

Softball Hitting Swing Analysis

Introduction:

11 female competitive travel ball softball players participated in a softball swing analysis to collect & analyze various data points and see what changes occurred in one training session using the Powercore 360 Advanced Training System hitting softballs off a tee.

Subjects:

The females ranged from 9-17 years of age with the average age being 13 years of age. All of the subjects are competitive travel ball players who volunteered to participate in the analysis. The athletes came from two sources: 1) a local softball training facility (who sent emails to various to the parents of the athletes who train at their facility), and 2) a local softball club, (who sent emails to various parents of the athletes who play for their club). None of the parents or athletes were paid for their participation in the analysis.

Format:

Powercore 360 (PC360) did not choose or select any of the parents or athletes. Athletes all went through the same standardized check-in and warm-up procedure prior to participating in the analysis. Athletes were not given any information as to what they were being tested for prior to or during the analysis. The athletes went through the following testing process:

1. Athletes warmed up following the standardized process (see form below) outside the testing facility and were instructed to stay outside the facility so they wouldn't see or be biased by other athletes participating in the analysis.

Baseball & Softball Swing Analysis Check-in

1. Parent completes written sheet & release.
 2. Athlete warms up as follows:
 - a. **Jog** around cones for 1 minute
 - b. **Carioca** between cones for 30 seconds
 - c. **Arm circles** forwards & backwards with baseball 10 x each direction
 - d. **High knees** between cones for 20 seconds
 - e. **Butt kickers** between cones for 20 seconds
 - f. **Easy swings** with bat right and left handed for 1 minute
 - g. **Hit 5-10 balls** off tee into net
 - h. **Sit & wait** until someone comes for you
2. When it was their turn, PC360 test administrators brought the next athlete into the facility, introduced them to the 3 test administrators and proceeded as follows:
- a. The athlete was told where to place their back foot and then they self-selected the height and placement of the tee. They were then instructed to hit 5-7 balls off the tee. Each hit was recorded using a Pocket Radar gun to capture exit velocity.
 - b. The athlete then put on wireless sensors to capture, record & measure various body/swing metrics using a 3d motion capture system. Once the sensors were in place on the athletes body and calibrated, the athlete was instructed to hit a ball off the tee and the swing was recorded using the 3d system and with the radar gun. Once the swing data was validated (in the 3d system), the athlete had the sensors removed and the analysis continued.
 - c. The athlete was instructed to put on the PC360 Advanced Training System (hip harness, torso harness and arm cuff on bottom hand).

- d. The athlete was connected to the hip harness so the resistance band would assist the forward step/stride of the athlete and assist in the turn of the hips as they swung. The athlete was instructed to start slowly and feel how the band assisted in the movement of the hips as they swung. The speed of the swing was increased until the athlete could either make 5-7 full swings or could take 5-7 full speed hits off the tee (right handers hit the ball and left handers took full swing without hitting a ball).
- e. Once the athlete knew how to allow their back hip to turn fully in the swing the band was changed from the back hip to the front hip which now resisted the athletes forward hip motion and hip turn. Athletes were instructed to hit balls off the tee by turning their hips through the resistance as fast as they could and holding their finish for 2 seconds. After 5-7 reps, the athlete was given approximately 20-30 seconds rest and for some stronger athletes a higher level resistance band was connected to the athlete's front hip to make the hip movement harder. The athlete was instructed to hit 5-7 more balls, moving their hips as fast as they could and holding their finish for 2 seconds. All of the above hits were recorded using the radar gun.
- f. Then the resistance band was removed from the hip harness and the athlete was instructed to hit 5-7 more balls off the tee and the hits were recorded with the radar gun.
- g. Then a resistance band was connected to the athlete's torso harness under the front shoulder and the athlete was instructed to hit 5-7 balls off the tee and hold their finish. These swings were recorded using the radar gun.
- h. The band was removed from the torso harness and the athlete was instructed to hit 5-7 balls off the tee and hold their finish. These swings were recorded using the radar gun.
- i. A resistance band was connected to an arm cuff connected to the athlete's bottom hand and the athlete was taught how to

use the pull of the band to pull the hands back, to loads the hands, and then they were instructed to make slow motion swings down to ball contact position on the tee. The athlete was instructed to make 5-7 of these movements while being provided some specific instructions in regards to the movement of the hands and arms.

- j. The band was removed from the bottom hand and the athlete was instructed to hit 5-7 balls off the tee and hold their finish. These swings were recorded using the radar gun.
- k. The PC360 Advanced Training System was removed from the athlete's body and the 3d sensors were once again paled back on in the same positions as the pre-test positions.
- l. A post-test 3d swing was recorded off the tee as the athlete was instructed to hit 5-7 balls off the tee and hold their finish. These swings were captured using the radar gun.
- m. All data was recorded on the form shown below.

