Comparison of Body Composition and Physical Power and Speed Capabilities of Over and Under 60-MPH High School Softball Pitchers

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ABSTRACT

Pitching in softball may be the most important aspect of the sport. Increased pitching velocity in softball increases the difficulty for the batter, making it less likely that they will reach base safely and significantly impact the game's outcome. Anecdotal evidence suggests that 60 mph pitching velocity is a minimal cut-off for female high school athletes to pitch at the collegiate level, however no study has explored this. **PURPOSE**: To compare the physical characteristics of body composition, speed, and power measurements in high school female fastpitch softball pitchers who throw < 60 mph (SP<60) and ≥ 60 mph (SP≥60). **METHODS**: Thirteen competitive high school female fastpitch softball pitchers participated in 1 testing session (age: 15.9±1.8 years; mass: 72.0±29.8kg; height: 166.5±2.5cm; softball experience 8.0±2.0 years). Participants were stratified (n=6-7/group – based on a power analyses) into pitchers who throw < 60 mph (SP<60) and ≥ 60 mph (SP≥60). Body composition lean body mass (LBM) and body fat percentage (BF%) were collected using a bioelectrical impedance scanner (InBody 570). Following body composition analysis, each subject performed a standardized dynamic warm-up. Countermovement vertical jump (CMVJ) height, drop jump (DJ) height, and Reactive Strength Index (RSI; air time ÷ ground time) were measured using a jump map (Skyhook). Distance for a seated chest pass (SCP), sit-up and throw (SUAT), and rotational medicine ball throw (RMBT) was measured using a laser tape measure device (Bosch). Acceleration was measured using a 10-yard dash with a laser timing system (Dashr). Three trials were completed for each test with the best used for analyses. Independent t-tests were used for analyses ($p<0.05$), with Cohen's *d* effect sizes also calculated and interpreted as small (≥0.2) medium (≥0.5), and large (≥0.8). **RESULTS**: No significant ($p>0.05$) differences were seen in body composition for BF% (SP<60 29.3±8.4% vs SP≥60 25.6±7.5%; *d*=0.44) or LBM (SP<60 28.1±3.4kg vs SP≥60 29.1±2.2kg, *d*=0.34). Lower body power also showed no differences in CMVJ height (SP<60 45.7±6.1cm vs SP≥60 48.4±3.4cm, *d*=0.53), DJ height (SP<60 44.2±6.9kg vs SP≥60 48.8±4.2kg, *d*=0.76), and RSI (SP<60 1.1±0.3 vs SP≥60 1.3±0.5, *d*=0.60). No differences (but moderate to large effect magnitude) were also seen in acceleration (SP<60 2.09±0.15sec. vs SP≥60 1.97±0.06sec., *d*=0.93) and the upper body power test of RMBT (SP<60 6.8±0.6 m vs SP≥60 7.2±0.5 m, *d*=0.72). In contrast, SP≥60 compared to SP<60 had greater upper body power measures of SCP (SP≥60 4.3±0.2 m vs SP<60 4.1±0.2 m, *d*=1.12) and SUAT (SP≥60 3.9±0.5 m vs SP<60 3.3±0.3 m, *d*=1.22). **CONCLUSIONS**: In the sample measured, high school softball pitchers who throw ≥60 mph compared to <60 mph pitchers there were only significant and large magnitude differences observed in certain upper body power measures (SCP and SUAT), but no differences seen in body composition, lower body power measures, or the upper body power measure of RMBT. **PRACTICAL APPLICATIONS**: A certain level of body composition and upper and lower body power development is warranted to be a competitive high school fastpitch softball pitcher throwing at any velocity, as shown herein. However, for coaches or strength professionals working with high school softball pitchers aiming to play at the collegiate level, upper body power development should be a key training emphasis to assist the athlete in pitching at or above 60 mph. **ACKNOWLEDGEMENTS:** None.

