

Defining the Long-Toss

A Professional Baseball Epidemiological Study

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Background: Despite widespread use of long-toss throwing in baseball as a component of arm conditioning, interval throwing programs, and rehabilitation, long-toss distance and throwing mechanics remain controversial.

Purpose: To ascertain the perceived definition of long-toss throwing through a survey of professional pitchers, pitching coaches (PCs), and certified athletic trainers (ATCs) associated with Major League Baseball.

Study Design: Descriptive epidemiology study.

Methods: Pitchers, PCs, and ATCs associated with 5 Major League Baseball organizations completed an anonymous survey that collected demographic data, personal use of long-toss throwing, and their perception of the distance and throwing mechanics that comprised long-toss.

Results: A total of 321 surveys were completed by 271 pitchers, 19 PCs, and 31 ATCs. For all respondents, the mean distance considered as long-toss was 175 ft (95% CI, 170-181 ft). Respondents categorized the throwing mechanics of long-toss, with 36% reporting throwing "on a line" and 70% reporting long-toss as "not on a line." Of those throwing "on a line," 28% reported using crow-hop footwork while 60% used crow-hop footwork when throwing "not on a line." Interpretation of long-toss distance significantly varied by position: pitchers, 177 ft (95% CI, 171-183 ft); PCs, 177 ft (95% CI, 155-200 ft); and ATCs, 157 ft (95% CI, 144-169 ft) ($P = .048$). When asked when long-toss throwing is used, pitchers reported using it more frequently in preseason ($P = .007$), during the season ($P = .015$), and in the off-season ($P = .002$) compared with that by ATCs. Functional goals for long-toss throwing demonstrated that pitchers and PCs use long-toss for shoulder stretching more frequently than ATCs ($P < .001$ and $P = .026$, respectively). ATCs used long-toss more than pitchers for interval throwing programs ($P < .001$).

Conclusion: The definition varies for long-toss throwing distance and throwing mechanics. Pitchers and PCs believe that long-toss comprised longer distances than ATCs and employed long-toss differently for strength conditioning, training, stretching, and rehabilitation. This discrepancy highlights a potential lost opportunity for protecting the shoulder. While long-toss is an important tool, a more scientific definition is warranted to better elucidate its role in enhancing throwing performance and rehabilitation.

Keywords: baseball; long-toss; pitchers; pitching; throwing

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Strategies to prevent and treat upper extremity injuries in baseball players continue to be an area of great importance for players, athletic trainers, and sports medicine physicians. One such strategy is the use of long-toss throwing as a component of interval throwing programs and rehabilitation. The use of interval throwing training for baseball conditioning and rehabilitation is widely accepted.^{1-4,7,9,11,12} Interval throwing programs were developed for a structured return to play after the off-season or during rehabilitation. These throwing programs contain both short-toss and long-toss components to target different aspects of the throwing game.^{1-4,9,12} The goal of the long-toss segment historically was to increase arm strength by the application of low-intensity, long-duration training sessions, and for pitchers, included mound and off-mound pitching.^{1,2} The goal of these interval throwing programs is to restore arm flexibility and

throwing mechanics, but the majority of the programs are primarily based on expert opinion.^{2,7,9,12,13}

Despite widespread use in baseball, the distances and long-toss throwing mechanics remain controversial. While long-toss throwing is generally accepted as a part of injury rehabilitation, the timing of long-toss throwing, flat-ground throwing, and use of lower extremity footwork are highly variable. Two reported biomechanical studies of long-toss throwing used vastly different approaches to evaluate long-toss, and consequently, little data are available on its goals.^{7,11} The lack of consensus for long-toss throwing programs raises several questions, and the first and foremost objective is identifying what “long-toss throwing” means for throwing athletes. The use of long-toss in strength building and strength maintenance both in season and out of season is not established because the strength and physiologic benefits are unknown. Long-toss should theoretically stretch the posterior shoulder capsule, but long-toss may place a potentially harmful stress on an injured shoulder or elbow.^{7,11} We believe that long-toss may offer benefits of arm strength maintenance, but this strategy is unproven. The first step in answering these questions is to determine how long-toss is currently being used in professional baseball. The purpose of this study was to ascertain the definition of long-toss throwing through a survey of professional pitchers, pitching coaches (PCs), and certified athletic trainers (ATCs) associated with Major League Baseball (MLB).