PC360 [®] P O W E R C O R E											
Baseball/Softball Swing Analysis Data Sheet											
Parent Info:		first name _____		last name _____		email _____		athlete is healthy (circle) yes / no		health concerns: (list)	
Athlete Info:		first name _____		last name _____		age _____		height _____			
	Warmup Swings	4D Test	Hip Assisted	Hip Resisted	Hit no bands	Torso Resisted	Hit no bands	Resisted bottom hand	Hit no bands	4D Test	Final everything off
V1											
V2											
V3											
V4											
V5											
V6											
V7											
V8											
V9											
V10											

- n. The sensors were removed and the athlete was thanked for their participation and the next athlete was tested until all 11 athletes had completed the process.
- o. Some athletes were asked what they liked about training in the system in terms of what they felt their body doing or how it helped them train their swing movements. Their comments were recorded on their individual data sheets.

Data:

Exit Velocity

The 5 best scores for each exit velocity were totaled and averaged for all metrics below.

Test data is reported here as follows:

1. Initial velocity (pre-test)
2. Post resisted hip training velocity
3. Post resisted torso training velocity
4. Post resisted hand training velocity
5. Final velocity

The data for all of the individual athletes is shown below:

#1					
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	57	58	53	59	71
	55	52	48	59	59
	53	51	48	59	56
	52	54	53	58	53

	57	51	55	58	51
average	54.8	53.2	51.4	58.6	58
% change		-2.9	-6.2	6.9	5.8
	#2				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	48	60	58	57	59
	56	58	58	57	58
	56	57	56	57	58
	48	56	54	56	57
	37	55	51	56	56
average	49	57.2	55.4	56.6	57.6
% change		16.7	13.1	15.5	17.6
	#3				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	62	64	62	65	61
	60	63	62	65	61
	58	63	59	63	60
	57	63	58	63	56
	55	62	57	63	56
average	58.4	63	59.6	63.8	58.8
% change		7.9	2.1	9.2	0.7
	#4				

	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	54	53	54	54	52
	50	53	53	53	45
	48	51	50	49	46
	48	50	48	48	50
	47	50	46	48	46
average	49.4	51.4	50.2	50.4	47.8
% change		4.1	1.6	2	-3.2
	#5				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	35	35	45	48	46
	46	45	43	45	45
	31	45	40	43	44
	35	47	38	41	44
	44	39	37	37	34
average	38.2	42.2	40.6	42.8	42.6
% change		10.5	6.8	12.1	11.5
	#6				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	54	70	59	66	61
	57	68	57	62	56
	51	64	55	59	56
	50	57	55	56	55
	59	54	54	54	54

average	54.2	62.6	56	59.4	56.4
% change		15.5	3.3	9.6	4.1
	#7				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	45	62	59	58	53
	53	61	56	57	63
	50	53	56	57	53
	56	57	52	57	54
	47	55	52	54	
average	50.2	57.6	55	56.6	55.75
% change		14.7	9.6	12.8	11.1
	#8				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	62	65	63	62	64
	62	65	63	61	63
	50	63	63	60	63
	50	56	59	56	62
	47	56	52	52	55
average	54.2	61	60	58.2	61.4
% change		12.6	10.7	7.4	13.3
	#9				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final

	57	62	57	65	67
	56	62	56	65	67
	55	59	50	61	65
	50	58	46	59	61
	50	55	46	52	60
average	53.6	59.2	51	60.4	64
% change		10.5	-4.9	12.7	19.4
	#10				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	70	72	71	71	70
	69	68	71	70	68
	69	66	70	70	67
	66	65	69	70	65
	64	64	67	67	61
average	67.6	67	69.6	69.6	66.2
% change		-0.9	3	3	-2.1
	#11				
	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
	60	61	56	65	67
	63	55	58	59	60
	61	59	51	57	61
	66	58	67	57	58
	58	57	54	56	58
average	61.6	58	57.2	58.8	60.8
% change		-5.8	-7.1	-4.6	-1.3

Body Movement Speeds

Test data is reported here as follows:

1. Hip turn speed (pre-test & post-test)
2. Chest turn speed (pre-test & post-test)
3. Lead arm speed (pre-test & post-test)
4. Trail arm speed (pre-test & post-test)
5. Bat speed (pre-test & post-test)

The data for all of the individual athletes is shown below:

