THE CrossFit JOURNAL

Who Will Win the CrossFit Games?—Part 1

Tony Leyland examines what makes the ideal CrossFit athlete.

By Tony Leyland **July 2011**

Staff/CrossFit Journal

Many of us want to know what makes an elite CrossFit athlete in terms of physical attributes, and as the Reebok CrossFit Games approach, more questions arise.

What type of athlete can win the Games?

What factors will determine the winner?

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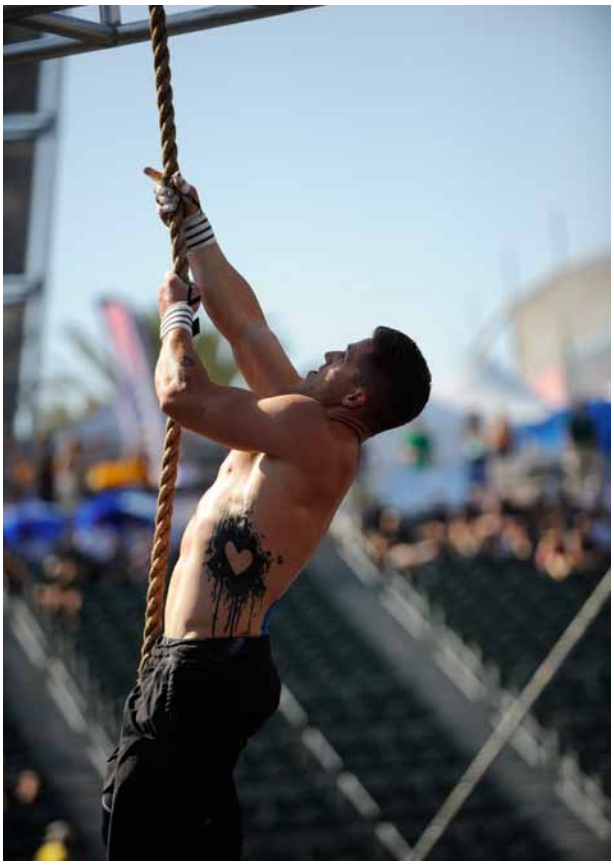
I am indeed going to be silly enough to attempt to discuss the factors that will determine the winner on July 31.

To a some degree, it's going to depend on what comes out of the hopper. Even 10 WODs deliberately picked to challenge all 10 physical skills will throw a slight advantage to one athlete compared to another. If we then picked 10 different WODs (again trying to challenge all 10 physical skills), we might have a different winner. Such is the incredible combination of human movement patterns and power outputs that we literally have an infinite number of options when creating CrossFit WODs.

However, the Games are programmed to provide the broadest possible test of fitness and select the best athletes for the podium. With enough events, the hopper has less influence. And even if the programming should favor one individual over another, a host of other factors will help decide who is fittest. We'll examine some of those factors here.



In CrossFit, strength is important, but so is technique, endurance, heart, nutrition, mental preparation ... .

Before I get into this discussion, I want to review some simple definitions and their relevance to the Games WODs.

Terms to Remember

Work—This is force multiplied by the distance the force acts. Most WODs require the athlete to move an external load, or several loads, a given distance (e.g., ground to overhead) and to move body weight, or a portion of it, a certain distance (e.g., toes to bar). Therefore, an elite CrossFit athlete is one who is able to do a prescribed workload quicker or sustain a very high power output and do more work in a prescribed time period than the vast majority of other CrossFit athletes.

Power—This is work divided by time. Elite CrossFit athletes can sustain high power outputs for longer periods than other CrossFit athletes; that is, they can do the prescribed work in the WOD faster. Another factor, of course, is maximum-effort WODs like the thruster ladder (Regional Workout 2). There, the requirement isn't about sustaining high power for an extended period of time, but rather about the maximum power output you can generate executing that particular movement.

Strength—This is the maximum amount of force a muscle or muscle groups can produce. Strength is clearly related to work and power, but you can have very strong athletes who do not have the central-nervous-system training (or innate ability) to generate very high power outputs. Power can also be thought of as force multiplied by velocity. Some very strong individuals who perform well in exercises like the deadlift do not have equally as good performances in high-power activities like the snatch.

Bodies of the Best

It has taken amazing efforts from eight amazing athletes to win previous Games titles, as it will this summer. However, there are some basic mechanics at play that mean an amazing effort from an amazing athlete may not be enough. The laws of physics effectively dictate that while a 6'6" athlete could win a particular WOD, he or she would probably not be able to string together enough results to win the Games. Let us look at the past eight winners in simple terms of athlete height and weight.

