EXERCISE SCIENCE

Format of Basic Instruction Program Resistance Training Classes: Effect on Fitness Change in College Students

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Abstract

New resistance training programs such as CrossFit are gaining favor among college-aged students. CrossFit and related commercial resistance training programs may provide a valuable elective option within basic instruction program (BIP) curricula, but the fitness benefits of this course have not been compared with those of existing BIP resistance training classes. The purpose of this study was to examine the effect of different formats for BIP resistance training classes (traditional, independent, and CrossFit) on changes in fitness over the course of a semester. Participants (N = 60; M_{Height} = 173.60 ± 8.63 cm; M_{Weight} = 76.45 ± 17.00 kg) were recruited from six existing resistance training classes and were matched for age, sex, training experience, and total exercise sessions completed. Fitness measures included body composition (body mass index), muscular strength (hand grip), muscular endurance (1-minute

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squat, pull-up test, and YMCA bench press test), and muscular power (standing long jump). Testing was performed at the start and end of a semester, and the change in score was computed for each fitness variable (before – after). Independent group analysis of variance (ANOVA) was conducted on each change to determine the effect of course format on fitness. Changes in two fitness variables differed significantly ($p < .008$*) by class format. The mean increase in muscular power was significantly greater among participants in traditional versus CrossFit classes, who in turn gained significantly greater muscular power than those in independent classes. The gain in upper body muscular endurance (YMCA bench press) also was significantly greater among participants in traditional classes compared with independent group participants (*$p < .05$*). CrossFit-type resistance training programs may yield greater fitness gains than unsupervised programs but may not yield the same benefits as traditional BIP resistance training courses.*

Due to limited finances and personnel resources, colleges and universities often target physical education basic instruction programs (BIP) for budget cuts and curriculum reduction (Crawford, Greenwell, & Andrew, 2007). More than 90% of higher education institutions required collegiate BIP credits for graduation in 1960, but that number dropped to less than 63% by 1998 (Hensley, 2000). Despite institutional reductions in required BIP credits, these courses remain popular among undergraduates. Many colleges and universities report that between 25% and 30% of the student population enrolls in a physical education BIP annually, and more than 80% of students say they would choose a physical education BIP over another elective if given the opportunity (Hensley, 2000).

Motivations for taking a BIP course have remained fairly consistent. The most commonly reported motivations are fitness improvement, fun/enjoyment, participation in regular exercise, and exposure to a new skill or activity (Cunningham, 2007; Roberts, Evans, & Ormond, 2006). Although groups of students participating in required versus elective BIP classes show little variation in motivation overall, notable differences are apparent between the sexes. Male students have indicated greater interest in competition, whereas female students have expressed a greater desire to improve body image (Hardin, Andrew, Gi-Yong, & Berniller, 2009). Of

interest, few students have reported improvement in grade point average as a primary motivation for taking a BIP course.

Given typical student interest and demand, it is not surprising that the most popular BIP courses are physical fitness activities (Hensley, 2000). Fortunately, these courses have demonstrated important behavioral (i.e., activity) and fitness outcomes. In a survey of 188 students enrolled in various aerobic fitness courses, Roberts et al. (2006) reported that 93% improved their aerobic performance over the course of a semester. Additionally, 94% of BIP participants stated that their understanding of physical fitness concepts improved and 95% claimed they had gained the knowledge to design and implement their own fitness programs (an increase from 63% before enrollment). Finally, more than 80% of alumni from the same institution reported that their college physical education BIP had positively affected their physical activity habits. Clearly, BIP courses provide a valuable service to undergraduate college students; however, given the reality that colleges may choose to reduce or eliminate such opportunities, delivery of BIP courses must be of sufficient quality and interest to maximize student interest and therefore enrollment (Crawford et al., 2007; Russell, 2008).

Common BIP courses focusing on physical fitness include a variety of lifetime activities, including resistance training. In the latest national survey of collegiate BIP programs, resistance training courses trailed only fitness/aerobic courses in terms of popularity (Hensley, 2000). Resistance training, traditionally termed *weight training,* has been offered through various BIP course formats, including traditional classes, independent classes, and commercial classes such as CrossFit. The advantages and disadvantages of each format are described below.

