Interaction Between Age and Change in Velocity During a Baseball Training Program

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Background: Pitching velocity is one of the most important metrics used to evaluate a baseball pitcher's effectiveness. The relationship between age and pitching velocity after a lighter ball baseball training program has not been determined.

Purpose/Hypothesis: The purpose of this study was to examine the relationship between age and pitching velocity after a lighter ball baseball training program. We hypothesized that pitching velocity would significantly increase in all adolescent age groups after a lighter baseball training program, without a significant difference in magnitude of increase based on age.

Study Design: Cohort study; Level of evidence, 2.

Methods: Baseball pitchers aged 10 to 17 years who completed a 15-week training program focused on pitching mechanics and velocity improvement were included in this study. Pitchers were split into 3 groups based on age (group 1, 10-12 years; group 2, 13-14 years; group 3, 15-17 years), and each group trained independently. Pitch velocity was assessed at 4 time points (sessions 3, 10, 17, and 25). Mean, maximum, and mean change in pitch velocity between sessions were compared by age group.

Results: A total of 32 male baseball pitchers were included in the analysis. Mean/maximum velocity increased in all 3 age groups: 3.4/4.8 mph in group 1, 5.3/5.5 mph in group 2, and 5.3/5.2 mph in group 3. While mean percentage change in pitch velocity increased in all 3 age groups (group 1, 6.5%; group 2, 8.3%; group 3, 7.6%), the magnitude of change was not significantly different among age groups. Program session number had a significant effect on mean and maximum velocity, with higher mean and maximum velocity seen at later sessions in the training program ($P = .018$). There was no interaction between age and program session within either mean or maximum velocity ($P = .316$ and .572, respectively).

Conclusion: Age had no significant effect on the magnitude of increase in maximum or mean baseball pitch velocity during a velocity and mechanics training program in adolescent males.

Keywords: velocity; baseball; shoulder; elbow; pitcher; injury

One of the most coveted aspects of a baseball pitcher's skill set is pitch velocity. Study of the mechanical complexity of the overhead pitch has demonstrated intrinsic and acquired traits that contribute to pitch velocity, including age, height, stride length, strength, and technique.[3] The desire to maximize pitch velocity has given rise to a variety of training programs focusing on modifiable factors, including increased strength and improved throwing technique with the ultimate goal of increasing pitch velocity.[14] However, studies of the musculoskeletal and biomechanical factors associated with injury subsequent to overhead pitching have identified pitching velocity as a primary risk factor for injury.[2,9,10,13,16]

Baseball pitchers have traditionally focused on improving strength with a combination of resistance exercises and pitching-specific programs.[3,4] Several studies have demonstrated that nonspecific strength training increases velocity in several sports, including baseball, golf, water polo, and cricket.[3] Escamilla et al[6,7] established that various baseball-specific training programs improve throwing velocity in youth baseball players, though the authors did not demonstrate that one specific resistance training program was more effective than the others.

Similarly, several studies have investigated a variety of kinematic correlates with pitch velocity, though few have focused on important demographic data such as age.[1,5,6,8,11,12,17-19] Sgroi et al[16] showed that each year of pitcher age is associated with an increase in pitch velocity of 1.5 ± 0.1 mph (mean ± SD), contributing to 66% of pitch velocity variance among 420 youth and adolescent overhead pitchers (mean age, 14.7 ± 2.6 years). Riff et al[15] demonstrated a significant increase in pitch velocity with age in 295 youth pitchers studied at a single time point. However, there have been no studies focusing on absolute and percentage improvement of pitch velocity based on age. While older players throw faster, it is unclear if they will see a

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more significant percentage increase in their pitching velocity than younger players over the course of a velocity training program. The purpose of this study was to examine the relationship between age and pitching velocity after a lighter ball baseball training program. We hypothesized that pitch velocity would significantly increase in all adolescent age groups, without a significant difference in magnitude of increase based on age.

