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How to analyze more precisely physiological anaerobic responses in CrossFit practitioners?

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Abstract

CrossFit grew for the last one decade and a half and attracted plenty of new practitioners and competitions all over the word. Recently (more precisely since 2013) researchers started to focused more in CrossFit studies, responding many questions about its practice. Data about physiology were widely studied using many assessments that could help athletes and coaches to understand better ways to work with the CrossFit methodology. In the literature there are no studies investigating and sharing the measurement tools for physiological assessment in CrossFit participants. In this mini review, selected anaerobic evaluation in different participants level were presented through the CrossFit literature and some of them are briefly discussed. Data and brief comment about vertical jump, speed tests and 1 maximum repetition test were made. In conclusion, more studies that use valid methods are needed to estimate anaerobic performance, it is suggested the use and comparison of methods with reliability and benchmarks (WODs) to better approximation between the theory and practice.

Introduction

CrossFit is a brand that uses high intensity training method (HIT) in its concept. CrossFit grew for the last one decade and a half and attracted plenty of new practitioners and competitions all over the word. The main proposal of CrossFit training (WOD) is to cluster weightlifting movements, such as snatch, clean and jerk etc; gymnastic movements, such as parallel bar, rings, balls, free body exercises etc; and metabolic exercises, such as running, skiing and rowing (simulator), swimming, cycling etc.

Recently the brand suffered from the comments of the CrossFit creator and ex-CEO that did not was accepted by the CrossFit community, since then some changes have been done for the brand to gain public trust again [1]. The capacity for physical and psychological improvement of its practitioners is indisputable through CrossFit [2]. Recently (more precisely since 2013) researchers started to focus more in CrossFit studies, responding many questions about its practice. Data about physiology were widely studied using many assessments that could help athletes and coaches to understand better ways to work with the CrossFit methodology. In the literature there is no studies investigating and sharing the measurement tools for physiological assessment in CrossFit participants.

In this mini review, selected anaerobic evaluation in different participants level are presented through the CrossFit literature and some of them are briefly discussed. Only, validated assessments were included, any other method that does not have scientific validation was excluded.

Anaerobic assessment

Through the anaerobic assessments, here is discussed power, speed and strength in CrossFit practitioners.

Vertical jump

Vertical jump can provide data on the power of lower limbs. Between the jumping tests, the countermovement jump (CMJ) is the most used in studies involving CrossFit. The CMJ starts with the knee extended and arms placed on hip during all the movement, then the participant bend the knees in 90 degrees and jump as high as possible (cm); the squat jump starts with the knees in 90 degrees to jump as high as possible (cm), arms must be placed on the hip during all the movement; the drop jump starts with the participants over a box (normally 30 cm, 40 cm or 50 cm height), then they must step out of the box touching both feet on the floor and jumping as fast as possible the highest height (cm). It measures the stretching-shortening cycle using elastic energy. Most of them measured two or three vertical jumps with rest time that vary between 10 seconds and 30 seconds between the jumps, to analyze power fatigue (watts and centimeters, cm) [3,4]. Matínez-Gomes et al. [5], investigated physiological predictors in amateur CrossFit athletes. Vertical jump was used to analyze performance, using squat jump, CMJ and drop jump. Many authors used the CMJ to analyze performance and fatigue in CrossFit athletes, using digital platform. Mobile apps are increasingly common and some of them were validated to allow the use of vertical jump using mobile, My Jump2 and Jumpster are apps that were already used in studies (including CrossFit), and they reported high to very high correlation with the electronic circuit platform, r = 0.80 and r = 0.79, respectively [6,7]. Well trained CrossFit athletes normally jump in CMJ around 42 cm, squat jump around 39 cm[5]. 32 male wrestlers (16 control and 16 experimental group) were exposed to training CrossFit for eight weeks analyzing many factors including squat (cm). After eight weeks they improved the squat jump from 32.75 to 35.97 (p = 0.00) [8]. In our research we did not find any study involving CrossFit and drop jump test analysis.

