

# CrossFit: An Overview and Considerations for Physical Therapists



**Holli M. McClendon, SPT**

University of North Carolina at Chapel Hill

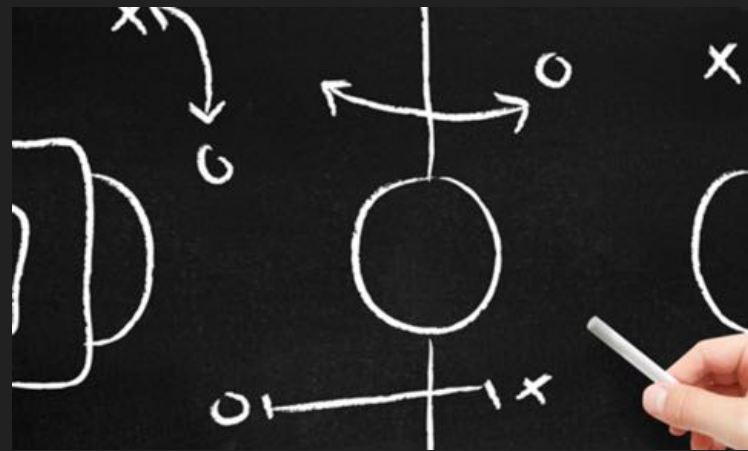
Division of Physical Therapy

# Learning Objectives

- Listeners will understand the need to be familiar with CrossFit in outpatient settings
- Listeners will be able to provide an overview of benefits and risks of CrossFit to their patients
- Listeners will understand 3 general risk factors for injury of CrossFit and other high-intensity, low-volume fitness regimens
- Listeners will be familiar with how to evaluate a squat
- Listeners will be familiar with helpful screening tools for abnormal movement patterns

# The Game Plan

- Why do we (physical therapists) need to know?
- What is Crossfit?
- Potential Benefits
- Potential Risks
- Screening for Abnormal Movement
  - Screening Tools
  - Certifications & Resources
- The Squat: Fundamental Movement



# Why Do Physical Therapists Need to Know About CrossFit?

- CrossFit is one of the most rapidly growing sports in the US (Bellar et al 2015; Chachula et al 2016; O'Hara et al 2012; Partridge et al 2014)
- CrossFit is often a controversial topic among physical therapists
- Physical therapists bridge the gap between healthcare and community (American Physical Therapy Association)
- Physical therapists should be aware of possible benefits and risks in order to educate patients (Partridge et al 2014)
- Physical therapists should be aware of the typical programming of CrossFit for rehabilitation of CrossFit participants (Partridge et al 2014)

# What is CrossFit?



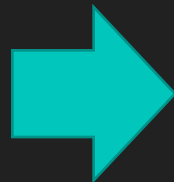
- 2000: Started by Greg Glassman with one “box”
- 2007: First CrossFit Games, \$500 prize (Wikipedia)
- 2011: Legitimized as a sport through Reebok sponsorship/ESPN coverage (Bellar et al 2015)
- 2015: Over 13,000 boxes worldwide (Price K 2015)
- 2016: \$2,200,000 total prize payout (Wikipedia)

# What is CrossFit?

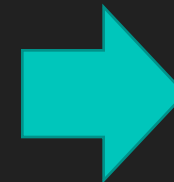
In CrossFit terminology: (Fainaru-Wada 2014; Hak et al 2013; Pope D 2013; What is CrossFit?; Worthington M)



Accuracy  
Agility  
Balance  
Cardiovascular and  
Respiratory Endurance  
Coordination  
Flexibility  
Power  
Speed  
Stamina  
Strength



Air Squat  
Front Squat  
Overhead Squat  
Shoulder Press  
Push Press  
Push Jerk  
Deadlift  
Sumo Deadlift High Pull  
Medicine Ball Clean  
+  
Gymnastics  
Rowing  
Running  
Plyometrics  
Kettlebells  
Jumping Rope



**WOD: 1 hour**

10 minutes:  
warm-up  
+  
10-20 minutes:  
Weightlifting  
+  
10-20 minutes:  
AMRAP  
METCON  
Chipper  
EMOM  
+  
Cool-down

# What is CrossFit?

In CrossFit terminology:

## Workout of the Day

← Sunday 160410  156 →


### Maupin

4 rounds for time of:

- Run 800 meters
- 49 push-ups
- 49 sit-ups
- 49 squats

Post time to comments.

## Workout of the Day

← Saturday 151226  74 →

### Harper

Complete as many rounds as possible in 23 minutes of:

- 9 chest-to-bar pull-ups
- 135-lb. power cleans, 15 reps
- 21 squats
- 400-meter run with a 45-lb. plate

Post rounds completed to comments.

