KPC Kinesiology and Physiotherapy Comprehensive

P-ISSN: 2830-6317
E-ISSN: 2962-5491

# Factors affecting ball velocity in baseball pitchers

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**ABSTRACT**

**Background:** Baseball is a sport played between two teams that alternate between offence and defence. For pitchers, ball velocity is crucial, making understanding the factors influencing pitching speed essential. This study aimed to determine the factors that affect ball velocity in baseball pitchers.
**Methods:** The study used a descriptive study design with a literature review approach, which took secondary data from journals related to factors that affected ball velocity in baseball pitchers. Five articles published within the last five years (2019–2024) were analyzed to identify factors affecting ball velocity in baseball pitchers. The inclusion criteria comprised studies published within the previous five years and on factors influencing pitching velocity. Meanwhile, the exclusion criteria included irrelevant articles, studies with subjects other than baseball pitchers, and studies with incomplete data or without full access.
**Results:** The results showed that external and internal factors affect a pitcher's ball velocity. External factors, such as the biomechanics of pitching and the training program run, while internal factors, such as height and age.
**Conclusion:** External factors, such as the biomechanics of the pitching motion and the implemented training program, play a crucial role in determining a pitcher's throwing speed. Additionally, internal factors, including the pitcher's height and age, were found to have a significant impact on ball velocity.

**Keywords:** ball velocity, baseball, pitcher, risk factors, sports game, throwing speed

**Received**: July 26, 2024. **Accepted**: November 27, 2024.
**Type**: Review article; **Doi**: 10.62004/kpc.v3i3.53

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## Introduction

Baseball is a popular sport in the United States, with over 15 million Americans participating, starting as young as six. Statistics show that 14% of children aged 6 to 12 play baseball regularly.[1] Baseball in Indonesia remains less prevalent than in America. The Indonesian Softball Baseball Association governs the sport.[2] Baseball is an open-skill sport where players face unpredictable situations, enhancing cognitive function. The team that scores more runs wins the game, making superior skills crucial. Two teams alternate roles: defence and offence. The defensive team begins with the pitcher throwing a pitch, which the batter from the offensive team tries to hit.[3]

Pitching is a key factor in a baseball team's success. According to Cairney et al. (2023), pitching performance accounts for 38% of a team's winning percentage variability.[4] The pitcher is the most crucial baseball position responsible for delivering the ball the opposing team attempts to hit. The pitcher aims for speed and precision to challenge the batter, forcing quick decisions on whether to swing.[5] Effective pitching requires fluid, dynamic movement. It generates significant force on the upper extremities, placing high pressure on the joints to produce strength beyond their usual capacity.[6]

Upper extremity injuries account for 37% of head and neck injuries, 35% of shoulder dislocations and strains, 22% of hand fractures and finger dislocations, and musculoskeletal strains to the back.[7] This highlights the vital role of a pitcher in a baseball game. Key indicators of a pitcher's success include statistics such as strikeouts, pitch count, innings pitched, and game duration.[5,8]

The statement highlights the importance of a pitcher's role in a baseball game. Researchers suggest several factors can enhance a pitcher's throwing ability, particularly in increasing ball speed. Therefore, the author will conduct a literature review to identify the factors influencing ball speed in pitchers.

## Methods

The study used a literature review method with secondary data from study journals and articles accessed through the Google Scholar and PubMed databases using the keywords "baseball," "baseball pitcher," and "ball velocity." The articles obtained were then reviewed and synthesised to answer the study questions. Five articles published within the last five years (2019–2024) were analysed to identify factors

P-ISSN: 2830-6317
E-ISSN: 2962-5491

affecting ball velocity in baseball pitchers. The inclusion criteria comprised studies published within the past five years on factors influencing pitching velocity. Meanwhile, the exclusion criteria included irrelevant articles, studies with subjects other than baseball pitchers, and studies with incomplete data or without full access.

**Results**

Five relevant studies from the past five years, listed in Table 1, explore factors affecting ball velocity in baseball pitchers. Jon-Michael et al. found a 9.2 mph increase in ball speed in the intervention group, while the control group showed no improvement. Bullock et al. observed a 2 m/s difference in ball speed between pitchers and non-pitchers, with a *p*-value of <0.001, indicating a mechanical difference in trunk rotation during pitching.

The study by Brandon et al. found that using a lighter ball in training significantly increased pitcher ball speed by 4.8 mph ($p<0.001$). Gomaz et al. showed that pitcher height was a key factor in ball speed, with groups two and three showing promising results. Additionally, Antonacci et al. found that age significantly influenced ball speed ($p<0.001$), with older pitchers producing faster throws.