METHODS

Study Design

Male baseball pitchers between the ages of 10 and 17 years were eligible to participate in the velocity training program. Players were excluded if they were currently injured or had recent surgery and were not cleared to return to throwing at the start of the program. A history of an injury that was resolved at the time when the program began did not exclude pitchers from taking part in the program. All players who participated (and their legal guardians) assented/consented to participate in the program and to have their data analyzed. All data were collected by the facility where the program was run as standard of care and was de-identified before sharing for analysis. Therefore, this study was deemed exempt by the institutional review board. The velocity-based training program was designed and monitored by one of the authors (T.R.A.), who is a former professional baseball pitcher. A total of 37 pitchers met these criteria and agreed to participate.

Training Program

The program was divided into 3 phases (25 training sessions, referred to as "sessions") and run out of a single facility, with all players going through the same scheduled sessions. The program is detailed in Appendices 1 to 6. Briefly, the training program involved a combination of core strengthening exercises, medicine ball throws, and throws with lighter and regulation weight baseballs. The core strengthening exercise involved front and side planks, deadbugs, glute bridges, crunches, bicycles, and Russian twists. The training sessions took place in the winter months (November-February) over 15 weeks. Participants were divided into 3 groups based on age (group 1, 10-12 years; group 2, 13-14 years; group 3, 15-17 years). Only 1 group trained on a given day such that each age group trained together. Group 1 trained on Mondays and Fridays, group 2 on Tuesdays and Saturdays, and group 3 on Wednesdays and Sundays. Hence, coaches who were training the athletes were able to give each group the same amount of attention and put each group through the same routine. No group had more than 2 sessions per week during the program. Pitch velocity was tested with a radar gun (JUGS Sports) at 4 time points during the program: sessions 3, 10, 17, and 25 (evaluations 1-4, respectively). Pitchers were instructed to throw 5 fastballs at maximum effort after warming up per their own routine. Pitch velocity was recorded for each pitch.

Statistics

Mean and maximum pitching velocity at each evaluation was calculated for each participant by using all 5 recorded velocities. Additionally, individual and mean progress relative to evaluation 1 was calculated at all subsequent evaluations. A repeated-measures analysis of variance for mean and maximum velocity across program sessions was performed with age as a covariate and including the interaction term between program session and age. The effect of age on velocity was determined via the between-participants effects results. The effect of program session on velocity was determined by Roy's largest root as the within-participants effects results. All analyses were performed in Excel 16 (Microsoft) and SPSS (v 25; IBM).

RESULTS

A total of 37 pitchers enrolled in the lighter ball training program. One (2.7%) participant was excluded owing to a broken ankle sustained in a nonbaseball recreational activity outside the training program. Four (10.8%) participants were further excluded upon analysis because their ages were not listed among the de-identified data set. As a result, 32 pitchers who completed the training program were included in analysis. There were no baseball-related injuries sustained during the training program. Of the athletes, 8 were in group 1, 11 in group 2, and 13 in group 3.

Mean and maximum pitching velocities improved in all 3 age groups across all 4 time points (Table 1, Figure 1). Age had a significant effect on mean and maximum velocity ($P < .001$ in both cases; observed power, 1.00), indicating

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TABLE 1
Mean and Maximum Pitch Velocity per Age Group[a]

Data Type: Session No.	Mean ± SD, mph		
	Group 1	Group 2	Group 3
Mean velocity			
3	52 ± 3.5	64.1 ± 6.1	69.6 ± 4.9
10	52.2 ± 2.9	65.3 ± 5.6	70.8 ± 4.5
17	53 ± 2.9	66.7 ± 6.8	71.7 ± 4.7
25	55.4 ± 3.5	69.4 ± 5.4	74.9 ± 4.8
Maximum velocity			
3	53 ± 3.8	65.0 ± 6.6	70.9 ± 4.6
10	53.8 ± 2.9	66.5 ± 7.4	71.8 ± 4.6
17	54.8 ± 2.9	67.7 ± 7.4	72.7 ± 4.6
25	57.8 ± 3.0	70.5 ± 7.4	76.1 ± 4.9

[a] Group 1, ages 10-12 years; group 2, ages 13-14 years; group 3, ages 15-17 years.

