Relationships Between Age, Body Size, Strength, and Power with Throwing Velocity and Hitting Exit-Velocity in High School Softball Athletes

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ABSTRACT

Female high school softball athletes require multiple fitness competences (e.g., muscular speed, strength, and power) to compete on a team and effectively perform the skills required by their sport. Performance in certain fitness tests could be used to inform athlete potential for sport success. This information could also be used to design training programs for athletes that may have specific limitations. **PURPOSE:** To investigate the relationships between age, height, body mass, lower-body power, and lower-body strength on throwing and hitting velocity in female high school softball athletes. **METHODS:** Retrospective analysis was conducted on 34 high school softball athletes (age: 14.91±1.00 years; height: 1.66±0.07 cm; body mass: 63.21±9.59 kg) from a strength and conditioning facility that specializes in training softball athletes. Testing for each athlete occurred in one 45–60 minute session. Age, height, and body mass were recorded first. Linear speed was measured by the 18.29-m (20-yard) sprint using timing gates positioned at the 0-m, 9.14-m (10-yard), and 18.29-m (20-yard) marks. Lower-body power was measured by the standing broad jump (SBJ); athletes performed a countermovement prior to jumping forward as far as possible. Overhand throwing velocity was measured using a portable pitching tracker. Hitting ability was inferred from hitting exit-velocity measured using a portable hitting tracker. For linear speed and power tests, athletes performed three trials and the best trial was used for analysis. Lower-body strength was measured by the 3-repetition maximum (3RM) front squat and 3RM trap bar deadlift. Pearson's correlations were used to calculate relationships between throwing velocity and hitting exit-velocity with age, body size, power, and strength (p<.05). **RESULTS:** Age (r=.470), height (r=.386), and SBJ (r=.349) all showed positive, significant relationships with throwing velocity. Age (r=.420), height (r=.481), body mass (r=.558), SBJ (r=.496), 3RM front squat (r=.457), and 3RM trap bar deadlift (r=.448) all showed significant positive relationships with hitting exit-velocity. **CONCLUSION:** The results reinforced the importance of overall fitness for female high school athletes relative to competing in their specific sport. Age and height significantly related to the athlete's ability to throw and hit the ball more powerfully (i.e., with faster velocity), which could be expected with maturation and increased age and body size. Lower-body power also significantly related to the softball-specific motor skills measured in the athletes from this study; the SBJ also showed a stronger relationship to hitting exit-velocity relative to age and height. Additionally, lower-body strength appeared to impact the likelihood for softball athletes to successfully hit the ball with high velocity. **PRACTICAL APPLICATIONS:** High school softball coaches could use fitness test data to distinguish an athlete's ability to perform certain sport-specific skills. Although it may be expected that high school athletes improve fitness and motor skill skills with growth, the current results emphasize how specific tests could highlight limitations in athlete fitness that could affect their performance on the field. Furthermore, the data suggests that lower-body power and lower-body strength could improve a softball athlete's chances of efficiently hitting the ball with high velocity, which could influence an athlete's ability to get on base in a game.

INTRODUCTION

- Female high school softball athletes require multiple fitness competences (e.g., muscular speed, strength, and power) to compete on a team and effectively perform the skills required by their sport (1, 2, 5).
- Performance in certain fitness tests could be used to inform athlete potential for sport success. For example, sprinting speed could contribute to successful softball performance (1), as athletes need to sprint when running the bases or attempting to field a ball in play. Two important skills within softball are throwing and hitting. Although there is a motor control aspect to throwing and hitting, it is possible that other fitness qualities (e.g., muscular strength and power) could contribute to effective these skills. However, limited research has investigated relationships between strength and power with hitting and throwing in high school softball players.
- This information could also be used to design training programs for athletes that may have specific limitations. Athletes who need to improve their hitting power may need to undergo training programs focused on increasing both upper- and lower-body body strength (4).
- The purpose of this study was to investigate the relationships between age, height, body mass, lower-body power, and lower-body strength on throwing and hitting velocity in female high school softball athletes.

