International Journal of Kinesiology & Sports Science
ISSN: 2202-946X
www.ijkss.aiac.org.au

Effect of a Four Weeks Aerobic Training Intervention on Body Fat Percentage and Physical Fitness Indices among 5 to 6-year-old Obese, Overweight and Normal Weight Children: A Quasi-experimental Study

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ARTICLE INFO

Article history
Received: November 01, 2018
Accepted: December 30, 2018
Published: January 31, 2019
Volume: 7 Issue: 1

Conflicts of interest: None
Funding: None

ABSTRACT

Background: Optimal physical activity and functional fitness is fundamental in children. The purpose of this study was to assess the effect of a four-weeks aerobic training intervention on body fat percentage and selected physical fitness indices among five to six-years-old obese, overweight and normal weight children. **Methods:** A quasi-experimental pre-test/post-test study design was used; a statistical sample of 20 preschool girls participated in the study. One group (n=10) comprised of normal weight children and another for overweight and obese children (n=10). SPSS Version 21 was used for data analysis, a 95% level of significance was considered. Paired independent t-test and Analysis of Covariance were used to test the impact of the intervention within and between groups. **Results:** the intervention had a significant influence on body weight (p=0.023), BMI (p=0.025), flexibility (p=0.005) and muscular endurance (p=0.001) among children with obesity or overweight. It also showed a significant influence on balance (p=0.03) among normal weight children. However, it showed no significant difference between groups with exception of balance (p=0.002). **Conclusions:** The four-weeks training intervention had a significant difference on some physical fitness indices among children aged 5 to 6 years with obesity or overweight. Programmed aerobic training interventions can be used to achieve optimal body fat percentage and improve on some physical fitness indices among children.

Key words: Obesity, Children, Body Mass Index, Aerobic Exercises, Body Fat

INTRODUCTION

Overweight and obesity are a major health concern today especially among children (Mirmoha Mehrparvar, Rezaeian, & Akbari, 2011). For example; a global survey of 195 countries showed that approximately 107.7 million children were obese (GBD 2015: Obesity Collaborators et al., 2017). In addition, between 1975 to 2016, the prevalence of age-standardised obesity increased from 0.7% to 5.6% among girls, and from 0.9% to 7.8% among boys (NCD Risk Factor Collaboration (NCD-RisC), 2017). Among school going children in Iran, it was estimated that 9.27% and 3.22% children are overweight and obese respectively (Mirmohammadi et al., 2011). Similarly, in India, estimates showed that overweight and obesity are significantly high especially in private schools. Estimates based on the International Obesity Task Force (IOTF), showed that 21.4% and 3.6% of children in private and government schools respectively experienced overweight and obesity in India (Jagadesan et al., 2014).

Notwithstanding, underweight, overweight and obesity during childhood through adolescence have been associated with detrimental health consequences throughout the life-course (NCD Risk Factor Collaboration (NCD-RisC), 2017). Obesity and overweight have been associated with non-communicable diseases such as hypertension, diabetes mellitus, cardiovascular diseases, and some cancers. Indeed, health effects of high Body Mass Index (BMI) in 195 countries during a period of over 25 years has accounted for approximately four million deaths, of these, more than two-thirds were due to cardiovascular disease (GBD 2015 Obesity Collaborators et al., 2017).

Such alarming levels of overweight and obesity have attracted attention from researchers. Various interventions have been studied among children. For instance: Larsen et al. (2017) showed that frequent low-volume ball games and interval running for children 8 to 10 years showed limited positive fitness effects. However, an intervention that involved 10 months of 3 sessions for 40 minutes per week among 8 to 10 year old children decreased diastolic blood pressure and elicited discrete cardiac adaptation (Larsen et al., 2018). Nonetheless, a major concern is designing and assessing effective

Published by Australian International Academic Centre PTY.LTD.

http://dx.doi.org/10.7575/aiac.ijkss.v.7n.1p.12

and feasible interventions for management of already overweight and obese children (McGuigan, Tatasciore, Newton, & Pettigrew, 2009). Some studies have identified some impactful interventions, for instance; a systematic review and meta-analysis of energy and macronutrient responses to physical activity interventions in children and adolescents with obesity revealed that structured physical activity interventions favour decreased daily energy intake in obese adolescent (Schwartz, King, Perreira, Blundell, & Thivel, 2017). Another review showed that thirteen studies noted significant improvements in cardiorespiratory fitness (CRF) among children aged 6 to 12 years (Braaksma et al., 2018). Despite the above noted studies, our literature search revealed scanty studies utilizing aerobic exercises on body fat percentage and physical fitness indices. Therefore, in this study we sought to assess the effect of a four weeks aerobic training intervention on body fat percentage and selected physical fitness indices among three categories of children aged five to six years.