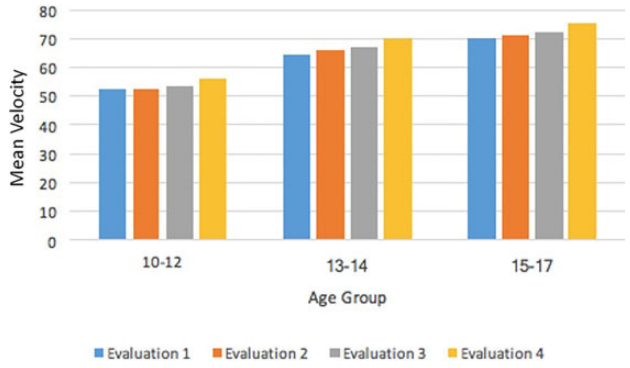

Figure 1. Mean pitch velocity (mph) by age group and evaluation number. Mean and maximum pitch velocities improved in all 3 age groups across all 4 time points. Evaluation 1, session 3; evaluation 2, session 10; evaluation 3, session 17; evaluation 4, session 25.

that older patients throw harder. Program session number also had a significant effect on mean and maximum velocity ($P = .018$; observed power, 0.766), indicating that pitchers' velocity improved throughout the course of the program. However, there was no interaction between age and program session within either mean or maximum velocity ($P = .316$ and .572, respectively; observed power, 0.244 and 0.156), indicating that the amount of increase in velocity (mean or maximum) did not differ among age groups.

Mean progress and percentage change at each time point relative to Evaluation 1 (session 3) improved within each age group (Table 2). Mean percentage change within and between age groups did not show significance.

TABLE 2
Mean Progress and Percentage Change Relative to Evaluation 1

Data Type: Age Group (y)	Evaluation[a]			*P* Value Within Age Group
	1 to 2	1 to 3	1 to 4	
Progress, mph				.16
1 (10-12)	0.2	1.0	3.4	
2 (13-14)	1.4	2.6	5.3	
3 (15-17)	1.2	1.9	5.3	
Percentage change				.87
1 (10-12)	0.385	1.9	6.5	
2 (13-14)	1.9	4.1	8.3	
3 (15-17)	1.8	3.0	7.6	
P value across age groups	.05	.056	.92	.18

[a] Evaluation 1, session 3; evaluation 2, session 10; evaluation 3, session 17; evaluation 4, session 25.

DISCUSSION

Pitch velocity is one of the most important metrics used to evaluate a baseball pitcher's effectiveness. Our hypothesis was confirmed, as mean and maximum pitch velocity significantly increased in all 3 age groups without a significant difference in magnitude of increase based on age. These results demonstrate that during a baseball training program focused on velocity and pitching mechanics, age had no significant effect on the magnitude of change in maximum or mean pitching velocity.

Several studies have investigated a variety of kinematic correlates with pitch velocity, but few have incorporated demographic data such as age in relation to velocity.[1,5,6,8,11,12,17-19] Sgroi et al[16] performed a multivariate regression analysis on 420 youth and adolescent overhead pitchers (mean age, 14.7 ± 2.6 years) who underwent dual-orthogonal high-speed video analysis while pitching. The study identified 4 factors independently correlated with an increase in pitch velocity: age ($P < .001$; multivariate $R^2 = 0.658$), height ($P < .001$; multivariate $R^2 = 0.076$), hip and shoulder separation ($P < .001$; $R^2 = 0.027$), and stride length ($P < .001$; multivariate $R^2 = 0.016$). These 4 factors in combination contributed 78% of pitch velocity variance, while age alone accounted for 66%.[16] The authors suggested the covariance of age and pitch velocity to be due to multiple factors—better pitching mechanics and greater muscle development in older pitchers, for example—and, after correction for remaining variables, associated each year of pitcher age with an increase in pitch velocity of 1.5 ± 0.1 mph. Unlike the current study, however, Sgroi et al evaluated these pitchers at only 1 time point, so it is not clear from the study how age correlates with the magnitude of change in maximum or mean pitching velocity over the course of a training program.

Riff et al[15] collected demographic, anthropometric, kinematic, and pitching history data on 295 youth pitchers (n = 63 [age, 9-12 years]; n = 130 [age, 13-15 years]; n = 78 [age, 16-17 years]; and n = 24 [age, 18-22 years). In regard to observed pitching mechanics, the study determined that as pitchers get older, they generally adopt strategies and movements that may minimize injury risk and increase pitching efficiency, such as maintaining their hand on top of the ball, maintaining closed shoulders at foot strike, leading with their hips, and improving hip to shoulder separation.