**Discussion**

Pitching is a kinetic chain where energy from the lower body is transferred through the rotation of the hips and trunk to the upper body, generating ball velocity.[9] Pitch speed is one of the most common metrics measured by baseball enthusiasts.[10] Professional baseball coaches prioritise a pitcher's ball speed as a key factor in building a strong team. On average, 46% to 50% of the players on Major League Baseball teams are pitchers.[8] Effective pitching relies on proper biomechanics, which involves complex motor skills across several stages: windup, stride, arm cocking, arm acceleration, arm deceleration, and follow-through. Correct biomechanics enable a pitcher to generate maximum ball speed.[11,12] Each stage plays a distinct role and works together to maximise ball speed. The 2021 Alderink study determined that the upper extremities contribute more significantly than the trunk and lower extremities. Specifically, the shoulders account for 31% of arm acceleration, while the elbows contribute 18.1% during the arm cocking stage.[13]

Bullock et al. (2021) compared ball speed in fastballs, breaking balls, and change-ups between pitchers and non-pitchers. The findings highlight distinct biomechanical differences: pitchers use varying trunk rotations for each pitch, while non-pitchers maintain the same rotation speed across all three.[14] This study demonstrates that pitchers employ various strategies to generate maximum force, including increasing trunk rotation speed. Faster torso rotation enhances energy transfer to the upper extremities, boosting ball speed. Tanaka et al. (2022) explored the correlation between trunk rotation and ball speed, finding a positive relationship. The trunk speed during pelvic rotation can create a good moment of energy transfer from the lower extremities to the ball through the pelvis, trunk, and upper extremities.[15]

Several external factors, including training with heavier and lighter balls, can influence a pitcher's ball speed, alongside proper biomechanics. In general, a baseball weighs 5 oz. Coaches have implemented training modifications to increase pitching speed. Caldwell et al. (2019) reviewed 10 studies that met specific inclusion and exclusion criteria.[16] Ten studies reported increased ball speed after training with lighter or heavier balls, with average improvements ranging from 2 to 11 mph. However, the variability in exercise types and dosages makes direct comparisons difficult. A potential concern is the increased risk of injury, especially given the 16 to 32-oz ball weights, which significantly stress athletes. As Erickson et al. (2020) also explored, a lighter ball training program offers an alternative approach for baseball pitchers. As a result, of the 44 participants who participated in the training until the end, 43 experienced an increase in speed, and one other participant did not experience it. The average speed increases by 4.8 mph. Researchers state that pitchers can train their arms to move faster with lighter balls, thereby increasing the speed of the ball.[10]

Pitcher height can affect ball speed. Gomaz et al. (2021) included height as a predictor but disregarded the biomechanics of throwing.[5] Pitchers with greater height tend to produce faster ball speeds, making height a key factor for coaches seeking a pitcher with quicker ball velocity. However, this does not negate the influence of age or weight. A 2018 study by Bart van Trigt found that height is the primary determinant of ball speed, with a strong correlation between height, weight, age, and strength.[17] Another study by Lori A. Michener found that normalising a pitcher's weight can influence the strength of internal and external rotation, affecting ball speed.[18] Antonacci et al. (2020) divided participants into three age-based groups.[19] Older pitchers can achieve faster ball speeds due to improved throwing mechanics and stronger muscles. As pitchers age, their muscle development, particularly in the elbow region (e.g., flexors and pronators), enhances, with these muscles contracting by 20-40% during throws.[20] This suggests that age-related muscle development may impact a pitcher's ball speed.[21]

This study has several limitations. First, reliance on secondary data from journal articles and literature may introduce publication bias or exclude relevant unpublished studies. Additionally, using only two databases (Google Scholar and PubMed) and a limited set of keywords may have restricted the comprehensiveness of the search, potentially missing key studies. Lastly, the small sample size of five articles may not provide a fully representative or exhaustive overview of the factors influencing ball velocity in baseball pitchers.

**Conclusions**

This study highlights the significant impact of both external and internal factors on baseball pitchers' ball speed. External factors, such as proper throwing techniques and

P-ISSN: 2830-6317
E-ISSN: 2962-5491

structured training, enhance performance and velocity. Internal factors, including height and age, also influence pitching speed. Understanding these factors is crucial for developing effective training strategies to optimise performance.

**Funding**

Any institution did not fund the study.

**Conflict of interest**

This study has no conflicts of interest.

**Author contributions**

JVI conceived the study design and data collection and drafted the manuscript, and AANTND and NLNA collected and revised the data.

**Ethical consideration**

This review study used publicly available articles, so it did not require informed consent or ethical approval.

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