

AUTHORS:

Samuel Aloï¹
 Michael Ryan¹
 Paul Reneau¹
 Julia Matzenbacher dos Santos¹

¹Fairmont State University,
 Department of Education, Health
 and Human Performance,
 Fairmont, WV, USA

<https://doi.org/10.5628/RPCD.19.01.64>

The relationship among throwing velocity, one-repetition maximum bench press and squat and body composition in college baseball pitchers

KEYWORDS:

One repetition maximum. BMI.
 Mean maximum throwing velocity.

SUBMISSÃO: 10 de Março de 2019

ACEITAÇÃO: 28 de Abril de 2019

ABSTRACT

The strength of the lower body is possibly the most crucial consideration when examining the maximal throwing velocity of a baseball pitcher. The relationship between one-repetition maximum (1-RM) squat and bench press, throwing velocity and body mass index (BMI) have not received proper attention regarding research. This study aims to examine the correlation between the 1-RM squat and bench press tests, and throwing velocity in collegiate baseball pitchers. Thirteen pitchers from a National Collegiate Athletic Association division II baseball team volunteered to participate in a single lifting and throwing session. Height, weight and BMI were noted for each subject upon arrival for testing. Each subject performed a 1RM-test in both squat and bench press. After two days, pitching velocity measurements of 10 pitches throw at maximum effort from a pitcher's mound (60 ft 6 inches, 18.44 m) was assessed. Correlation among the mean of 10 pitching throws, 1-RM (squat and bench press) and BMI was tested by Pearson correlation test. Although 1-RM bench press and 1-RM squat were not found to be correlated with max throwing velocity ($r = .01$ and $-.01$, respectively), BMI was negatively correlated with maximum throwing velocity ($r = -.648$). 1-RM of both bench press and squat do not seem to predict throwing velocity. However, BMI was found to be a potential predictor of throwing velocity of college baseball pitcher.

Corresponding author: Julia Matzenbacher dos Santos. Department of Education, Health and Human Performance, Fairmont State University, 1201 Locust Avenue, Fairmont, WV 26554, USA. email: jdossantos@fairmontstate.edu; jumatzsantos@gmail.com

A relação entre velocidade de arremesso, composição corporal, o teste de uma repetição máximo de supino e agachamento em jogadores de beisebol universitário.

RESUMO

A força dos membros inferiores é possivelmente um fator crucial na determinação da velocidade máxima de arremesso da bola no beisebol. Até o momento, não há estudos sobre associações entre a velocidade de lançamento no beisebol com teste de força de uma repetição máxima (1-RM). Este estudo teve como objetivo avaliar as associações entre a velocidade de arremesso de jogadores universitários de beisebol com o teste de força de 1-RM de membros inferiores (agachamento e de supino) e com o índice de massa corporal (IMC). Treze jogadores de beisebol da divisão II da Associação Atlética Universitária dos Estados Unidos participaram voluntariamente de uma única sessão de levantamento e de arremesso. Para cálculo do IMC, a altura e o peso foram medidos antes dos testes. O teste 1-RM de agachamento e de supino foi realizado dois dias antes do teste de arremesso. Posteriormente foram avaliadas as velocidades de 10 arremessos de cada jogador executadas com esforço máximo. As variáveis apresentaram distribuição normal (teste de *Shapiro Wilks*) e as associações entre a média dos 10 arremessos e as demais variáveis foram avaliadas pelo teste de correlação de Pearson. Embora o 1-RM agachamento e o 1-RM supino não tenham se correlacionado com a velocidade máxima de arremesso ($r = .01$ e $-.01$, respectivamente), o IMC relacionou-se inversamente com a velocidade máxima de arremesso ($r = -.648$). Assim, os dados obtidos com 1-RM de supino e de agachamento parecem não prever a velocidade de lançamento no beisebol. No entanto, o IMC parece ser um potencial preditor de velocidade de arremesso de jogadores de beisebol do nível universitário.

PALAVRAS CHAVE:

Uma repetição máxima. IMC.
 Velocidade de arremesso máxima média.

INTRODUCTION

Since the first organized baseball game in the 1840s, the game has sustained a substantial amount of adaptations (Kirsch, 1989). Pitching velocity, or throwing velocity, is perhaps one of the most important elements in the sport today. An athlete's ability to throw a baseball with high velocity is dependent on various components including pitching mechanics, strength, and body size. The overall strength of an athlete has been shown in many studies to have a positive correlation with throwing velocity (Lehman, Drinkwater, & Behm, 2013; McEvoy & Newton, 1998; Van Den Tillaar, 2004).