Traditional Class

The traditional class format consists of a BIP instructor leading students through a training program during regularly scheduled class times. The instructor is typically a graduate student or athletic coach, and the course is typically offered in the academic or athletic departments' facilities. The benefits of this course format include the potential for proper instruction and supervision of resistance exercise as well as adequate mentoring. Given that academic administrators rank development of lifelong participation and basic skill competency as primary BIP course goals (Hensley, 2000), this course format offers a sound teacher–learner environment in

which to help students toward these goals (e.g., direct instruction and supervision). The major concern with the traditional class format is instructor qualification. Coaches assigned to teach these courses may not have expertise with nonathletic populations, and graduate assistants assigned to teach the course might not yet have the experience to instruct students on correct form.

Independent Class

An independent class format includes a BIP instructor who provides a semester-long training program, but students complete the program unsupervised on their own time. One primary benefit of this format is enhanced flexibility for students. Colleges and universities are experiencing declines in BIP enrollment, and institutions must identify formats that interest a larger student base (Crawford et al., 2007). This course format also enables students to use facilities open to the college community at large. Rather than requiring students to exercise around other academic or athletic activities, the independent class format allows students greater flexibility in choosing when and where to exercise. The primary limitation to this class format is the limited teacher–student interaction. Students who enroll in BIP courses want to improve fitness, want quality instruction from instructors, and desire social interaction with peers (Roberts et al., 2006; Russell, 2008). The independent class format inhibits both an instructor's influence on students, due to limited course meetings, and affective benefits from regular peer interactions.

CrossFit Class

Many institutions contract BIP courses to local exercise or sport organizations. This practice is typically used for golf and bowling courses when the university does not have access to proper facilities. However, universities will also contract with exercise facilities to offer the latest popular resistance training programs (e.g., Curves). Recently, new resistance training programs, generally termed *muscle confusion* programs, have emerged and are gaining favor among college-aged students. CrossFit is one example. These programs are similar to traditional BIP courses in that the program emphasizes typical fitness variables (muscular endurance, strength, flexibility, and power); however, they differ from traditional training programs in that they emphasize the use of one's own body weight as the major resistance stimulus and require variation in exercise intensity within each session to stress different metabolic pathways. Such

variety of training may provide an entertaining course within a BIP curriculum. Given that student interest in and perceived quality of BIP courses are imperative to repeat enrollment (Crawford et al., 2007), CrossFit-type programs therefore might increase student interest and demand.

Although students value BIP courses for many reasons, improvement in fitness is certainly a common theme (Russell, 2008). Unfortunately, which of the aforementioned class formats yields the greatest fitness gains is unknown. Because BIP consumers (i.e., students) desire improved fitness from BIP courses, examining fitness outcomes is necessary among various resistance training formats before inclusion into BIP curricula. The purpose of this study was to examine the effect of BIP course format (traditional, independent, or CrossFit) on fitness changes over the course of a semester.

Methods

Participants

Participants were recruited from six intact BIP resistance training classes at a regional university (~10,000 students). Although a total of 87 students participated in the study, the final sample was delimited to match participants for age, sex, training experience, and total exercise sessions completed. Because out-of-class activity could confound the analysis of fitness change, students who were collegiate athletes or Reserve Officer Training Corps (ROTC) cadets were excluded from the study. The university's institutional review board approved the study before enrollment began, and each student provided written informed consent before any study procedures took place.

Instruments

Several instruments were used to assess fitness and fitness changes over the course of the semester. Field tests of fitness were chosen over laboratory tests for two reasons. First, tests were selected to complement, not detract from, the scheduled resistance training course. Specifically, tests that could be used as both an exercise and an assessment (e.g., pull-ups) were selected over performance-based tests that were not part of the class format (e.g., one-repetition maximum). Second, assessment instruments that could be used by BIP programs (or researchers wanting to duplicate the current study

within BIP programs) were prioritized over alternative laboratory measures not accessible to a BIP setting. All testing was conducted by the research team rather than by coaches or academic department instructors to maximize the internal validity of the findings. All researchers had experience in strength and conditioning assessment and were present for all baseline and poststudy assessments.

