reconstruction in the National Basketball Association. *Arthroscopy: The Journal of Arthroscopic & Related Surgery: Official Publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, 2009, vol. 25 (8), pp. 825–830. DOI: 10.1016/j.arthro.2009.02.021

6. Deitch J.R., Starkey C., Walters S.L., Moseley J.B. Injury Risk in Professional Basketball Players: A Comparison of Women's National Basketball Association and National Basketball Association athletes. *The American Journal of Sports Medicine*, 2006, vol. 34 (7), pp. 1077–1083. DOI: 10.1177/0363546505285383

7. Drakos M.C., Domb B., Starkey C. et al. Injury in the National Basketball Association: A 17-Year Overview. *Sports Health*, 2010, vol. 2 (4), pp. 284–290. DOI: 10.1177/1941738109357303

8. Harris J.D., Erickson B.J., Bach B.R. et al. Return-to-Sport and Performance After Anterior Cruciate Ligament Reconstruction in National Basketball Association Players. *Sports Health*, 2013, vol. 5 (6), pp. 562–568. DOI: 10.1177/1941738113495788

9. Kester B.S., Behery O.A., Minhas S.V., Hsu W.K. Athletic Performance and Career Longevity Following Anterior Cruciate Ligament Reconstruction in the National Basketball Association. *Knee Surgery, Sports Traumatology, Arthroscopy*, 2017, vol. 25 (10), pp. 3031–3037. DOI: 10.1007/s00167-016-4060-y

10. Mack C.D., Meisel P., Herzog M.M. et al. The Establishment and Refinement of the National Basketball Association Player Injury and Illness Database. *Journal of Athletic Training*, 2019, vol. 54 (5), pp. 466–471. DOI: 10.4085/1062-6050-18-19

11. McInnes S.E., Carlson J.S., Jones C.J., McKenna M.J. The Physiological Load Imposed on Basketball Players During Competition. *Journal of Sports Sciences*, 1995, vol. 13 (5), pp. 387–397. DOI: 10.1080/02640419508732254

12. Nwachukwu B.U., Anthony S.G., Lin K.M. et al. Return to Play and Performance after Anterior Cruciate Ligament Reconstruction in the National Basketball Association: Surgeon Case Series and Literature Review. *The Physician and Sportsmedicine*, 2017, vol. 45 (3), pp. 303–308. DOI: 10.1080/00913847.2017.1325313

13. Official NBA Stats | Stats | NBA.com. (n.d.). Retrieved March 29, 2023, from https://www.nba.com/stats

14. Ostojic S.M., Mazic S., Dikic N. Profiling in Basketball: Physical and Physiological Characteristics of Elite Players. *Journal of Strength and Conditioning Research*, 2006, vol. 20 (4), pp. 740–744. DOI: 10.1519/R-15944.1

15. Petway A.J., Freitas T.T., Calleja-González J. et al. Training Load and Match-play Demands in Basketball Based on Competition Level: A Systematic Review. *PLOS ONE*, 2020, vol. 15 (3), e0229212. DOI: 10.1371/journal.pone.0229212

16. Prodromos C.C., Han Y., Rogowski J. et al. A Meta-analysis of the Incidence of Anterior Cruciate Ligament Tears as a Function of Gender, Sport, and a Knee Injury-reduction Regimen. *Arthroscopy: The Journal of Arthroscopic & Related Surgery: Official Publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, 2007, vol. 23 (12), pp. 1320–1325. DOI: 10.1016/j.arthro.2007.07.003

17. Rangel W., Ugrinowitsch C., Lamas L. Basketball Players' Versatility: Assessing the Diversity of Tactical Roles. *International Journal of Sports Science & Coaching*, 2019, vol. 14 (4), pp. 552–561. DOI: 10.1177/1747954119859683

18. Ranisavljev I., Mandic R., Cosic M. et al. NBA Pre-Draft Combine is the Weak Predictor of Rookie Basketball Player's Performance. *Journal of Human Sport and Exercise*, 2021, vol. 16 (3), pp. 493–502. DOI: 10.14198/jhse.2021.163.02

19. Scanlan A.T., Dascombe B.J., Reaburn P., Dalbo V.J. The Physiological and Activity Demands Experienced by Australian Female Basketball Players During Competition. *Journal of Science and Medicine in Sport*, 2012, vol. 15 (4), pp. 341–347. DOI: 10.1016/j.jsams.2011.12.008

20. Starkey C. Injuries and Illnesses in the National Basketball Association: A 10-year Perspective. *Journal of Athletic Training*, 2000, vol. 35 (2), pp. 161–167.

