The effect of a non-traditional strength training program on the health-related fitness outcomes of youth strength training participants

by Wendy Cowan, Ph.D. and Byron Foster, Ph.D.

Abstract

The purpose of this study was to determine the extent to which a non-traditional strength training program will impact the health-related fitness of youth. Researchers hypothesized that the strengthening program would positively affect the fitness outcomes. Participant physical education classes incorporated strengthening exercises three days weekly, and cardiovascular and agility activities each once weekly. Over time decreases in mean scores for one-mile and shuttle run and increases in push-ups, curl-ups, and overall percentile scores were detected. Results suggest that fitness gains are achievable through the utilization of readily available equipment in the elementary physical education setting.

Key Words: Prepubescent, Pubescent, Physical education

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Introduction

For the past several decades strength training has been considered an inappropriate activity for children and adolescents because of a presumed high risk for injury (Faigenbaum, 2000; Pikosky, Faigenbaum, Westcott, & Rodriguez, 2002). This assumption of risk primarily stems from data gathered by the National Electronic Injury Surveillance System (US CONSUMER PRODUCT SAFETY COMMISSION, 1987) which did not take into consideration, when stating their claim for injury potential, improper use of equipment, improper supervision, or program design. An example of such accidents, as reported by the NEISS, concerns the accidental death of a four-year-old boy whose death resulted from falling off of a weight-training bench and hitting his head on the floor. The data generated by this report was misleading to generalize the findings to supervised and properly designed strength training programs. Perhaps it is better to seek findings from scientific literature to make this determination.

Contrary to claims of risk made by the NEISS (US Consumer Product Safety Commission, 1987), recent research (Faigenbaum et al., 2002; Flanagan et al., 2002; Siegel, Camaione, & Manfredi, 1989) concerning pubescent and prepubescent strength training find statistically significant results suggesting that strength training be considered a favorable activity for this age group. Hamill (1994) reported findings from a retrospective study of youth aged 13 to 16 years of age that strength training was safer than other sports such as soccer, basketball, and football. Strength training resulted in 0.7% of the 1,576 reported injuries whereas football, basketball, and soccer resulted in approximately 19%, 15%, and 2%, respectively, of all injuries. Very few published studies (Docherty, Wenger, Collis, & Quinney, 1987; Hetherington, 1976) have reported strength training injuries in children, both of which were considered minor and may have been attributed to methodological limitations (Faigenbaum, Westcott, & Micheli, 1996). Faigenbaum (2000) states that although there have been reported cases of epiphyseal plate damage these injuries were caused by poor training, excessive loading, poorly designed equipment, free access to the equipment, or lack of qualified adult supervision. Furthermore he states that if children are taught how to train properly in a supervised setting the chance of injury is minimal. Generally, the risk of strength training injuries is similar for children and adults (Faigenbaum et al., 1996). This finding is the general consensus among the professional organizations associated with youth and strength training (AAP, 2001; ACSM, 1993, 2000; AOSSM, 1988; Faigenbaum, 2000; NSCA, 1996).

The American College of Sports Medicine (ACSM, 1993, 2000), the American Academy of Pediatrics (AAP, 2001), the American Orthopaedic Society for Sports Medicine (AOSSM, 1988) and the National Strength and Conditioning Association (Faigenbaum et al., 1996; NSCA, 1996) each support participation in youth resistance training activities, provided the program is appropriately designed and competently supervised. Various organizations (AAP 2001; ACSM, 1998, NSCA, 1996) have developed general guidelines for safe and effective participation in strength training for preadolescent and adolescent children (AAP, 2001; Faigenbaum et al., 1996; Faigenbaum, 2000; Pikosky et al., 2002). Despite former assumptions about youth strength training, it is currently viewed as an important component of youth fitness programs, health promotion objectives, and injury prevention strategies (ACSM, 1993, 2000; Faigenbaum et al., 1996; HHS, 1991.). Likewise, there is surmountable evidence suggesting that strength training may improve health factors associated with chronic disease (Faigenbaum, 2000).