Body composition. Body mass index (BMI) was computed (as kg/m^2) as an indirect measure of body composition. The BMI does not assess body fatness but rather is a measure of overall health risk (American College of Sports Medicine, 2005). Because BIP consumers have reported the desire to improve health-related physical fitness rather than performance, a noninvasive measure of health risk was considered appropriate for the study.

Muscular strength. A hand grip dynamometer test was used to assess muscular strength. Standard administration procedures were used: Participants held the dynamometer (Model LA-78010, Lafayette Instrument Company, Lafayette, IN) parallel to the side of the body at waist level (American College of Sports Medicine, 2005). Three trials were collected, with the highest right and left hand scores summed to obtain the hand grip score (kg).

Muscular power. The standing long jump (cm) was used to assess muscular power. This test requires the participant to stand behind a starting line and perform a countermovement just before jumping forward as far as possible. The score represents the best of three jumps recorded to the nearest cm (Baechle & Earle, 2008).

Muscular endurance. A standard pull-up protocol was used to assess arm and shoulder girdle endurance (Baumgartner, Jackson, Mahar, & Rowe, 2007). Participants began each attempt from a free-hanging position with arms extended. Using an overhand grip, participants were required to pull the body upward until the chin crossed the bar and then lower the body to full arm extension before beginning the next attempt. The score was the total number of completed attempts, and kicks or kip movements were not allowed. A 1-minute body-weight squat test was used to assess lower body muscular endurance. This test is not well documented in the literature, but it is used in practice as an alternative to timed push-up or sit-up tests of upper body endurance (Baumgartner et al., 2007). Participants had to complete as many squat repetitions as possible within 1 minute, and they had to touch their buttocks to a 9-kg medicine ball underneath for a repetition to be counted. The YMCA

bench press test was used to assess upper body muscular endurance (American College of Sports Medicine, 2005). As required for the YMCA bench press, a 30-repetition-per-minute cadence was used with the appropriate resistance for men (80 lbs/36.36 kg) and women (35 lbs/15.9 kg). Whereas the standard bench press assesses the total weight lifted for a set number of lifts (e.g., one-repetition maximum, 10-repetition maximum), the YMCA bench press test assesses the total repetitions completed with the specific weight at a specific cadence. The score for this test is the total repetitions completed on cadence until fatigue develops.

Study Procedures

Participants completed either a traditional resistance training class (supervised by a BIP instructor), an independent resistance training class (identical prescription to the supervised class, completed on each participant's own time), or a CrossFit class (supervised by a researcher). Recruitment, training, and testing occurred through two intact sections of each course type, and all sections used the same foundational exercises in their respective programs. To maximize the internal validity of the study, the complete traditional, independent, and CrossFit programs were designed by one member of the research team (C.P.). This member is a certified CrossFit instructor, certified strength and conditioning specialist, and current head strength and conditioning coach at the university. The research team agreed that having one person design all weekly training activities was the most effective method to match training volumes across class types to the extent possible, so that fitness changes would primarily reflect course type rather than course instructor (some instructors may choose more/less training). Closed-chain exercises were given high priority in the program design because this type of activity is integral to both traditional and CrossFit programs. Participants in each course section were also given exercise demonstrations and assistance with technique at the start of the study. Daily warm-up and cooldown procedures were identical for the traditional and CrossFit classes (Table 1). Examples of the traditional and CrossFit training prescriptions are provided in Table 2.

All participants completed fitness testing in the same order. Baseline testing was conducted on the third day of academic classes, allowing the research team to describe the project, describe and demonstrate typical exercises, and convey specific testing procedures before baseline. After baseline testing, students in the traditional and