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Year	Male Winner	Height	Weight	Female Winner	Height	Weight
2007	James Fitzgerald	5'10"	168 lb.	Jolie Gentry	5'4"	125 lb.
2008	Jason Khalipa	5'9"	205 lb.	Caity Matter	5'9"	165 lb.
2009	Mikko Salo	5'8½"	176 lb.	Tanya Wagner	5'6"	145 lb.
2010	Graham Holmberg	5'11"	185 lb.	Kristan Clever	5'2"	133 lb.

Table 1: Heights and weights of previous CrossFit Games champs.

Although the above table shows quite a range of weights on the male side, we can see a very tight range of heights. Why is this? Although the ranges of heights and weights are fairly varied on the female side, we can suggest that the 2008 Games WODs favored the larger athlete as that was the year the heaviest male and female in the above table won the Games.

In terms of physics, the two fundamental factors in completing the met-con WODs are work required and athlete work capacity (his or her ability to produce high power outputs for the duration of the WOD).

The external work required is not conceptually hard to understand. However, the actual energy cost to the athlete is incredibly complex. Nevertheless, let's start with the obvious: height and weight.

1. Body dimensions—I am going to refer to "height" as "body dimensions" because limb-length ratios are a factor. However, given an average proportion of limb and trunk lengths, it's safe to say taller athletes will generally do more work moving an external load. They have to move the bar, kettlebell or dumbbell through a greater distance. Even during a push-up they will move their body weight a greater distance than someone with shorter arms. So typically the tall athlete has to do more work moving his/her body weight and any prescribed external load.

For any given height, heavier athletes will do more work.

2. Body weight—Even performing a clean and jerk means performing work moving your body mass up and down against gravity. Obviously, air squats, pull-ups, burpees, etc. are all about moving your body weight. For any given height, heavier athletes will do more work.

Therefore, the actual calculation of the external work done is largely dependent on load weight, athlete weight and athlete height. With fixed loads (e.g., Grace), the tall and heavy athlete will do more work, as he or she will on burpees, pull-ups and also thrusters. I should point out that a short, heavy athlete, if he or she is sufficiently heavier than a tall, lean athlete, might in fact be doing more work.

I think movements like handstand push-ups are particularly tough on the tall and heavy athlete. If you look at the amazing performances of an athlete like North Central's Phillip Kniep (6'0", 205 lb.), you can see he crushed most regional workouts with the exception of the first one (he was 14th in that region's Workout 1 and yet first in the thruster and chipper WODs). I wasn't there, but I would imagine his rowing is awesome, and although his running may only be average for the CrossFit elite, I would speculate it was handstand push-ups that slowed him up on the WOD.

With maximum-effort WODs, however, heavy, well-muscled athletes are at less of a disadvantage, as they will likely have more muscle mass (simply put, they are stronger and, if trained correctly, more powerful). Note that I say the "heavy, well-muscled athlete"; the best performances will still not necessarily be from a tall athlete due to the distance the bar has to travel. On the thruster ladder, Rob Orlando (5'8", 196 lb.) reached 275 lb., Jason Khalipa (5'9", 205 lb.) lifted 285, and Danny Nichols (6', 230 lb.) lifted 325 lb. On the women's' side Katie Hogan (5'9", 165 lb.) of the Southern California region lifted 190. Granted, Katie is quite tall for a female, but you are always bound to have a few slight exceptions. I say "slight" because a 6-foot female will really be at a disadvantage in most WODs. The bottom line is that unless there are several WODs favoring strength, the tall, heavy athlete is going to find it tough to win.

Another body type to discuss is the short and heavy athlete. I believe there is only so much muscle mass you can pack onto a smaller frame and still be mobile and agile enough for CrossFit. Elite powerlifters are often short and heavy as this is the ideal body type to lift heavy weight (lots of muscle mass and shorter distances to move the bar). However, it isn't the ideal body type to row, run, perform burpees, etc.

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The bottom line: I believe the male winner will be under 6 feet tall and more likely under 5'11". The lower limit? That's harder, but I would say 5'6" or 5'7" would probably be the lower end. Body weight is harder still, but I think between 155-195 lb. is the likely range.