METHODS

Pitchers, PCs, and ATCs associated with 5 MLB organizations received an anonymous survey (Survey available in the Appendix). The survey was available in both English and in Spanish depending on the recipients preferred language. The survey collected anonymous data for demographics, personal use of long-toss throwing, and the respondent's perception of the distance and throwing mechanics that comprised long-toss. Surveys were returned to our institution and tabulated. All professional organizations received the same instructions for administration, and all surveys were completed voluntarily without reimbursement. Surveys were administered by the chief ATC without clarifications or oversight of the responses.

The survey consisted of 3 parts. The first part focused on acquiring demographics and whether the respondent was a pitcher, a PC, or an ATC. Additional demographics included hand dominance and duration of playing professional baseball, including whether or not the respondent was a starter or reliever. The second section of the survey analyzed when the respondent would utilize long-toss throwing as a component of training. The timing of use for preseason, in-season, postseason, and off-season was collected for 4 categories: (1) arm strengthening and conditioning, (2) shoulder stretching, (3) as a component of an interval throwing program, and (4) as a component of a rehabilitation program. Finally, the third section sought to ascertain what the respondent considered long-toss throwing regarding both distance and biomechanics. This was accompanied by illustrations differing throwing “hard,

TABLE 1
Demographic Data From Major League Baseball
Organization Respondents^a

	Pitchers	Pitching Coaches	Athletic Trainers Certified
Respondents, n	269	19	31
Years in professional baseball, mean (range)	3.35 (0-15)	23.1 (3-42)	15.3 (0-38)
Starters, %	60	70	N/A
Right hand dominant, %	69	79	93

^aN/A, not applicable.

on a line” versus “hard, not on the line.” The throwing techniques differ based on the trajectory of the ball and the torso and upper extremity motion. Throwing “hard, on a line” is performed with a linear trajectory of the ball, while throwing “hard, not on a line” results in a parabolic ball trajectory. The use of “crow-hop” footwork was also assessed with an accompanying image. Employing “crow-hop footwork” utilizes small steps from the lower extremities to leverage lower extremity motion for enhancing throwing power versus throwing without stepping into the throw.

Statistical Analysis

Results were tabulated and analyzed using multivariate analysis of variance and descriptive statistics with significance set at $P \leq .05$. Post hoc testing was performed as statistically appropriate. All confidence intervals (CIs) reported are 95%.

RESULTS

A total of 321 surveys were completed by 271 pitchers, 19 PCs, and 31 ATCs. All surveys mailed to the professional baseball organizations were returned (100%). All surveys contained respondent position; however, 24 (7.5%) surveys had incomplete demographic data. These surveys were primarily missing hand dominance for throwing, which was not considered necessary for evaluation of the respondent's perception of long-toss throwing. Two (0.6%) respondents did not complete section 2 (timing of long-toss throwing), and 3 (0.9%) respondents did not report what they consider to be the long-toss distance (section 3). Those surveys were excluded from the section analysis. The demographic data is provided in Table 1.

For all respondents, the mean distance considered long-toss was 175 ft (95% CI, 170-181 ft). Interpretation of long-toss distance significantly varied by position: pitchers, 177 (95% CI, 171-183 ft); PCs, 177 (95% CI, 155-200 ft); and ATCs, 157 (95% CI, 144-169 ft) ($P = .048$) (Figure 1). Respondents categorized the throwing mechanics of long-toss, with 36% reporting throwing “on a line” and 70% reporting long-toss as “not on a line.” Of those throwing “on a line,” 28% reported using crow-hop footwork while

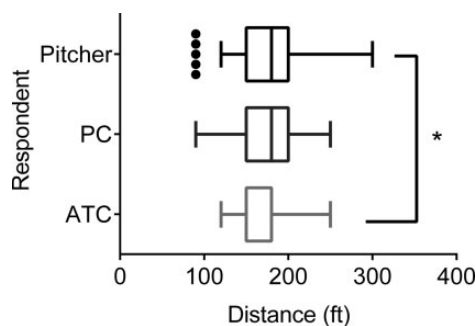


Figure 1. Reported perception of long-toss throwing distance by player position: pitchers, $n = 269$; pitching coaches (PCs), $n = 19$; certified athletic trainers (ATCs), $n = 31$. Box and whisker plot with 25th-75th percentiles illustrated as the box and 5th-95th percentiles as whiskers. The line in the box signifies the mean, and outliers are denoted by the dots. * $P < .05$.