In a review of literature by Faigenbaum et al. (1996) it is stated that while there is limited research supporting overall health benefits to children through strength training it is likely to improve rather than be adversely affected. Youth strength training studies have not reported blackouts and/or chronic hypertension; furthermore, sub maximal training has in fact been shown to decrease the blood pressure of hypertensive adolescents (Hagberg et al., 1984). Strength training may favorably influence growth at any stage of development without disturbing the genotypic maximum (Bailey & Martin, 1994). Seventy-five adolescent female athletes who engaged in swimming, cycling, running, triathlons, or no activity were studied and results positively demonstrated the potential beneficial influence of increased weight bearing exercises on bone mineral density (Duncan et al., 2001). The ACSM (1998) reported that youth strength training programs might play an important role in effective weight loss strategies. Several studies have shown decreased skin fold thickness following a strength training program (Faigenbaum, Zaichkowsky, Westcott, Micheli, & Fehlandt, 1993; Lillegard, Brown, Wilson, Henderson, & Lewis, 1997; Siegel et al., 1989). Youth strength training regimens contribute to gains in muscular strength (Benjamin & Glow, 2003; Lillegard et al., 1997) and endurance, and flexibility (Benjamin & Glow, 2003; Lillegard et al., 1997) as well as possible decreases in sports-related injuries (ACSM, 1993, 2000; Faigenbaum et al., 2001).

The purpose of this study was to determine the extent to which a non-traditional, elementary physical education strength training program would impact the health-related fitness components of fifth grade students. The researchers hypothesized that the strength training program would positively affect the health-related fitness outcomes, as measured by the Presidential Fitness test, of the participants.

Methods

Approach to the Problem

This research utilized a quasi-experimental design in order to examine the hypotheses and research question. Utilizing a quasi-experimental design allows the researcher to gain insight into methods of instruction, have control over variables, and determine what is best for a population. In addition, quasi-experimental designs provide greater transferability than anecdotal research (Thomas & Nelson, 2001). The specific approach utilized for this research was a randomized treatment group pretest posttest design.

Subjects

The population for this research study included 100 fifth grade physical education students, from two classes per school, in two North Alabama schools. The schools were selected based on the voluntary participation of the physical education instructors and the superintendents and principals of the selected schools. Per IRB requirements, signed parental consent forms and assent forms signed by the participants were mandatory for all study participants.

Participants ranged in age from 10 to 13 years old. Caucasian, Black/African American, and Hispanic populations were represented (48.0%, 29.6%, 16.4%, respectively [see Table 1]). Minority populations were over represented in comparison with findings from the 2000 Census (U.S. Census Bureau, 2000) for the state of Alabama which reported the state's population as 71.8% Caucasian, 26.3% Black/African American, and 1.7% Hispanic (see Table 1).

Procedures

The physical education instructors who participated in this study volunteered to undergo training concerning how to safely conduct and supervise a strength training program for elementary-aged children. They agreed to adhere to protocol as designed by the researcher, which included following the provided lesson plan outlines and strength training exercises.

Pretest scores for the President's Challenge Test (PCPFS, n.d.) were obtained for each participant. Participating classes attended their regularly scheduled physical education class Monday through Friday for eight consecutive weeks. The instructors utilized lesson plans incorporating a strength training regimen on Mondays, Wednesdays, and Fridays. Tuesdays were devoted to speed, agility, and quickness type activities while Thursdays were considered a choice day for students. Suggested activities for choice day, were activities that would enhance cardiorespiratory endurance. Upon completion of the study the participants were administered the President's Challenge Test (PCPFS, n.d.). The President's Challenge Presidential Fitness Test (PCPFS, n.d.) was utilized to measure five health-related fitness components: 1) Curl-Ups to measure abdominal strength and endurance, 2) Shuttle Run to measure anaerobic endurance, 3) Endurance Run to measure cardiorespoiratory endurance, 4) Right Angle Push-Ups to measure upper body strength and endurance, and 5) V-Sit Reach to measure muscular flexibility. For comparison purposes, a fitness index was constructed consisting of each of the individual performance measures (mile run, shuttle run, v-sit reach, push ups, and curl ups) as well as a percentile scoring. For the percentile scoring analyses, participants were assigned a percentile score, based upon Norm-Referenced criterion supplied by the PCPFS (n.d.). This is the measure used in the North Alabama public school system in order to award participants for meeting specified goals on the fitness test. All testing results were scored by trained physical education specialists.