The strength of the lower body is possibly the most crucial consideration when examining the maximal throwing velocity of a pitcher. The amount of lower body muscular activation is notably high throughout the pitching motion and is therefore reasonably assumed a critical characteristic with regards to velocity (Campbell, Stodden, & Nixon, 2010). In addition, lower body muscular strength has been linked to improved performance in explosive movements such as sprinting (Comfort, Bullock, & Pearson, 2012). Since the pitching motion in baseball is considered an extremely explosive movement it is easy to infer that increased lower body strength will correlate with higher throwing velocities.

There have been numerous studies involving different training programs and field tests, which included both upper body and lower body movements, and their relationships in throwing velocity and performance (Bishop, Herron, Ryan, Katica, & Bishop, 2016; Lehman et al. 2013; Yanagisawa, Wakamatsu, & Taniguchi 2019). However, there is an absence of literature in the area of one-repetition maximum (1-RM) and pitching velocity (Lehman et al. 2013; McEvoy & Newton, 1998; Van Den Tillaar, 2004). The main purpose of this study was to examine the correlation between the 1-RM squat and bench press tests and throwing velocity in collegiate baseball pitchers.

METHODS

Thirteen male (18-23 years old) division 2 college baseball players from Fairmont State University participated in this study. All participants were pitchers and the study was performed during the baseball season to ensure athlete was in maximal physical condition. Before data collecting the study was approved by the Institutional Review Board of Fairmont State University and an Informed Consent were filled out by the participants

The instruments used to measure squat and bench press weight measurement were a standard 45 lbs barbell (20.412 kg) and weight plates ranging from 5 pounds (2.268 kg) up to 45 pounds (20.412kg.) A scale and a stadiometer (Ozeri Precision Digital Bath Scale) were used to collect the weight (kg) and height (meters) of the subjects. The throwing

velocity was measured by a radar gun in miles per hour (Ball Coach Radar-Model PR1000-BC) from a distance of 60 feet 6 inches (18.44m).

The study was conducted over the course of one week. Before any testing was done, each participant was given details regarding the testing procedures. The subjects were asked to take two days of rest before the 1-RM test to ensure peak performance. Before the 1-RM test, the pitchers warmed up (self-selected) for 5- 10 min. Subjects chose a weight they felt they could perform 6-10 repetitions. Subjects then selected a weight they felt they could do for 3 repetitions while using the first set as a reference point. Then subjects added weight progressively until they reached their one-repetition maximum. Participants performed the same protocol for both 1-RM squat and bench-press test.

Two days after the 1-RM, throwing velocity was measured. After warm up, each participant was asked to make 10 maximum effort pitches from the pitcher's mound (18.44 m). The velocity of each pitch was assessed using a radar gun.

For statistical analysis throwing velocity data was converted to meters per second. The mean of the ten throws for each subject was calculated and used to compare with the 1-RM measurement. Statistical analyses were performed using SPSS-statistical software (IBM SPSS- statistics 18). Normal distribution was tested by the Shapiro-Wilk test. Correlation test between 1-RM tests, BMI and throwing velocity was analyzed by Pearson. Data are represented as mean ± standard deviation.

RESULTS

The baseball pitchers weight, height and BMI were 88.9 ± 6.9 kg, 186.4 ± 3.6 cm and 25.56 ± 1.53 kg/m², respectively (TABLE 1). The mean of the squat 1-RM test was 152.03 ± 19.95 Kg, while the mean 1-RM bench press was 98.75 ± 8.12 Kg (TABLE 1). The mean maximum throwing velocity was measured to be 36.09 ± 1.81 m/s. The correlation between the 1-RM bench press and mean maximum throwing velocity was weak ($r = .099$) as well as 1-RM squat and throwing velocity ($r = -.010$) (Fig. 1A and 1B). However, a negative correlation was found between body mass index (BMI) and mean maximum throwing velocity ($r = -.648$), Fig 2A. A stronger correlation was found between body weight and mean maximum throwing velocity ($r = -.458$) as presented in Fig 2B.

TABLE 1- Sample characteristics - Baseball players (n = 13), age, height, weight, body mass index (BMI), maximal bench press (Max Bench), maximal squat (Max squat), mean of maximal throwing velocity (Av. Max Velocity).