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Speed

Speed is a factor that is decisive in CrossFit workout, mainly in competitors. The most used methods to evaluate speed are cycling and running. The Wingate test is considered the gold standard test for anaerobic capacity. It was developed In Israel, during the mid- and late 1970's. The Wingate test requires pedaling or arm cranking for 30 seconds at maximal speed and against a constant force [9]. It is possible to measure peak power in this test, and this value is assumed to reflect the rate of anaerobic glycolysis in the muscle. Butcher et al. [10], Investigated high level CrossFit athletes, analyzing some physiological characteristics to correlate with some famous trainings (WODs benchmark). The average anaerobic peak power found through Wingate test was 953 watts (ranging from 565 to 1180 watts). Recreational CrossFit participants from United States of America (USA) showed average values of anaerobic peak power using Wingate test of 828 watts for men and 572 watts for women. This test is very specific for CrossFit, analyzing that most of the WODs work glycolytic metabolic system. Otherwise, the motor gesture in CrossFit is not fixed, like most individual sports and it can be flaw for specific tests analyzing specific movements. CrossFit WODs normally change the movements all the time.

A recently published study demonstrated peak power, critical power and anaerobic work capacity through 3-min maximal cycling sprint that is more specific for CrossFit due the time not be so short of application of high intensity [11]. This test is composed by 3-min of maximal sprint in cycling preceding a specific warmup before the test (for more details read the study of Mangine et al, [11]). The 3-min maximal cycling sprint was validated to estimate the anaerobic capacity (glycolytic system) by the measurement of blood lactate and excess post-exercise oxygen consumption [12]. Analyzing running tests, repeated sprint test (RST) that is considered a subtype of (HIT) was developed by Draper and Whyte in 1997 in order to analyze athlete's anaerobic system through endurance, considering the similar mean values of Wingate test. This test comprises six sets of maximal 35 m running speed repetitions, with recovery intervals of 10 seconds between each set (this method is known as Rast test, also). Kartal et al. [13], investigated basketball players through six weeks of CrossFit training using RST pre and post periodization. Through this test they do not find any difference in anaerobic endurance after the protocol of six weeks using RST (p = 0.51). Although the relatively easy RST application and the given information this method can provide, there are not so many studies involving the application of this method in CrossFit.

1 maximal repetition test (1RM)

Among the tests used to evaluate maximal strength, the 1RM is considered the gold standard, and it is suggested in many guidelines for exercise testing and exercise prescription, mainly due its practical and safe method [14]. There are multiples protocols to apply the 1RM test, one of them is the protocol described in Fleck & Kraemer's book, that is very popular in multiple sports [15]. It is common to find 1RM test in studies involving CrossFit performance. Recently, our research group (GEDEFITE-USP) investigated elite athletes in an important competition, the basis of the study was the athlete's characteristics, using back squat 1RM parameter, showing that some athletes can lift over than 200 kg, that is very unusual in recreational CrossFit participants [16]. Brazilian CrossFit practitioners with minimum of six months experience showed an average of 146 kg in the 1RM test. One factor that is very important to know is the difference between recreational and athletes CrossFit participants to lift weight. Strength training must be fit according to the practitioner, perhaps 1RM test is not the best test to do with beginners due the effort and neuromotor activation it requires. There are better tests to predict 1RM in beginners (like the 5 to 10 RM test), that may be healthier and delayed onset of muscle soreness that may be associated with 1RM test [17].

Perspectives and concluding remarks

In this mini review was exposed some of the most used methods to evaluate anaerobic performance in CrossFit participants. It is clear that studies involving physiological CrossFit analyzes tend to use vertical jump test and 1RM test to describe the participants. Studies exploring CrossFit do not usually test anaerobic performance using sprint tests. Some of them use Wingate test, but not so many. In our research we did not find more than two articles evaluating anaerobic performance using RST test or 3-min maximal cycling sprint test. Each year more studies search to investigate physiological CrossFit analyzes due the relative recently invention and many open questions about it, most of the studies researched tests using methods that is not validated, such as benchmarks to predict performance. Benchmarks are very important and even more important if measured using validated anaerobic methods as well. We strongly encourage researchers to study anaerobic performance using validated methods that present more reliability than only Benchmarks, alone. Besides that, there are studies correlating WODs with anaerobic capacity, this is very important for better understanding of CrossFit practice, it is important to correlate WODs with gold standard and validated methods such as Wingate and 3-min maximal cycling sprint test in addition to strength and power tests, such as 1RM test and vertical jump.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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