Analysis and comparison of body mass index and estimated maximum oxygen consumption between practitioners and non-practitioners of *CrossFit*®

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ABSTRACT. The body mass index (BMI) and the maximum oxygen volume (VO_2Max) are indicators used to assess obesity-related physical status, and to assess fitness and intensity control, respectively, and both are directly associated with the profile evaluated health. The aim's study is to evaluate and compare the profile of BMI and VO_2Max values of the *Crossfit*® modality practitioners (GCF) and practitioners of random non-oriented physical activities (CG). Thirty-nine participants divided between GCF ((n = 20, years 20.4 ± 6.4; height (m) 1.6 ± 0.1; body mass (kg) 69.35 ± 11.63) and CG (n = 19, years 29.4 ± 8.2; height (m) 1.71 ± 0.1; body mass (kg) 76.3 ± 16.84)) were classified according to the physical activity level using the short version of IPAQ questionnaire and assessed using BMI and VO_2Max obtained through anthropometric data. The results suggest that *Crossfit*® practitioners have lower values of BMI and higher values of VO_2Max when compared to CG (BMI, GCF 23.7 ± 1.84; GC 26.4 ± 3.76; $p = 0.009$) (VO_2Max, GCF 44.24 ± 5.09; GC 34.26 ± 6.63; $p < 0.001$). *Crossfit*® practitioners have lower BMI and higher VO_2Max compared to a group of random non-oriented physical activity practitioners.

Keywords: Physiology, VO2, IPAQ, Cardiovascular capacity, Metabolism, BMI.

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INTRODUCTION

Sedentary lifestyle, one of the factors that go hand in hand with modernity advance is one of the triggering causes of metabolic and cardiac diseases. Worldwide data show that 70% of the adult population does not reach the levels considered a minimum of physical activities, in Brazil 76% of the population above 15 years old is characterized as sedentary (IBGE, 2015).

It is observed within the historical context that the human used physical activity as an instrument for the survival and evolution of the species, and that after the technology arrival in a global way it was necessary to reinsert the practice of physical exercises in its routine (Gualano & Tinucci, 2011).

With the search for this reinsertion into the modern world, the appearance of physical exercises practitioners without guidance grows exponentially. There is favorable evidence demonstrating improvements in health indicators of irregular physical exercise practitioners (Hamer, O'Donovan, Lee, & Stamatakis, 2017; O'Donovan, Sarmiento, & Hamer, 2018, O'Donovan, Lee, Hamer, & Stamatakis, 2017).

Even with these improvements, it is demonstrated that the physical profile as indicators related to the health of irregular physical exercise practitioners is worrying, with the body composition and physical conditioning directed to the activity a greater attention state, due to risks of injuries and cardiovascular accidents (de Castro Ishida, Turi, Pereira-da-Silva, & do Amaral, 2013).

Increasingly aiming at engaging in physical exercise programs, the offer of sports modalities grows, such as CrossFit®. Characterized by being an extreme conditioning method where its activities in groups and multimodal exercises involve gymnastic movements, basic weight lifting and calisthenics, in which individual adaptation is performed according to the age, physical limitations or physical conditions of the practitioner (Tibana, de Sousa, & Prestes, 2017, de Souza, Arruda, & Gentil, 2017).The modality has been gaining great adherence due to the fast results in body composition and physical conditioning, mainly in novice practitioners in physical exercise plans (Brisebois, Rigby, & Nichols, 2018).

Being a practitioner already engaged in a training plan or an irregular practitioner of physical activities, knowing the real state of conditioning and health of the participant through tests and assessments is the direction that promotes success between a guided practice and any exercise practice. Therefore, having parameters that demonstrate the practitioner real state of the modality chosen at the beginning of a program reduces the accident risk that can lead to death, in addition to being direct indicators of gains in results and adjustments in training intensity and health indicators (Heyward, 2004).

One of the basic indicators recommended at the beginning of a training plan is the BMI, indicated by the World Health Organization (Organization, 1995). For the intensity control and assessment of cardiorespiratory fitness, maximum VO_2 can be observed between the methods, which can be direct or estimated. Both have their direct correlation with the health profile, the second being also used in training prescription and training load control, especially in sports such as endurance, given its direct relationship with the uptake capacity and transport of oxygen varying according to the intensity (De Sá, 2014, Marques, 2014).