INTRODUCTION

- Pitching in fastpitch softball may be the most important aspect of the sport (1, 2). Pitchers must strategically control the game (3, 4) and their play may have the greatest impact on team success. Pitching velocity may be one of the most important aspects for pitchers as higher velocities lead to less reaction time for the hitter, increasing the difficulty of reaching base safely (1).
- Many girls aspire to play or pitch at the collegiate level. According to data gathered on National Collegiate Athletic Association Division I and II levels, pitching speeds are consistently 58 to 65 mph or greater with the average sitting at 60 to 64 mph (5, 6). It could be inferred that pitching at greater than 60 mph will get a pitcher noticed by collegiate scouts and increase the chances of playing at that level. Through anecdotal evidence, pitching 60 mph or higher could be considered elite. However, no study has explored this yet.
- Analysis of motor performance tests would provide information to strength professionals on which areas of training need the greatest emphasis.

PURPOSE AND HYPOTHESIS

- The *purpose* of this study was to compare the physical characteristics of body composition, speed, and power measurements in high school female fastpitch softball pitchers who throw < 60 mph (SP<60) and ≥ 60 mph (SP≥60).
- We *hypothesized* that multiple motor performance tests, specifically the lower body measures of countermovement vertical jump, drop jump, and reactive strength index, would be significantly higher in SP≥60 when compared to SP<60 and that there may be a minimum amount of lean body mass needed to reach 60 mph.

METHODS

Body composition: data including body mass, BF%, skeletal muscle mass, and lean body mass was collected using an InBody 570 bioelectrical impedance scanner. Participants were instructed to maintain normal fluid intake, stand upright for at least 5 minutes, remove socks, jewelry, and jackets, use the restroom and not to eat or exercise for at least three hours, consume alcohol or excess caffeine for at least 24 hours, shower or use a sauna, or use lotion on hands and feet prior to testing in accordance with the manufacturer's recommendations for accurate testing. Participants stood on the InBody device and followed the instructions given by the device. Following the InBody scan, height was collected using a tape measure taped to the wall.

Lower Body Muscular Power: A Skyhook Contact Mat was used to measure lower body muscular power. Data collected included countermovement jump (CMVJ), drop jump (DJ), and Reactive Strength Index (RSI: air time ÷ ground time) during the DJ. A Skyhook Contact Mat was used to collect CMVJ and DJ height and calculate RSI. CMVJ was performed first with each subject completing three trials with the highest taken for analysis. Participants were instructed to stand on the mat, jump as high as they can in whichever fashion they chose, and land on the mat to complete each trial. DJ and RSI data were then collected with the highest of three trials taken for analysis. Participants stepped off a 46-cm (18-in) bench before landing on the contact mat and jumping as high as they can as fast as they can and landing on the mat.

Upper Body Muscular Power: The Titleist Performance Institute power screening medicine ball protocols consisting of the seated chest pass (SCP), sit-up and throw (SUAT), and rotational medicine ball throw (RMBT) were used to measure upper body muscular power. A 4-kg medicine ball was thrown for distance during each test. The highest of three trials for each test was used for analysis. The SCP is a measure of upper body pushing power. Participants used only their arms to throw the medicine ball as far as possible in similar fashion to a basketball chest pass while in a seated position. The SUAT is a measure of upper body pulling and core muscular power. Participants started on their backs in a sit-up position. They were then instructed to throw the medicine ball as far as possible and finish at the top of the sit-up position. The RMBT is a measure of whole-body rotational power. Participants were instructed to stand with their foot on a line perpendicular to the throwing direction, hold the medicine ball with two hands in front of their chest, load in similar fashion to their softball batting technique, and throw the ball with one hand as far as possible.

Acceleration: A 10-yard dash was measured using a Dashr Laser Timing System to collect acceleration data. Participants started in a 3-point stance with their hand breaking the start laser at ground level to set the system with an audible beep. The participants were instructed to start their sprint at any moment after the beep went off with timing starting as their hand leaves the laser. Participants then sprinted at maximal effort through the finish laser pre-measured and marked at 10 yards. The best of three trials was used for analysis. Each trial was performed on an indoor turf surface free of obstructions. This methodology follows the protocols for laser timing used at the NFL Combine.

