



Overweight and Underweight Baseball Protocols

And their relationship to velocity, injury risk, and other aspects of overhead athleticism

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1. **Background and Relevance**
2. **General Parameters**
3. **Overweight Baseballs**
4. **Underweight Baseballs**
5. **Mixed Program**
6. **Next Steps**



Background & Relevance

- ◉ **Use of weighted baseballs is becoming more prevalent at youth/amateur level**
 - ◉ Is there an increased risk of injury?
 - ◉ Should this be considered a “Red Flag”
- ◉ **Many private facilities are now incorporating them into their training/lessons**
 - ◉ Will professional players be persuaded to use them in the offseason?
 - ◉ Is this something we should be concerned about?
- ◉ **Regulation**
 - ◉ Should there be suggested guidelines?



- **The reality: many people/facilities make their livelihood off of enhancing velocity, oftentimes making it difficult to find unbiased information.**

*“They don’t sign the guys throwing 80 pooh.
Velocity equals opportunity...”*

- **Increased velocity seems to be a given**

- Overload Principle

- **But at what cost?**

- Injury Risk

- Research suggests that pitching year-round is a risk factor for Tommy John^[22]
 - Overuse is also a significant risk factor for elbow injury^[2]
 - High volume of max effort throws (weighted and traditional) are usually involved...*similar to pitching*.
 - Maximum effort throws needed for training effect
 - Mechanics may be altered due to velocity-oriented throws and goals
 - Velocity is a vital component contributing to success, but is what about gaining too much velocity, too soon?

General Parameters

Weights:

- According to Soviet research, 5% - 20% increases/decreases in load should be utilized for weighted implement training.^[3]
 - Majority of studies using weighted implement throws stay within the following parameters:
 - Up to +/- 2 oz. from standard 5 oz. baseball
- *7 oz. and 4 oz. baseballs are predominantly used*

Rationale: *training speed-strength (Power)*

- Overweight balls used to target *strength* gains
 - Slower limb speed, greater muscular force
- Underweight balls used to target *speed* gains
 - Faster limb speed, less muscular force ^[3]

Overweight Implement Training

1. Velocity
2. Accuracy
3. Shoulder Strength
4. Warm-Up
5. Injury
6. Biomechanical Implications
7. Youth Implications

Velocity:

- 10 studies specifically on baseball players:
 - Increase in velocity seen in 9 studies
 - Duration of studies range from **6-12 weeks** and average **8.67 weeks**

Overweight Throws

| Author(s) | Age | # of Subj | Implement | Duration | Increase? |
|---|--------------------|-----------|-----------------------|----------------|-----------|
| DeRenne et al. ^[5] | High School | 10 | 6oz. | 10 weeks | Yes |
| DeRenne et al. ^[6] | High School | 30 | 6oz. | 10 weeks | Yes |
| Van Huss et al. ^[7] | College | 50 | 11oz. | (--) | Yes |
| Brose and Hanson ^[8] | College | 21 | 10oz. | 6 Weeks | Yes |
| <i>Straub (Warm-up)^[9]</i> | <i>High School</i> | <i>60</i> | <i>10 & 15oz.</i> | <i>(--)</i> | <i>No</i> |
| <i>Straub (Training)^[9]</i> | <i>High School</i> | <i>48</i> | <i>7-17oz.</i> | <i>6 weeks</i> | <i>No</i> |
| Litwhiler and Hamm ^[10] | College | 5 | 7-12oz | 12 weeks | Yes |
| Bagonzi ^[11] | High School | ? | ? | ? | Yes |
| Egstrom ^[12] | College | ? | ? | ? | Yes |
| Elias ^[13] | College | ? | ? | ? | Yes |
| Carter et al. ^[14] | College | 24 | Ballistic Six | 8 weeks | Yes |
| <i>Handball Studies:</i> | | | | | |
| Edwards van Muijen et al. ^[15] | National Level | 15 | (+25%) | 8 weeks | No |
| Mikkelsen and Olesen ^[16] | Recreational | 20 | (+100%) | 8 weeks | Yes |

Accuracy:

- **3** studies tried to determine if weighted implement training increases or decreases pitching accuracy:
 - Used a grid and a number system correlating pitch location to accuracy
 - *No significant* difference in throwing accuracy found in any studies^[17]

Shoulder Strength:

- No studies found looking at the affect of overweight implement training on shoulder strength.

