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Differences in Physical Fitness between Recreational CrossFit® and Resistance Trained Individuals

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ABSTRACT

Sousa AFM, Santos BS, Reis T, Valerino AJR, Del Rosso S, Boullosa DA. Differences in Physical Fitness between Recreational CrossFit® and Resistance Trained Individuals. **JEPonline** 2016;19 (5):112-122. The aim of this study was to compare physical capacities between recreational Crossfit® and resistance trained practitioners. Twenty-six young men participated in this study. They were divided into recreational Crossfit® practitioners of resistance training (CF, N = 13) and resistance trained (RT, N = 13) practitioners. Body mass, height, and percent of body fat were recorded. After familiarization with procedures, components of physical fitness were randomly evaluated on separate days with the following exercises: (a) fixed bar pull-ups for relative strength of upper limbs; (b) shuttle run test over 20 m for endurance assessment; and (c) countermovement jump (CMJ) of lower limbs explosiveness. There were no differences between groups for body composition and performance in pull-ups and CMJ. However, effect size (ES) analyses revealed a greater CMJ performance in CF practitioners (P=0.86, ES=0.73) while the RT subjects exhibited a greater relative strength of the upper limbs (P=0.31, ES=0.67). Meanwhile, the CF group exhibited a better performance in the shuttle run test (P=0.008, ES=1.16). It could be concluded that the CF practitioners exhibit a greater endurance and jump capacities, while the RT practitioners exhibited a greater relative strength in the upper limbs. Further longitudinal studies are warranted for a better understanding of physical training adaptations following these fitness modalities.

Key Words: Strength Training, Physical Fitness, High-Intensity Training, Endurance

INTRODUCTION

High-intensity cross-training programs have been used for decades to improve physical conditioning in several populations with different training backgrounds (5). More recently, a modification of this type of training, “High Intensity Power Training” (HIPT), which includes resistance exercises performed as fast as possible and with the highest number of possible repetitions (38) has also become popular among training enthusiasts. In this context, Crossfit® (CF) rose as a new and popular method of exercise training and competition (9). As a variant of HIPT, CF is often characterized by the execution of exercises integrating large muscle groups (i.e., squat, push, press, etc.) or more specifically resistance training (RT) exercises using free weights or body mass performed on high intensity circuits with short rest intervals (38).

Meanwhile, there has been a tendency towards a generalized use of HIIT as an alternative to conventional continuous endurance training (29). This appears to be based on evidence showing that low-volume HIIT produces moderate improvements in aerobic power (i.e., maximal oxygen uptake, VO_2 max) of active non-athletic and sedentary subjects when compared with low-intensity training (39). Consequently, any training program that combines high-intensity resistance exercise with high cardiorespiratory demands could be a training method of high interest for individuals with the desire to improve their fitness.

The improvement of physical fitness by simultaneous development of aerobic endurance and muscle strength is often the main objective of both health and performance enhancing training programs (40). As a consequence of the reduced time availability for training, concurrent endurance and strength training emerged as an appealing, time-saving alternative when compared to traditional training programs. In this sense, it has been shown that CF elicited increases in aerobic capacity and anaerobic performance (30,38). Moreover, it appears that CF training improves VO_2 max and body composition in healthy adults (27), with aerobic capacity and anaerobic power associated with success in CF exercises (4). Consequently, it is reasonable to suggest that CF could be considered a type of concurrent training.

Interestingly, despite the potential for a wide range of benefits when combining resistance and endurance training (14), one possible drawback of concurrent training is its potential to negatively affect strength development (with a greater effect on explosive strength vs. maximal strength) (40). This phenomenon is called the ‘interference effect’ (12). Although there is some evidence that shows concurrent training could affect strength development when compared to resistance training alone (14,40), there is also evidence that seems to suggest otherwise (15,26). Therefore, given the absence of studies comparing CF with RT alone, it is not known if CF training programs would elicit similar gains in muscular strength when compared to traditional RT.

The only study that has compared CF training with ACSM’s guidelines-based RT showed that CF acutely led to "very hard" perceived exertion causing detrimental post-exercise effects on muscle and ventilatory function in experienced athletes (13), a phenomenon that would likely enhance the ‘interference effect’. However it is not known if such training programs can lead to differential chronic training adaptations and thus differences in physical fitness. Thus, the aim of this study was to ascertain if there are differences in physical fitness (i.e., explosive strength, dynamic muscle strength, and cardiorespiratory fitness) between recreational CF and RT individuals.