## Workout of the Day

← Friday 160325  151 →

### Workout 16.5

21-18-15-12-9-6-3 reps for time of:

- Thrusters
- Burpees

Men use 95 lb.  
Women use 65 lb.

# What is CrossFit?

In more scientific terminology:

## High-Intensity Functional Training

**(HIFT)** (Boutcher 2011; Little et al 2011; Miller et al 2014; Shing et al 2013)

- Neuroendocrine Response
  - Increased Adiponectin Concentrations
  - Decreased fasting insulin
  - Improved hyperglycemia
- Cardiorespiratory Adaptations
  - Decreased Resting HR
  - Increased  $VO_2$ max
- Skeletal Muscle Adaptations
  - Increased mitochondrial capacity
- Body Composition
  - Decreased Body Fat %



# Other Potential Benefits of CrossFit

- **Promotion of functional fitness** (Bellar et al 2015)
- **Motivational programming**
  - Intra- and Interpersonal factors (Hak et al 2013)
  - Mastery vs. performance (Partridge et al 2014)
- **Impact on behavioral variables**
  - Adherence to exercise
    - 75% (Heinrich et al 2015)
    - 97% (Gremeaux et al 2012)
  - Higher exercise enjoyment (intrinsic motivation) (Heinrich et al 2014)



# Potential Risks of CrossFit

**Injury Rates are rising along with popularity, but aren't any greater than similar sports.**

- 19.4% injury rate (Weisenthal et al 2014)
  - Introductory training sessions for beginners
  - Higher level of coach supervision/attentiveness
  - Female rate < male rate
- 16% subject drop-out due to injury (Smith et al 2013)

# Potential Risks of CrossFit

## Injury:

Shoulder > Low Back > Knee (Hak et al 2013, Weisenthal et al 2014)

## Risk Factors

- Fatigue (Hooper et al 2013; Myer et al 2014)
- Improper Technique (Lavallee et al 2010)
- Male (Weisenthal et al 2014)



# Potential Risks of CrossFit

*Use discretion when picking a box.*

Common critiques of the CrossFit business model? (Camacho; Fainaru-Wada 2014; Hak et al 2013; Heinrich et al 2014)

What participants should look for:

- Introductory training sessions for beginners
- Attentive coach, small class size or large staff
- Program individualization through scaling
- Emphasis on technique

# How can I screen for movement abnormalities?

## **Why?**

Movement abnormalities + balance deficits + decreased core stability  
= increased injury risk

## **Screening Tools:**

- FMS
- Y Balance Test

# How can I screen for movement abnormalities?



## Functional Movement Screen

(Butler RJ 2013; Cuchna JW 2015; Smith CA 2013)

- 7 Movements
- Possible score for each: 0 - 3

	Score = 3	Score = 2	Score = 1
<b>Deep Squat</b>			
<b>Hurdle Step</b>			
<b>In-line Lunge</b>			
<b>Shoulder Mobility</b>			
<b>Active Straight Leg Raise</b>			
<b>Trunk Stability Push-Up</b>			
<b>Rotary Stability</b>			

# How can I screen for movement abnormalities?



## Functional Movement Screen (Butler

RJ 2013; Cuchna JW 2015; Smith CA 2013)

- Quick and easy to administer
- Cut-off score of  $\leq 14$  for increased injury risk
- Moderate to good intra- and interrater reliability
- Overhead squat and trunk stability push