Subjects	Age (years)	Height (cm)	weight (kg)	BMI (kg/m ²)	Max Bench(kg)	Max Squat(kg)	Av. Max Velocity(m/s)
Players (n = 13)	21.3 ± 1.6	186.4 ± 3.6	88.9 ± 6.9	25.6 ± 1.5	98.7 ± 8.1	152 ± 19.9	36.1 ± 1.8

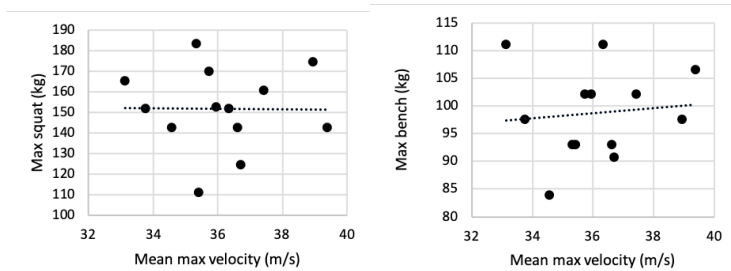


FIG 1. Correlation between throwing velocity and one max repetition of bench press (A) and squat (B) of 13 pitchers.

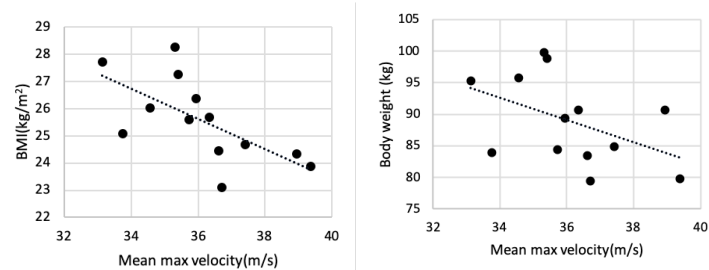


FIG 2. Correlation between throwing velocity and body mass index (BMI) (A) and body weight (B) of 13 pitchers.
* Significant Person correlation.

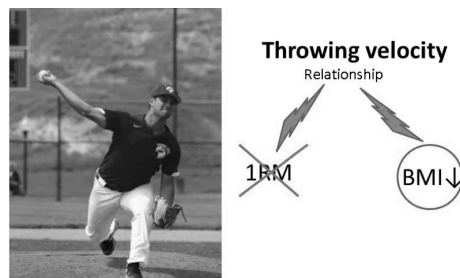


FIG 3. Schematic figure illustrating the main finding of the study. Body mass index (BMI), one-repetition maximum (1-RM).

DISCUSSION

Throwing velocity of pitching is perhaps one of the most important elements in baseball (Forsythe, Crotin, Greenwood, Bhan, & Karakolis, 2017). Several studies have been carried out to understand pitching biomechanics to improve evidence-based athlete performance in baseball (Darke, Dandekar, Aguinaldo, Hazelwood, & Klisch, 2018; Forsythe et al., 2017; Nakata, Nagami, Higuchi, Sakamoto, & Kanosue, 2013; Thompson, Guess, Plackis, Sherman, & Gray, 2018). Previous studies have shown that muscular strength plays an important role in throwing velocity (Campbell et al. 2010). Our data suggest that 1-RM squat and bench press might not be an accurate test to associate lower body muscle strength with pitching velocity. However, our results strongly support that BMI may be a potential predictor.

High measurements of maximum voluntary isometric contraction, a standardized method for measurement of muscle strength, have shown in lower extremity strength and endurance of highly skilled pitchers (Campbell et al. 2010). Moreover, these high levels of activation are demonstrated when lifting at maximum. There is evidence that an increase in muscular strength can have a positive effect on the throwing velocity of an athlete. Athletes who trained at or above 85% of maximum, over a prolonged period demonstrated a 1.2-18% higher throwing velocity post-training (Van Den Tillaar, 2004). Furthermore, ballistic training and lateral/medial jumping abilities have shown a positive correlation to higher throwing velocities in overhead athletes in various sports (McEvoy & Newton, 1998; Van Den Tillaar, 2004). Considering that many studies have found muscular strength and explosive agility to have a positive effect on throwing velocity, it is possible the 1-RM test may not be a helpful predictor to velocity. It should not be ruled out that the lack of correlation found between 1-RM squat and bench-press results and throwing velocity might be attributed to the pitchers being in the middle of the competitive season. Furthermore, we acknowledge that other measures of strength and explosive power could provide a better correlation with the throwing velocity.