Table 1

Standard Warm-Up Exercises for Traditional and CrossFit Classes

Component	Repetitions	Exercise	Links to Video Demonstrations
Warm-Up	10	Squat Thrusts	http://www.youtube.com/watch?v=rpDRwxR6jHI
	30	Seated Twists	http://www.youtube.com/watch?v=ZmAglEpgKUY
	15	Body Squats	http://www.youtube.com/watch?v=EASDW3pAO7U
	5	Inch Worms	http://www.youtube.com/watch?v=yr-HHgxXTqg
	10	Push-Ups	http://www.youtube.com/watch?v=ynPwl6qyUNM
Cooldown	10	Roll-n-Reach	http://www.youtube.com/watch?v=pyGIUdkJVh0
	20	Knee Hug on Ground	http://www.youtube.com/watch?v=gc7cs3SmpUk
	20	Lumbar Knee Rock	http://www.youtube.com/watch?v=H1FeFkzfKCQ
	20	Static Squat Stretch	http://www.youtube.com/watch?v=bUKWnGcu5Ss
	20	Static Standing Toe Touch	http://www.youtube.com/watch?v=Xvr5N_Xf6QM
	10	Trunk Twist	http://www.youtube.com/watch?v=RunSwduad8Y

Table 2

Resistance Training Program Examples

Program Type	Traditional Program	Independent Program	CrossFit Program
Session	Week 1 - Day 1 Warm-Up	Week 1 - Day 1 Warm-Up	Week 1 - Day 1 Warm-Up
Focus Area 1	**Strength Work**	**Strength Work**	**Strength Work**
	Front Squat - 4 sets of 10 Bench Press - 4 sets of 10	Front Squat - 4 sets of 10 Bench Press - 4 sets of 10	Front Squat - 4 sets of 10 reps —
Focus Area 2	**Assistance Work**	**Assistance Work**	**Metabolic Conditioning Circuit***
	Kettle Bell Swing - 3 sets of 12 Pull-Ups - 3 sets of 8 Sit-Ups - 3 sets of 8** — Cooldown	Kettle Bell Swing - 3 sets of 12 Pull-Ups - 3 sets of 8 Sit-Ups - 3 sets of 8** — Cooldown	60% Bench Press - 5 reps Kettle Bell Swings - 5 Pull-Ups - 5 Sit-Ups - 10 Cooldown

*As many rounds as possible in 10 minutes. **With medicine ball.

CrossFit classes could participate in two class sessions per week for a total of 10 classes, followed by spring break (1 week). At the conclusion of the break, students again could participate in two class sessions per week for a total of 10 classes before poststudy testing. All class sessions were 55 minutes long and were offered on a Monday/Wednesday or Tuesday/Thursday schedule. Testing order was standard across all course sections and both testing time periods. Specifically, participants first completed height, weight, and hand grip testing before performing a standardized warm-up (i.e., dynamic low-intensity body-resistance exercise). Hand grip assessment does not require the same warm-up necessary for large muscle groups and was assessed prior to the standardized warm-up to ensure all testing could be completed within one class session (set rotation between assessment of height/weight and grip strength). Participants then completed two to three trials of the standing long jump, followed by one trial each on the pull-up test, 1-minute squat test, and YMCA bench press test. Participants had 4–5 minutes between each test item, and the same data collectors were present for both the pre- and poststudy administrations. The research team also assessed 14 individuals not participating in the study to ensure scoring consistency for each test item.

Analysis

After the poststudy testing, participants were matched for age, sex, experience level (beginner or regular weight trainer), and years of resistance training experience. To determine how each course type affected fitness, the percentage change (from pre- to poststudy test score) was computed for each test item for each group. To examine statistical differences among groups, change scores were computed for each dependent muscular fitness variable (pre- minus poststudy value) and separate independent group analysis of variance (ANOVA) were conducted to determine whether course type (traditional, independent, or CrossFit) significantly affected mean fitness changes. The α (.05/6 ANOVA tests) was set at .008 to reduce the risk of type I error associated with multiple comparisons (Dunn, 1961). We performed least-significant-difference post hoc comparisons when a significant difference was detected.

Results

Of the 87 students who participated, 60 were matched for age, sex, experience level, and years of resistance training. The mean height of the 45 male and 15 female students was 173.60 ± 8.63 cm, and their mean weight was 76.45 ± 17.00 kg. As shown in Table 3, each group had a variety of training experiences. Class standing was distributed across academic levels, including a good mix of freshmen (n = 16), sophomores (n = 22), juniors (n = 12), and seniors (n = 10). Participants reported "improvement of muscular fitness" and "improvement of overall health" as the most common reasons for enrolling in the resistance training courses.

