Associations between High-Intensity Training, Body Composition and Fitness in Youth

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ABSTRACT

Fitness is protective against childhood obesity. In particular, greater cardiorespiratory (CR) fitness is associated with less total and abdominal adiposity. High-intensity (HI) exercise is associated with greater CR fitness levels in youth, and is an overall key to improving fitness. PURPOSE: This pilot study examined the relationship between changes in body composition and fitness for youth participating in a HI intervention as compared to active youth. **METHODS:** The intervention group (IG; n=9, 8m, 1f) were ages 10-13 (mean=10.78y) and the comparison group (CG; n=6m) were ages 10-12 (mean=11.17y). The IG participated in 4 weeks of HI exercise (2d/wk, 45m/session). Pre- and posttest assessments included measured body composition (height and weight for body mass index-BMI, waist circumference-WC, dual X-ray absorptiometry for bodyfat percentage-BF%) and fitness (power-Margaria-Kalamen step test, vertical and horizontal jumps; speed-40m dash; muscular endurance- curlups and pushups; balance-Stork Balance Test; accuracy-wall toss test; agility-Illinois agility test; CR endurance-Fitnessgram Pacer). **RESULTS:** Based on BMI %iles, 2 IG and 1 CG participants were overweight and 1 CG participant was obese. Based on WC %iles, 3 IG and 2CG participants were overweight. Based on BF%iles, 1 CG participant was overweight and 1 CG participant was obese. After 4 weeks, both groups averaged lower BMIs (IG = -.038±.44; CG = -.234±1.21) and increased WC (IG = .498±1.89; CG = 1.0±.77). Significant differences existed between groups for change in BF% (CG = -.43, IG = .83; p=.021). For the IG, BMI was negatively associated with speed; BF% was negatively associated speed (p=.008); and WC was positively associated with agility (p=.018), but negatively with pushups (p=.014). For the CG, BMI was positively associated with lower vertical jump (p=.031). **CONCLUSIONS:** Despite high activity levels, 33% of the IG and CG participants were overweight or obese. Children participating in the HI intervention did not see gains in CR fitness. Overall the IG improved BMI, but had increased WC and BF%. The increased BF%, despite lower BMI, resulted in decreased speed, while the increased WC resulted in greater agility, but lower muscular endurance for the IG. Lower BMI in the CG decreased power.

INTRODUCTION

- Physical activity is promoted as a strategy to help prevent childhood obesity.
- Youth who participate in sports do not always have high levels of fitness nor successfully maintain their weight.
- Fitness is protective against childhood obesity.
- In particular, greater cardiorespiratory fitness is associated with less abdominal and total adiposity.
- High-intensity exercise is associated with greater cardiorespiratory fitness levels in youth, and is an overall key to improving fitness.

PURPOSE

This pilot study examined the relationship between changes in body composition and fitness for youth participating in a high intensity exercise intervention as compared to active youth.

METHODS

Design: Two group, quasi-experimental, pre-test posttest (1 month apart)

Participants:

- Nine youth volunteered for the intervention group (IG): 8 males, 1 female, mean age 10.78±1y (range 10-13).
- Six males were recruited from a local basketball camp for the comparison group (CG): mean age 11.17±0.5y (range 10-12).

Measures:

- Body composition
  - Measured height and weight were used to calculate BMI percentiles (%iles)
  - Waist circumference (WC) measured 1-inch above umbilicus was used to calculate WC percentiles (%iles)
  - Dual X-ray absorptiometry (DXA) scans were used to determine fat mass, fat free mass, and bodyfat percentage (BF%)

METHODS

Measures (continued):

- Fitness
  - Power was tested using the Margaria-Kalamen step test (1.05m up a flight of stairs; best of 3 trials); standing vertical jump (best of 2 trials), and standing broad jump (best of 2 trials).
  - Speed was tested as the time to sprint 40m.
  - Muscular endurance was tested with FITNESSGRAM curlups (80 maximum) and pushups (50 maximum) .
  - Balance was tested using the Stork Balance Test (standing shoeless on the ball of one foot for maximum time).
  - Coordination (accuracy) was tested using the wall toss test (tossing and catching a tennis ball with one hand, 2m away from a wall for 30 seconds).
  - Agility was tested as the time to complete the Illinois running test (10m zig-zag course).
  - Cardiorespiratory endurance was tested using the Fitnessgram Pacer (20m laps in time to a decreasing cadence).

Procedure:

- Written parental consent and youth assent were obtained.
- Intervention
  - The intervention consisted of 4 weeks of high intensity exercise with a dose of 2 days per week for 40m/session.
  - Sessions consisted of an overview (5min), a warm-up (5-10min), skill work (5-8min), workout (5-15min), active game (5-15min), and stretching (5min)
- CG participants completed assessments only, one month apart.
- Between-group differences for changes in body composition were assessed using analysis of covariance with the baseline value as the covariate and group as the constant.
- Pearson correlations were conducted to assess within-group relationships between changes in body composition and fitness variables.