METHODS

Participants

A quasi-experimental pre-test/post-test design was used. The study was conducted in Pre-schools in Qazvin, Iran. All five to six year old girls in Qazvin were eligible to participate in the study. Golhay Zendegy pre-school was purposively selected to represent the pre-schools. A convenience sample of 20 girls between five to six years participated in this study. Children who had self-exercise limiting diseases and those who had regular exercise in the last six months were excluded from the study.

Procedures

After holding a briefing and obtaining consent from parents of the children, background measurements including height, weight, age and body mass index of the children were measured. The World Health Organization criteria for BMI (WHO,2018) was used in this study. Using the BMI outcomes, the children were classified into three categories that is normal weight, overweight and obese. These were further divided into two groups of 10 children. The first group consisted of overweight and obese participants while the comparison group consisted of normal weight participants. We recommended a diet for all participants that would not cause significant weight loss or gain to minimize dietary variability among groups.

Intervention

The intervention consisted of a four weeks training sessions of aerobic exercise. This comprised of three sessions per week. Each aerobic training session for the two groups included (15 minutes) warm-up, the main exercises (20 minutes), which included lower muscles exercises (lower and upper trunk muscles) and lastly cool-down (10 minutes) that involved stretching (Table 1).

At the end of the period, the considered variables were re-evaluated under similar pre-test conditions. Tolerance during the training sessions was assessed using a speaking test specifically the Borg common scale of perceived exertion (Borg, 1990). Here, the participant was assessed whether they could talk without difficult and whether they could perform the activity without difficulty in breathing.

Outcome and Measurements

The primary outcomes included body fat percentage, muscle strength, respiratory endurance, flexibility, balance and muscular endurance. Baseline characteristics measured included weight in kilograms (kg), body fat percentage, muscle strength, Maximum Oxygen Consumption (VOX2), muscle endurance, flexibility and balance.

We measured these variables three times; the first measurements were taken after giving the participants the same breakfast. This was done to get acquainted with cases and eliminate learning effects. The second evaluation was carried out 48 hours after the first evaluation and the results were recorded as pre-test scores. The third evaluation was carried out 48 hours after the last exercise session and after a common breakfast after four weeks of aerobic training, and the results were recorded as post-test scores.

Weight was measured using a weighing scale and height (centimeters) was measured using a height gauge. Flexibility was measured using the "bending and reach test" for flexibility estimation (Mayorga-Vega, Merino-Marban, & Viciana, 2014). Body fat percentage was measured using calipers and the Skin-fold equations for estimation of body fatness in children and youth (Janz et al., 1993). The two-point method (under the shoulder and back arm) was used. This was done to ensure reliable measurements. In addition, all measurements were made on the same day in the morning, three times from the right side of the body, then the average of the three measurements was recorded as the final size. This was validated according to Johns et al.(1993) such that for girls if the total of two measurements (under the shoulder and back of the arm) is less than 35 mm, then the following procedure is performed. "*Body fat percentage =5.2 (total two measurements)2 x 13.0-(total two measurements)x 33.1", a*nd if the total of two measurements (under the shoulder and back of the arm) is greater than 35 millimeters, then the following procedure is performed. *Body fat percentage = 7.9 + (total two measurements) x 546.0* (Janz et al., 1993). Muscle strength was measured using the Swedish Swim test. Balance was measured using the Flamingo balance test. Muscle endurance was measured using sit-ups (Safrit, 1990). Maximum Oxygen Consumption (millilitres per kg/minute) was measured using the the guidelines based on the methodology and interpretation of the American Chest Association (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002). A formula was then used to estimate VO2 Max (3.98+distance(m)x 0.03 (ml/kg/min); (Vanhelst, Fardy, Salleron, & Béghin, 2013).

