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SHORT REPORT OPEN ACCESS

EFFECT OF CROSSFIT™ ON HEALTH-RELATED PHYSICAL FITNESS: A PILOT STUDY

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ABSTRACT

PURPOSE: CrossFit™ is a novel training modality but empirical support of its effectiveness is lacking (1). The purpose of the current study was to: 1) examine the effect of CrossFit™ on health-related physical fitness, and 2) to compare the effects of CrossFit™ against matched participants in a traditional training program. **METHOD.** Pre- and post-assessments of body composition, upper-body muscular endurance, muscular power, and hamstring flexibility were conducted on 25 male CrossFit™ participants (*Age:* 22 ± 3 yrs, *Weight*: 91 ± 14 kg, *Waist/Hip Ratio*: 0.87 ± 0.06, *Moderate Activity Minutes*: 239 ± 191) and 25 male traditional resistance program participants matched on baseline push-up and vertical jump performance. CrossFit™ participants were also assessed on pre- and post-aerobic capacity. Percent change was used to examine the effect of CrossFit™ over twelve weeks of training and ANOVA was used to examine the fitness change differences between groups. **RESULTS**. CrossFit™ participants improved aerobic capacity (6%) and muscular endurance (22%) with the mean change in endurance differing significantly from the traditional training group (p = 0.004). **CONCLUSION.** CrossFit™ Basic Instruction Program (BIP) courses may be a viable option to traditional weightlifting programs in terms of health-related physical fitness improvement and/or maintenance.

Keywords: Aerobic fitness, Muscular fitness, Training Adaptations

INTRODUCTION

CrossFit™ is a relatively new training program that is gaining favor as a non-traditional resistance training modality (2). Smith and colleagues (2) published one of the seminal studies on CrossFit™ and reported improved aerobic fitness and body composition among middle-aged adults following ten weeks of training. However, this study did not address other components of health-related physical fitness and because individuals desire varied benefits from resistance training, it is imperative to examine

CrossFit™ adaptations across all areas of health-related physical fitness.

In an attempt to extend research in this area, Barfield and colleagues (3) examined the effect of a functional fitness program on four components of health-related physical fitness. Functional fitness training is similar to CrossFit™ in that it incorporates high-intensity, short-rest programming. Although functional training is not the same as CrossFit™, it does provide evidence on the potential effectiveness of these training programs. Barfield et al. (3) reported improvements in muscular endurance and muscular power following twelve weeks of functional training among young adult males. However, participants matched by training experience and baseline strength who participated in a traditional weightlifting program demonstrated greater muscular fitness gains across the twelve weeks. Because functional training in this study was not lead at a CrossFit™ facility by certified instructors, caution is warranted in extrapolating these findings to CrossFit™ training adaptations.

The current pilot study seeks to extend the previous work in this area by examining the effect of CrossFit™ on all four health-related physical fitness components (i.e., aerobic fitness, muscular fitness, body composition, and flexibility). To provide context for the purported results, the secondary purpose was to compare effects to those demonstrated by matched participants in a traditional resistance training program.

METHODS

Participants

Participants (*N* = 50) were recruited from intact college weightlifting courses or CrossFit™ courses contracted through the university. To ensure groups were similar at baseline, participants were matched on muscular endurance and muscular power (i.e., Vertical Jump). Baseline data indicated that group participants were similar in terms of age, physical activity level, and body type (Table 1). IRB approval was obtained prior to the study and all participants signed inform consent before participation. There was no coercion as participants could participate in the either program without participating in the research study.

Table 1. Baseline Demographics (M ± SD, N = 50)

		CrossFit	*Traditional*
Demographics	Age (yrs)	22 ± 3	20 ± 2
	Height (m)	1.82 ± .05	1.78 ± .04
	Weight (kg)	91 ± 14	84 ± 15
	Moderate Physical Activity Minutes*wk^{-1}	239 ± 191	230 ± 200
	Vigorous Physical Activity Minutes*wk^{-1}	131 ± 155	153 ± 216
Matching Variables	Push-Ups	31 ± 13	30 ± 13
	Vertical Jump	23 ± 3	22 ± 4

Instruments

All instruments were selected from the American College of Sports Medicine's (ACSM) health-related physical fitness assessments (4) with the exception of the vertical jump (5). Assessments targeted typical health-related domains and were selected from tests used in previous work on the topic (2-3, 6).