Importantly, the authors noted a statistically significant increase ($P < .001$) in pitch velocity with age (49.5 mph [age, 9-12 years]; 62.7 mph [age, 13-15 years]; 71.8 mph [age, 16-17 years]; and 73.5 mph [age, 18-22 years]). While this single-episode cross-sectional study is very useful for its large sample size, breadth of information recorded about each pitcher, and acknowledgment of age as an important contributing factor to pitch velocity, its utilization of only 1 pitching episode does not shed light on the relationship between age and change in pitch velocity over time.

The current study showed that mean progress and percentage change at each time point relative to session 3 improved within each age group, with age and session number having a significant effect on mean and maximum pitching velocity. This indicates that older pitchers threw harder at baseline and maintained this over the course of the training program, as expected. However, as the pitchers progressed through the training program, there was no more significant increase in maximum or mean velocity in older pitchers as compared with younger pitchers. As previous studies have demonstrated that pitchers develop improved muscle strength and mechanics that contribute to increased pitching efficiency and velocity with age, it is interesting that age in this study had no significant effect on the magnitude of change in maximum and mean pitch velocity.[15,16] One possibility is that while older pitchers had a better baseline in strength and mechanics, there was more room for improvement in the younger pitchers; as such, their velocity increased at the same rate as the older pitchers. It is possible that the structure of this velocity and pitching mechanics program enabled all participants to develop age-equivalent muscle strength and throwing techniques that contributed to significant velocity gains with insignificant percentage change differences by age. This would suggest that the baseball training program was equally beneficial in terms of velocity improvement based on age, which is further supported by the finding that session number had a significant effect on velocity across all 4 time points. Future studies evaluating the effects of different types of training programs on velocity, as well as the effect of age, body mass index, and so forth on velocity, will also be helpful to provide information to these athletes. As the number of velocity training programs for baseball pitchers increases in society, this information will be useful to the baseball community to set expectations for these players throughout the course of the program.

Limitations

This study included only healthy pitchers who had no current shoulder or elbow injuries, so there may have been a selection bias. Additionally, while all participants underwent the same training sessions over the 15 weeks, it is not known if any participants were engaged in strength and conditioning programs outside the baseball training program; thus, it cannot be conclusively stated that each participant's improved pitching velocity was due exclusively to the training program. The purpose of this study was to evaluate age and velocity, not height, weight, and body mass index, as these variables are not used to separate out youth athletes. Essentially, age is the only variable currently used to separate out youth baseball players, and while these other factors likely play a role in velocity, we chose age because this is the most translatable variable to youth baseball. We also did not conduct an a priori power analysis, and so it is unclear whether our study was adequately powered to test differences among age groups. It is possible that this study suffered from type II error given the sample size. It is unknown how velocity would have been affected by simple aging for 15 weeks if these athletes did not complete a training program, as no control group was utilized. Finally, it is unclear if the gains that pitchers made during the program were maintained over time.

CONCLUSION

Age had no significant effect on the magnitude of increase in maximum or mean baseball pitch velocity during a velocity and mechanics training program in adolescent males.

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APPENDIX 1

Phase 1: Sessions 1-10

Session 1

1. Active warm-up + stretching routine
   a. Before your group starts
2. Velocity program med-ball routines
   a. Heavy med-ball routine
   b. Light med-ball routine
3. Recovery routine

Session 2

4. Active warm-up + stretching routine
   a. Before your group starts
5. Velocity program med-ball routines
   a. Heavy med-ball routine
   b. Light med-ball routine

Session 3

6. Active warm-up + stretching routine
   a. Before your group starts
7. First pitching evaluation: 5 fastballs at maximum effort
8. Velocity program med-ball routines
   a. Heavy med-ball routine
   b. Light med-ball routine

Session 4

9. Active warm-up + stretching routine
   a. Before your group starts
10. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine

Session 5

11. Active warm-up + stretching routine
    a. Before your group starts
12. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine

Session 6

13. Active warm-up + stretching routine
    a. Before your group starts
14. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
15. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise

Session 7

16. Active warm-up + stretching routine
    a. Before your group starts
17. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
18. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise

Session 8

19. Active warm-up + stretching routine
    a. Before your group starts
20. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
21. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss
       i. Feet moving (lengthen it out): 10 throws

Session 9

22. Active warm-up + stretching routine
    a. Before your group starts
23. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
24. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss
       i. Feet moving (lengthen it out): 10 throws

Session 10

25. Active warm-up + stretching routine
    a. Before your group starts
26. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
27. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
28. Second pitching evaluation: 5 fastballs at maximum effort

APPENDIX 2

Phase 2: Sessions 11-17

Session 11

29. Active warm-up + stretching routine
    a. Before your group starts
30. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
31. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
32. Pitching routines
    a. Feel work
        i. Cool down (flat ground): 5 primary + 5 change-ups + 5 fastballs (not primary)

Session 12

33. Active warm-up + stretching routine
    a. Before your group starts
34. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
35. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss: increase distance of throws with medium/high effort
        i. 20 throws
    c. Pull-downs
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
36. Pitching routines
    a. Feel work: low effort
        i. Cool down (flat ground): 5 primary + 5 change-ups + 5 fastballs (not primary)

Session 13

37. Active warm-up + stretching routine
    a. Before your group starts
38. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
39. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss: increase distance of throws with medium/high effort
        i. 20 throws
    c. Pull-downs: on mound with regular motion
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
40. Pitching routines
    a. Feel work: low effort
        i. 30 pitches

Session 14

41. Active warm-up + stretching routine
    a. Before your group starts
42. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
43. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss: increase distance of throws with medium/high effort
        i. 20 throws
    c. Pull-downs
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
44. Pitching routines
    a. Feel work: low effort
        i. 30 pitches

Session 15

45. Active warm-up + stretching routine
    a. Before your group starts
46. Velocity program med-ball routines
    a. Heavy med-ball routine
    b. Light med-ball routine
47. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss: increase distance of throws with medium/high effort
        i. 20 throws
    c. Pull-downs: on mound with regular motion
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
48. Pitching routines: 25 min
    a. Feel work: low effort
        i. 35 pitches

Session 16

49. Active warm-up + stretching routine
    a. Before your group starts
50. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss: increase distance of throws with medium/high effort and slight elevation
        i. 20 throws
    c. Pull-downs
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
51. Pitching routines
    a. Feel work
        i. 35 pitches

Session 17

52. Active warm-up + stretching routine
    a. Before your group starts
53. Velocity program med-ball routines
    a. Light med-ball routine
54. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss
        i. Feet moving: 10 throws
55. Third pitching evaluation: 5 fastballs at maximum effort
56. Pitching routines
    a. Feel work
        i. Cool down (flat ground): low effort work on spin/action/command—20 throws

APPENDIX 3

Phase 3: Sessions 18-25

Session 18

57. Active warm-up + stretching routine
    a. Before your group starts
58. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss: increase distance of throws by adding effort throughout each phase
        i. Walking with step behind (90'): 5 throws
        ii. Walking with step behind + hop (120'): 5 throws
        iii. Jog with step behind + hop (150'): 5 throws
    c. Pull-downs
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
59. Pitching routines: game-day preparation
    a. Feel work
        i. Drills with focus on mechanical issues and/or any pitch that you are struggling with (action/feel/command): 20 pitches max (pitcher's choice)
        ii. Bull pen: 20 pitches

Session 19

60. Active warm-up + stretching routine
    a. Before your group starts
61. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
    b. Long toss: increase distance of throws by adding effort throughout each phase
        i. Walking with step behind (90'): 5 throws
        ii. Walking with step behind + hop (120'): 5 throws
        iii. Jog with step behind + hop (150'): 5 throws
    c. Pull-downs
        i. 5 (5 oz)
62. Pitching routines: game day—bull pen routine + making adjustments against hitters
    a. Bull pen routine: 20 pitches
    b. Execution: pitchers will simulate the first inning of a start by facing the first 3 hitters in a lineup; coaches will describe typical tendencies for the first 3 hitters in most lineups
        i. 3 hitters (1 lefty 2 righty 3 righty)

