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Original research

The use of a pitch count estimator to calculate exposure in collegiate baseball pitchers

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ABSTRACT

Objective: Excessive pitch counts have been associated with arm pain in pitchers. Tracking of exposure is difficult based on participation on multiple teams and variability in organizational rules. Statisticians have estimated exposure for professional pitchers using pitch count estimators. Our objective was to determine the utility of pitch count estimators at the collegiate level.
Design and participants: Cohort; 29 collegiate pitchers.
Methods: The team athletic trainer collected game pitch count data. The total number of batters faced (PA), strike outs (SO), and walks (BB) were recorded from the box score and entered into the pitch count formula (3.3*PA + 1.5*SO + 2.2*BB) to estimate pitch counts. Intraclass correlation coefficients ($ICCs_{(2,1)}$) and standard error of measurement (SEM), were used to examine the agreement between actual and estimated pitch counts.
Results: The mean pitch count was correlated with the estimated pitch count (628 ± 476vs.603 ± 426; $r = .99$, $p < .001$). The actual and estimated pitch counts per season demonstrated excellent agreement ($ICC_{(2,1)} = 0.99$; SEM = 56 pitches). The $ICC_{(2,1)}$ calculated to compare actual and estimated pitch counts for starters and relievers ($ICC_{(2,1)} = 0.98$; SEM = 77; 0.98; SEM = 39) reflect good agreement.
Conclusions: The estimator provides a method of quantifying exposure for pitchers to help plan safe participation and control for confounding factors when attempting to understand the risks of pitching.

1. Introduction

Baseball is a popular sport for athletes from children to young adults. Participation has grown by 16% in the last decade amongst high school players (Associations NFoSHS, 2005-06; Rechel, Yard, & Comstock, 2008). The incidence of injury in scholastic athletes has been established, ranging from 1 to 5.87 per 1000 athletic exposures (AEs) in high school (Centers for Disease Control and Prevention, 2006; Knowles, 2010) and collegiate players (Dick et al., 2007). The upper extremity has been reported as the most commonly injured body site in baseball pitchers, (Bonza, Fields, Yard, & Comstock, 2009; Collins & Comstock, 2008; Rechel et al., 2008) the most frequent mechanism being overuse related to throwing (Collins & Comstock, 2008; Petty, Andrews, Fleisig, & Cain, 2004).

Many injury risk factors have been theorized for baseball players including physical parameters (Borsa, Dover, Wilk, & Reinold, 2006; Fleisig, Weber, Hassell, & Andrews, 2009; Myers, Laudner, Pasquale, Bradley, & L, 2006; Sciascia & Kibler, 2006) and performance characteristics (pitching with pain or fatigue, pitch types, and pitch counts) (Lyman, Fleisig, Andrews, & Oskinski, 2002; Lyman et al., 2001; Olsen II et al., 2006). Sport specialization of athletes participating in one sport year round (Cuff, Loud, & O'Riordan, 2010) has been theorized as any injury risk factor. Descriptive research has established an association between an increased number of pitches thrown in injured players as compared to healthy controls (Lyman et al., 2001; Olsen II et al., 2006). A long-

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term cohort of youth baseball players found pitching in excess of 100 innings per year were 3.5 times more likely to be injured (Fleisig et al., 2011). Safety measures have been recommended to protect pitchers including instruction in throwing mechanics, training principles, and a restriction in the number of pitches thrown in practices and competition for each game, season, and year (American Academy of Pediatrics Committee on Sports Medicine and Fitness, 1994; USA Baseball Medical & Safety Advisory Committee. Youth Baseball Pitching Injuries. November 30, 2008).

Little League Baseball implemented mandatory game pitch counts and pitching rest days by age group (Little League Baseball Inc., 2009) based on the number of pitching appearances and pitch counts associated with youth injury in the medical literature (Lyman et al., 2002; Olsen II et al., 2006). However, the new rules did not address seasonal and yearly pitch counts in 2010 (Little League Baseball Inc., 2009). A survey of youth baseball coaches formulated to test the coaches' knowledge and compliance with age-specific pitching guidelines documented that 43% understood the guidelines correctly and 73% complied with the league pitch count rules (Fazarale, Magnussen, Pedroza, & Kaeding, 2012). This may suggest that additional opportunities to inform and educate athletes, coaches, and parents might help increase compliance with these injury prevention recommendations.

In addition to the potential confusion and lack of compliance with pitch count guidelines, baseball leagues are available year round in many states. In an attempt to refine skills and perform at the highest level, some athletes specialize as a pitcher and will pitch in multiple leagues and showcases during the same and subsequent seasons with little control or awareness of aggregate pitch counts (Fazarale et al., 2012). The practice of competing in multiple leagues occurs at all levels of baseball and presents the challenge of accounting for increasing exposure to understand the stress on the arm and impact on performance. Knowledge of exact pitch counts would allow a more precise understanding of the demands faced by athletes, the potential risk for injury, and influence on performance.