Therefore, the aim's study is to assess and to compare the BMI and the maximum VO_2 estimated between regular *CrossFit*® practitioners and irregular physical exercise practitioners through easy-to-apply questionnaires in sports environments, to emphasize the best gains provided of exercises when organized in a methodological manner.

MATERIAL AND METHODS

Participants

The research participants, chosen for convenience, were classified into two groups, a group of *CrossFit*® practitioners (n = 20) (GCF) and a control group of irregular physical activities practitioners (n = 19) (GC).

The *CrossFit*® group was selected from a center in Brasília. A total of 20 individuals who practiced the modality between men and women, were selected according to the following inclusion criteria: Be a modality practitioner for at least 1 year, aged between 18 and 42 years old, classified as very active or active according to the International Questionnaire of Physical Activity (IPAQ) short version (CRAIG et al., 2003), not having used any anabolic substance that could interfere with their cardiovascular performance, not having followed any calorie-restricted diet during practice time.

For the control group, the selection also carried out for convenience followed the following inclusion criteria: Not having practiced any physical activity for at least 1 year, classified as irregularly active according to the IPAQ, being the same age group as the group *CrossFit*®.

Instruments for data collection of physical activity level and calculation of maximum estimated VO_2

The assessment was made using questionnaires applied in the CrossFit® group and in the Control group, the questionnaire was applied in 39 people. The questionnaires applied were the IPAQ (Craig et al., 2003), the Physical Activity Rating (PA-R) (Jackson et al., 1990)and an anamnesis with questions about weight, height and BMI.

The maximum VO_2 calculation was estimated using the variables of gender, age and BMI and the PA-R questionnaire, which has a progressive scale with scores from 0 to 7, according to the intensity of the physical activities presented, in which select the most appropriate score according to the activity history of the last thirty days (Neto, de Albuquerque, Leon, & Farinatti, 2008).

The equation used to define the maximum VO_2 prediction was:$VO_2peak = 56,363 + 1,921(PA\text{-}R) - 0,381(age) - 0,754\ (BMI) + 10,987(W = 0,\ M = 1)$(Jackson et al., 1990).

Statistical analysis

The data were expressed as mean and standard deviation for quantitative variables and absolute and relative frequency for qualitative variables. The Shapiro-Wilk normality test was applied to verify the data normality. The comparison between independent groups, for the variable VO_2 maximum and BMI, was calculated using the independent t-test. The significance level adopted was $p \leq 0.05$ and to verify the clinical effect, Cohen's d was calculated. The tests were calculated using the software Statistical Package for the Social Sciences (SPSS version 21.0).

RESULTS

Table 1 shows the sample characterization, the GCF has 10 men and 10 women, whereas the GC has 10 men and 9 women.

Table 2 shows the statistically significant difference between the groups for maximum VO_2 (t = 5,279; p< 0,01) and for BMI (t = -2,820; p = 0,009), in which the GCF has a higher maximum VO_2 and a lower BMI compared to the CG.

Table 3 shows the statistically significant difference of men between the groups for the maximum estimated VO_2 (t = 4,460; p< 0,00) and for the BMI (t = -3,228; p = 0,005), in which the GCF has a higher maximum VO_2 and lower BMI compared to CG.

Table 4 shows the statistically significant difference of women between the groups for maximum VO_2 (t = 4,445; p< 0,001) and for BMI (t = -1,868; p = 0,079), in which the GCF has a higher maximum VO_2 estimated and a lower BMI compared to the CG.

Table 1. Sample characterization.

	GCF (n=20)			GC (n=19)		
	Mean	**±**	**Standard deviation**	**Mean**	**±**	**Standard deviation**
Age (years)	29,4	±	6,4	29,4	±	8,2
Height (m)	1,6	±	0,1	1,71	±	0,1
Weight (kg)	69,35	±	11,63	76,3	±	16,84
	IPAQ		**Frequncy**	**IPAQ**		**Frequency**
Veryactive	14		35,9%	0		0
Active	6		15,4 %	0		0
Irregularlyactive	0		0	14		38,5 %
Sedentary	0		0	5		10,2 %
Total	20		51,3	19		48,7%

Table 2. The VO_2 estimated and BMI of GCF and GC.