#1	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	731	769	1041	839	1917
<i>Post</i>	661	735	1096	1101	2030
% change	-9.6	-3.9	5.3	32.5	5.9
#2	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	570	706	690	746	1582
<i>Post</i>	563	641	737	702	1680
% change	-1.2	-9.2	6.8	-5.9	6.2
#3	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	603	715	881	561	1763
<i>Post</i>	642	723	836	523	1833
% change	6.5	1.1	-5.1	-6.8	4
#4	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	579	754	769	792	1707
<i>Post</i>	609	823	823	1018	2808

% change	5.2	9.2	7	28.5	64.5
#5	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	515	575	771	513	1387
<i>Post</i>	506	577	585	577	1424
% change	-1.8	0.3	-24.1	12.5	2.7
#6	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	632	748	950	1090	1901
<i>Post</i>	594	714	903	1081	1861
% change	-6	-4.5	-4.9	-0.82	-2.1
#7	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	578	671	862	735	1608
<i>Post</i>	557	653	810	896	1769
% change	-3.6	-2.7	-6.03	21.9	10
#8	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	669	889	1069	877	2014
<i>Post</i>	633	877	985	1031	2023
% change	-5.4	-1.3	-7.9	17.6	0.5
#9	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	553	755	937	719	1868
<i>Post</i>	601	808	913	811	1850
% change	8.7	7	-2.6	12.8	-1
#10	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	544	783	955	868	1744

<i>Post</i>	697	883	1016	871	1829
% change	28.1	12.8	6.4	0.4	4.9
#11	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	666	815	855	980	1658
<i>Post</i>	714	815	891	923	1630
% change	7.2	0	4.2	-5.8	-1.7

Athlete Feedback:

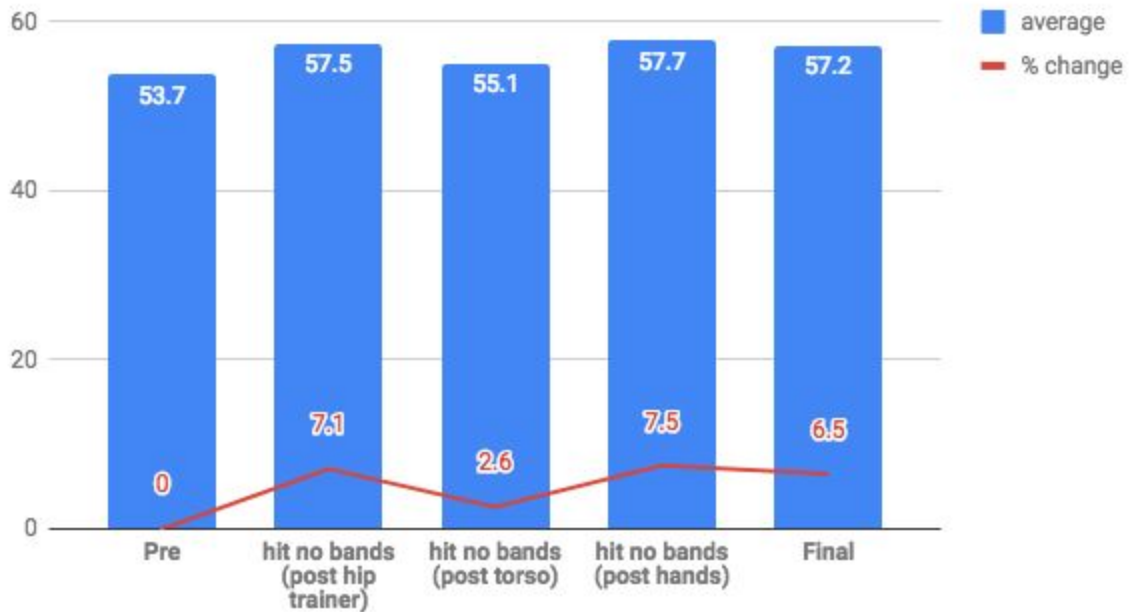
These were the comments provided by the athletes when asked about how they feel the training system helped them:

1. Likes that it makes their hips move faster.
2. Likes hip pulling through stronger.
3. Faster hands.
4. Likes the difference between using the resistance and then taking the bands off.
5. Helps with hips.
6. More power to the ball.
7. More strength coming forwards.
8. Engaged the hips.
9. Feels hips going through faster.

Results:

Table 1 below shows that on average all athletes improved their exit velocity after each PC360 training phase.