Aerobic Fitness.

CrossFit™ instructors administered the 1.5 mile run. This option was presented because it can be used to predict $VO_{2\ Max}$. However, because of the training goals of the traditional group (i.e., muscular strength), weightlifting participants did not complete this test.

Muscular Fitness.

The push-up and the no-step vertical jump were administered to assess muscular endurance and muscular power, respectively. The push-up requires participants to touch their chin to the mat and the score is the number of continuous repetitions.

Body Composition.

Wasit:hip ratio was used to assess body composition. This method was chosen over body mass index because of the atypical muscle mass inherent among active, college-aged males.

Flexibility.

The YMCA sit-and-reach test was used to assess hamstring flexibility.

Procedures

Testing was conducted during the first two weeks (baseline) and the final week (post-test) of the course semester. The lead researcher trained all program instructors on testing procedures and the instructors, in turn, conducted all baseline and post-testing. This method ensured that all participants were tested by the same raters and under the same conditions for both the pre and post assessments. All participants attended training sessions at a frequency of twice per week and completed a minimum of 24 of the 28 training sessions.

To determine the effects of CrossFit™ relative to traditional resistance training, it was imperative to administer distinct programs to similar groups under similar conditions. Matching participants on two performance variables (i.e., muscular endurance and muscular power) was an effective means of selecting two training groups. Although training outside of class was not prevented, the similar physical activity levels and training conditions allowed the training program to be the major distinction between training groups.

CrossFit™ Training Program.

Participants traveled off-campus to participate in the contracted CrossFit™ training led by two certified instructors at their own facility. Classes consisted of 10 students and programming consisted of a non-linear design emphasizing high-intensity resistance training with self-selected rest between repetitions and sets. Each session started with a 10-minute dynamic warm-up, followed by 15 minutes of technique instruction and 10-25 minutes of CrossFit™ training. For a detailed description of CrossFit™ training sessions, see Smith and colleagues (2). In general, this training includes varied gymnastic and multi-joint exercises (e.g., squats, Olympic lifts) organized into: a) maximum repetitions to be completed within a given time period, or b) a given repetition goal to be completed within the shortest time possible. As a rule, training sessions are characterized by high-intensity exercise with minimal rest.

Traditional Resistance Training Program.

The traditional resistance training class was led by one experienced campus instructor. Classes consisted of 16 students and programming consisted of a linear periodized program with appropriate rest between sets. Each session started with a 10-minute dynamic warm-up, followed by 10 minutes of resistance warm-up (e.g., full-body exercises) and 25 minutes of traditional weightlifting. Training addressed hypertrophy [3 sets, 8-12 repetition maximum (RM), 45 seconds rest], strength (3-5 sets, 3-6 RM, 90 seconds rest), and power (3-5 sets, 2-3 reps of low- to moderate-intensity weight, 90 seconds rest). In general, training included core multi-joint exercises (e.g., bench press, deadlift, squat) with supporting multi- and single-joint lifts. Although frequency of training was matched between groups, training volume was not.

Analysis

Percent change was computed to examine improvement on each dependent variable in each group. Separate independent groups ANOVA (p <0.01) were used to examine fitness change score differences between groups.

RESULTS

CrossFit™ participants improved aerobic fitness (6%) and upper body muscular endurance (22%) but did not demonstrate improvement in muscular power, body composition, or flexibility (Table 2). Fitness changes were greater among CrossFit™ participants on muscular endurance (F = 9.14, df = 49, p = 0.004) compared to traditional weightlifting participants. Better waist:hip changes were noted in the traditional class (0% vs. -3%).