The strength-training program was designed following safety protocol for youth participants. The instructors adhered to recommendations made by the American College of Sports Medicine (1993, 1998) and the American Academy of Pediatrics (2001). The strength-training regimen consisted of the following exercises:

Body weight: Participants performed exercises in which their body served as the resistance used to build strength. Examples of this type of exercise are squats, lunges, push-ups, pull-ups, and crunches.

Tubing exercises: Participants performed exercises using a piece of elastic tubing attached to a stationary object in order to provide resistance.

Medicine ball exercises: Participants performed strengthening exercises using weighted balls as the form of resistance. Ball weights ranged between ½ lb to 5 lbs.

Dumbbell exercises: Participants performed strengthening exercises using light dumbbells as the form of resistance. Dumbbells were 5 lbs or less.

Training bar exercises: Participants performed exercises using a training bar, which is similar in size and weight to a broomstick. Examples of the type of exercises that were performed are front squats, back squats, and overhead press.

Speed, agility and quickness exercises: Participants performed exercises that specifically enhance speed, agility and quickness. Examples of the type of exercises that were performed are sprinting, pro-agility, reaction drills, and plyometrics. No ballistic type exercises were performed.

Data Analysis

The President's Challenge Fitness Test (PCPFS, n.d.) was administered to determine the extent to which participants exhibited a change in health-related fitness outcomes following the intervention period. Paired sample t-tests were used to analyze the extent to which there were statistically significant differences between pretest and posttest for the mile run, shuttle run, v-sit reach, push up test, curl up test and overall percentile score. Analyses included all participants, female only, and male only groups. The effects of the independent variables were considered statistically significant at $p < 0.05$.

Results

Analyses of all participants revealed an improved score in all Presidential Fitness Test components. However, a statistically significant difference was observed in all test areas except for the V-Sit reach. A paired samples t test revealed a statistically reliable difference between the mean pretest mile run and shuttle run times ($M = 12.26$, $SD = 3.23$; $M = 11.90$, $SD = 1.29$) and posttest mile run and shuttle run times ($M = 10.86$, $SD = 2.91$; $M = 11.27$, $SD = 1.29$) for all participants, $t\ (88) = 5.10$, $p = 0.000$, $\alpha = 0.05$; $t\ (85) = 5.46$, $p = 0.000$, $\alpha = 0.05$, respectively. Other statistically significant findings existed between the mean pretest push up and curl up scores ($M = 10.42$, $SD = 9.04$; $M = 32.97$, $SD = 10.31$) and posttest mile run and shuttle run times ($M = 16.66$, $SD = 10.45$; $M = 37.64$, $SD = 10.43$) for all participants, $t\ (92) = -5.49$, $p = 0.000$, □ = 0.05; $t\ (88) = -3.73$, $p = 0.000$, $\alpha = 0.05$, respectively. Overall percentile rankings increased approximately 17%, which is statistically significant at $p < 0.001$.

Data analyses of the female only group pretest and posttest Presidential Fitness testing revealed improvements in the mile run, v-sit reach, push up scores, curl up scores, and overall percentile ranking (see Table 2). Statistically significant improvements for this group were for the mile run, push ups, curl ups, and overall percentile ranking ($p < 0.000$, 0.000, 0.01, and 0.000, respectively).

Analysis of the male group pretest and posttest Presidential Fitness testing revealed improvements in the mile run, push up test, curl up test, and overall percentile ranking. Statistically significant improvements for this group were in overall percentile ranking ($p < 0.000$).

Discussion

The research question being addressed was to what extent a strength training program affects the health related fitness outcomes of elementary physical education students. The researchers hypothesized that the strength training program would positively affect the health-related fitness outcomes, as measured by the President's Challenge Test (PCPFS, n.d.), of the participants. Data analysis indicated that the hypothesis was accepted (See Table 2).