Session 20

63. Active warm-up + stretching routine
    a. Before your group starts
64. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
        i. Hip hinge routine
    b. Long toss: increase distance of throws by adding effort throughout each phase
        i. Walking with step behind (90'): 5 throws
        ii. Walking with step behind + hop (120'): 5 throws
        iii. Jog with step behind + hop (150'): 5 throws
    c. Pull-downs
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
65. Pitching routines: midweek preparation day
    a. Feel work: work on any/all pitches here—40 pitches

Session 21

66. Active warm-up + stretching routine
    a. Before your group starts
67. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
        i. Hip hinge routine
    b. Long toss: increase distance of throws by adding effort throughout each phase
        i. Walking with step behind (90'): 5 throws
        ii. Walking with step behind + hop (120'): 5 throws
        iii. Jog with step behind + hop (150'): 5 throws
    c. Pull-downs
        i. 5 (5 oz)
68. Pitching routines: game day—pitcher's role as a starter + reading hitters
    a. Feel work: 15 pitches
    b. Bull pen routine: 20 pitches
    c. Execution: simulated 2 innings of work—30 pitches

Session 22

69. Active warm-up + stretching routine
    a. Before your group starts
70. Velocity program throwing routines
    a. Precatch routine: 5 reps each exercise
        i. Hip hinge routine
    b. Long toss: increase distance of throws by adding effort throughout each phase
        i. Walking with step behind (90'): 5 throws
        ii. Walking with step behind + hop (120'): 5 throws
        iii. Jog with step behind + hop (150'): 5 throws
    c. Pull-downs
        i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
71. Pitching routines
    a. Feel work: 40 pitches

Session 23

72. Active warm-up + stretching routine
    a. Before your group starts
73. Velocity program throwing routines
    a. Precatch routine
    b. Long toss: 15 throws
    c. Pull-downs
        i. 5 (5 oz)
74. Pitching routines: game day—facing the heart of a lineup multiple times during a game
    a. Bull pen routine: 20 pitches
    b. Execution: 30 pitches (6 simulated hitters)

Session 24

75. Active warm-up + stretching routine
    a. Before your group starts
76. Velocity program throwing routines
    a. Precatch routine
        i. Hip hinge routine: 20 reps
    b. Long toss: 10 throws
77. Final pull-down evaluation: will be using the data from this evaluation to calculate overall improvement with these drills
    i. 5 (5 oz) + 5 (4 oz) + 5 (3 oz) + 5 (5 oz)
78. Pitching routines
    a. Feel work: 40 pitches

Session 25

79. Active warm-up + stretching routine
    a. Before your group starts
80. Velocity program throwing routines
    a. Precatch routine
    b. Long toss: 20 throws
81. Final (fourth) pitching evaluation: 5 fastballs at maximum effort
82. Pitching routines
    a. Feel work: 30 pitches max
83. Program wrap-ups

APPENDIX 4

Warm-up Routine

1. Lunge/twist: 5 each side
2. Standing knee hugs: 5 each side
3. Alternating high kicks with toe touch: 5 each side
4. Alternating hip turnouts: 5 each side
5. High knees (quick): 10-second count
6. Butt kicks (quick): 10-second count
7. Squat jumps: 5 reps
8. Trunk twists: 10 each side
9. Back slaps: 10-second count
10. Arm circles (forward/palm down): 10-second count
11. Arm circles (backward/palm up): 10-second count
12. Sleeper stretch: 3 sets for 10-second count
13. Stretch anything else that needs attention before we start

APPENDIX 5

Light Med-Ball Routine

This routine uses 2- and 4-lb medicine balls to execute "over the head" throws with both arms. These drills are great for building velocity because the arm is not carrying the work load, whereas most velocity programs place all the stress on the arm, which leads to overuse and a higher potential for injury. The drills in this routine involve the feel of the concepts from the heavy med-ball routine and the strength gained with each concept in those drills with emphasis on acceleration instead of power. The lighter ball combined with the power development from the heavy med-ball routine will be used to teach the body to be the primary accelerator for the motion while the arm remains in a healthier position for a longer period of time and does less work.