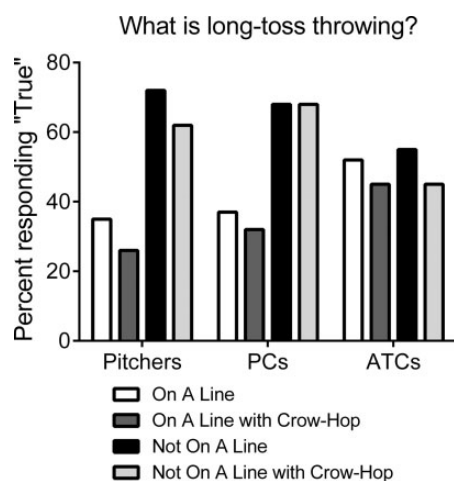


Figure 2. Defining the long-toss throwing mechanics. Percent of respondents reporting long-toss throwing as throwing “on a line” versus “not on a line.” Respondents were also asked to clarify whether “crow-hop” footwork was employed while throwing long-toss for each respective throwing trajectory. Percentages may exceed 100% because some respondents considered long-toss at a given distance both “on a line” and “not on a line.” ATCs, certified athletic trainers; PCs, pitching coaches.

60% used crow-hop footwork when throwing “not on a line.” Long-toss throwing mechanics delineated by position are provided in Figure 2. Respondents were also asked to clarify whether “crow-hop” footwork was employed while throwing long-toss for each respective throwing trajectory.

The overwhelming majority of respondents reported using long-toss throwing as a component of arm strengthening and conditioning throughout the year. Less than one-third of respondents used long-toss as a component of rehabilitation programs. When asked when pitchers use long-toss throwing, pitchers themselves reported using long-toss throwing more frequently during the preseason

($P = .007$), within the season ($P = .015$), and off-season ($P = .002$) versus that reported by PCs and ATCs. Starting pitchers reported using long-toss more frequently than relievers during off-season training ($P = .042$).

Functional goals for long-toss throwing were also collected, including use of long-toss for the following: arm strengthening and conditioning, shoulder stretching, during interval throwing programs, and as a component of rehabilitation programs (Figure 3). Pitchers and PCs reported using long-toss throwing for shoulder stretching significantly more than ATCs ($P < .001$ and $P = .026$, respectively). Pitchers used long-toss throwing significantly less in an interval throwing program than that reported by ATCs ($P < .001$), while the difference was not significant between pitchers and PCs ($P = .647$). ATCs reported using long-toss throwing during a rehabilitation program significantly more than pitchers ($P < .001$), and demonstrated a trend for using long-toss in rehabilitation more than PCs ($P = .085$).

DISCUSSION

The use and purpose of long-toss throwing continues to differ among pitchers, PCs, and ATCs in the professional MLB organizations surveyed. Although pitchers and PCs appear to agree on the approximate distance that comprises long-toss throwing, ATCs interpret long-toss throwing differently. The biomechanics used in long-toss throwing also differ and may influence what is considered the optimal long-toss distance.

The primary goal of this study was to help establish what is considered the long-toss throwing distance. The pitching literature to date has not objectively defined the long-toss throwing distance, but the consensus appears to be that long-toss throwing is within the range of 37 to 55 m (120-180 ft) for baseball athletes at the high school to professional levels.^{3,7,9,11-13} In our survey, pitchers and PCs both reported a mean 177 ft to be the appropriate long-toss distance, which is at the top of the reported range. Since many PCs were former pitchers themselves, it is not surprising that the 2 considered the same distance for long-toss throwing. The differing opinions of the long-toss throwing techniques between pitchers and PCs and the ATCs is a more interesting finding. Nearly three-quarters of pitchers and PCs considered long-toss as throwing not on the line and using crow-hop footwork to more easily reach the distance. The ATCs surveyed reported that approximately 50% considered long-toss throwing to be on a line. Throwing on a line may be a consequence of the shorter throwing distance that ATCs considered as long-toss throwing—this distance may be more easily achieved while still throwing on a line.

