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INPLASY

Effects of weighted ball training on throwing velocity and safety considerations for baseball pitchers: systematic review and meta-analysis

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ADMINISTRATIVE INFORMATION

Support - None.

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 23 September 2025 and was last updated on 23 September 2025.

INTRODUCTION

Review question / Objective P: Is there any evidence to support the effects of weighted ball training on throwing velocity, injury risk, and safety for baseball pitchers? I: with the intervention of Weighted ball training. C: without the intervention of Weighted ball training. O: throwing velocity and injury reports.

Rationale Throwing velocity is a critical determinant of pitching performance in baseball. Enhancing throwing velocity through targeted training is a primary objective for pitchers at all levels of play. Among various training modalities, weighted ball training (WBT) has gained popularity due to its purported benefits in optimizing the throwing kinetic chain and enhancing sport-specific energy transfer. However, concerns have been raised regarding its safety, with some studies suggesting a potential increase in the risk of throwing-related injuries. This study aims to systematically review and meta-analyze existing literature on the effects of weighted ball training on throwing velocity and injury incidence among baseball pitchers, thereby providing an evidence-based foundation for training practices.

Condition being studied To increase pitching speed, baseball pitchers often employ various training methods, including weight training, medicine ball/kettlebell training, and plyometric training. In recent years, a specialized baseball training method called weighted ball training (WBT), which claims to improve the pitching kinetic chain and enhance energy transfer, has gained popularity among professional pitchers. However, several systematic reviews and studies have questioned the effectiveness of WBT, suggesting that it may not necessarily improve pitching mechanics/biomechanics or pitching speed, and may even increase the risk of injuries to the pitching arm. Currently, only three systematic reviews on this topic have been published internationally, and there is no rigorous meta-analysis data specifically addressing the effects of WBT on pitching speed and injury risk. Therefore, this study will conduct a systematic review and

meta-analysis of the literature to examine the effects of WBT on pitching speed and the safety and injury risks for baseball pitchers, in order to provide a more scientifically sound basis for developing WBT training programs.

METHODS

Search strategy This study conducted a systematic literature review and meta-analysis following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Academic searches were performed using the library database search system of the National University of Sports, primarily utilizing five databases (3 English databases and 2 Chinese databases). The English databases included PubMed, SportsDiscus (EBSCOhost), and Google Scholar, while the Chinese databases included the Journals database (formerly CEPS) and the "Taiwan Academic Dissertation Knowledge Value-Added System." Boolean logic (OR and AND) was used to input keywords in both English and Chinese. The English keyword search was set as "Baseball and Weighted ball program and Ball velocity," and the Chinese keyword search was set as "Baseball," "Weighted ball training," and "Pitching speed." The language setting was both English and Chinese, and the literature collection period covered publications up to 2025.

Participant or population The study subjects were baseball pitchers from elementary school, junior high school, high school, university (adults), and professional teams.

Intervention The intervention method involved incorporating weighted balls into a training program.

Comparator Without weighted ball training.

Study designs to be included Systematic literature review and meta-analysis.

Eligibility criteria The inclusion criteria for this study were: (1) The study subjects were baseball pitchers from elementary, middle, high school, university (adult), and professional teams; (2) The intervention involved using weighted balls during training; (3) The literature was published in Chinese or English; (4) One of the research parameters was "pitch speed". The exclusion criteria were: (1) Expert opinions, literature reviews, systematic literature reviews, and meta-analyses; (2) Studies that did not involve weighted ball training; (3) Studies whose subjects were baseball batters, fielders, or athletes not specializing in baseball; (4) Studies for which the full text was unavailable.

Information sources Academic searches were performed using the library database search system of the National University of Sports, primarily utilizing five databases (3 English databases and 2 Chinese databases). The English databases included PubMed, SportsDiscus (EBSCOhost), and Google Scholar, while the Chinese databases included the Journals database (formerly CEPS) and the "Taiwan Academic Dissertation Knowledge Value-Added System."

Main outcome(s) Throwing velocity and injury reports.

Additional outcome(s) None.

Data management Meta-analysis was performed using CMA 4.0 software (Biostat, Inc., NJ, USA). A two-tailed p-value less than 0.05 was considered statistically significant. After compiling the journal data, the effect sizes of each study were analyzed. Heterogeneity between studies was assessed using the I^2 statistic; an I^2 value ≥ 50% indicated heterogeneity. In such cases, a random effects model was used. I^2 values of 25%, 50%, and 75% were considered to represent low, moderate, and high heterogeneity, respectively (Higgins et al., 2003). A sensitivity analysis was then conducted, excluding unsuitable studies and reanalyzing the data. Mean and standard deviation data were used to estimate the pooled effect size, quantified using Hedges' g and 95% confidence intervals (CI) for the primary outcome (change in ball speed). Hedges' g values of 0.2, 0.5, and 0.8 were considered small, moderate, and large effect sizes, respectively (Hedges, 1981). A forest plot was used to present the pooled effect size and 95% CI. Publication bias was assessed visually using funnel plots and Egger's test. Odds ratios (ORs) and their 95% CI were used to evaluate the secondary outcome (incidence of training-related adverse events). The odds for each group were calculated as the number of participants experiencing the event divided by the number who did not experience the event.

Quality assessment / Risk of bias analysis Oxford Center of Evidence Based Medicine and physiotherapy evidence database scale (PEDro scale).

Strategy of data synthesis Meta-analysis was performed using CMA 4.0 software (Biostat, Inc., NJ, USA). A two-tailed p-value less than 0.05 was considered statistically significant. After compiling

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the journal data, the effect sizes of each study were analyzed. Heterogeneity between studies was assessed using the I^2 statistic; an I^2 value ≥ 50% indicated heterogeneity. In such cases, a random effects model was used. I^2 values of 25%, 50%, and 75% were considered to represent low, moderate, and high heterogeneity, respectively (Higgins et al., 2003). A sensitivity analysis was then conducted, excluding unsuitable studies and reanalyzing the data. Mean and standard deviation data were used to estimate the pooled effect size, quantified using Hedges' g and 95% confidence intervals (CI) for the primary outcome (change in ball speed). Hedges' g values of 0.2, 0.5, and 0.8 were considered small, moderate, and large effect sizes, respectively (Hedges, 1981). A forest plot was used to present the pooled effect size and 95% CI. Publication bias was assessed visually using funnel plots and Egger's test. Odds ratios (ORs) and their 95% CI were used to evaluate the secondary outcome (incidence of training-related adverse events). The odds for each group were calculated as the number of participants experiencing the event divided by the number who did not experience the event.CMA 4.0 version.

Subgroup analysis None.

Sensitivity analysis Heterogeneity test.

Country(ies) involved Taiwan.

Keywords Baseball-specific training, Throwing mechanics, Shoulder injury, Elbow injury, pitching kinetic chain.

Contributions of each author

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