RESULTS

Body Composition

As shown in Table 1, the baseline percentage of participants in each group who were considered overweight or obese, varied by the measure used, with WC identifying the most as overweight.

After 4 weeks, both groups averaged lower BMIs (IG = -.038±.44; CG = -.234 ±1.21) and increased WC (IG = .498±1.89; CG = 1.0±.77). Significant differences existed between groups for change in BF% (IG = +.83, CG = -.43; p=.03).

Table 1. Group Percentages of Overweight or Obese Participants

Body Composition Variable	Intervention Group (n)	Comparison Group (n)
BMI %ile		
Percent Overweight (85-94th)	22.2% (2)	16.7% (1)
Percent Obese (≥95th)	0	16.7% (1)
WC %ile – Percent Overweight	33.3% (3)	33.3% (2)
DXA BF%		
Percent Overweight	0	16.7% (1)
Percent Obese	0	16.7% (1)

RESULTS

Table 2. Mean Scores by Group

	Intervention Group		Comparison Group		p-value for between–group differences in changes
	Pre-Test	Post-Test	Pre-Test	Post-Test	
BMI	18.56 (1.66)	18.52 (1.84)	19.10 (3.28)	18.86 (3.28)	.70
WC (in)	26.82 (1.31)	27.32 (1.89)	26.00 (2.65)	27.00 (2.90)	.64
DXA BF%	23.61 (4.97)	24.44 (5.65)	22.40 (11.78)	21.97 (11.56)	**.03**
Step Test (sec)	1.09 (0.39)	1.16 (0.30)	1.00 (0.27)	1.10 (0.42)	.94
Vertical Jump (in)	9.56 (2.49)	10.73 (2.69)	12.33 (2.89)	11.96 (3.04)	.19
Broad Jump (in)	58.44 (5.22)	59.17 (8.12)	56.63 (11.49)	56.92 (11.78)	.90
40m dash (sec)	7.77 (0.66)	7.94 (0.70)	7.58 (0.85)	7.29 (0.86)	**.02**
Curlups	35.44 (21.41)	35.78 (18.77)	51.67 (29.48)	64.00 (26.32)	.08
Pushups	13.44 (10.78)	13.22 (5.54)	13.50 (9.14)	14.33 (7.15)	.66
Balance (sec)	4.20 (3.63)	5.30 (6.71)	5.23 (5.78)	5.34 (3.98)	.70
Wall toss (catches)	13.67 (7.87)	14.44 (9.21)	16.50 (3.45)	17.00 (3.52)	.91
Agility (sec)	20.14 (2.27)	20.48 (2.13)	19.55 (2.27)	19.52 (2.34)	.48
Pacer (laps)	37.78 (13.37)	32.33 (17.61)	37.50 (18.00)	33.83 (15.68)	.66

Within-Group Correlations

Relationships between pre-post differences are shown in Table 3. For the IG, lower BMI was associated with faster 40m dash times; greater WC was associated with fewer pushups but faster times on the agility test; and greater BF% was associated with slower 40m dash times. For the CG, lower BMI was associated with a lower vertical jump.

Table 3. Correlations for Changes in Body Composition and Fitness Variables

Fitness Variable	Intervention Group			Comparison Group		
	BMI	WC	BF%	BMI	WC	BF%
Power – step test	.62	.58	.54	-.03	.47	-.11
Power –vertical jump	.60	.04	.44	**.85***	.26	-.74
Power – broad jump	.51	.40	.19	.20	.24	-.66
Speed – 40m dash	**.67***	.01	**.81****	-.10	-.57	.40
Muscular endurance – curlups	.26	-.06	.66	.18	.66	-.56
Muscular endurance – pushups	-.42	**-.78***	-.07	-.32	.57	.02
Balance – stork balance test	-.02	.11	-.58	-.08	-.39	-.31
Coordination – wall toss	-.02	.11	-.58	-.62	-.24	.07
Agility – Illinois running test	-.28	**-.76***	.01	-.52	-.42	.01
Cardiorespiratory endurance – Pacer	-.07	-.17	-.52	.33	.13	-.73

*p<.05, **p<.01

CONCLUSIONS

Despite high activity levels, 33% of the IG and CG participants were overweight or obese.

Youth participating in the intervention did improve BMI, but had increased WC and BF%. The decrease in BMI was associated with greater speed. The increase in WC was associated with lower muscular endurance, but better agility. Body composition changes were not significantly associated with changes in cardiorespiratory endurance.

Youth in the comparison group improved BMI and BF%, but had greater WC. The lower BMIs were associated with a decrease in power.

Several youth in the IG indicated that they were tired on the post-test assessment day, which may have contributed to fewer completed laps on the pacer (mean = -5.44±5.79; range -11 to +8). However, youth indicated that they enjoyed the exercise program; with 4 who participated in June continuing the program with the 5 who participated in July.

Future research could examine increases in training frequency and dose as well as allowing more rest before post-tests in order to determine longer-term effects of the high-intensity exercise intervention.