Functional use of long-toss throwing also varied among professional pitchers and trainers. The responses suggest that most professional pitchers use long-toss throwing as a component of arm strengthening, conditioning, and recovery via stretching. This approach was employed during the majority of the season, with the exception being in immediate postseason play. Since respondents reported using

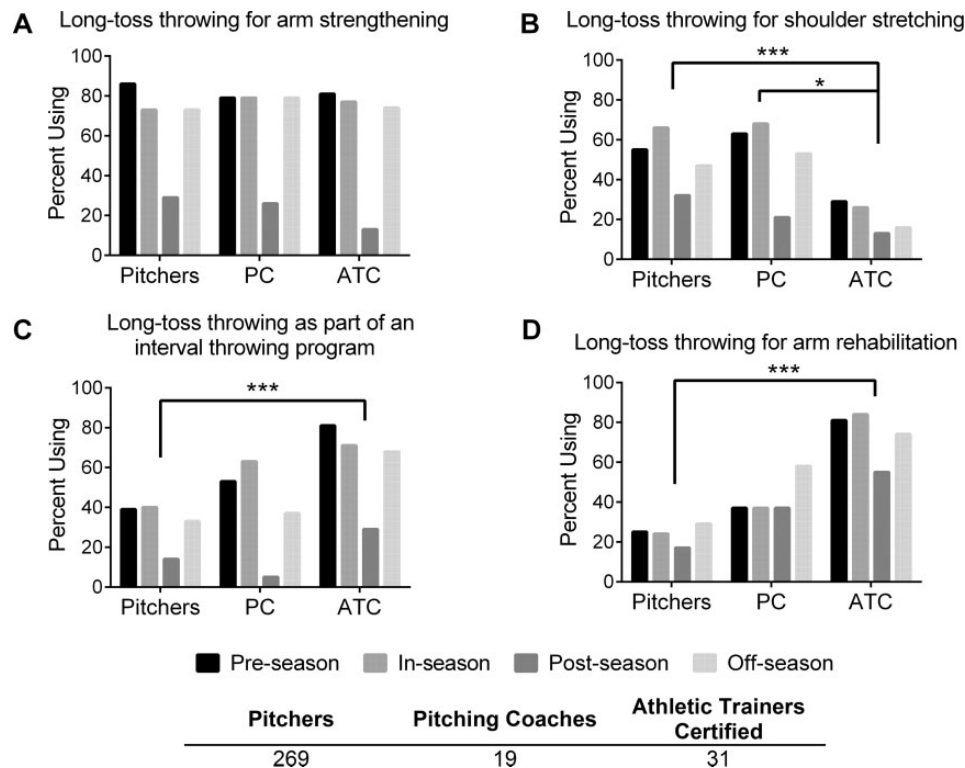


Figure 3. Timing of use and functional goals of long-toss throwing including (A) arm strengthening, (B) shoulder stretching, (C) part of an interval throwing program, and (D) arm rehabilitation: pitchers (n = 269), pitching coaches (PCs, n = 19), and certified athletic trainers (ATCs, n = 31). * $P < .05$; *** $P < .001$.

long-toss throwing for arm strengthening and conditioning, we anticipated that it would be a more recognized component of interval throwing programs. Interval throwing programs are themselves used for stretching, strengthening, and conditioning.

Interval throwing training for baseball conditioning and rehabilitation is widely accepted^{1-4,7,9,11,12} and several programs employ long-toss throwing as a component for strengthening and return to play.^{2,7,11-13} In the development of these programs, the short-toss segments simulate game demands and throwing mechanics while the long-toss segments seek to develop arm strength through low-intensity, long-duration training sessions.^{1,2} In 2 of the programs incorporating rehabilitation and maintenance, pitchers progress to throwing to 37 m (120 ft) while position players progress to throwing to 60 m (180 ft).^{12,13} These interval throwing programs are designed to gradually allow recovery of the athlete's flexibility, arm strength, and proper throwing mechanics, but despite incorporating long-toss components, they remain variable in their approach.^{2,7,9,12,13} The discrepancy in endpoint throwing distance between pitchers and position players is interesting since the distance considered long-toss in our survey of pitchers is substantially longer (177 ft vs 120 ft). The inconsistent use of long-toss throwing in interval throwing programs and rehabilitation in the literature may provide an explanation for why pitchers and PCs did not report implementing long-toss throwing for rehabilitation. While