Overweight Warm-Ups:

- 1 study looking at weighted baseball **warm-ups** in relation to throwing velocity and accuracy
 - Study by Van Huss, Albrecht, Nelson, et al. looked at 50 collegiate pitchers^[25]
 - 11 oz baseball max effort throws used as part of a warm-up
- **Accuracy**
 - Measured by utilizing a rectangular grid with point values (1-5) assigned to portions of the grid
 - Significant increase in accuracy
- **Velocity**
 - Readings were taken after a traditional warm-up with regulation baseballs.
 - After 10 minute break and 25 max effort throws with 11 oz ball, velocity readings were taken again with regulation baseballs

Limitations:

1. *With only 1 study, looking at warm-up implications, it's hard to draw conclusions.*
2. *Each player served as his own control, meaning there was no independent control group*

Injury:

- No injuries reported in all overweight studies reviewed

Noteworthy statement:

*“Baseball weighted implement training is a unique but essential training protocol that is research based, **injury free**, and most important, enhances youth, high school, and collegiate players’ performances.” [3]*

- DeRenne and Szymanski

But, does this statement take into account the general chronic nature of baseball throwing Injuries?

- Major limitation pertaining to **injuries** when considering overweight baseballs:
- **Duration of Studies: 6-12 weeks**
 - Too short to determine relationship to injuries^[17]

“...most of the training studies with overweight and underweight baseballs stated that there were no injuries reported...However performance was the primary focus...In addition, these training studies were only 10-12 weeks in duration, which may not have been long enough to observe injury pattern differences...”^[17]

-R. Escamilla, K. Speer, G. Fleisig, S. Barrentine, J. Andrews

Kinematics:

- One study to note: 2011 study by Tillaar and Ettema, looking at 24 experienced female handball players.
- Looked at differences between kinematics of throwing 20% underweight, regular, and 20% overweight implements.
- **Results:**
 - Underweight: Increased maximal velocity of *elbow extension* and *shoulder internal rotation*
 - Overweight: Decreased maximal velocity of *elbow extension* and *shoulder internal rotation*^[23]

Other Biomechanical Implications...

◦ Range of Motion:

- Increased MER in late cocking phase when distal limb is loaded with 7 oz^[18]
 - *Could increased MER in late cocking phase coupled with greater load increase the risk of elbow injury through increased elbow torque?*

◦ Altered Mechanics on Max-Effort Throws:

- Pitchers – especially less technically sound – tend to “pull off” in an attempt to increase pitch velocity
- Improper lumbopelvic timing associated with:
 - Higher **velocity**^[19]; but also...
 - increased **elbow valgus torque**^[1]
- ***What happens when we add additional load to these mechanics?***

Youth Implications...

o **Increased Internal Rotation Strength**

- o A 2010 Study by Harada et al. finds an increase in concentric IR strength (> 100 N) is a risk factor for youth pitchers^[20]
- o Carter, Kaminski, Douex et al. find that Upper Extremity “Plyometrics” (Ballistic Six) significantly increase concentric IR strength^[21]

Hard to say that the “Ballistic Six” increased IR strength – experimental group performed more than just weighted throws, including a general upper extremity S&C program.

Underweight Implement Training

1. Velocity
2. Accuracy
3. Shoulder Strength
4. Injury
5. Biomechanical Implications

Velocity:

- 3 studies specifically on baseball players:
 - Increase in velocity seen in all 3 studies
 - 10 week** duration used in all 3 studies

| Author(s) | Age | # of Subj | Implement | Duration | Increase? |
|---|----------------|-----------|-----------|----------|-----------|
| DeRenne et al. ^[5] | High School | 10 | 4oz. | 10 weeks | Yes |
| DeRenne et al. ^[6] | High School | 30 | 4oz. | 10 weeks | Yes |
| DeRenne et al. ^[7] | High School | 34 | 4oz. | 10 weeks | Yes |
| <i>Handball Studies:</i> | | | | | |
| Edwards van Muijen et al. ^[15] | National Level | 15 | (-25%) | 8 weeks | Yes |

Accuracy:

No studies found looking at the affect of underweight implement training on throwing accuracy.

Shoulder Strength:

No studies found looking at the affect of underweight implement training on shoulder strength.