Yes, I know Joshua Bridges is 5'5" and 160 lb. However, his thruster ladder at regionals ended at 225 lb., so if we assume a few WODs at the finals will have very heavy weights or require a 1RM effort, I think he might be too small. He will be in the mix for sure because he's an amazing athlete, but athletes like Bridges and Chris Spealler (5'5", 139 lb.)—arguably the best on a pound-for-pound basis—are up against some equally amazing athletes who have a little more size and muscle mass. On the men's side, many regional winners were on the small side, but over the course of the Open, regionals and finals, I believe the averages will favor someone between 5'7"and 5'11".

Staff/CrossFit Journal

2008 Games champ Jason Khalipa is a heavier athlete who always finds his way near the top of the leaderboard.

Many small athletes (including Bridges) crushed the deadlift/box-jump WOD, but keep in mind the deadlifts, although heavy at 315 lb. for males and 205 lb. for women, did not require the bar to move much distance, and the lighter athlete then had an advantage on the 30-inch box jumps. Despite the heavy look of this WOD, the results showed it actually balanced out, with lots of different body types posting great times. If anything, it favored the shorter, lighter athlete.

Regional winners on the female side were quite varied. I think the range between Kristan Clever (5'2") and Annie Thorisdottir (5'6½") would present a reasonable guess as to the height of this year's winner. As for weight, I will speculate it will be between 125-150 lb. Those ranges would suggest an athlete the size of 2008 winner Caity Matter is not going to win.

Additional Factors to Consider

Height doesn't tell the whole story. For example, consider the deadlift. Athletes with long legs must start the lift with the back more horizontal, while those with short legs and relatively long arms and torsos can deadlift (or start the clean) with the back more upright. This will be advantageous, especially after multiple lifts. Technique often does start to break down in high-speed WODs, and the more horizontal back position will experience more shear force. Therefore, the back musculature will have to work harder.

> The actual muscle force required to move a fixed weight, even for two athletes of the same height and weight, may be different due to differences in body proportions.

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Kristan Clever's compact stature helps her with gymnastics movements but can be a disadvantage when rowing or doing wall-balls.

I talked to a few athletes who found the limiting factor for them in Open Workout 11.1 was that their back fatigued during the power snatches. Therefore, the actual muscle force required to move a fixed weight, even for two athletes of the same height and weight, may be different due to differences in body proportions.

Clearly, long arms are not your friends in those handstand push-ups. However, some body-proportions advantages and disadvantages can cancel each other out, as the athlete with the shorter arms might have to do less work in handstand push-ups compared to an athlete of similar height and weight who has short legs and long arms.

Another factor in body proportions is something like broad vs. narrow shoulders. In addition to the male hormone testosterone stimulating more muscle mass, males develop broader shoulders during their adolescent growth spurt. This combination of broad shoulders and the ability to pack muscle onto this larger frame is beneficial. This is the reason males have on average twice the bench-press maximums of females; they have better leverage in addition to more muscle mass. However, when we look at an activity like the leg press, we do not see as large a discrepancy because females have broad hips, and that improves leverage with this lift. I used the leg press as an example here because the benefit of broader hips does not necessarily mean the average female's 1RM back squat will be closer to the male's, because as we all know the shoulder and core musculature have to stabilize the bar. Another reason is, of course, that more subjects get studied performing exercises like leg presses.

I do not think body-proportion differences will be much of a factor in the Games. As stated, it may explain why some athletes have a slight edge in one WOD, but this factor will often average out over the course of several events.

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Technique

Obviously, a huge factor in the work the athlete actually does is technique. For example, if the bar moves only up and down during a deadlift, you will do less work than an athlete who is less skilled and exerts forces on the bar that cause some horizontal motion. The same is true of a clean and jerk, and although there is some horizontal movement even with elite athletes, less skilled athletes will move the bar less efficiently, performing more work. To simply think it is about getting the bar from the ground to overhead anyway possible is too simplistic.

Less-than-ideal movement can cause the bar to move further away from a joint pivot point, resulting in the muscle having to produce more torque to rotate the joint.

At the Canada West Regional, I witnessed Andy Swartz of CrossFit Vancouver squat-clean every thruster attempt including 255 lb. Many athletes didn't do that because they needed to rack (control) the bar after a power clean, were not flexible enough to risk racking in a deep squat, or simply did not have the skill. However, this is a good example of technique saving you work. If you power-clean, you raise the bar and your body center of gravity higher than a squat clean (i.e., you do more work). You still then have to drop down with the bar under control into your full squat and then thruster the bar back up. Athletes with good O-lifting technique simply did less work per lift. This reduced the cumulative fatigue (muscular and nervous system) of having to do a thruster every 30 seconds. That interval is no problem when the bar is light, but as the athletes reached high percentages of their 1RM, 30 seconds was too short a rest period for optimal results.