pitchers and PCs did not report a great deal of use in interval throwing programs and arm rehabilitation, almost 80% of ATCs reported using it throughout the season. The reason for this disconnect is unclear, but it may be indicative of an evolving role of long-toss throwing in rehabilitating the arm and highlights the potential lost opportunity for protecting and developing the throwing arm. This difference may be secondary to the working role the ATC plays on a daily basis. Pitchers and PCs may be defining normal functional throwing routines, whereas the normal routine for an ATC deals with the rehabilitation of an injured or post-operative pitcher.

Interval throwing programs are often used in the off-season to develop game-ready strength by beginning with fewer throws at a shorter distance with progression to increased distance and throw count, ultimately ending in mound work. It is interesting that pitchers reported using long-toss less in the off-season than in the preseason and in season. This finding suggests that elite throwers may have personal or organizational routines for conditioning the arm for the upcoming season.

Another interesting finding is the difference in perceived long-toss throwing mechanics. A greater number of pitchers said that long-toss throwing was performed not on a line compared with throwing on a line, and the majority of these pitchers used crow-hop footwork while throwing long-toss. ATCs believed that long-toss could be performed with either throwing trajectory but uniformly endorsed use of

crow-hop footwork. The aforementioned interval throwing programs for male baseball throwers do not recommend one throwing trajectory or footwork, but interval throwing programs for softball players and other overhead athletes utilize different techniques.^{4,8} Softball players follow a similar stepwise progression of throwing as baseball players but the interval throwing program uses shorter distances with a more limited program duration.⁴ The reported softball player interval throwing program recommends using the crow-hop technique with a shorter distance of 45 m (150 ft).⁴ The reason for recommending utilizing the crow-hop technique is unclear but may be related to offloading the upper extremity, even at the shorter throwing distances of the interval throwing program. This reasoning may also be related to why PCs and ATCs in our study identify long-toss throwing with crow-hop footwork.

The rehabilitation and conditioning implications for the differences in the biomechanics are unclear since interval throwing programs containing long-toss are designed to build strength and flexibility in the arm. Despite the apparent utility of long-toss, the differing mechanics when comparing long-toss to the pitching motion may not be beneficial for certain injuries and postoperative rehabilitation protocols. During the cocking phase of pitching, the shoulder is maximally externally rotated, which increases the stress along the anterior capsule.⁶ The arm produces increased humeral internal rotation torque after reaching maximal shoulder external rotation when throwing. Both increased humeral internal rotation torque and biceps stress during deceleration are associated with superior labral anterior-to-posterior (SLAP) tears.^{5,6} Movements that increase these torques may contribute to SLAP tear development,¹⁰ and players were advised against throws producing greater torque after labral repair and capsular plication until healing is complete.^{7,11} Long-toss throwing may offer some potential protection against stresses on these repairs but would not be expected to be employed by players who believed long-toss throwing should be hard and on a line. Organizations that consider long-toss throwing to be not on a line with the use of crow-hop may offer the upper extremity additional protection by using the lower extremities to generate additional force in distance and the throw, thereby potentially offloading the throwing arm.

Our study is limited by the fact that we surveyed 5 MLB organizations; however, the survey response rate in our study was extremely high, with 100% of surveys returned. The completed surveys were further strengthened by the exclusion of only 1.5% of surveys with missing data. Despite not sampling all MLB organizations, we believe we have a representative sample of perceptions given the high response rate and multiple geographic locations. We attempted to achieve a comprehensive analysis by providing surveys in English and Spanish to capture perceptions of all pitchers, PCs, and ATCs polled. Our study also examined responses in members of professional baseball organizations. These practices and perceptions may not be applicable to collegiate, high school, and Little League organizations. Furthermore, our survey was not designed to establish a link between long-toss and injury or specific rehabilitation

protocols and was consequently unable to assess these potential interactions. Future research should explore how long-toss is utilized in collegiate, high school, and Little League organizations to gain a better understanding of how its use may evolve through skill progression. Additional studies should be designed to specifically examine variations in throwing technique. Long-toss studies should standardize the approach to ball trajectory (on a line vs not on a line) and use of footwork (crow-hop or not). The distance of the throw should also be standardized in addition to the technique to better identify which throwing distances may strain the arm. Organizations that participate in future research should also report when in the player's training or rehabilitation that long-toss throwing is specifically avoided or utilized. By examining these aspects of a player's conditioning and rehabilitation, we might better identify throwing techniques to protect a player's arm.