Trunk Throw

Start on your knees with your body square to the target (feet, hips, shoulders) checking to make sure that you have a straight line from your knees to your shoulders. The ball should be sitting slightly above and behind your head with the elbows bent and arms loose. This is not a high-effort throw. The torso will generate the movement forward to start the throw with your arms following. Your elbow should follow your chest, allowing your throwing arm to rotate externally. Your hands will come through last, and as you release, you need to focus on feeling your throwing hand pronate (hand rotates thumb in and down). This is not a high-effort throw, and the torso is still what you're using to get the arms moving.

Back Leg Drive + Front Foot Stabilization + Trunk Throw: With Stop

Start with both feet pointing forward (feet, hips, and chest facing forward toward your target) with the plant foot slightly in front of the drive foot and both arms above your head with elbows bent and the ball sitting slightly above and behind your head. Starting from the drive foot, you will drive your hips forward with your plant foot extending. Once your drive foot drags, you will plant and stabilize your front foot/leg and hold this position. Your plant foot should be ahead of your knee with your leg almost straight, and your torso should be chest up and sitting slightly behind your belt buckle with your arms in the same position as when you started. If your positioning is off, then you will fix it. Once you are in a good stable position, you will drive with the back foot and extend your trunk to initiate the throw as you "push the earth down" with your lead leg. You want to try to create an explosive move with your torso on this drill, with increasing intensity as you improve with the drill. Do not worry about finishing in a "perfect position" with this drill; simply allow your body to react to the momentum of your torso generating power with a strong front leg.

Back Leg Drive + Front Foot Strike + Trunk Throw: 1 Motion

The starting position and the details from the previous drill are the same for this drill. The only difference is that you will not stop the motion at front foot strike. The goal here is to delay the throw until your drive foot drags and you feel front foot strike. Do not worry about finishing in a "perfect

position" with this drill; simply allow your body to react to the momentum of your torso generating power with a strong front leg.

Hip–Shoulder Separation Throw: With Stop

Start with both feet pointing forward (feet and hips facing forward toward your target) with the plant foot slightly in front of the drive foot. Your shoulders should be perpendicular to your hips (starting with hip/shoulder separation) and the ball sitting above your throwing shoulder and behind the ear with both hands on the ball and elbows bent with arms loose. Starting from the drive foot, you will drive your hips forward with your plant foot extending and your torso riding the back leg and maintaining hip/shoulder separation. Once your drive foot drags, you will plant and stabilize your front foot/leg and hold this position. Check to see that you are maximizing hip/shoulder separation before you start the throw. You will initiate the throw by driving with your back leg and leading your front shoulder forward and down as you "push the earth down" with your lead leg. Your trunk should rotate to extension with your arms following into the throw. You want to create velocity with your trunk and legs and will again add intensity as you improve with this drill. Do not worry about finishing in a "perfect position" with this drill; simply allow your body to react to the momentum of your torso generating power with a strong front leg.

Hip–Shoulder Separation Throw: 1 Motion

The starting position and the details from the previous drill are the same for this drill. The only difference is that you will not stop the motion at front foot strike. The goal here is to delay the throw until your drive foot drags and you feel front foot strike. Do not worry about finishing in a "perfect position" with this drill; simply allow your body to react to the momentum of your torso generating power with a strong front leg.

Squat Throw: With Contralateral Trunk Rotation

Start with your body (feet, hips, shoulders) perpendicular to your target. Your feet should be about shoulder-width apart, and you want to feel like you are sitting in your heels with a slight bend in both knees (similar to being halfway into a squat in the gym); the ball should be in the same position that your glove would be. You will initiate drive trying to keep your back heel and back knee from rotating immediately. As you drive forward and extend your lead foot, you will load your hands and ball to the same loaded position as the previous drills. During the motion, your hips will start to release into the front leg while you force the shoulders to rotate slightly closed (contralateral trunk rotation) while keeping your body loaded over your back hip ("ride your back leg"). The goal is to delay the throw until your front leg stabilizes, increasing hip–shoulder separation. Again, the throw and the velocity are coming from the legs and your trunk as it extends over a strong front leg. Allow your momentum to lead you into your finish.