The population as a whole showed statistically significant improvement in all areas of the President's Challenge test (n.d. [see Table 2]), excluding V-sit reach, in which case they improved, but not significantly. These findings support previous research conclusions indicative of increases in cardiorespiratory endurance (Weltman, Janney, & Rians, 1986), speed (Weltman et al., 1986), and muscular strength and endurance (Benjamin & Glow, 2003; Lillegard et al., 1997; Siegel et al., 1989; Weltman et al., 1986) following a strength training regimen. In addition, support is lent to the notion that children can increase strength using a variety of methods (Faigenbaum, 1993; Faigenbaum, et al., 1996; 2000; 2001; Flanagan, et al., 2002; Siegel et al., 1989; Weltman et al., 1986).

The lack of significant improvement in the area of V-sit reach, which conflicts with previous research (Benjamin & Glow, 2003; Lillegard et al., 1997; Siegel et al., 1989) may be attributed to the participants not performing flexibility exercises daily during the study or to the type of strength training utilized for the study. If implementing the study program, physical education instructors should be encouraged to spend a percentage of every class period involved in flexibility enhancing activities.

Meeting the Presidential standard on the President's Challenge test (PCPFS, n.d.) is achieved by scoring at or above the 85th percentile in all test categories. The national standard is achieved by scoring at or above the 50th percentile in all categories. Results from this study indicated that study participants' mean scores were below the presidential and national in all test categories.

The program, as designed for this study, would lead to monotony if performed in physical education class over the course of the school year, however results of this study lend credence to strength training exercises being incorporated as part of the fitness development component of elementary physical education programs. It is possible that two days of strength training (Faigenbaum et al., 1993, 2002), versus three, would lessen the monotony while achieving similar results. The practicality of the equipment used in this study lends support to the adoption of these exercises by physical education instructors because of the low cost of the equipment and the lowered potential for injury as is possible in large settings.

These findings suggest that the strength-training intervention had a positive affect on the health-related fitness components measured via the President's Challenge Test (PCPFS, n.d.). With the current rise in obesity that is being evidenced across the nation (CDC, 2007), findings such as the ones in this research study are very promising to physical education instructors who are searching for interventions to significantly impact the health related fitness of their elementary physical education students.

Finally, this study contributes to the body of research (Faigenbaum, 2000; Faigenbaum et al., 1996; 2001; NSCA, 1996; Siegel et al., 1989) supporting the notion that youth can safely engage in strength training when a program is properly designed and supervised. There were no strength training related injuries associated with this eight-week study.

Practical Implications

This study serves to demonstrate the practicality of incorporating strength training into elementary physical education programs. The protocol, as followed in this study can successfully be incorporated into both small and large physical education classes that include a diversity of students.

The low percentile rankings as evidenced in this study lend support to the notion for the drastic measures that are needed to increase the productivity of elementary physical education classes. Merely attending physical education classes alone is not significant in impacting the health related fitness of students. Although sometimes not viewed as fun, it is essential that students are participating in programs that will adequately improve their overall health and well being.

Professional organizations and administrators should encourage physical education instructors to implement a curriculum that does not merely meet the state course of study. It should improve the overall body composition and health related fitness of students as well.

Table 1. ***Demographic Characteristics of Participants (N = 100)***

Personal Characteristics	*n*	Percent
Gender		
Male	46	45.0
Female	54	55.0
Ethnicity		
Caucasian	47	48.0
Black/African American	29	29.6
Hispanic	19	19.4
Other	3	3.1
Age at time of study (years)		
10	12	12.0
11	66	66.0
12	18	18.0
13	4	4.0

Table 2. ***Pretest and Posttest Differences for Health-Related Fitness Measurements***

	Pretest		Posttest			
Source	*M*	*SD*	*M*	*SD*	*df*	*T*
All Participants						
Mile run	12.26	3.23	10.86	2.91	88	5.10***
Shuttle run	11.90	1.29	11.27	1.29	85	5.46***
V-sit reach	3.24	3.05	3.66	3.21	.91	-1.01
Push-up	10.42	9.04	16.66	10.75	92	-5.49***
Curl-up	32.97	10.31	37.64	10.43	88	-3.73***
Percentile	14.95	15.55	32.18	25.00	93	7.17***
Females						
Mile run	11.40	6.40	8.70	6.82	53	4.17***
Shuttle run	9.42	7.27	9.56	6.11	53	-0.18
V-sit reach	2.64	4.22	3.16	5.14	.53	-0.99
Push-up	6.59	8.25	13.24	11.12	53	-6.14***
Curl-up	27.83	15.00	33.35	16.88	53	-3.18***
Percentile	12.76	15.61	27.67	24.74	53	4.84***
Males						
Mile run	10.09	6.17	8.97	6.44	44	1.33
Shuttle run	9.26	6.64	10.23	4.37	44	-1.22
V-sit reach	2.29	4.11	2.06	3.94	44	0.35
Push-up	12.78	10.86	16.8	13.02	44	-1.90
Curl-up	30.73	16.27	34.78	15.60	44	-1.53
Percentile	14.39	16.82	32.11	27.80	45	5.12***