Our results support the hypothesis that the definition varies for long-toss throwing distance and throwing mechanics. Pitchers and PCs believe that long-toss was composed of longer distances than ATCs. Additionally, the function of long-toss significantly varied in its role in strength conditioning, training, stretching, and rehabilitation. Pitchers and PCs also reported using long-toss less for interval throwing programs and for rehabilitation than ATCs. This discrepancy highlights a potential lost opportunity for protecting the shoulder. Long-toss is ultimately used throughout the season by the majority of players and as a tool for strengthening and recovery. While long-toss is an extremely important tool, a more scientific definition is warranted to better elucidate its role in enhancing throwing performance and rehabilitating injured athletes. Our epidemiologic study better defines long-toss distance and its use in professional baseball organizations.

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APPENDIX

Long-Toss Survey

Thank you for agreeing to participate in our survey of "long-toss" throwing. Please select best descriptors

☐ Pitcher ☐ Pitching Coach ☐ Athletic Trainer

☐ Right Hand Dominant ☐ Left Hand Dominant

Total years in professional baseball _____ Highest level reached in professional baseball _____

☐ Starter; years as a professional _____ ☐ Reliever; years as a professional _____

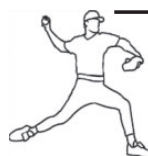
Please check the times when would utilize "long-toss • throwing as a component of your training:

Purpose	Timing of Use				
<input type="checkbox"/> Arm strenghtening and conditioning	<input type="checkbox"/> Pre-season	<input type="checkbox"/> In-season	<input type="checkbox"/> Post- season	<input type="checkbox"/> Off-season	
<input type="checkbox"/> Shoulder stretching	<input type="checkbox"/> Pre-season	<input type="checkbox"/> In-season	<input type="checkbox"/> Post- season	<input type="checkbox"/> Off-season	
<input type="checkbox"/> As a component of an interval throwing program	<input type="checkbox"/> Pre-season	<input type="checkbox"/> In-season	<input type="checkbox"/> Post- season	<input type="checkbox"/> Off-season	
<input type="checkbox"/> As a component of a rehabilitation program	<input type="checkbox"/> Pre-season	<input type="checkbox"/> In-season	<input type="checkbox"/> Post- season	<input type="checkbox"/> Off-season	

What do you consider "long toss • throwing? Please select the best definition.

Distance	Technique	Footwork
90 ft	<input type="checkbox"/> On a line <input type="checkbox"/> Not on a line	
120 ft	<input type="checkbox"/> On a line <input type="checkbox"/> Not on a line	<input type="checkbox"/> with crow-hop <input type="checkbox"/> without crow-hop
150 ft	<input type="checkbox"/> On a line <input type="checkbox"/> Not on a line	<input type="checkbox"/> with crow-hop <input type="checkbox"/> without crow-hop
180 ft	<input type="checkbox"/> On a line <input type="checkbox"/> Not on a line	<input type="checkbox"/> with crow-hop <input type="checkbox"/> without crow-hop
200 ft	<input type="checkbox"/> On a line <input type="checkbox"/> Not on a line	<input type="checkbox"/> with crow-hop <input type="checkbox"/> without crow-hop
250 ft	<input type="checkbox"/> On a line <input type="checkbox"/> Not on a line	<input type="checkbox"/> with crow-hop <input type="checkbox"/> without crow-hop
300 ft o mas	<input type="checkbox"/> On a line <input type="checkbox"/> Not on a line	<input type="checkbox"/> with crow-hop <input type="checkbox"/> without crow-hop

Demonstrates throw „hard, on a line”:



Demonstrates throw "hard, not on a line":



Schematic of use of "crow-hop" footwork which incorporates and an additional step-hop prior to throwing.