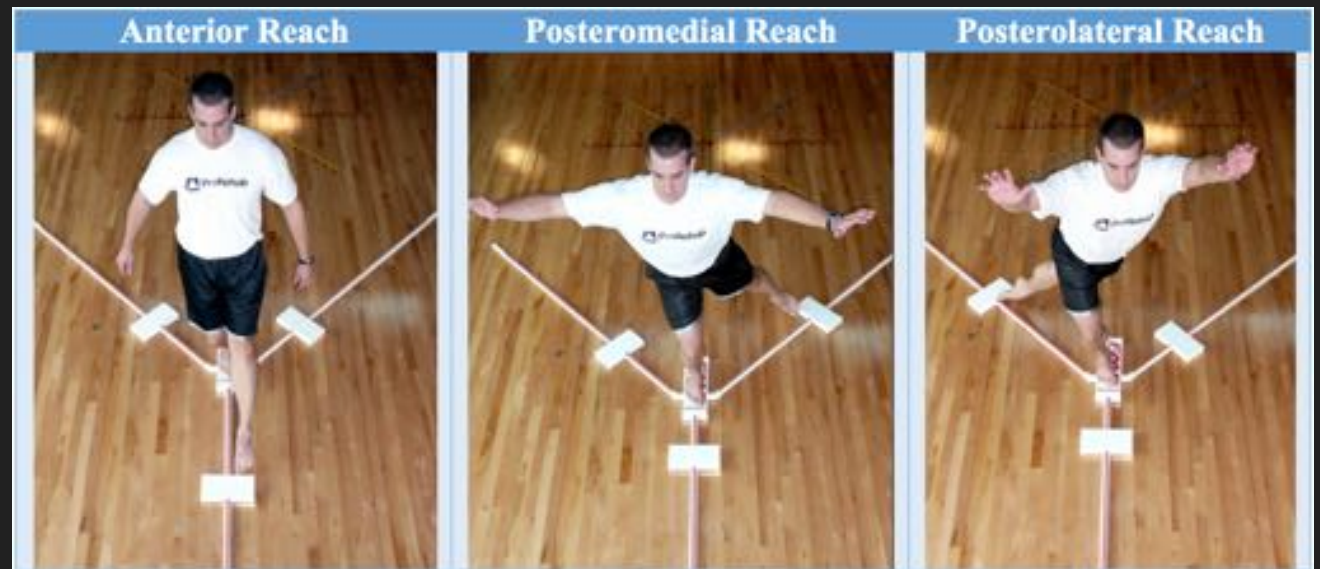
# How can I screen for movement abnormalities?



**Y Balance Test** (Overmoyer et al 2015; Plisky et al 2009; Plisky et al 2006; Shaffer et al 2013)

- 3 reach directions
- Score:

$(\text{ANT reach distance} + \text{PL reach distance} + \text{PM reach distance}) / \text{leg length} \times 100\%$



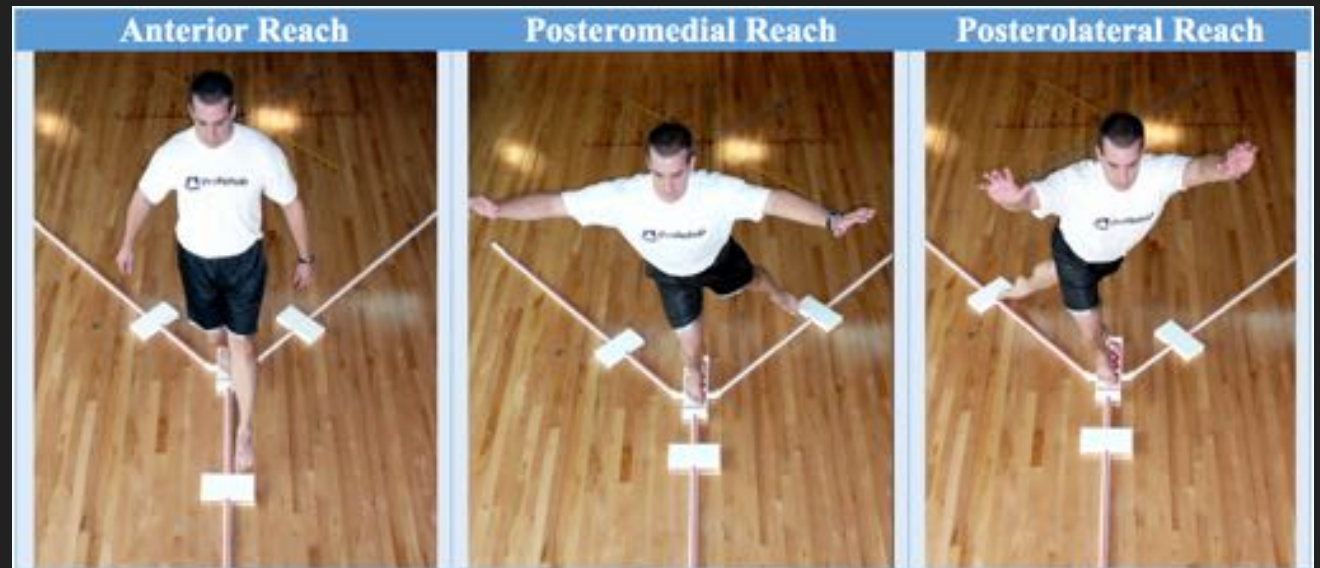


# How can I screen for movement abnormalities?



## Y Balance Test (Overmoyer et al 2015; Plisky et al 2009; Plisky et al 2006; Shaffer et al 2013)

- Good intra- and interrater reliability
- Risk factors:
  - Difference of  $\geq 4$  cm between L & R ANT reach distance
  - Score of  $\leq 94\%$
- Affected by flexibility
  - Ankle dorsiflexion