Ethical Considerations

The study objectives and protocol was clearly explained to the parents of the children who were then requested

Table 1. Summary of aerobic training sessions

Brief description	Session
First meeting; the purpose and need for aerobic exercises and how to perform them was taught to children. This was aimed at encouraging the children to participate in the exercises	1
The training sessions were started with observation of the trainer's leg movement with some music during the session. (visual attention to both leg and hand movement).	2
Training the participants with observation of trainer's movement along with some music rhythm with another kind of leg movement.	3
Reviewed the training movements using hand and leg flexion-extension movements, visual attention, movement of the hands	4
Training movements and rhythm, hand and leg flexion-extension movements, visual and auditory leg movement attention and movement of the hands by observation of the trainer.	5
Training compound movements of hands and feet following a rhythm: compound movements training using hands and feet while following a rhythm, visual and auditory attention to the movements of the players	6
Training complex combination of hand and foot movements: compound movements training of hands and feet, visual and auditory attention to the rhythm and visual movements of the players and the accuracy and speed of movements and exercises.	7
Training complex combination of hands and foot movements: complex combination of hand and foot, visual and auditory attention, movements with rhythm while paying attention to the movements of the participants	8
Training complex combination of hands and foot movements: combination of hand and foot movements following a rhythm, visual and auditory attention to movements of the participants, accuracy and speed of movements and exercises.	9
Composition training combined with balance preservation, compound movements of hands and feet with a rhythm, visual and auditory attention to movements of the participants	10
Composition training combined with balance preservation, compound movements training of hands and feet with a rhythm, visual and auditory attention to the movements of the players, attention to accuracy and speed of movements and exercises.	11
Combined training with maintaining balance and speed: training of hands and feet compound movements following a rhythm, auditory and visual attention to movements of the players, accuracy and speed of movements and exercises	12

to consent on behalf of their children. Ethical clearance to conduct the study was sought from the Department of Physical education and Sports Science, Qazvin Islamic Azad University.

Statistical Analyses

Statistical Package for Social Scientists (SPSS) version 21 was used for data analysis. For statistical analysis of raw data, descriptive statistics including mean and standard deviation were used to describe characteristics of the sample. The Kolmogorov Smirnov (K-S test) and the Levene test were used to test the normality of data in the study groups. The paired sample t-dependent test was used to determine differences within groups while Analysis of Covariance (Ancova) was used to test the difference between the two groups. Statistical significance was considered for all statistical analyzes of p-value <0.05.

RESULTS

20 participants were invited to participate in the study. These all completed the study yielding a 100% response rate. The age of the participants ranged from 65 to 76 months. The mean age of the obese and overweight group was 67 months (SD=3.36) while that of the normal BMI group was 70 months (S.D=3.8).

The pre and post-test characteristics of the participants are presented in Tables 2. The mean pre and post intervention measurements of outcome variables among obese, overweight group and the normal weight group are shown in Table 3. The mean height of obese and overweight children was 117cm (SD=5.4). The average pre-test weight, BMI body fat percentage for the obese and overweight children were 26.6 kg, 26.63kg/m2, and 26.7 respectively. Average pre and post-test scores of maximum oxygen consumption, flexibility, balance, muscle strength and muscle endurance for the overall sample are shown in Table 2.

Influence of the Intervention on Physical Fitness Indices

Analysis of covariance revealed that the intervention had no significant influence on body fat percentage maximum oxygen consumption and muscle strength within both groups (Table 3). On the other hand, it had significant influence on selected physical fitness indices including weight, BMI, flexibility, balance and muscle endurance within groups. Specifically, the intervention showed significant difference on body weight (p=0.023), BMI (p=0.025), flexibility and muscle endurance within the group of obese and underweight children. Similarly, there was a strong significant difference with regards to balance among normal weight children ($p<0.01$).

Table 2. Pre and post test physical fitness indices of the participants (n=20)

Indices	Obese and overweight children		Normal weight children	
	Pre-test	Post-test	Pre-test	Post-test
Maximum oxygen consumption (millilitres per kg/minute)	25.27 (± 1.98)	22.09(± 1.92)	26.62(±1.33)	26.67(±1.35)
Flexibility	17.60 (±14.47)	24.80 (±12.83)	22.30 (±10.57)	24.2(±9.00)
Balance	18.80 (±5.01)	18.10 (±7.14)	19.50 (±5.01)	22.70(±4.13)
Muscle strength	11.10 (±6.15)	11.60(±5.79)	14.60 (±5.64)	14.90(±5.70)
Muscle endurance	7.60 (±4.24)	9.60 (±3.47	16.80 (±5.69)	17.30 (±5.49)

Table 3. Comparing the effectiveness of aerobic exercises on selected physical fitness indices within groups