21. Stojanović E., Faude O., Nikić M. et al. The Incidence Rate of ACL Injuries and Ankle Sprains in Basketball Players: A Systematic Review and Meta-analysis. *Scandinavian Journal of Medicine & Science in Sports*, 2023, vol. 33 (6), pp. 790–813. DOI: 10.1111/sms.14328

22. Stojanović E., Stojiljković N., Scanlan A.T. et al. The Activity Demands and Physiological Responses Encountered During Basketball Match-Play: A Systematic Review. *Sports Medicine*, 2018, vol. 48 (1), pp. 111–135. DOI: 10.1007/s40279-017-0794-z

23. Teramoto M., Cross C.L., Rieger R.H. et al. Predictive Validity of National Basketball Association Draft Combine on Future Performance. *The Journal of Strength & Conditioning Research*, 2018, vol. 32 (2), p. 396. DOI: 10.1519/JSC.0000000000001798

24. Vaquera A., Santiago S., Gerardo V.J. et al. Anthropometric Characteristics of Spanish Professional Basketball Players. *Journal of Human Kinetics*, 2015, vol. 46, pp. 99–106. DOI: 10.1515/hukin-2015-0038

25. Vaudreuil N.J., van Eck C.F., Lombardo S.J., Kharrazi F.D. Economic and Performance Impact of Anterior Cruciate Ligament Injury in National Basketball Association Players. *Orthopaedic Journal of Sports Medicine*, 2021, vol. 9 (9), 23259671211026616. DOI: 10.1177/23259671211026617

26. Watartu O., Tomoyasu O. A Cross-sectional Comparative Study of Movement Distances and Speed of the Players and a Ball in Basketball Game. *International Journal of Sport and Health Science*, 2008, vol. 6, pp. 203–212. DOI: 10.5432/ijshs.ijshs20080336

27. Wilk K.E., Arrigo C.A. Rehabilitation Principles of the Anterior Cruciate Ligament Reconstructed Knee: Twelve Steps for Successful Progression and Return to Play. *Clinics in Sports Medicine*, 2017, vol. 36 (1), pp. 189–232. DOI: 10.1016/j.csm.2016.08.012

28. Zarić I., Dopsaj M., Marković M. Match Performance in Young Female Basketball Players: Relationship with Laboratory and Field Tests. *International Journal of Performance Analysis in Sport*, 2018, vol. 18 (1), pp. 90–103. DOI: 10.1080/24748668.2018.1452109

29. Zarić I., Kukić F., Jovićević N. et al. Body Height of Elite Basketball Players: Do Taller Basketball Teams Rank Better at the FIBA World Cup? *International Journal of Environmental Research and Public Health*, 2020, vol. 17 (9), art. 9. DOI: 10.3390/ijerph17093141

Information about the authors

Igor Ranisavljev, PhD, Professor of Department Theory and Technology of Sports and Recreation, University of Belgrade – Faculty of Sport and Physical Education, Belgrade, Republic of Serbia.

Filip Kojic, PhD, Assistant Professor of University of Belgrade – Teacher Education Faculty, Belgrade, Republic of Serbia.

Marko Cosic, PhD, Professor of Department Theory and Technology of Sports and Recreation, University of Belgrade – Faculty of Sport and Physical Education, Belgrade, Republic of Serbia.

Nikola Todorovic, MSc, Postgraduate student, University of Belgrade – Faculty of Sport and Physical Education, Belgrade, Republic of Serbia.

Filip Kukic, PhD, Assistant professor, University of Banja Luka – Faculty of Physical Education and Sports, Banja Luka, Republic of Serbia.

Информация об авторах

Ранисавлев Игорь, PhD, профессор кафедры теории и технологии спорта и рекреации, факультет спорта и физического образования, Белградский университет, Белград, Сербия.

Коич Филип, PhD, доцент, факультет педагогического образования, Белградский университет, Белград, Сербия.

Цосич Марко, PhD, профессор кафедры теории и технологии спорта и рекреации, факультет спорта и физического образования, Белградский университет, Белград, Сербия.

Тодорович Никола, магистр наук, аспирант, факультет спорта и физического образования, Белградский университет, Белград, Сербия.

Кукич Филип, PhD, доцент, факультет физического образования и спорта, Баня-Лукский университет, Баня-Лука, Сербия.

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

Вклад авторов: все авторы сделали эквивалентный вклад в подготовку публикации.

Авторы заявляют об отсутствии конфликта интересов.

The article was submitted 13.03.2024

Статья поступила в редакцию 13.03.2024