# How can I screen for movement abnormalities?

Know what correct (and incorrect) movement looks like

## Common Faults or Anatomy of a Bad Squat



*Not breaking the parallel plane*



*Rolling knees inside feet*



*Dropping head*



*Losing lumbar extension (rounding the back - this may be the worst)*



*Dropping the shoulders*



*Heels off the ground*

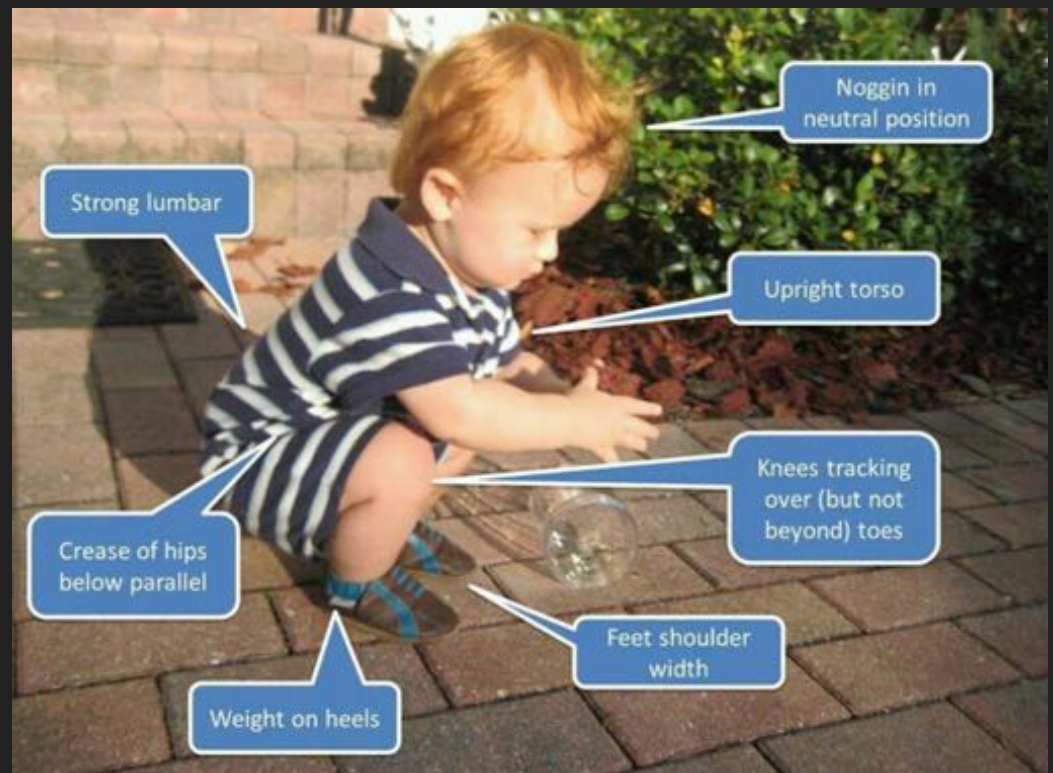


*Not finishing the squat - not completing hip extension*

# The Squat: Fundamental to CrossFit, HIIT, and life.

(Chandler et al 1989; The CrossFit Training Guide; Hartmann et al 2013; Myer et al 2014)

- The squat is a natural, necessary and fundamental movement
- The squat is the basis for proper technique in other advanced lifts (overhead squat, snatch, clean, lunge to name a few)
- The squat is extremely effective for improving strength and power by activating multiple muscle groups and prime movers in the kinetic chain



# The Squat: Fundamental to CrossFit, HIFT, and life.

## Squat Depth

- **Can full depth squatting cause damage to the knees?**
  - No difference in knee ligament stability post 8-week full-depth squat program (Chandler et al 1989)
  - Full-depth squat can be effective for injury prevention (Hartmann et al 2013)
- **Why full depth?**
  - Recruitment of gluteus maximus (Caterisano et al 2002)
  - Increased hip and knee extensor relative contribution (Bryanton et al 2012)



# The Squat: Fundamental to CrossFit, HIIT, and life.

## Type of Squat

- Barbell squats vs. Machine squats
- Front squat vs. Back squat



# The Squat: Fundamental to CrossFit, HIIT, and life.

**What can muscle fatigue do to a squat?** (Hooper et al 2013; Myer et al 2014)

**Utilizing rest periods:**

- Supine or seated (Ouellette et al)

