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ORIGINAL ARTICLE

# How many innings can we throw: does workload influence injury risk in Major League Baseball? An analysis of professional starting pitchers between 2010 and 2015

**Brian M. Saltzman, MD[a], Benjamin C. Mayo, MD[b], John D. Higgins, BS[a], Anirudh K. Gowd, BS[a], Brandon C. Cabarcas, BS[a], Timothy S. Leroux, MD[c], Bryce A. Basques, MD[a], Gregory P. Nicholson, MD[a], Charles A. Bush-Joseph, MD[a], Anthony A. Romeo, MD[a], Nikhil N. Verma, MD[a,*]**

[a]*Division of Sports Medicine, Department of Orthopedic Surgery, Rush University Medical Center, Chicago, IL, USA*
[b]*Department of Orthopedic Surgery, University of Illinois Hospital & Health Sciences System, Chicago, IL, USA*
[c]*Division of Sports Medicine, Department of Orthopedic Surgery, University of Toronto Hospital, Toronto, ON, Canada*

**Background:** There has been increasing interest regarding the association between pitch counts, as well as total workload per season, and the risk of injury among Major League Baseball (MLB) starting pitchers.
**Methods:** We used publicly available databases to identify all MLB starting pitchers eligible for play who made at least 5 starts in seasons between 2010 and 2015. For all included pitchers, annual pitching statistics (number of starts, total season pitch counts, total season inning counts, and average pitch count per game started) and annual disabled list (DL) information (time on DL for any reason and time on DL related to upper extremity, lower extremity, or axial body injury) were collected. A multiple logistic regression analyzed games started, pitch counts, innings pitched, and pitches per start during all previous seasons as a risk factor for injury in the current season, controlling for previous injury.
**Results:** A total of 161 starting MLB pitchers met the inclusion criteria. With the exception of total innings pitched from 2010-2011 being significantly associated with DL placement in 2012 (no DL, 310.5 ± 97.5 innings; DL, 344.7 ± 85.9 innings; $P = .040$), no other finding for starts, pitch counts, innings, or pitches per start in the cumulative years from 2010-2014 had a significant association with pitcher placement on the DL for any musculoskeletal reason or for an upper extremity reason between 2011 and 2015.
**Conclusions:** In this study, we demonstrate that there is no association between preceding years of cumulative pitches, starts, innings pitched, or average pitches per start and being placed on the DL for any musculoskeletal reason.

Institutional review board or ethics committee approval was not applicable as all information was gathered from publicly available databases.

*Reprint requests: Nikhil N. Verma, MD, Division of Sports Medicine, Department of Orthopedic Surgery, Rush University Medical Center, 1611 W Harrison St, Ste 300, Chicago, IL 60612, USA.

E-mail address: Nikhil.verma@rushortho.com (N.N. Verma).


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**Level of evidence:** Level II; Retrospective Design; Prognostic Study

**Keywords:** Major League Baseball (MLB); pitcher; pitches; disabled list; injury; innings pitched

Conservative estimates have found that the sport of baseball accounts for greater than 50,000 injuries per year, with documented rates ranging from 2 in 100 players at the Little League level[15] to 58 in 100 players at the Major League Baseball (MLB) level.[14] From the 2002 MLB season through the 2008 season, an average of 438.9 players per year were placed on the disabled list (DL), yielding a rate of 3.61 per 1000 athlete exposures. An important finding was that a significant 37% increase in injuries was also noted between 2005 and 2008.[23] Over this study period, pitchers had a 34% higher incidence rate of injury when compared with fielders, as well as a significantly greater proportion of injuries to the upper extremity. Pitchers also had a greater proportion of days on the DL when compared with fielders. From 1998-2015, a total of 8357 DL designations were recorded (mean of 464 annually) among all MLB players. As in other sports, there is widespread concern about the incidence, epidemiology, and associated costs of injuries in these professional athletes.

Pitchers are at particular risk of injuries to the upper extremity given the biomechanics of the overhead throwing motion, in which shoulder internal rotation velocities and elbow extension velocities are high and activation of the accelerator muscles (subscapularis, latissimus dorsi, and pectoralis major) is unparalleled.[20] In addition, the strenuous training and season schedule may fatigue pitchers. The starting pitcher plays a prominent role in a club's success. Injuries in pitchers may be more significant than those in position players with greater numbers of days missed, particularly from injury to the elbow, in which injury leads pitchers to 27 times and 34 times the rate of days missed compared with position players and all players, respectively.[20]

While the aforementioned epidemiologic studies have identified rising trends in injuries, they have not provided clear reasons or predictive factors for them. Observed injury patterns in baseball are multifactorial, and studies that identify a causal relationship between pitching variables and injury patterns in MLB pitchers are lacking. For instance, there has been increasing attention in the media regarding the association between pitch counts and the risk of injury among MLB starting pitchers, yet at present, there are no data linking pitch counts to injury risk. Limits on pitch counts for professional pitchers have been decided arbitrarily or nonscientifically but have led to a drastic decline in the maximum number of pitches thrown per game over the past 30 years.[2]

The ability to predict which pitchers are more susceptible to injury and need for time on the DL would provide invaluable information to the team medical staff, players, and management, as these injuries greatly affect the athlete's income, performance, and career longevity and the baseball organization's success.[19] Conversely, the ability to suggest which factors do not increase a pitcher's risk of injury could help to select which variables of a pitcher's game should be modified. The primary purpose of this study was to determine whether there was an association between average pitch count per game, cumulative pitch counts, cumulative innings pitched, or cumulative number of starts over a multi-year period and the subsequent risk of injury requiring time on the DL. Our hypothesis was that there would be no correlation between the aforementioned pitching metrics and the ensuing risk of any injury requiring DL time.

## Methods

We used publicly available databases to retrospectively identify all MLB starting pitchers eligible for play who made at least 5 starts in seasons between 2010 and 2015. Players were excluded from the analysis if they underwent a previous surgical procedure during the period of interest, had an injury in a current year from trauma or a medical reason, or began a season on the DL because of an injury that carried over from the previous year; if they were injured during spring training and began the season on the DL, they were included in the analysis for that year. Trauma was defined as any injury due to an impact or/blunt trauma such as a fracture, laceration, contusion, or concussion. Annual pitching statistics (number of starts, total season pitch counts, total season inning counts, and average pitch count per game started) and annual DL information (time on DL for any reason and time on DL related to upper extremity, lower extremity, or axial body injury) were collected for all included pitchers from 2010 through 2015. Information on player statistics was obtained from the publicly available Baseball-Reference.com and Fangraphs.com websites, as has been used before in studies of this genre.[12] Data on player injuries and the DL were identified through prior studies, MLB team websites, and publicly available Internet-based injury reports.[13]

The DL is a mandated part of MLB that defines, in a single database, the injuries of all professionals and the time lost from participation. To be placed on the DL, a player is certified as unable to play, with a specific diagnosis made by the head team physician; the player remains on the DL for a minimum of 15 days but remains longer if necessary to be ready for return to play.[7]

### Statistical analysis

Descriptive statistics were determined and reported as means and standard deviations for continuous variables. Time on the DL was a binary variable (any time vs no time on the DL). We performed a multiple logistic regression analyzing games started, pitch counts, innings pitched, and pitches per start during all previous seasons as a risk factor for any musculoskeletal injury in the current season, controlling for previous injury. We performed an additional analysis looking only at players with upper extremity injuries versus uninjured players using the same analysis, as well as a comparison