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Original research

## Game injuries in relation to game schedules in the National Basketball Association

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### ABSTRACT

**Objectives:** Injury management is critical in the National Basketball Association (NBA), as players experience a wide variety of injuries. Recently, it has been suggested that game schedules, such as back-to-back games and four games in five days, increase the risk of injuries in the NBA. The aim of this study was to examine the association between game schedules and player injuries in the NBA.

**Design:** Descriptive epidemiology study.

**Methods:** The present study analyzed game injuries and game schedules in the 2012–13 through 2014–15 regular seasons. Game injuries by game schedules and players' profiles were examined using an exact binomial test, the Fisher's exact test and the Mann–Whitney–Wilcoxon test. A Poisson regression analysis was performed to predict the number of game injuries sustained by each player from game schedules and injured players' profiles.

**Results:** There were a total of 681 cases of game injuries sustained by 280 different players during the three years (total  $N = 1443$  players). Playing back-to-back games or playing four games in five days alone was not associated with an increased rate of game injuries, whereas a significant positive association was found between game injuries and playing away from home ( $p < 0.05$ ). Playing back-to-back games and away games were significant predictors of frequent game injuries ( $p < 0.05$ ).

**Conclusions:** Game schedules could be one factor that impacts the risk of game injuries in the NBA. The findings could be useful for designing optimal game schedules in the NBA as well as helping NBA teams make adjustments to minimize game injuries.

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### 1. Introduction

Playing in the National Basketball Association (NBA) places a great deal of physical demand on athletes throughout the 82-game regular season. Consequently, NBA players must endure and cope with various injuries. Previous research suggested that NBA players experienced twice the rate of game-related injuries compared with college basketball players.<sup>1</sup> Data show that in the 17-year period from the 1988–89 through the 2004–05 seasons, there were 12,594 reported injuries, including 6287 game-related injuries.<sup>2</sup> NBA players sustain a wide variety of injuries with ankle sprains, patellofemoral inflammation and lumbar strains being the most prevalent.<sup>2</sup> Injuries are detrimental to both individual performance

and team performance in professional sports.<sup>3–5</sup> Similar to any other sports, injury management is a critical component for NBA teams.

In order to minimize injuries in athletes, it is essential to understand the risk factors associated with injuries. Literature suggests numerous risk factors for sports injuries based on type and location of injury in different sports.<sup>6</sup> Research has been conducted with an aim to prevent sports injuries from various perspectives, including biomechanics,<sup>7</sup> physiology<sup>7</sup> and psychology.<sup>8</sup> Recently in the NBA, the rigorous game schedules have been proposed as one risk factor for injury.<sup>9</sup> Specifically, it has been speculated that playing back-to-back games and playing four games in five days in the NBA increase the risk of injuries among players.<sup>10</sup> Consequently, the NBA reduced back-to-back games (from 19.3 to 17.8 times per team) and four games in five days (from 70 to 27 times across the league) in the 2015–16 regular season from the previous year.<sup>11</sup> Research suggests that fatigue and overscheduling are some of the risk factors

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for athletic injuries.<sup>12,13</sup> Furthermore, travel schedules and playing on the road in the NBA may increase the risk of injury because of sleep loss during road trips<sup>9</sup> and potential cognitive changes caused by sleep deprivation.<sup>14</sup> To our knowledge, however, there is no published study relating game schedules to injuries in the NBA. There may be a gap between research and practice on this topic, and we believe that it would be important to bridge the gap if it existed. The aim of this study was to examine the association between game schedules and player injuries in the NBA.

## 2. Methods

The present study was based on the analysis of data on game injuries and game schedules over the 2012–13 through 2014–15 regular seasons (3 years; excluding preseasons and playoffs). Data were retrieved from publically available sources: [Basketball-Reference.com](http://www.basketball-reference.com) (<http://www.basketball-reference.com/>), [NBASTuffer.com](http://www.nbastuffer.com) (<http://www.nbastuffer.com/tag/Schedule-Analysis.html>) and [NBA.com/Stats](http://stats.nba.com/) (<http://stats.nba.com/>). Institutional Review Board (IRB) approval was not required for this study, as we analyzed data available through web-based public access domains, and this study discloses no individual health information. The variables of interest included: injury that occurred during the game forcing the player to leave the game (=game injury), whether or not the injury occurred in the second game of back-to-back games (=back-to-back game injury, dichotomous categorical variable), whether or not the injury occurred in an away game (dichotomous categorical variable), number of games played by the injured player in the past five days before injury (quantitative variable), player's age at the time of injury (quantitative variable), total games played by the injured player in the season before injury (quantitative variable), minutes played per game by the injured player in the season before injury (quantitative variable) and games missed by the injured player in the season after injury (quantitative variable). In addition, we calculated cumulative minutes played in the past five, seven, and 28 days before injury. Game injuries were further classified by type and location of injury. Age and minutes played per game (season average) of all players were collected for the comparisons against those of injured players. The number of game injuries sustained by each player was recorded and used as an outcome variable (=count data) in the analyses that follow.