METHODS

Subjects

Twenty-six male subjects (20 to 32 yrs of age) with at least 1 yr of experience in CF (N = 13) or RT (N = 13) and a training frequency of 2 to 3 weekly sessions volunteered for the study. Before engaging in any test, participants were informed about the risks and benefits of the study, provided written informed consent, and completed the questionnaire for physical activity readiness (PAR-Q) (19). The protocol of the study was approved by the local ethics committee.

Training Description

To be included in the RT group the men were required to be training in accordance with the American College of Sports Medicine (2) recommendations for resistance training. Briefly, their training included 1 to 12 maximum repetitions (RM) in a periodized fashion with eventual emphasis on heavy loading (1 to 6 RM) using 3- to 5-min rest periods between sets performed at a moderate contraction velocity (1 to 2 sec concentric; 1 to 2 sec eccentric). The participants of the CF group were required to be in training in a certified academy under the supervision of a certified trainer. Although CF training had day-to-day variations, it had a basic structure that included a standardized initial warm-up with familiarization exercises, such as weightlifting exercises (WLE) and traditional resistance exercises (TRE, i.e., squats, bench press, and dead lifts), and the main "workout of the day" (WOD), which must be completed in the fastest time possible. The typical WOD included a mixture of functional exercises performed at high intensity targeting several muscle groups such as squatting, pushing, pressing, and jumping plus TRE with free weights and other equipment like Olympic horizontal bars and still rings, boxes, balls, or tires, and all arranged in high intensity circuits with short recovery periods.

Body Composition

On the first visit to the laboratory, the subjects' body mass and height were measured using a weighing digital scale (weighing digital scale Onron, China) and stadiometer (ES2020 – Sanny, Brazil). Immediately, body composition was assessed by means of skin folders using a skin folder caliper (AS1010, Sanny, Brazil). The sites for folder measurement were chest, tricipital, subscapular, axillar, supra-iliac, femoral, and abdominal. These measures were then used to calculate body density (18) and, subsequently, the subjects' percent of body fat (%BF) according to the equation of Siri & Brozek (8). The values of %BF were in time used to classify qualitatively the subjects according to their %BF as follows very bad, bad, mean, good, very good, or excellent (36).

Performance Measurements

On the same day of body composition assessment, a familiarization session with the testing procedures was carried out. One week later, the following tests were performed in random order and with at least 48 hrs recovery between tests: (a) maximum pull-ups repetitions (37); (b) a shuttle-run test (21); and (c) a countermovement jump (CMJ) (6). These bodyweight exercises were selected to evaluate very different physical fitness components without important restrictions for equipment, space, and time. All tests, with exception of the shuttle-run, were preceded by a 15-min standardized warm-up that included 10 min of moderate intensity aerobic exercise followed by 5 min of calisthenics.

The pull up is a multi-joint upper-body exercise that is considered a valid measure of weight-relative muscular strength (34). The pull-up test started with the subjects hanging from a stationary horizontal bar. Their hands were in a pronated position approximately shoulder width apart. At an auditory signal the subjects were instructed to perform the maximum number of repetitions possible without stopping and with the proper technique. A complete repetition was considered if the subjects' chin was above the bar with their elbows flexed at ~90º.

Aerobic fitness was assessed using the 20 m multistage shuttle run test (MSRT) (22). The MSRT is a simple and reliable test that is widely used to assess cardiorespiratory fitness in adults and yields a valid estimation of VO_2 max (20). Briefly, the test protocol consisted of 40 m (20 m + 20 m) shuttle-runs, starting with a speed of 8.5 $km·h^{-1}$ and with increases in speed of 0.5 $km·h^{-1}$ every 1 min. The subjects had to run between two lines guided by an auditory signal until volitional exhaustion. The test ended when the subjects stopped or when they failed to reach one of the lines in two consecutive occasions and the speed of the last completed stage were registered (i.e., maximal speed of the MSRT, S_{MSRT}). Verbal encouragement was given to all subjects. VO_2 max was estimated according to the following equation: VO_2 max = -27.4 + 6.0 × A; where "A" is the speed of the last completed stage in $km·h^{-1}$ (20). The results were used to qualitatively classify the subjects according to sex and age (1).

The countermovement jump (CMJ) was selected because is easy to perform and has been shown to be a measure of explosive strength of the lower limbs (6). The CMJ was recorded using a contact platform connected to a digital timer through an interface (ChronoJump-BoscoSystem). The flight time of each individual jump was recorded and converted automatically to jump height by the specific software that was connected to a computer (32). In each CMJ, the subjects were encouraged to jump as high as possible with the arms in akimbo position (in which the hands are on the hips and the elbows are bowed outward). The depth of each jump was freely chosen by the subjects (7). Each subject had three attempts with 1 min of recovery between jumps. The best jump was used for further analyses.