	GCF (n=20)			GC (n=19)					
	Mean	**±**	**Standard deviation**	**Mean**	**±**	**Standard deviation**	***p-value***	**Effect size**	**Effect power**
BMI	23,7	±	1,84	26,4	±	3,76*	0,009	0.91	0.79
VO_2maximum	44,24	±	5,09*	34,26	±	6,63	0,000	1.66	0.99

Table 3. The VO_2 estimated and BMI of GCF and GC for men.

	GCF (n=10)			GC (n=10)					
	Mean	**±**	**Standard deviation**	**Mean**	**±**	**Standard deviation**	***p-value***	**Effect size**	**Effect power**
BMI	24,74	±	1,33	28,74	±	3,67*	0,005	1.44	0.86
VO_2 maximum	47,71	±	4,34*	37,40	±	5,70	0,000	2.03	0.99

Table 4. The VO_2 estimated and BMI of GCF and GC for women.

	GCF (n=10)			GC (n=9)					
	Mean	**±**	**Standard deviation**	**Mean**	**±**	**Standard deviation**	***p-value***	**Effect size**	**Effect power**
BMI	25,67	±	1,73*	24,49	±	2,48	0,079	1.40	0.82
VO_2 maximum	40,77	±	3,03*	30,64	±	6,18	0,001	2.08	0.98

DISCUSSION

This study aimed to evaluate and compare the BMI and the maximum VO_2 estimated between *CrossFit*® practitioners and a group of non-oriented physical activity practitioners, to assess the differences in the physical conditioning of people submitted to oriented activities, when compared to people practitioners of activities, but in an unguided way. The results show that those who practice physical activity in a guided way have a lower BMI and a higher maximum VO_2.

Regarding the influences of training with the *CrossFit*® method, some studies have demonstrated improvements in VO_2 and a reduction in the fat percentage. The VO_2 of *CrossFit*® practitioners tends to be higher due to the training method adopted by the modality, circuits with low weight lifting and within the aerobic pathway, which lead to significant improvements in VO_2 maximum, this increase in maximum oxygen consumption directs a greater reduction in body mass causing changes in the final BMI value of men and women (Goins, 2016, Smith, Sommer, Starkoff, & Devor, 2013, Willis et al., 2012).

In the groups of women who practice *CrossFit*® and those who practice non-oriented physical activities, there was also a visible difference between the groups. The estimated VO_2 maximum variable showed a highly significant value, with great power and effect size, according to the study (Goins, 2016) where an improvement of 15% in VO_2 maximum was presented in individuals and specifically in women, the values from 35.98 ± 1.60 to 40.22 ± 1.62 $ml.kg^{-1}.min^{-1}$ the authors attribute these results to a higher ability to promote maximum VO_2 improvements in well-trained *CrossFit*® training practitioners when compared to interval training practitioners.

The fact that groups of women practitioners and non-practitioners have shown a significant difference in BMI may be due to hormonal and metabolic differences between men and women. As the training model created in 1995 by Greg Glassman

aims to develop conditioning in a broad, inclusive and general way, preparing the trained for any physical contingency needed (Paine, Uptgraft, & Wylie, 2010), having a lower BMI value would not be the main training objective, but a likely consequence of it.

This difference in the male group may demonstrate an unreliable point regarding the use of BMI in this type of study, due to the variability of BMI among this gender, to high variations of factors such as muscle mass, bone mass and fat (Korkeila, Kaprio, Rissanen, & Koskenvuo, 1991).

The limitations of the present study are 3. First, the fact that no sample calculation was performed, which can generate a type 2 error in the study. Second, not was controlled the physical activity level, an active individual is different from a very active one. Third, participants when filling out questionnaires may underestimate or overestimate some data. It is suggested for future studies to perform the sample calculation and apply some kind of questionnaire to control the level of physical activity. As a practical application, for *CrossFit*® practitioners, the questionnaire is easy to apply and interpret, and will display approximate values given the practice history.

CONCLUSION

CrossFit® practitioners have a lower BMI and a higher VO_2 maximum when compared to irregular and unguided practitioners of physical exercises.

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