We utilized both univariate and multivariate approaches to analyze the data. Descriptive statistics were calculated for the variables associated with game injuries, game schedules and injured players' profiles. Also, acute to chronic workload was compared by: (1) the ratio of cumulative minutes played in the past five days before injury to an average five-day cumulative minutes played in the past 28 days before injury (i.e., cumulative minutes played in the past 28 days divided by 28/5 = 5.6), and (2) the ratio of cumulative minutes played in the past seven days before injury to an average seven-day cumulative minutes played in the past 28 days before injury (i.e., cumulative minutes played in the past 28 days divided by 28/7 = 4).<sup>15</sup> Only injuries occurring 28 days or more after the beginning of the season were included in this workload analysis. The Mann–Whitney–Wilcoxon test with a Monte Carlo simulation (10,000 samples) was applied to compare age and minutes played per game between all NBA players who had played in the 2012–13 through 2014–15 seasons and injured players (at the time of injury). An exact binomial test was used to compare: (1) the proportion of game injuries that occurred in back-to-back games to that of total back-to-back games scheduled over the 2012–13 to 2014–15 regular seasons, (2) the proportion of game injuries that occurred in away games to that of total away games scheduled in these seasons and (3) the proportion of game injuries that occurred in players

**Table 1**

Types and locations of game injuries sustained by NBA players in the 2012–13 to 2014–15 regular seasons.

Injury type/location	Frequency (%)
Type	
[total = 687 (100.0%)]	
Sprain/hyperextension	230 (33.5%)
Superficial injury <sup>a</sup>	114 (16.6%)
Strain	88 (12.8%)
Irritation/soreness/swelling	87 (12.7%)
Not specified	57 (8.3%)
Spasm/tightness	36 (5.2%)
Fracture/dislocation	33 (4.8%)
Torn ligament/tendon/muscle	20 (2.9%)
Illness	12 (1.7%)
Concussion	10 (1.5%)
Location	
[total = 697 (100.0%)]	
Ankle	180 (25.8%)
Knee	104 (14.9%)
Head/face/neck	59 (8.5%)
Back	53 (7.6%)
Hip/quadriceps/groin	51 (7.3%)
Wrist/hand	49 (7.0%)
Shoulder/arm/elbow	45 (6.5%)
Foot	37 (5.3%)
Hamstring	36 (5.2%)
Other	24 (3.4%)
Leg	20 (2.9%)
Calf	20 (2.9%)
Chest/abdomen	19 (2.7%)

Note: a total cases of injuries was 681. Six players and 16 players sustained multiple types and locations of injuries in one injury occurrence, respectively, resulting in totals of 687 types and 697 locations of injuries. NBA = National Basketball Association.

<sup>a</sup> Includes bruise, contusion, laceration, and abrasion.

who had played four games in the past five days to that of four games in five days scheduled in these seasons. A two-way contingency table analysis with the Fisher's exact test was performed to examine the associations between injuries in back-to-back games, those in away games and those by the number of games played in five days (3–4 games played vs. 1–2 games played). An odds ratio (OR) and its 95% confidence interval (CI) were calculated for each association. The same analysis above was also carried out to examine types and locations of injuries by game schedules. Additionally, the Mann–Whitney–Wilcoxon test was used to compare injured players' profiles by game schedules. To evaluate the data in a multivariate context, we performed a Poisson regression analysis to predict the number of injuries sustained by each player during the three years from the following variables: total number of back-to-back games played, total number of away games played, average number of games played in the past five days before injury, average age, average of total games played before injury, average of minutes played per game before injury and total games missed after injury.

## 3. Results

Of the 1443 players examined in the analysis, we identified a total of 681 cases of game injuries (i.e., injuries forcing players to leave the game) sustained by 280 different players during the three years from the 2012–13 to 2014–15 regular seasons. Six players and 16 players sustained multiple types and locations of injuries in one injury occurrence, respectively, resulting in totals of 687 types and 697 locations of injuries. Injury data for the New Orleans Hornets in the 2012–13 season were not available on [Basketball-Reference.com](http://www.basketball-reference.com) at the time of this study. Table 1 shows types and locations of injuries. Injury classifications in the tables are the same as those reported on [Basketball-Reference.com](http://www.basketball-reference.com). Profiles of players who sustained game injuries are presented in Table 2. The Wilcoxon–Mann–Whitney test showed that there was no significant difference in age distributions between all players who had played in the 2012–13 to 2014–15 seasons (median = 26 years

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