Plyometric Throw: 3 Hops for Momentum With Throw on Third Hop

Start in your stretch, in your set position, with the ball sitting above your throwing shoulder and behind the ear with both hands on the ball and elbows bent with arms loose. You will hold your balance, and the drill will start by you sitting slightly into your heel (hips back, knee steady, heel connected to the ground) and then hopping laterally in a controlled way. When you land, make sure that your back heel gets down and your knee is not rolled in toward flexion as you cushion the landing by sitting slightly into your heal (repeat). You will initiate the throw by driving and extending your lead foot, with your head staying behind your belt buckle and your shoulders staying locked on to the target. Again you are delaying the throw until front foot strike, and the throw should start with your lead shoulder going forward and rotating down as the trunk extends into the throw. Allow your momentum from the throw to carry you into your finish.

APPENDIX 6

Heavy Med-Ball Routine

This routine uses 8-lb medicine balls to execute "chest pass" throws with both arms. The routine involves several progressive drills with work on connection to the ground with the drive foot, position of the back knee prior to drive, increasing output of force and momentum from the drive leg, hip load and release, front foot strike, front leg stabilization, and hip/shoulder separation. Improvements to these concepts will increase power from the ground through the hips and into the torso.

Back Leg Drive + Front Leg Stabilization + Trunk Extension: With Stop

Start with both feet pointing forward (feet, hips, and chest facing forward toward your target) with the plant foot slightly in front of the drive foot and both arms above your head with elbows bent and the ball sitting slightly above and behind your head. Starting from the drive foot, you will drive your hips forward with your plant foot extending. Once your drive foot drags, you will plant and stabilize your front foot/leg and hold this position. Your plant foot should be ahead of your knee with your leg almost straight, and your torso should be chest up and sitting slightly behind your belt buckle with your arms in the same position as when you started. If your positioning is off, then you will fix it. Once you are in a good stable position, you will drive with your back leg extending your trunk over your stabilized lead leg, and the arms will follow into the throw. Do not worry about your finish looking like you were pitching. If your body falls back due to the lead leg being straight/strong, that is OK.

Back Leg Drive + Front Foot Strike + Trunk Extension: 1 Motion

The starting position and the details from the previous drill are the same for this drill. The only difference is that you will not stop the motion at front foot strike. The goal here is to delay the throw until your drive foot drags and you feel front foot strike. Again, do not worry about your finish looking like you were pitching. If your body falls back due to the lead leg being straight/strong, that is OK.

Squat Throw: With Stop

Start with your body (feet, hips, shoulders) perpendicular to your target. Your feet should be about shoulder-width apart, and you want to feel like you are sitting in your heels with a slight bend in both knees (similar to being halfway into a squat in the gym); the ball should be in the middle of your chest. You will initiate drive trying to keep your back heel and back knee from rotating immediately. As you drive forward, extend your lead foot while keeping your body loaded over your back hip and preventing your torso from rotating (shoulders are to stay in line with your target). Front foot strike and lead leg stabilization should occur after your back foot rotates and drags. You will hold this position and check to make sure that your front foot is facing the target, your lead leg is stabilized, and you have good hip–shoulder separation. Once positioning is correct, you will initiate the throw by driving and leading your front shoulder forward with the chest rotating to extension and the throw following. You are trying to use your trunk as the power behind the throw. Allow the momentum from the throw to carry you into your finish.

Squat Throw: 1 Motion

The starting position and the details from the previous drill are the same for this drill. The only difference is that you will not stop the motion at front foot strike. The goal is to focus on the details from trunk throw while trying to keep your shoulders and trunk loaded during drive and front foot strike so that when you throw, you will be doing so from a position of maximized hip–shoulder separation. The key is to delay the throw for as long as you can and to feel front foot strike before throwing. Allow the momentum from the throw to carry you into your finish.

Plyometric Throw: 3 Hops for Momentum With Throw on Third Hop

Start in your stretch, in your set position, with the ball in the same position that your glove would be. You will hold your balance, and the drill will start by you sitting slightly into your heel (hips back, knee steady, heel connected to the ground) and then hopping laterally in a controlled way. When you land, make sure that your back heel gets down and your knee is not rolled in toward flexion as you cushion the landing by sitting slightly into your heal (repeat). You will initiate the throw by driving and extending your lead foot with your head staying behind your belt buckle and your shoulders staying locked on to the target. Again you are delaying the throw until front foot strike, and the throw should start with your lead shoulder going forward and rotating down as the trunk extends into the throw. Allow your momentum from the throw to carry you into your finish.