*$p<0.05$**$p<0.01$***$p<0.001$

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~~Southern Chinese Collegiate Stage of Exercise Behavior Changes and Exercise Self-Efficacy~~

~~*by Xiaofen Deng Keating, Yong Huang, Minying Deng, Li Chen, Chuanwei Dwan, and Dwan Bridges*~~

~~Abstract~~

~~This study aimed to examine southern Chinese college student (N = 1983) stage of exercise behavior changes (SEBC) and their exercise self-efficacy (ESE). The SEBC and ESE scales were used to collect data. ANOVA was performed to investigate the differences in ESE by SEBC. Post Hoc Tukey tests were employed to determine which variables contributed to the differences. The data from the study indicated that those who maintained regular participation in exercise had significantly higher ESE than those who did not. It is concluded that improving college student ESE might lead to an increase in exercise.~~

~~**Key words:** Chinese college students, stages of exercise behavior changes, and exercise self-efficacy.~~

~~*Southern Chinese Collegiate Stage of Exercise Behavior Changes and Exercise Self-Efficacy*~~

~~Introduction~~

~~Obesity has become an epidemic across the world (World Health Organization, 1998) and no age, gender, or ethnicity is spared (U.S. Department of Health and Human Services [USDHHS], 2000). Reducing obesity in the general population has become one of the greatest challenges of our time (Keating, Guan, Castro, & Bridges, 2005a). To date, many efforts have been made to investigate the etiological factors concerning the increase of obesity since the 1980s (Eisenmann, 2006; Finkelstein, Ruhm, & Kosa, 2005). It is suggested that either genetic (i.e., defective genes) or environmental (i.e., adverse conditions or infectious agents) factors must be the cause if a disease happens persistently in a population over several generations (Jablonka, 2004). Because evolution of human genetics is a very slow process, it is very likely that environmental variables have resulted in the epidemic of obesity in recently years (Brownson, Boehmer, & Luke, 2005; Eisenmann, 2006).~~

~~Although many environmental factors may have contributed to the obesity epidemic, as one of the critical factors, physical inactivity has captured tremendous attention among health and PA experts (National Institute of Health [NIH], 1996; USDHHS, 2001). Both individual current and lifetime PA levels have been targeted for change (Calfas et al., 2000; Thompson, Humbert, & Mirwald, 2003). Very limited success has been reached in increasing either current or lifetime PA levels in the general population, however, resulting in continuous calls for more action on this issue from public health institutes (e.g., USDHHS, 1996, 2000). Health and PA experts are frustrated by the fact that no effective approaches have been identified to change individual's PA behaviors. This gap in knowledge hinders preventive efforts to reduce chronic diseases caused by obesity and overweight.~~

~~In response to the long-term failure to significantly promote PA in the general population, public health professionals have come to the conclusion that effective intervention strategies sensitive to specific settings and cultural background are urgently needed (USDHHS, 2000). It has been suggested that strategies to enhance awareness, change behaviors, and create environments that support physically active lifestyle may produce enduring PA pattern changes (Bauman, Sallis, Dzewaltowski, & Owen, 2002; King, Stokols, Talen, Brassington, & Killingsworth, 2002).~~

~~Studies have shown that the steepest decline in PA occurs during adolescence (i.e., 15 to 18 years of age) and young adulthood (i.e., 20 to 25 years of age) (USDHHS, 1996). Because it is difficult getting adults to be physically active, public health associations have set up several national health objectives targeting adolescents and young adults in an effort to establish habitual PA patterns as early as possible in life (USDHHS, 2000). As the last opportunity to~~