Statistical Analysis

Descriptive statistics were performed using means ± SD. Normality of the distributions was assessed by means of the Shapiro-Wilk test. Comparison between groups was carried out using *t* tests for independent samples. Cohen's d was also calculated for assessing the effect size (ES). All statistics were performed on BM SPSS Statistics for Windows® (Version 20.0; Armonk, NY), and the alpha level for significance was set at a $P<0.05$.

RESULTS

The subjects' characteristics and tests performances are shown in Table 1. Regarding %BF, 23.1% were classified as "mean", 34.6% "good", 19.2% "very good", and 23.1% "excellent" while there were no significant differences between groups. There were also no significant differences regarding performance in the tests related to muscle strength (i.e., CMJ and fixed bar pull-ups, Table 1). Although there were no significant differences, the RT group achieved a higher number of pull-up repetitions (ES = 0.67) compared to CF. The CF subjects showed a greater CMJ height (ES = 0.73) compared to the RT subjects, but the differences was not significant.

Table 1. Participants Characteristics and Tests Performances.

	RT (N = 13)	CF (N = 13)	P	Effect Size (d)
Age (yrs)	24 ± 4	26 ± 3	0.81	0.56
Body Mass (kg)	82.70 ± 11.24	84.9 ±12.8	0.63	0.18
%BF	11.9 ± 4.1	13.6 ± 4.6	0.34	0.39
Height (cm)	178.7 ± 6.6	174.5 ± 5.2	0.83	0.70
$\mathbf{S_{MSRT}}$ (km· h^{-1})	12.08 ± 1.2	13.31 ± 0.9	0.008	1.16
$\mathbf{VO_2}$ **max** (mL·kg^{-1}·min^{-1})	45.98 ± 5.28	52.45 ± 5.55	0.006	1.22
Pull-Ups (reps)	11 ± 3	9 ± 6	0.31	0.67
CMJ (cm)	35.85 ± 7.1	41.08 ± 7.7	0.86	0.73

RT = resistance training; **CF** = Crossfit®; $\mathbf{S_{MSRT}}$ = maximum speed of the multistage shuttle run test; $\mathbf{VO_2}$ **max** = estimated maximal oxygen uptake; **%BF** = percentage of body fat; **CMJ** = countermovement jump.

Finally, there were significant differences between CF and RT for VO_2 max (P = 0.006, ES = 1.22) and S_{MSRT} (P = 0.008, ES = 1.16). Accordingly, for aerobic fitness and using the ACSM guidelines (1), 30.8% of the subjects in the RT group were classified as “regular”, 61.5% as “good”, and 7.7% as “excellent”, while 46.2% of the CF group were classified as “good” and 53.8% as “excellent”.

DISCUSSION

The main objective of the present study was to verify if there were significant differences in physical capacities such as explosive and dynamic strength and aerobic fitness between recreational CF and RT participants. Firstly, subjects of both groups scored a higher number of repetitions in the pull-up test compared with adults of similar age (23), as for CMJ, the results observed for the entire sample are similar to those shown for age-matched male athletes in sports like soccer, (28). Interestingly, we found no significant differences between CF and RT regarding upper body relative strength (pull-ups) and explosive strength (CMJ height), although the ES for the differences (0.67 and 0.73 for pull-ups and CMJ height, respectively) suggest that these differences might achieve significance with a larger sample.

At the same time, there were strong significant differences in aerobic fitness (ES = 1.22, see Table 1). Therefore, based on the magnitude of ES for strength and aerobic measures, it appears that CF is as effective as the traditional RT for the development of muscular strength while CF seems to be also effective in developing cardiorespiratory fitness. However, caution must be exercised when interpreting these results due to the cross-sectional nature of the current study.

Although there is relatively little research on chronic training responses to CF, it seems that likely this type of exercise could be an effective means to increasing aerobic fitness. In fact, the higher aerobic fitness observed for the CF subjects in our study is in line with previous research showing that CF is associated with an high aerobic performance (30,38), VO_2 max and body composition (27), and that aerobic capacity is associated with success in CF competitions (29). Moreover, one of the few longitudinal studies by Smith et al. (38) showed that 10 wks of CF training elicited a significant increase in VO_2 max concomitant with a reduction in %BF in healthy men and women. More recently, Murawska-Cialowicz et al. (27) observed that 3 months of CF training led to a significant increase in VO_2 max in women but not in men, with concomitant increases in upper and lower limb circumferences and lean body mass in both groups. While in our study both groups showed %BF values within the normal range for age and sex (36), there were no significant differences between CF and RT in %BF or body mass. This finding could suggest that chronic CF training may have contributed to the higher aerobic fitness observed in the CF subjects. Thus, based on our observations and the results from previous research (27,30,38), it appears that CF training has the potential to develop aerobic fitness at least when compared to RT using the ACSM guidelines.