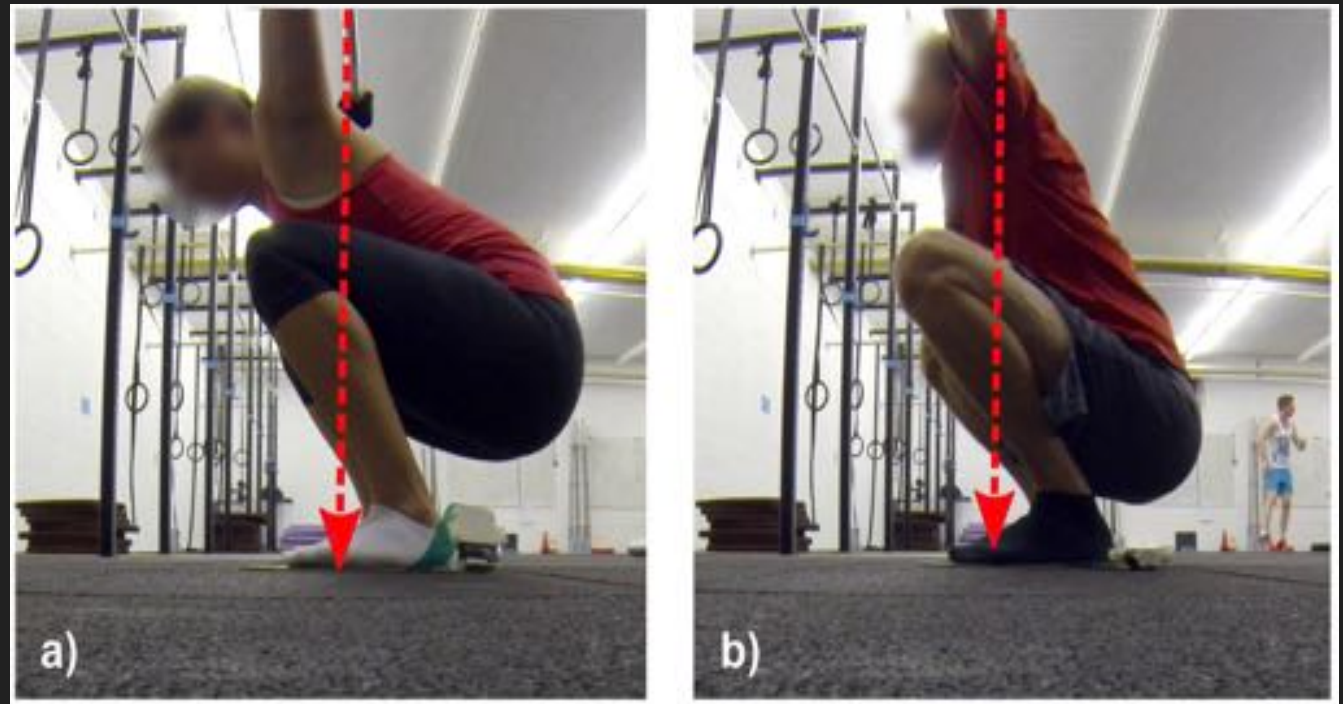


# The Squat: Fundamental to CrossFit, HIIT, and life.

## What can poor ROM do to a squat?

- 10-minute warm-up vs. 10-minute stretching routine
- Stretching = greatest impact on stability and center of pressure

(Adelsberger et al 2014)



# The Squat: Fundamental to CrossFit, HIFT, and life.

## Internal and External Influence on Squat Form:

- Visual and verbal cueing (CrossFit Training Guide; Myer et al 2014)
- Direction of gaze (Donnelly et al 2006; Myer et al 2014)
- Shoe wear (Sato et al 2012)



1. Start with the feet about shoulder width apart and slightly toed out.
2. Keep your head up looking slightly above parallel.
3. Don't look down at all; ground is in peripheral vision only.
4. Accentuate the normal arch of the lumbar curve and then pull the excess arch out with the abs.
5. Keep the midsection very tight.
6. Send your butt back and down.
7. Your knees track over the line of the foot.
8. Don't let the knees roll inside the foot.
9. Keep as much pressure on the heels as possible.
10. Stay off of the balls of the feet.
11. Delay the knees forward travel as much as possible.
12. Lift your arms out and up as you descend.
13. Keep your torso elongated.
14. Send hands as far away from your butt as possible.
15. In profile, the ear does not move forward during the squat, it travels straight down.
16. Don't let the squat just sink, but pull yourself down with your hip flexors.
17. Don't let the lumbar curve surrender as you settle in to the bottom.
18. Stop when the fold of the hip is below the knee - break parallel with the thigh.
19. Squeeze glutes and hamstrings and rise without any leaning forward or shifting of balance.
20. Return on the exact same path as you descended.
21. Use every bit of musculature you can; there is no part of the body uninvolved.
22. On rising, without moving the feet, exert pressure to the outside of your feet as though you were trying to separate the ground beneath you.
23. At the top of the stroke stand as tall as you possibly can.