Pitch counts were first established in major league baseball (MLB) in 1988. Real time pitch and strike totals are available per game but have yet to be associated with injury at the major league level. Other research has demonstrated each pitch thrown in the preceding MLB game and those thrown in the previous 5-10 games negatively effect earned run average (ERA) in subsequent games (Bradbury & Forman, 2012). Pitch counts are difficult to find at other levels of competition. Many teams especially at lower levels of competition do not publish daily or aggregate pitch count data therefore, it is difficult to ascertain total load, as it requires monitoring participation on several teams and leagues. An alternate solution to counting pitches during each competition throughout the year that would combine information about exposure, pitching efficiency, and overall performance might be beneficial to teams, coaches, and athletes.

Tom M. Tango has been credited with the creation of the first online pitch count estimators. (Engine, April 12, 2014) To validate this formula he compared his estimates against actual pitch count data collected by the Dodgers organization in the 1950s and 1960s (Tango, 2012; Treder, April 12, 2014). This estimator has been used by "sabermetricians" (passionate knowledge baseball fan statisticians) to compare individual pitchers and teams current workload to previous hall of fame pitchers and team workload throughout history (Treder, April 12, 2014). Additionally, other estimators were used to compare styles of pitchers (i.e. power versus finesse pitchers) to determine if one pitching style was more efficient than another but these formulas use elaborate equations and analyses (Nation, 2014; Treder, April 12, 2014). The basic estimator has been used in the last decade and employs a combination of events, such as batters faced, balls in play, strikeouts, and walks to calculate the estimates (Tango, 2012). The purpose of this study was to compare a basic pitch count estimator (Tom M. Tango available at http://www.tangotiger.net/) to actual daily and seasonal pitch counts to determine their reliability and appropriateness for use by coaches and parents. We hypothesize that the pitch count estimator will demonstrate good reliability when compared to actual pitch counts for an entire cohort of pitchers including both starting and relief pitchers.

2. Methods

Twenty-nine healthy collegiate baseball pitchers (age = 20.2 ± 1.1 y.o.) volunteered for participation in this study. Eight of the pitchers were followed for 2 seasons and 21 were followed for 1 season. For inclusion into the study, the participant must have been on the opening day roster, classified by the coaching staff as either a starting or relief pitcher, currently free from injury and participating fully in all team activities. Players were excluded from participation in the study if they were classified as a position player by the university baseball coaching staff. All subjects completed an informed consent that described the research methods, which was approved by the Greenville Health System Institutional Review Board. Subjects were NCAA Division I athletes fully participating in competition at the beginning of the spring baseball season during the 2010 and 2011 academic years. Game by game pitch count data was collected with a hand held pitch count device by the certified athletic trainer assigned to the men's baseball team for each pitcher. These statistics were recorded for all games throughout each season. The athletic trainer then verified each game pitch count and the roles of each pitcher with the pitching coach at the end of the season. Aggregate numbers were tabulated for all participants per game and per season.

The primary author, blinded to the actual pitch count data, consulted the official box score for each game recording the total number of batters faced (PA), strike outs (SO), and walks (BB) for each pitcher who participated. The statistics were entered into the pitch count formula ((3.3 PA) + (1.5 SO) + (2.2 BB)) (Tom M. Tango available at http://www.tangotiger.net/pitchCounts.html) to create estimated pitch counts per game and per season. Comparisons between the actual and estimated pitch counts were examined for each athlete and team for each game and over the course of the season.

2.1. Statistics

Means and standard deviations were calculated for all data. Paired t-tests, intraclass correlation coefficients ($ICC_{s(2,1)}$) and associated standard error of measurement (SEM) were used to examine the agreement between actual and estimated pitch count data for the entire cohort, starters, and relievers. ICC results were interpreted by examining the value of *r*. A 1.0 correlation was understood to denote a perfect positive linear relationship and a correlation of 0.80 or better a strong positive relationship. One-way ANOVA was used to compare the difference in actual pitch counts between starters and relievers. Bland Altman plots were created to test the limits of agreement between actual and estimated pitch counts for starters and relievers. For all statistical analyses, an a priori alpha level of $p < 0.05$ was used. Data was analyzed using SPSS software (version 20.0; SPSS Inc, Chicago IL).

3. Results

Twenty-nine healthy males pitchers (age = 20.2 ± 1.1 years old) from one NCAA Division I school participated throughout the spring