Technique can also save you time as well as work done. Athletes who scored well in Open Workout 11.3 (five minutes of squat clean and jerks at 165/110 lb.) would have performed squat cleans. If you use a power clean then a front squat, you would do more work than necessary per lift and be slower per lift.

> All else being equal, you want to expend as little energy as possible to get a good score, and good technique will help with that.

Staff/CrossFit Journal

Austin Malleolo is incredibly strong, but at the CrossFit-USAW Open in 2010, he was working on eliminating an early arm bend that cost him power in the clean.

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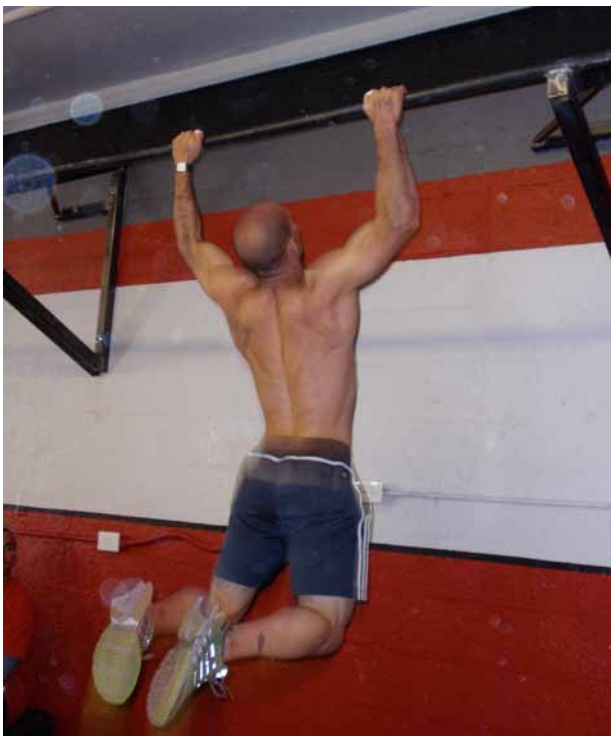
Now we all see the occasional "poor" technique in a firebreather who kills a WOD. I am not suggesting it is always about doing less work. For many WODs, it is simple: every second counts. If you have energy to burn and you have a quicker method of doing something, it may be useful to go for it even though it may cost more energy than if you use another technique. However, remember the Games comprise many events over several days. I witnessed an athlete burn out after Day 2 of a regional, and although he hung on to claim a spot in California, he nearly lost that place due to being very tired on Day 3. All else being equal, you want to expend as little energy as possible to get a good score, and good technique will help with that.

Isometric contractions against gravity will also cause a waste of energy. Hold your arms out to the side for a bit. Are you doing any external work? No. Is there a metabolic energy cost to the body? Yes. So even a momentary pause, often when the bar is traveling in a path you realize isn't optimal, causes an extra energy cost. In many ways, poor technique will cause lots of muscles to do extra work to stabilize the body and the bar.



Sarah Spealler

Chris Spealler's mastery of the pull-up is an asset in any competition.

Unnecessarily high accelerations will also cause you to burn excessive energy. It is amazing how many people driving in our cities fail to understand this. Have you ever seen anyone accelerate toward a red light? If I move my 5,000-lb. SUV 30 miles in the city and then 30 miles on the freeway, I have done the same amount of external work. Nevertheless, my gas usage is much poorer in stop-and-go city driving. This shows there is a large extra energy cost in stop-and-go movements vs. continuous movements. Basically, you need a burst of power to get your momentum back to where you want it.

An example would be to run 400 meters on a standard track and compare that to running 400 meters by shuttling back and forth over a 20-meter track. As in the car analogy, the same external work is done: moving your body weight 400 meters. You would cover more distance and do more work if you "circled" at the end of each 20-meter shuttle, but maintaining momentum is going to save you energy, and you would find this technique easier. This is one of the reasons that fitness tests like the 20-meter shuttle (beep test) specify you must stop and pivot.