# Closing Words



# References

1. Adelsberger R, Tröster G. Effects of Stretching and Warm-up Routines on Stability and Balance During Weight-lifting: A Pilot Investigation. *BMC Research Notes*. 2014; 7:938.
2. Bellar D, Hatchett A, Judge LW, Breaux ME, Marcus L. The Relationship of Aerobic Capacity, Anaerobic Peak Power and Experience to Performance in CrossFit Exercise. *Biology of Sport*. 2015; 32(4): 315-320.
3. Boutcher SH. High-Intensity Intermittent Exercise and Fat Loss: Review Article. *Journal of Obesity*. 2011; doi:10.1155/2011/868305.
4. Bryanton MA, Kennedy MD, Carey JP, Chiu LZ. Effect of Squat Depth and Barbell Load on Relative Muscular Effort in Squatting. *Journal of Strength and Conditioning Research*. 2012; 26(10): 2820-2828.
5. Butler RJ, Contreras M, Burton LC, Plisky PJ, Goode A, Kiesel K. Modifiable Risk Factors Predict Injuries in Firefighters During Training Academies. *Work*. 2013; 46(1): 11-17.
6. Calhoun G, Fry AC. Injury Rates and Profiles of Elite Competitive Weightlifters. *Journal of Athletic Training*. 1999; 34(3): 232-238.
7. Camacho R. The Safety of CrossFit from a Physical Therapy Viewpoint. *Breaking Muscle*. <http://breakingmuscle.com/functional-fitness/the-safety-of-crossfit-from-a-physical-therapy-viewpoint>. Accessed April 16, 2016.
8. Caterisano A, Moss RF, Pellingier TK, Woodruff K, Lewis VC, Booth W, Khadra T. The Effect of Back Squat Depth on the EMG Activity of 4 Superficial Hip and Thigh Muscles. *Journal of Strength and Conditioning Research*. 2002; 16(3): 428-432.
9. Chachula LA, Cameron KL, Svoboda SJ. Association of Prior Injury with the Report of New Injuries Sustained During CrossFit Training. *Athletic Training & Sports Health Care*. 2016; 8(1): 28-34.
10. Chandler TJ, Wilson GD, Stone MH. The Effect of the Squat Exercise on Knee Stability. *Medicine and Science in Sports and Exercise*. 1989; 21(3): 299-303.
11. Cook G, Burton L, Hoogenboom BJ, Voight M. Functional Movement Screening: The Use of Fundamental Movements as an assessment of function – Part 1. *The International Journal of Sports Physical Therapy*. 2014; 9(3): 396-408.

# References

12. Cook G, Burton L, Hoogenboom BJ, Voight M. Functional Movement Screening: The Use of Fundamental Movements as an assessment of function – Part 2. *The International Journal of Sports Physical Therapy*. 2014; 9(4): 549-563.
13. The CrossFit Training Guide. *CrossFit Library*. Retrieved from: [http://library.crossfit.com/free/pdf/CFJ\\_Seminars\\_TrainingGuide\\_REV122011.pdf](http://library.crossfit.com/free/pdf/CFJ_Seminars_TrainingGuide_REV122011.pdf).
14. Cuchna JW, Hoch MC, Hoch JM. The Interrater and Intrarater Reliability of the Functional Movement Screen: A Systematic Review and Meta-analysis. *Physical Therapy in Sport*. 2015; doi:10.1016/j.ptsp.2015.12.002.
15. Donnelly DV, Berg WP, Fiske DM. The Effect of the Direction of Gaze on the Kinematics of the Squat Exercise. *Journal of Strength and Conditioning Research*. 2006; 20(1): 145-150.
16. Fainaru-Wada M. CrossFit's Big Growth Fuels Concerns. ESPN. [http://espn.go.com/espn/otl/story/\\_id/11262964/crossf-explosive-growth-fuels-safety-concerns](http://espn.go.com/espn/otl/story/_id/11262964/crossf-explosive-growth-fuels-safety-concerns). July 27, 2014. Accessed April 16, 2016.
17. Garrison M, Westrick R, Johnson MR, Benenson J. Association Between the Functional Movement Screen and Injury Development in College Athletes. *International Journal of Sports Physical Therapy*. 2015; 10(1):21-28.
18. Glassman G. Foundations. *CrossFit Journal*. <http://journal.crossfit.com/2002/04/foundations.tpl#featureArticleTitle>. April 1, 2002. Accessed April 16, 2016.
19. Gremeaux V, Drigny J, Nigam A, Juneau M, Guilbeault V, Latour E, Gayda M. Long-term Lifestyle Intervention with Optimized High-Intensity Interval Training Improves Body Composition, Cardiometabolic Risk, and Exercise Parameters in Patients with Abdominal Obesity. *Am J Phys Med Rehabil*. 2012; 91(11): 941-950.
20. Gullett JC, Tillman MD, Gutierrez GM, Chow JW. A Biomechanical Comparison of Back and Front Squats in Healthy Trained Individuals. *Journal of Strength and Conditioning Research*. 2009; 23(1): 284-292.
21. Hak PT, Hodzovic E, Hickey B. The Nature and Prevalence of Injury During CrossFit Training. *Journal of Strength and Conditioning Research*. 2013; doi:10.1519/JSC.0000000000000318.