Softball Hitting Exit Velocity (tee) - All Athletes



The following data shows cumulative data for all of the 11 athletes tested and shown in the chart directly above:

	All athletes				
<i>table 1</i>	Pre	hit no bands (post hip trainer)	hit no bands (post torso)	hit no bands (post hands)	Final
<i>average</i>	53.7	57.5	55.1	57.7	57.2
<i>% change</i>	0	7.1	2.6	7.5	6.5

Individual variances:

10 of the 11 athletes all showed improvements in hitting velocity.

Exit Velocity Ranges:

Post Hip Training Velocity

The average improvement for all athletes was 7.1%

The greatest percent change was 16.7%

The lowest percent change was -5.8%

Post Torso Training Velocity

The average improvement for all athletes was 2.6%

The greatest percent change was 13.1%

The lowest percent change was -7.1%

Post Hand Training Velocity

The average improvement for all athletes was 7.5%

The greatest percent change was 15.5%

The lowest percent change was -4.6%

Final Training Velocity

The average improvement for all athletes was 6.5%

The greatest percent change was 19.4%

The lowest percent change was -3.2%

Body Movement Speeds

Body Movement Speeds - All Athletes



The following data shows cumulative data for all of the 11 athletes tested and shown in the chart directly above:

	All Athletes				
	Hip Turn Speed	Chest Turn Speed	Lead Arm Speed	Trail Arm Speed	Bat Speed
<i>Pre</i>	603.6	743.6	889.1	792.7	1740.8
<i>Post</i>	616.1	749.9	872.3	866.7	1885.2
% change	2.1	0.9	-2	9.4	8.3

Body Movement Speed Ranges:

Hip Turn Speed

The average improvement for all athletes was 2.1%

The greatest percent change was 28.1%

The lowest percent change was -9.6%

Chest Turn Speed

The average improvement for all athletes was 0.9%

The greatest percent change was 12.8%

The lowest percent change was -9.2%

Lead Arm Speed

The average improvement for all athletes was -2.0%

The greatest percent change was 7.0%

The lowest percent change was -24.1%

Trail Arm Speed

The average improvement for all athletes was 9.4%

The greatest percent change was 32.5%

The lowest percent change was -6.8%

Bat Speed

The average improvement for all athletes was 8.3%

The greatest percent change was 64.5%

The lowest percent change was -2.1%

Body Movement Speeds Interpretation:

Across these 11 athletes, on the average bat speed increased by 8.3% in about 20 minutes of time, which we believe is a function of the athlete learning to move & turn their body in a highly specific **sequenced** biomechanical fashion.

Our perspective is that the data suggests that many of the athletes came into the testing with a swing that was initiated with the lead arm and hands (left arm and hand for a right handed hitter). After the PC360 training & testing, on average, many of the athletes had changed their swing style/mechanics to one that was much more body based (meaning that they used a sequenced turn of the hips, followed by the turn of the chest and coordinated driving of the trail arm/elbow to connect with the back hip). The increase in the speed of the hips & hands after training we believe supports that the increase in bat speed is a function of the athlete learning to better use & sequence the turn of the hips, chest and adding the use of the back arm/elbow (loading the hands).

We believe that the improved bat speed is a function of adding the forces from using the entire body to turn the hips, core and chest along with the addition of the forces from the arms & hands to the initial body forces that were created. This is consistent with biomechanical models that propose a “summation of forces” occurs when the entire body is used to hit or throw objects.

Conclusions:

Based on the comparison of pre-training & post-training exit velocities (hitting off a tee), on average hitting velocities improved after using the Powercore 360 Advanced Training System in approximately 20 minutes of training. While all PC360 training system components showed improvements in exit velocity, the greatest average changes based on the data, came after the use of the hip trainer and hand trainer.

Based on the data from body movement speeds, on average, properly sequenced hip & hand speeds increased which was the major driver of the dramatically increased measured bat speed.

Anecdotally, from all the tester's eyes, the biggest changes in the athlete's body's (while swinging the bat) came after using the hip trainer. Along the same line of thinking, we also noted that the athletes seemed to learn the hip movement the fastest and seemed to be more challenged with the learning of the movements of the chest (upper torso) and the loading of the hands.

We speculate that it could very easily be that the athletes better understand that they need to move and turn their hips (guessing that they have been told this by their coaches). Furthermore, they probably didn't understand the importance of the movement of the upper torso as well as they did the hips.

Finally, many of the athletes (when shown how to load the hands after teaching them to move the body first) looked like the concept and the movement was really foreign to them.

While we believe that the body needs to move first (in a highly sequenced fashion), loading the hands is of critical importance in increasing bat speed and exit ball velocity.

It's also important to note that from the athlete's perspective most of them liked how the training system allowed them to feel how to move the movement of their hips as part of the softball swing.