The role of anthropometric characteristics of baseball players has been studied by many researchers (Darke et al., 2018; Forsythe et al., 2017; Nakata et al., 2013). Using publicly available heights and weights of baseball pitchers' to form a statistical database of 1028 pitching leaders from 1950-2010 it was demonstrated that pitchers with a higher BMI has a positive correlation with the number of saves and negatively correlated with a number of innings pitched. These results suggest that a more efficient pitcher has a higher BMI. Supporting this finding a study performed in youth baseball players (9-10 years old) showed that higher BMI positive correlates with joint torque/force during pitching movement (Darke et al., 2018). It has been shown that with young players (6.4-15.7 yrs.) there is a positive correlation with BMI and throwing velocity (Nakata et al., 2013). Our findings are opposed of what was found by Nakata et al. (2013), we suggest that there is a

correlation between lower BMI measurements and throwing velocity in division 2 college baseball pitchers (Fig 3). The reason of the distinct results might be due the distinct age group analyzed in this study, when compared to the previous report.

CONCLUSION

These findings suggest that one-repetition maximum squat and bench press might not be an accurate test to predict maximum pitching velocity in college division 2 pitchers. On the other hand, BMI did have a significant negative correlation on the mean maximum throwing velocity. Therefore, college baseball coaches may want to continue to assess BMI during the college baseball season as a predictor of throwing velocity and pitching efficiency in their players.

REFERENCES

- Bishop, S. H., Herron, R. L., Ryan, G. A., Katica, C. P., & Bishop, P. A. (2016). The effect of intermittent arm and shoulder cooling on baseball pitching velocity. *Journal of Strength & Conditioning Research*, 30(4), 1027-3102. doi:10.1519/JSC.000000000000256
- Campbell, B. M., Stodden, D. F., & Nixon, M. K. (2010). Lower extremity muscle activation during baseball pitching. *The Journal of Strength & Conditioning Research*, 24(4), 964-971. doi:10.1519/JSC.0b013e3181cb241b
- Comfort, P., Bullock, N., & Pearson, S. J. (2012). A comparison of maximal squat strength and 5-, 10-, and 20-meter sprint times, in athletes and recreationally trained men. *The Journal of Strength & Conditioning Research*, 26(4), 937-940. doi:10.1519/JSC.0b013e31822e5889
- Darke, J. D., Dandekar, E. M., Aguinaldo, A. L., Hazelwood, S. J., & Klisch, S. M. (2018) Effects of game pitch count and body mass index on pitching biomechanics in 9- to 10-year-old baseball athletes. *Orthopaedic Journal of Sports Medicine*, 6(4), 2325967118765655. doi:10.1177/2325967118765655.
- Forsythe, C. M., Crotin, R. L., Greenwood, M., Bhan, S., & Karakolis, T. (2017). Examining the influence of physical size among major league pitchers. *Journal of Sports Medicine and Physical Fitness*, 57(5), 572-579. doi:10.23736/S0022-4707.16.06355-6
- Kirsch, G. B. (1989). *The creation of American team sports: Baseball and cricket*. Chicago, IL, USA: University of Illinois Press. Available at <https://www.cabdirect.org/cabdirect/abstract/19921899668>.
- Lehman, G., Drinkwater, E. J., & Behm, D. G. (2013). Correlation of throwing velocity to the results of lower-body field tests in male college baseball players. *The Journal of Strength & Conditioning Research*, 27(4), 902-908. doi:10.1519/JSC.0b013e3182606c79
- McEvoy, K. P., & Newton, R. U. (1998). Baseball throwing speed and base running speed: The effects of ballistic resistance training. *The Journal of Strength & Conditioning Research*, 12(4), 216-221.
- Nakata, H., Nagami, T., Higuchi, T., Sakamoto, K., & Kanosue, K. (2013). Relationship between performance variables and baseball ability in youth baseball players. *The Journal of Strength & Conditioning Research*, 27(10), 2887-2897. doi:10.1519/JSC.0b013e3182a1f58a
- Thompson, S. F., Guess, T. M., Plackis, A. C., Sherman, S. L., & Gray, A. D. (2018). Youth baseball pitching mechanics: A systematic review. *Sports Health*, 10(2), 133-140. doi:10.1177/1941738117738189
- Van Den Tillaar, R. (2004). Effect of different training programs on the velocity of overarm throwing: A brief review. *The Journal of Strength & Conditioning Research*, 18(2), 388-396.
- Yanagisawa, O., Wakamatsu, K., & Taniguchi, H. (2019). Functional hip: Characteristics and their relationship with ball velocity in college baseball pitchers. *Journal of Sport Rehabilitation*. Advance online publication. doi:10.1123/jsr.2018-0122.