Mean baseline and poststudy fitness scores are reported by group in Table 4. Mean change scores differed significantly (p < .008) by class format for two fitness variables: muscular power as measured by standing long jump (F = 11.14, $d.f.$ = 57) and upper-body muscular strength as measured by YMCA bench press (F =

Table 3

Characteristics of the Students by Class Format

	Traditional Class	Independent Class	CrossFit Class
Mean (standard deviation)			
Age	20.30 (1.49)	20.15 (1.81)	19.90 (1.89)
Sessions Completed	15.00 (4.06)		15.50 (3.90)
Years of Experience	2.40 (2.41)	2.22 (2.09)	2.38 (2.34)
Number			
Males	15	15	15
Females	5	5	5
Beginners	11	11	11
Regular Weight Trainers	9	9	9

Note. Regular weight trainers were defined as individuals participating in resistance training two or more times per week at study baseline.

Table 4

Mean Changes in Fitness Variables With Standard Deviations

	Traditional Group	Independent Group	CrossFit Group
Body Mass Index (kg/m^2)			
Before	24.30 (2.20)	25.12 (5.88)	25.71 (5.04)
After	24.08 (2.19)	25.31 (6.10)	26.22 (5.05)
Percent Change (%)	-0.9	0.8	1.98
Handgrip (kg)			
Before	91.90 (22.30)	87.55 (19.72)	85.52 (25.06)
After	96.90 (23.10)	97.50 (22.46)	93.20 (24.80)
Percent Change	5.4	11.4	9.0
Standing Long Jump (cm)			
Before	199.60 (32.20)	195.60 (35.80)	182.10 (38.40)
After	214.60 (34.40)	194.70 (34.70)	188.00 (39.50)
Percent Change	7.5	-0.5	3.0
Pull-Ups (number)			
Before	4.60 (4.02)	3.70 (3.99)	3.15 (5.04)
After	7.20 (4.90)	4.55 (4.57)	4.50 (6.34)
Percent Change	56.5	23.0	42.9
Squat Thrusts (number)			
Before	46.25 (7.20)	49.55 (6.44)	42.55 (10.01)
After	53.00 (8.08)	55.15 (7.896)	52.95 (7.05)
Percent Change	14.6	11.3	24.4
YMCA Bench Press (repetitions on cadence)			
Before	23.70 (8.56)	25.70 (11.12)	22.55 (13.09)
After	28.00 (9.63)	23.80 (9.485)	24.25 (9.70)
Percent Change	18.1	-7.4	7.5

5.86, *d.f.* = 57). For muscular power, the mean improvement was significantly greater among traditional participants than among CrossFit participants, who in turn showed a significantly greater mean gain than did the independent participants. For upper body muscular strength, traditional group participants showed a significantly greater mean gain in the YMCA bench press compared with independent group participants, with this comparison being the only significant difference.

In general, traditional group participants had the most consistent gains across all test items. They were the only group to show a reduction in BMI and greater than 5% improvement on all muscular fitness variables over the semester (Table 4). Results from independent group participants were of concern, as they showed decreases in muscular power and endurance over the semester. CrossFit group participants showed improvement in all muscular fitness variables and actually showed the greatest gains in lower body muscular endurance. Unfortunately, this group also showed the greatest increase in BMI.

Discussion

Undergraduate students prefer physical education BIP courses as elective credits, assuming the course is perceived to be of sufficient quality (Crawford et al., 2007; Hensley, 2000; Russell, 2008). Because students desire fitness improvements from BIP courses, we must evaluate and maximize changes in fitness to ensure that classes offered through the curriculum will generate demand. However, little research has addressed the efficacy of BIP resistance training courses with respect to muscular fitness improvement. The current study supports the efficacy of traditional and muscle confusion resistance class formats but does not support the use of independent formats.

Traditional Class

Participants in traditional resistance training showed the greatest fitness gains, improving muscular fitness by an average 5%–57%, depending on the variable measured. In all, 60% of the traditional group students improved their scores on the pull-up test, and 90% improved on the standing long jump over the semester. These findings are similar to those of a previous study reporting that more than 90% of students in a BIP aerobic conditioning class improved their field-based test times over a semester (Roberts, 2006).