Kinematics and Kinetics:

One study of note:

A study conducted by Fleisig et al. looked at the kinematics and kinetics of youth baseball pitchers with standard and lightweight baseballs:

- 34 youth (11.1 +/- 0.7 years) pitchers
- Used standard (5oz.) and light (4oz.) baseballs
- High speed motion analysis

Results:

- *No difference in max. shoulder adduction and external rotation, or elbow flexion during cocking phase*
- *Increase in shoulder, elbow, and ball velocities*
- *Decrease in elbow varus torque and shoulder internal rotation torque^[24]*

Underweight Throws

| | Youth ^a (n = 34) | Youth ^a (n = 34) | High School ^b (n = 33) | College ^b (n = 115) | Professional ^b (n = 60) |
|--|--------------------------------|--------------------------------|--------------------------------------|-----------------------------------|---------------------------------------|
| Age range (years) | 9–12 | 9–12 | 15–20 | 17–23 | 20–29 |
| Weight of pitched ball (oz) | 5 | 4 | 5 | 5 | 5 |
| Arm cocking | | | | | |
| Maximum shoulder external rotation (°) | 179 ± 13 | 179 ± 13 | 174 ± 9 | 173 ± 10 | 175 ± 11 |
| Maximum shoulder horizontal adduction (°) | 19 ± 7 | 19 ± 7 | 20 ± 9 | 20 ± 8 | 17 ± 9 |
| Maximum elbow flexion (°) | 98 ± 8 | 98 ± 9 | 100 ± 14 | 99 ± 15 | 98 ± 15 |
| Elbow varus torque (N m) | 26.9 ± 7.2 | 24.4 ± 5.9 | 48 ± 13 | 55 ± 12 | 64 ± 15 |
| Shoulder internal rotation torque (N m) | 27.8 ± 7.8 | 25.4 ± 6.1 | 51 ± 13 | 58 ± 12 | 68 ± 15 |
| Arm acceleration | | | | | |
| Maximum elbow extension velocity (deg s ⁻¹) | 2060 ± 310 | 2130 ± 330 | 2180 ± 340 | 2380 ± 300 | 2320 ± 300 |
| Maximum shoulder internal rotation velocity (deg s ⁻¹) | 6950 ± 1520 | 7250 ± 1600 | 6820 ± 1380 | 7430 ± 1270 | 7240 ± 1090 |
| Near ball release | | | | | |
| Ball speed (m s ⁻¹) | 23 ± 2 | 25 ± 2 | 33 ± 2 | 35 ± 2 | 37 ± 2 |
| Elbow proximal force (N) | 354 ± 84 | 347 ± 78 | 630 ± 140 | 770 ± 120 | 910 ± 140 |
| Shoulder proximal force (N) | 391 ± 82 | 392 ± 91 | 750 ± 170 | 910 ± 130 | 1070 ± 190 |
| Elbow flexion torque (N m) | 12.0 ± 4.1 | 11.3 ± 4.2 | 45 ± 9 | 52 ± 11 | 58 ± 13 |

^a From current study

^b From Fleisig et al., 1999

Overweight & Underweight Implement (Mixed) Training

1. Velocity

Velocity:

One study of note:

A study conducted by DeRenne et al. looked at affect of integrated weighted *and* underweighted implement protocols on throwing velocity.

- **Sample Size:** 225 high school and college players
- **Duration:** 10 weeks
- **Experimental Groups:**

Group 1: used overweight, underweight, and regulation baseballs for all 10 weeks

Group 2: used overweight and regulation for the first 5 weeks; used underweight and regulation for the second 5 weeks

Group 3: used regulation baseballs only

Results:

- ***Group 1 and Group 2 saw significant velocity increases***

Questions that arise...

- Can we make any inferences about injury?
- What opinions can we make about weighted baseballs for youth, high school/college, and professionals?

Next Steps...

1. Long-term studies monitoring the use of weighted baseballs in relation to injury occurrence
2. Study analyzing the kinematics of throwing with overweight vs. regulation baseballs
3. Studies looking at changes in shoulder range of motion when using weighted implement training

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References

References

References:

1. Aguinaldo, A., & Chambers, H. (2009). Correlation of Throwing Mechanics With Elbow Valgus Load in Adult Baseball Pitchers. *The American Journal of Sports Medicine*, 37(10), 2043-2048.
2. Fleisig GS, Andrews JR, Cutter GR, et al. Risk of serious injury for young baseball pitchers: a 10-year prospective study. *Am J Sports Med*. 2011;39(2):253-257. Soviet Research
3. Derenne, C., & Szymanski, D. (2009). Effects of Baseball Weighted Implement Training: A Brief Review. *Strength and Conditioning Journal*, 31(2), 30-37. Studies for velocity
4. DeRenne, C. (1985). Increasing throwing velocity. *Athlet J*, 65(9), 36-9. Escamilla Review
5. Derenne, C., Ho, K., & Blitzblau, A. (1990). Effects of Weighted Implement Training on Throwing Velocity. *Journal of Strength and Conditioning Research*, 4(1), 16-19. Shoulder Strength
6. Van Huss WD, Albrecht L, Nelson R, et al.. (1994). Effect of overload warm-up on the velocity and accuracy of throwing. *Res Q*, 33(3), 472-5.
7. Brose, D., & Hanson, D. (1967). Effects of overload training on velocity and accuracy of throwing. *Res Q*, 38(4), 528-33.
8. Straub, W. (1968). Effect of overload training procedures upon velocity and accuracy of the overarm throw. *Res Q*, 39(2), 370-9.
9. Litwhiler, D., & Hamm, L. (1973). Overload: Effect on throwing velocity and accuracy. *Athlet J*, 53, 64-65, 8.
10. Bagonzi JA. *The Effects of Graded Weighted Baseballs, Free Weight Training, and Simulative Isometric Exercise on Velocity of a Thrown Baseball* [master's thesis]. Indiana University, Bloomington, IN, 1978
11. Egstrom, GH, GA Logan, and EL Wallis. "Acquisition of Throwing Skill Involving Projectiles of Varying Weight." *Res Q* 31 (1960): 420-25. Print.
12. Elias, J. "The Effect of "overload" Training on Speed in Baseball Pitching." [Master's Thesis] Springfield College (1964). Print.
13. Andrew B., Carter, Thomas W. Kaminski, Al T. Douex, Christopher A. Knight, and James G. Richards. "Effects of High Volume Upper Extremity Plyometric Training on Throwing Velocity and Functional Strength Ratios of the Shoulder Rotators in Collegiate Baseball Players." *Journal of Strength and Conditioning Research* 21.1 (2007): 208-15. Print.

References:

15. Edwards van Muijen, A.J., Jöris, H.J.J., Kemper, H.C.G., & Van Ingen Schenau, G.J. (1991). Throwing practice with different ball weights: effects on throwing velocity and muscle strength in female handball players. *Sports Training, Medicine and Rehabilitation*, 2, 103–113.
16. Mikkelsen F, Olesen MN. Handball 82±84 (Traeningafskudstyrken). Stockholm: Trygg-Hansa, 1976
17. Escamilla, R., Speer, K., Fleisig, G., Barrentine, S., & Andrews, J. (2000). Effects Of Throwing Overweight And Underweight Baseballs On Throwing Velocity And Accuracy. *Sports Medicine*, 29(4), 259-272.
18. Castagno PW, Richards JG, Axe MJ. The biomechanics of overload pitching [abstract]. *Med Sci Sports Exerc* 1995; 27 (5): 159S
19. Stodden, D., Fleisig, G., McLean, S., Lyman, S., & Andrews, J. (2001). Relationship of Pelvis and Upper Torso Kinematics to Pitched Baseball Velocity. *Journal of Applied Biomechanics*, 17, 164-172.
20. Harada, M., Takahara, M., Mura, N., Sasaki, J., Ito, T., & Ogino, T. (2010). Risk factors for elbow injuries among young baseball players. *Journal of Shoulder and Elbow Surgery*, 19, 502-507.
21. Carter, A., Kaminski, T., Douex Jr, A., Knight, C., & Richards, J. (2007). Effects of High volume upper extremity plyometric training on throwing velocity and functional strength ratios of the shoulder rotates in collegiate baseball players. *Journal of Strength and Conditioning Research*, 21(1), 208-215.
22. Olsen SJ, Fleisig GS, Dun S, Loftice J, Andrews JR. Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. *Am J Sports Med*. 2006;34(6):905-912.
23. Van den Tillaar, R., & Ettema, G. (2011). A Comparison of Kinematics Between Overarm Throwing With 20% Underweight, Regular, and 20% Overweight Balls. *Journal of Applied Biomechanics*, 27, 252-257.
24. Fleisig, G., Phillips, R., Shatley, A., Loftice, J., Dun, S., Drake, S., ... Andrew, J. (2006). Kinematics and kinetics of youth baseball pitching with standard and lightweight balls. *Sports Engineering*, 9, 155-163.
25. Vann Huss, WD, Albrecht L, Nelson R, et al. Effect of overload warm-up on the velocity and accuracy of throwing. *Res Q* 1962; 33 (3); 472-5