# References

22. Hartmann H, Wirth K, Klusemann M. Analysis of the Load on the Knee Joint and Vertebral Column with Changes in Squatting Depth and Weight Load. *Sports Med.* 2013; 43: 993-1009.
23. Heinrich KM, Becker C, Carlisle T, Gilmore K, Hauser J, Frye J, Harms CA. High-intensity Functional Training Improves Functional Movement and Body Composition Among Cancer Survivors: a pilot study. *European Journal of Cancer Care.* 2015; 24: 812-817.
24. Heinrich KM, Patel PM, O'Neal JL, Heinrich BS. High-intensity Compared to Moderate-intensity Training for Exercise Initiation, Enjoyment, Adherence, and Intentions: An Intervention Study. *BMC Public Health.* 2014; 14: 789. Doi: 10.1186/1471-2458-14-789.
25. Hooper DR, Szivak TK, DiStefano LJ, Comstock BA, Dunn-Lewis C, Apicella JM, Kelly NA, Creighton BC, Volek JS, Maresh CM, Kraemer WJ. Effects of Resistance Training Fatigue on Joint Biomechanics. *Journal of Strength and Conditioning Research.* 2013; 27(1): 146-153.
26. Knowles A, Herbert P, Easton C, Sculthorpe N, Grace FM. Impact of Low-volume, High-intensity Interval Training on Maximal Aerobic Capacity, Health-Related Quality of Life and Motivation to Exercise in Ageing Men. *Age.* 2015; 37(25): 1-12.
27. Lavallee ME, Balam T. An Overview of Strength Training Injuries: Acute and Chronic. *Current Sports Medicine Reports.* 2010; 9(5): 307-313.
28. Little JP, Gillen JB, Percival ME, Safdar A, Tamopolsky MA, Punthakee Z, Jung ME, Gibala MJ. Low-volume High-intensity Interval Training Reduces Hyperglycemia and Increases Muscle Mitochondrial Capacity in Patients with Type 2 Diabetes. *J Appl Physiol.* 2011; 111: 1554-1560.
29. Miller MB, Pearcey GEP, Cahill F, McCarthy H, Stratto SBD, Nofall JC, Buckle S, Basset FA, Sun G, Button DC. The Effect of a Short-Term High-Intensity Circuit Training Program on Work Capacity, Body Composition, and Blood Profiles in Sedentary Obese Men: A Pilot Study. *BioMed Research International.* 2014; doi:10.1155/2014/191797.
30. Myer GD, Kushner AM, Brent JL, Schoenfeld BJ, Hugentobler J, Lloyd RD, Vermeli A, Chu DA, Harbin J, McGill SM. The Back Squat: A Proposed Assessment of Functional Deficits and Technical Factors that Limit Performance. *Strength Cond J.* 2014; 36(6): 4-27.
31. O'Hara RB, Serres J, Traver KL, Wright B, Vojta C, Eveland E. The Influence of Nontraditional Training Modalities on Physical Performance: Review of the Literature. *Aviation, Space, and Environmental Medicine.* 2012; 83(10): 985-990.