Apply this thinking to kipping vs. butterfly pull-ups. While we all know kipping is better than dead-hang pull-ups, I do think this needs a bit of explanation. Why can I do more work in kipping pull-ups vs. dead hang? In my August 2007 *CrossFit Journal* article The Stretch-Shortening Cycle and Plyometric Training, I discuss this in more detail. Simply put, the traditional kipping pull-up elicits a stretch-shortening cycle, and a considerable amount of the kinetic energy gained from the down swing (due to gravity, not your energy cost) will be stored in the muscle and tendon and subsequently returned as energy in the up phase. So in terms of metabolic energy costs (which is ultimately what you feel), it costs you less energy to kip pull-ups vs. performing dead-hang pull-ups. Your shoulder extensors and elbow flexors aren't suddenly stronger.

The preference for the butterfly kip is therefore due to the cyclic motion being more efficient. Despite the return of energy from the forceful stretch-shortening cycle of the kipping motion, you are stopping and swinging back, and that isn't ideal if you can avoid it. There is some stretch-shortening cycle in the butterfly as well; it is just not as forceful as during a traditional kip.

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Good use of the stretch-shortening cycle is required in numerous CrossFit movements. The push press or push jerk use a stretch-shortening cycle, and the skill of timing that drop down and drive up is essential for an elite CrossFit athlete. The stretch-shortening cycle requires explosive, high-velocity, small-amplitude movements; any delay at the turnaround point is inefficient at maximizing energy return.

As CrossFit focuses on multi-joint functional movements, you need an excellent ability to effectively time the contraction of muscle groups.

As CrossFit focuses on multi-joint functional movements, you need an excellent ability to effectively time (sequence) the contraction of muscle groups. This is referred to as the "kinetic chain," where larger muscles are contracted first (core to extremity). A good example of poor technique would be pulling with the arms on a snatch before the large leg musculature has driven the body and bar upward to finish with a powerful hip extension prior to the pull.

The above discussion should have clarified why we will see performances from some athletes that don't seem possible based on the simple mechanics of their height and weight. You have to understand that when 140-lb. Chris Spealler clean and jerks 235 lb., he must be using good technique.

Mechanical Advantage?

Could you construct the ideal CrossFitter from the information above? Perhaps.

Staff/*CrossFit Journal*

Taller than most, Lindsey Smith had an outstanding performance at the 2009 Games in Aromas.

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Annie Thorisdottir doesn't fail at muscle-ups very often anymore.

You might come up with a 5'5", 140-lb. woman with spectacular strength packed into a fairly compact frame. She would be neither too tall for gymnastics movements nor too short for wall-ball, running, rowing or any of the movements that tend to favor taller athletes. She would carry limited body fat and would be light enough to be agile but strong enough to compete in the heavy events. Her limbs would be proportioned so as to allow the most efficient movement in the greatest number of modalities.

Nevertheless, elite CrossFit athletes come in many sizes.

Matt Chan and Jason Khalipa are heavier. Austin Malleolo is smaller. Tommy Hackenbruck is tall. So is Rebecca Voigt. And Lindsey Smith. Kristan Clever and Camille Leblanc-Bazinet are very compact. All have different limb and torso measurements.

Similarly, all have varying levels of technical proficiency. Some elite CrossFitters, like Spealler, for instance, have incredible skill that makes up for small stature. Malleolo, on the other hand, is brutally strong and can deadlift three times his body weight though he's still working on the high skill and power required for Olympic lifting.

In 2009, Annie Thorisdottir challenged Tanya Wagner for the overall title and was the only woman with a chance to beat her in the final event. Then Iceland Annie ran into muscle-ups, a movement she had never done. Her technique let her down then, but in 2010 she finished 12th in Amanda (muscle-ups, snatches) though she did not complete the workout under the time cap. In the 2011 regionals, she completed the same workout in 11:49. Annie's height and weight haven't changed much, if at all, but her technique has certainly improved, proving that skill can be just as important as any other factor that goes into creating an elite athlete.

But there's more.

What's inside an elite athlete? How do their energy systems work? How are they fueled? Do they have the software to use their elite hardware? Can they recover fast enough from one event to the next?

In Part 2, we'll look at the physiology that goes into creating the ultimate CrossFit athlete—the one who will stand atop the podium on July 31.

✦

About the Author

Tony Leyland is a senior lecturer in the department of biomedical physiology and kinesiology, Simon Fraser University, Vancouver, Canada. He has taught at the university level for 29 years and has been heavily involved in competitive sports such as soccer, tennis, squash and rugby as both an athlete and a coach for over 45 years. He is a professional member of the National Strength and Conditioning Association and the British Columbia Association of Kinesiologists. He is a Canadian national B-licensed soccer coach and a Level 1 CrossFit trainer. He is currently head coach/technical director of North Fraser Selects, an elite soccer program for young athletes.

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