Indices	Mean difference	p-value	t-statistics
Body weight			
Obese and underweight group	0.230	0.023*	2.725
Normal weight group	0.145	0.074	2.023
BMI			
Obese and underweight group	0.162	0.025*	2.691
Normal weight group	0.104	0.083	1.947
Body fat percentage			
Obese and underweight group	0.073	0.297	1.106
Normal weight group	0.103	0.632	0.496
Maximum oxygen consumption (millilitres per kg/minute)			
Obese and underweight group	-0.183	0.152	1.567
Normal weight group	-0.493	0.260	-1.202
Flexibility			
Obese and underweight group	-7.200	0.005*	-3.653
Normal weight group	-1.900	0.250	-1.230
Balance			
Obese and underweight group	0.700	0.519	0.670
Normal weight group	-3.200	0.001*	-6.249
Muscle strength			
Obese and underweight group	-0.500	0.427	-0.832
Normal weight group	-0.300	0.792	-0.271
Muscle endurance			
Obese and underweight group	-2.00	0.030*	-2.582
Normal weight group	-0.500	0.544	-0.631

On the other hand, while comparing the influence of the intervention on the selected physical fitness indices between the two groups, the intervention showed significant difference on balance (p-value=0.002) between the two groups (Table 4).

DISCUSSION

In this study, our intervention showed significant differences in physical fitness indices including weight, BMI, flexibility and respiratory endurance among obese and overweight children. We infer that aerobic training programs produce significant changes in body composition, strength and endurance among children who are overweight and obese. Implementation of such programs in schools could benefit obese and overweight children. In addition, it was clear that the intervention had significant impact on balance between the two study groups. This provides a relative advantage for overweight and obese children who are at a distinct disadvantage due to their body composition. Childhood is a critical period of life, therefore physical activity in childhood is one of the essential prevention measures to non-communicable diseases such as heart diseases, diabetes, obesity and overweight.

Elsewhere, aerobic exercise have been shown to have impact on weight, percentage of body fat, BMI and other physical fitness indices (Larsen et al., 2017; McNarry & Jones,

Table 4. Comparing the effectiveness of aerobic exercises on selected physical fitness indices between groups (n=20)

Indices	Mean square	F statistics	p-value
Body weight			
Obese and underweight group	0.012	0.250	0.623
Normal weight group	0.049		
BMI			
Obese and underweight group	0.011	0.367	0.552
Normal weight group	0.029		
Body fat percentage			
Obese and underweight group	0.000	0.001	0.971
Normal weight group	0.252		
Maximum oxygen consumption (millilitres per kg/minute)			
Obese and underweight group	0.097	1.198	0.289
Normal weight group	0.081		
Flexibility			
Obese and underweight group	88.583	3.496	0.079
Normal weight group	25.335		
Balance			
Obese and underweight group	80.569	13.783	0.002*
Normal weight group	5.846		
Muscle strength			
Obese and underweight group	0.375	0.049	0.828
Normal weight group	7.674		
Muscle endurance			
Obese and underweight group	0.343	0.064	0.804
Normal weight group	5.403		

2014; Sigal et al., 2007). Similarly, the study by Farsani and McGuigan showed a significant effect on body weight (Farsani & Rezaeimanesh, 2011; McGuigan et al., 2009). Furthermore, our findings indicated a significant influence on balance among normal weight children. This implies the exercise training represents a potent stimulus to maintenance of fitness in children. Moreover, this is essentially important given that aerobic exercises are the most relevant to children's daily activities and play schedules. Whilst physical activity guidelines are scarce for children, our study highlighted some parameters that can be improved by aerobic training/physical activity. We recommend that identification of such parameters would allow investigation of the training modalities and regimes that could elicit significant improvements in body fat percentage and physical fitness indices in overweight, obese and normal weight children in children's schools and other educational institutions. In addition, we assessed whether our training program would be well tolerated by children who are obese and overweight. Tolerance has been identified as a major failure of aerobic based interventions. Although our study reported on the influence of aerobic training, the study was only conducted among female participants with a relatively small sample size. This is a limitation of our study since there could be differences in response to aerobic exercises among girls and boys and the methodological limitations associated with small sample sizes.

CONCLUSION

A four weeks aerobic training intervention could be used to improve on selected physical fitness indices among obese or overweight girls between five to six years. In addition, it could also be useful in maintaining balance among children with normal weight. Our intervention involved aerobic training sessions that lasted for 45 minutes, it included a warm-up of 15 minutes, and main exercises of 20 minutes, which included lower muscles exercises (lower and upper trunk) and stretching and finally cooling down of 10 minutes. There was a significant influence on body weight, BMI, flexibility and muscular endurance among children with obesity or overweight. It also showed a significant influence on balance among normal weight children. Routine aerobic training among children at school could be an effective strategy in maintaining optimal body fat percentage and physical fitness indices.

ACKNOWLEDGEMENTS

We would like to thank the parents, children and teachers who contributed their time to participate in this study.

We also express our gratitude to the department of Sports Science of Qazvin University.

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