In line with the previous discussion, the frequent utilization of cyclic activities (such as rope jumping) in CF training could be a factor that contributes to an improvement in aerobic fitness by increasing systolic volume and cardiac output. Yet, to the best of our knowledge, there is a lack of studies that should be addressed in future research regarding cardiovascular adaptations to chronic CF training. On the other hand, it has been proposed that increased endurance capacity is also related to gains in muscle strength and, more specifically, in lower limb explosive strength (31). In particular, neuromuscular improvements in conjunction with a better re-utilization of elastic energy at the muscle-tendon junction could favor a lower energy cost and higher running economy for the same exercise intensity (31). Given that VO_2 max was estimated from S_{MSRT} and muscular strength can influence speed, it is possible that the greater lower limbs explosiveness, as reflected in the higher jump capacity of the CF group versus the RT group (ES = 0.73), may be one of the mechanistic causes of the higher S_{MSRT} observed in the CF subjects. Consequently, it is tempting to argue that CF can improve running capacity by acting at both central and peripheral levels. Additional studies are needed to bring clarity to this issue.

In reviewing the methods commonly used to train vertical jump performance, it has been pointed out that strength training with weightlifting exercises (32-34), plyometric exercises (10,11,25), or a combination of both exercises (35) are effective means to improving jumping performance. This appears to be related, at least partially to the influence of muscle contraction speed on strength gains (3). Furthermore, Pareja-Blanco et al. (33) recently observed an increase in maximum strength and CMJ height with high speed RT. On the other hand, it also been noted that increases in maximal power output following traditional RT are prominent only in the early phases of training (10). In this regard, it should be noted that the RT group in our study trained based on the ACSM guidelines for resistance exercise, while the CF group used a variety of different exercises including weightlifting and jump exercises. Therefore, we would expect that the CF subjects in our study exhibited higher values of muscular strength when compared with those in the RT group. However, both groups showed similar levels of explosive and dynamic muscular strength, although with moderate differences in both exercises based on the ES.

As previously noted, CF can be considered a form of concurrent training. Based on previous research (17,24,40) showing a compromised muscular strength development with concurrent training, it should not be surprising that the CF subjects exhibited similar values of muscular strength than the RT subjects as a consequence of the ‘interference effect’ that could have occurred with the CF training. This contention could also be partially supported by the recent results of Drum et al. (13), who compared CF and ACSM based training and found that CF training led to significantly higher levels of perception of effort and post-exercise fatigue symptoms than the ACSM based training. Thus, further studies are warranted to determine the level of interference between aerobic and muscular adaptations in CF practitioners when compared to other training modalities, especially when performing >3 sessions$\cdot$wk^{-1}.

Limitations of the Study

There are several limitations of our study. First, despite the heterogeneity of the subjects, the sample selection (by convenience) does not always allow considering the studied sample as representative of all CF and TR participants, especially the experienced athletes. Second, being a cross-sectional and observational study, we were not able to collect the training logs of the subjects (mostly because they did not keep training diaries). Had they done so, it might have allowed for a deeper insight regarding the effect of training variables on the measured outcomes. Third, there was also no control of the subjects’ nutritional status, which is likely to have influenced the training responses and adaptations. Finally, despite the popularity of non-conventional training methods for developing physical fitness, there is still a paucity of studies regarding the effects of this type of training on the improvement of different physical capacities or comparisons with other training protocols. Thus, the mechanisms by which CF and other popular methodologies improves physical fitness remain speculative. In this context, it is suggested that popular training methods such as CF may be an effective means to improving physical fitness in healthy individuals by improving both aerobic and strength training measures when compared to RT alone. Additionally, our results could contribute to a better understanding of the role of these popular training modalities on physical fitness for health while stimulating future research in this field.

CONCLUSIONS

The findings in the present study showed no significant differences on body composition, upper body dynamic strength, and lower body explosive strength between the CF and RT subjects. However, ES analyses revealed some differences for muscular strength of the upper and lower limbs between training modalities. Moreover, although all subjects had a “good” cardiorespiratory fitness, there were significant differences in aerobic capacity between the groups (with higher values for the CF subjects). Further longitudinal studies are warranted for a better understanding of physical training adaptations following these and other popular fitness modalities.

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