# References

32. Ouellette KA, Brusseau TA, Davidson LE, Ford C, Hatfield DL, Shaw JM, Eisenman PA. Comparison of the Effects of Seated, Supine and Walking Inter-set Rest Strategies Upon Work Rate. *Journal of Strength and Conditioning Research*. Doi:10.1519/JSC. 0000000000000885
33. Overmoyer GV, Reiser RF. Relationships Between Lower-Extremity Flexibility, symmetries, and the Y Balance Test. *Journal of Strength and Conditioning*. 2015; 29(5): 1240-1247.
34. Ozanian M. How CrossFit Became a \$4 Billion Brand. *Forbes: Sports Money*. <http://www.forbes.com/sites/mikeozanian/2015/02/25/how-crossfit-became-a-4-billion-brand/#7087ecc678c1>. February 25, 2015. Accessed April 16, 2016.
35. Partridge JA, Knapp BA, Massengale BD. An Investigation of Motivational Variable in CrossFit Facilities. *Journal of Strength and Conditioning Research*. 2014; 28(6): 1714-1721.
36. Physical Therapists' Role in Prevention, Wellness, Fitness, Health Promotion, and Management of Disease and Disability. *American Physical Therapy Association*. [http://www.apta.org/uploadedFiles/APTAorg/About\\_Us/Policies/Practice/PTRoleAdvocacy.pdf#search=%22About physical Roles in prevention in the promotion of health wellness fitness%22](http://www.apta.org/uploadedFiles/APTAorg/About_Us/Policies/Practice/PTRoleAdvocacy.pdf#search=%22About%20physical%20Roles%20in%20prevention%20in%20the%20promotion%20of%20health%20wellness%20fitness%22). June 3, 2015. Accessed April 19, 2016.
37. Plisky PJ, Gorman PP, Butler RJ, Kiesel KB, Underwood FB, Elkins B. The Reliability of an Instrumented Device for Measuring Components of the Star Excursion Balance Test. *North American Journal of Sports Physical Therapy*. 2009; 4(2): 92-99.
38. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB. Star Excursion Balance Test as a Predictor of Lower Extremity Injury in High School Basketball Players. *Journal of Orthopaedic and Sports Physical Therapy*. 2006; 36(12): 911-919.
39. Pope D. 10 Critical Principles Physical Therapists Need to Know About Crossfit for Successful Rehabilitation. *Fitness Pain Free* By Dr. Dan Pope. <http://fitnesspainfree.com/10-critical-principles-physical-therapists-need-to-know-about-crossfit-for-successful-rehabilitation/>. December 22, 2013. Accessed April 16, 2016.
40. Price K. No Sign of CrossFit Boom Slowing Down. *Pittsburg Tribune Review*. <http://www.iclubs.com/more-news/no-sign-of-crossfit-boom-abating.html>. July 20, 2015. Accessed April 16, 2016.
41. Sato K, Fortenbaugh D, Hydock DS. Kinematic Changes Using Weightlifting Shoes on Barbell Back Squat. *Journal of Strength and Conditioning Research*. 2012; 26(1): 28-33.

# References

42. Shaffer SW, Teyhen DS, Lorenson CL, Warren RL, Koreerat CM, Straseske CA, Childs JD. Y-Balance Test: A Reliability Study Involving Multiple Raters. *Military Medicine*. 2013; 178(11): 1264-1270.
43. Shing CM, Webb JJ, Driller MW, Williams AD, Fell JW. Circulating Adiponectin Concentration and Body Composition Are Altered in Response to High-Intensity Interval Training. *Journal of Strength and Conditioning Research*. 2013; 27(8): 2213-2218.
44. Siewe J, Rudat J, Röllinghoff M, Schlegel UJ, Eysel P, Michael JWP. Injuries and Overuse Syndromes in Powerlifting. *Int J Sports Med*. 2011; 32: 703-711.
45. Smith MM, Sommer AJ, Starkoff BE, Devor ST. CrossFit-Based High-Intensity Power Training Improves Maximal Aerobic Fitness and Body Composition. *Journal of Strength and Conditioning Research*. 2013; 27(11): 3159-3172.
46. Smith CA, Chimera NJ, Wright NJ, Warren M. Interrater and Intrarater Reliability of the Functional Movement Screen. *Journal of Strength and Conditioning Research*. 2013; 27(4): 982-987.
47. The System. *Functional Movement Systems*. Retrieved from: <http://www.functionalmovement.com/site/systemdefined>
48. Weisenthal BM, Beck CA, Maloney MD, DeHaven KE, Giordano BD. Injury Rate and Patterns Among CrossFit Athletes. *The Orthopaedic Journal of Sports Medicine*. 2014; 2(4): 1-7.
49. What is CrossFit? Crossfit.com. <https://www.crossfit.com/what-is-crossfit>. Accessed April 16, 2016.
50. Worthington M. What the WOD? Decoding the Language of CrossFit. *Men's Fitness*. <http://www.mensfitness.com/training/build-muscle/what-the-wod-decoding-the-language-of-crossfit>. Accessed April 17, 2016.
51. CrossFit Games. Wikipedia. Retrieved from: [https://en.wikipedia.org/wiki/CrossFit\\_Games](https://en.wikipedia.org/wiki/CrossFit_Games).

Questions?

Thank You!