METHODS

- Retrospective analysis was conducted on data recorded from 34 high school softball athletes from a strength and conditioning facility that specializes in training softball athletes. The players were about to begin an 8-week strength and conditioning program at the facility, and they came from different high school programs within southern California.
- Testing for each athlete occurred in one 45–60 minute session. Age, height, and body mass were recorded first. Linear speed was measured by the 18.29-m (20-yard) sprint using timing gates positioned at the 0-m, 9.14-m (10-yard), and 18.29-m (20-yard) marks. Lower-body power was measured by the standing broad jump (SBJ); athletes performed a countermovement prior to jumping forward as far as possible. Overhand throwing velocity was measured using a portable pitching tracker. Hitting ability was inferred from hitting exit-velocity measured using a portable hitting tracker. For linear speed and power tests, athletes performed three trials and the best trial was used for analysis. Lower-body strength was measured by the 3-repetition maximum (3RM) front squat and 3RM trap bar deadlift.
- Pearson's correlations were used to calculate relationships between throwing velocity and hitting exit-velocity with age, body size, power, and strength (p < .05).

RESULTS

- Descriptive data is shown in Table 1. Correlation data is shown in Table 2. Age, height, and SBJ all showed positive, significant relationships with throwing velocity. Age, height, body mass, SBJ, 3RM front squat, and 3RM trap bar deadlift all showed significant positive relationships with hitting exit-velocity.

Table 1. Descriptive data (mean ± SD) for age, height, body mass, 0-9.14 m sprint interval, 0-18.29 m sprint interval, SBJ, throwing velocity, hitting velocity, and 3RM front squat and TBD for high school softball players.

	Athletes (n=34)
Age (years)	14.91 ± 1.00
Height (cm)	1.66 ± 0.07
Body Mass (kg)	63.21 ± 9.59
0-9.14 m Sprint (s)	1.82 ± 0.08
0-18.29 m Sprint (s)	3.12 ± 0.14
SBJ (m)	1.94 ± 0.17
Throwing Velocity (km/hr)	93.76 ± 5.77
Hitting Velocity (km/hr)	107.27 ± 9.35
3RM Front Squat (kg)	66.30 ± 11.67
3RM TBD(kg)	100.59 ± 20.27

Table 2. Correlation data for age, height, body mass, 0-9.14 m sprint interval, 0-18.29 m sprint interval, SBJ, throwing velocity, hitting velocity, and 3RM front squat and trap bar deadlift with hitting velocity and throwing velocity.

		Hitting Velocity (n=34)	Throwing Velocity (n=34)
Age (years)	r	.420*	.470**
	p	.013	.005
Height (cm)	r	.481**	.386*
	p	.004	.024
Body Mass (kg)	r	.558**	.234
	p	<.001	.184
0-9.14 m Sprint (s)	r	-.291	-.239
	p	.095	.173
0-18.29 m Sprint (s)	r	-.243	-.116
	p	.167	.515
SBJ (m)	r	.496**	.349*
	p	.003	.043
Throwing Velocity (km/hr)	r	.385*	
	p	.025	
Hitting Velocity (km/hr)	r		.385*
	p		.025
3RM Front Squat (kg)	r	.457**	.299
	p	.007	.086
3RM Trap Bar Deadlift (kg)	r	.448**	.236
	p	.008	.180

* Significant (p < .05) relationship between the two variables.
** Significant (p < .01) relationship between the two variables.

CONCLUSIONS

- The results reinforced the importance of overall fitness for female high school athletes relative to competing in their specific sport.
- Age and height significantly related to the athlete's ability to throw and hit the ball more powerfully (i.e., with faster velocity), which could be expected with maturation and increased age and body size (6).
- Lower-body power also significantly related to the softball-specific motor skills measured in the athletes from this study (3). This can be expected as the early phases to throwing a ball utilizes the lower-body to transfer energy to the upper-body and to the ball (7). The SBJ also showed a stronger relationship to hitting exit-velocity relative to age and height, suggesting that lower-body power development could be beneficial to the softball-specific skill of hitting, beyond just changes in body size due to maturation.
- Additionally, lower-body strength (8) appeared to impact the likelihood for softball athletes to successfully hit the ball with high velocity (5). Since the swing is also initiated from the lower-body, it is crucial that athletes would need to improve maximal force capabilities to increase the power of their swing (8).

PRACTICAL APPLICATIONS

- High school softball coaches could use fitness test data to distinguish an athlete's ability to perform certain sport-specific skills. Although it may be expected that high school athletes improve fitness and motor skill skills with growth, the current results emphasize how specific tests could highlight limitations in athlete fitness that could affect their performance on the field.
- Furthermore, the data suggests that lower-body power and lower-body strength could improve a softball athlete's chances of efficiently hitting the ball with high velocity, which could influence an athlete's ability to get on base in a game.
- The results from this study underline the importance of strength and power development in high school girls softball athletes for improved sport-specific skills, and encourages the delivery of strength and conditioning programs for high school girls.

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