Table 2. Fitness Changes (M ± SD) across the Semester by Resistance Class Type

		CrossFit (N = 25)	*Traditional* (N = 25)
Aerobic Fitness	Baseline 1.5	41.49 ± 8.00	
	Post 1.5	43.90 ± 7.32	
	Percent Change	-6%	
Body Composition	Baseline Waist:Hip	0.87 ± 0.06	0.89 ± 0.05
	Post Waist:Hip	0.87 ± 0.08	0.86 ± 0.09
	Percent Change	0%	-3%
Muscular Fitness	Baseline Push-Ups	31 ± 13	30 ± 13
	Post Push-Ups	38 ± 11	30 ± 9
	Percent Change	22%	0%
	Baseline Vertical Jump	23 ± 3	22 ± 4
	Post Vertical Jump	23 ± 3	22 ± 3
	Percent Change	0%	0%
Flexibility	Baseline Sit-and-Reach	4.5 ± 3.0	2.5 ± 3.0
	Post Sit-and-Reach	4.5 ± 2.5	2.5 ± 3.0
	Percent Change	0%	0%

DISCUSSION

The purpose of the current study was to examine the effect of CrossFit™ on health-related physical fitness. The secondary purpose was to compare the effects of CrossFit™ against matched participants in a traditional resistance training program. Findings from the current study support aerobic and muscular endurance benefits from CrossFit™ training. Similar, if not greater, improvement on health-related physical fitness variables occurred following CrossFit™ training compared to traditional resistance training. The results from this pilot study support the use of CrossFit™ as an alternative resistance training modality.

Findings from the current study are consistent with the aerobic benefit of CrossFit™ reported by Smith and colleagues (2). These authors reported a 13.6% improvement in $VO_{2\ Max}$ among young adult men following ten weeks of CrossFit™ training. It is worth noting that although our participants demonstrated a similar pattern (i.e., improved aerobic fitness), the current findings were not as substantial despite the younger sample (6% vs. 14% improvement). This difference is likely explained by the lower training frequency, as current participants were limited to two sessions per week.

CrossFit™ training has a high aerobic stimulus due to minimal rest periods; therefore, the improvement in aerobic fitness among CrossFit™ participants was not surprising (Table 2). Current findings are consistent with the work of Astorino and colleagues (6), who reported a 6% increase in $VO_{2\ Max}$ among young men who completed 6 sessions of high intensity training (4-6 Wingate tests per session). Although Asotrino et al. (6) did not examine CrossFit™ participants, the consistent high intensity exercises were an appropriate comparison to the current training program.

Current findings conflict with a prior study on functional fitness training. Barfield and colleagues (3) reported a 7.5% improvement in upper body muscular endurance following functional training and even greater improvement (18%) among traditional weightlifting participants. Current findings support a much greater training adaptation for muscular endurance among CrossFit™ participants (22%). Our results clearly indicate how training setting and instructor affect adaptations within high-intensity training programs. We incorporated a similar sample, training intensity, training frequency, and training mode as aforementioned study (3). The primary distinctions between the two studies were the trainers (i.e., certified CrossFit™ in the current design) and location (i.e., CrossFit™ facility in the current design).

There are a couple of limitations to the current study. We chose general health-related physical fitness variables to ensure neither group had a training-specific advantage; however, given the lack of improvement on several muscular fitness items (e.g., vertical jump), examination of training-specific variables is warranted. It is likely that traditional weightlifting participants would demonstrate greater grains on certain muscular fitness variables such as strength. Also, we did not match training volume. It is difficult to match volume between linear (i.e., traditional) and non-linear (i.e., CrossFit™) programs. A valid means of matching work output must be developed if empirical comparisons between traditional and non-traditional programming continue.

PRACTICAL APPLICATIONS

CrossFit™ training is a popular commercial program but empirical research on its effectiveness is lacking. The current study extends the formative work on this topic and documents chronic adaptations resulting from this non-traditional training program. Additionally, the current study demonstrates similar fitness adaptations between CrossFit™ and traditional programming.

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