Fitness gains with the traditional class format also were superior to other formats in our study in terms of muscular power and upper body muscular endurance. This finding supports the inclusion of traditional resistance training programs within BIP curricula, given that the average improvement across muscular fitness test items was 20%. This value approximates the average improvement in muscular fitness reported for the general population (American College of Sports Medicine, 1998).

Independent Class

Fitness improvements were lacking among the independent group participants. The mean BMI increased over the semester, whereas mean muscular power (standing long jump) and upper body muscular endurance (bench press) actually decreased. There were gains in other areas of muscular fitness, including an 11% improvement in overall grip strength, a measure typically associated with overall muscular strength. However, the overall performance of this group indicates that unsupervised resistance training programs may not be effective at increasing physical fitness, an outcome that student consumers demand from BIPs. For example, only 30% and 35% of independent group participants improved their performance on the YMCA bench press and standing long jump, respectively, over the semester. The move to independent resistance training classes has occurred because of reductions in physical education faculty and use of academic funds to support athletic coaches. This type of class format does not appear to be an effective format for BIP curricula.

CrossFit Class

Muscle confusion resistance training participants showed fitness gains of 17% on average. This group showed the greatest lower body endurance gains, as assessed by a 1-minute squat test, among the three class formats. Individually, 70% of CrossFit students improved their squat test score over the semester, consistent with the proportions in the traditional (75%) and independent (80%) classes. Unfortunately, participants within the CrossFit class did not improve across all muscular fitness items. Specifically, 60% of group participants improved their standing long jump scores across the semester, but only 50% and 40% improved their performance on the bench press and pull-up tests, respectively. As a result, the

mean increase was slightly lower than the 25%–30% improvement in muscular fitness reported for adults over 6 months of training (American College of Sports Medicine, 1998).

However, gains in the CrossFit group were consistent with alternative muscular fitness gains over a similar duration (up to 12 weeks) and for a similar, nonperiodized design (Fleck & Kraemer, 2004). Thus, inclusion of muscle confusion training programs into BIP offerings appears prudent, and administrators can feel confident that participants can improve muscular fitness over the semester. Interest in alternative resistance training programs is increasing among college students, but institutions should ensure that new program offerings continue to improve fitness to satisfy student demand. Based on the current findings, CrossFit (or a similar muscle confusion resistance training program) appears to be a viable BIP addition.

Limitations

Several limitations to the study are worth noting. Exercise intensity and volume were the most difficult factors to match between the traditional, independent, and CrossFit training classes. Although intensity and volume could be held constant in the traditional and independent classes, instructors estimated volume for the CrossFit classes to match the other course conditions. Actual intensity and volume for CrossFit classes, however, depended entirely upon participants' personal motivations. For instance, in the training circuit (Table 2), individual students simply were given 10 minutes to complete as many rounds of the circuit as possible. At times, highly motivated students could complete twice as many rounds as could less motivated students. Consequently, these methods created entirely different intensities and volumes for the CrossFit participants. Although completely controling for exercise intensity and volume is difficult, future studies could improve internal validity by dictating target heart rate ranges and delimiting the number of circuits to be completed during muscle confusion training.

In addition, CrossFit is only one type of muscle confusion program, and the findings do not necessarily reflect potential effects of alternative programs. We chose CrossFit because a certified instructor was available to design the program, and the activity space was conducive to its implementation. Future studies should examine alternative types of muscle confusion programs on fitness outcomes.

Finally, we evaluated intact classes rather than subgroups based on sex or training experience. We chose to include male and female students in our study because courses are offered to and chosen by both sexes, but future studies may wish to consider the influence of sex or experience on training outcomes.

Summary

This study examined the effect of BIP course format (traditional, independent, or CrossFit) on fitness changes over one semester. Participants in both traditional and muscle confusion resistance programs (i.e., CrossFit) showed similar trends in fitness improvement, with the traditional group participants outperforming the muscle confusion group participants on most fitness items. Although differences existed, the general improvement among the CrossFit participants supports the inclusion of such training into BIP offerings. Students take and repeat BIP courses to improve fitness and learn new activities, and muscle confusion programs meet this demand. We also found that independent resistance training, or training completed outside of typical class meeting times, is not as effective as other BIP alternatives in improving muscular fitness.

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