Pitching Velocity: Following the motor performance testing battery, participants were given as much time as needed to complete their typical pre-competition warm-up routine for pitching. Once warm, each participant was given the opportunity to familiarize themselves with the portable indoor pitching rubber. Participants then threw fast ball pitches toward a strike zone pitching target 43 feet away until five strikes were thrown. Twenty seconds of rest was given between trials to simulate the time between pitches during competition. Velocity was measured with a Pocket Radar. The fastest of the five trials was used for analysis.

RESULTS

Table 1. High School Softball Pitcher Characteristics (n = 13).*

Variable	Pitchers <60 mph	Pitchers >60 mph	*P* Value	Cohen's *d* difference
Age (yrs)	15.6 ± 1.0	16.3 ± 1.5	0.318	0.61
Height (cm)	168.0 ± 6.1	164.7 ± 1.9	0.214	0.69
Body Mass (kg)	73.0 ± 16.7	70.9 ± 11.0	0.786	0.16
Body Fat %	29.3 ± 8.4	25.9 ± 7.5	0.451	0.44
Skeletal Muscle Mass (kg)	28.1 ± 3.4	29.1 ± 2.2	0.560	0.34
Lean Body Mass (kg)	50.5 ± 5.5	51.9 ± 3.5	0.608	0.29
Softball Experience (yrs)	8.3 ± 2.1	7.7 ± 2.1	0.607	0.30
Resistance Training Experience (yrs)	3.9 ± 1.1	3.5 ± 1.6	0.660	0.27
Pitching Arm				
Right	6/7 (86%)	5/6 (83%)	N/A	N/A
Left	1/7 (14%)	1/6 (17%)		
Year in School				
Freshman/Sophomore	4/7 (57%)	2/6 (33%)	N/A	N/A
Junior/Senior	3/7 (43%)	4/6 (67%)		
Secondary Position				
Infield	5/7 (71%)	3/6 (50%)	N/A	N/A
Outfield	3/7 (43%)^	4/6 (67%)^		

*Yrs = years, cm = centimeters, kg = kilograms' ^some participants played both infield and outfield.

Table 2. High School Softball Pitcher Power and Speed Measurements.*

Variable	Pitchers <60 mph	Pitchers >60 mph	*P* Value	Cohen's *d* difference
Pitching Velocity (m/sec)	56.1 ± 2.7	61.5 ± 1.2	0.001*	1.54
CMJ Vertical Jump Height (cm)	45.7 ± 6.1	48.4 ± 3.4	0.348	0.53
Drop Jump Height (cm)	44.2 ± 6.9	48.8 ± 4.2	0.167	0.76
Reactive Strength Index (sec)	1.11 ± 0.30	1.34 ± 0.47	0.327	0.60
Seated Chest Pass (m)	4.1 ± 0.2	4.3 ± 0.2	0.035*	1.12
Sit-up and Throw (m)	3.3 ± 0.3	3.9 ± 0.5	0.030*	1.22
Rotational Medicine Ball Throw (m)	6.8 ± 0.6	7.2 ± 0.5	0.205	0.72
10-yard Sprint (sec)	2.09 ± 0.15	1.97 ± 0.06	0.088	0.93

*Data are mean±SD; m = meters, sec = seconds, cm = centimeters. * = significant ($p<0.05$) differences between groups.

CONCLUSIONS AND PRACTICAL APPLICATIONS

CONCLUSIONS:

- In the sample measured, high school softball pitchers who throw ≥60 mph compared to <60 mph pitchers, there were only significant and large magnitude differences observed in certain upper body power measures (Seated Chest Pass and Sit-Up and Throw), but no differences seen in body composition, lower body power measures, or the upper body power measure of Rotational Medicine Ball Throw

PRACTICAL APPLICATIONS:

- A certain level of body composition and upper and lower body power development is warranted to be a competitive high school fastpitch softball pitcher throwing at any velocity, as shown herein. However, for coaches or strength professionals working with high school softball pitchers aiming to play at the collegiate level, upper body power development should be a key training emphasis to assist the athlete in pitching at or above 60 mph.

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