PHYSICAL FITNESS OF OBESE SCHOOL CHILDREN IN HAT YAI, SOUTHERN THAILAND

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Abstract. 259 primary school children (average age 9.2 years) were randomly selected from three groups of children whose weights-for-height were 90-110% (normal 111), > 110-120% (over weight 25), and > 120% (obesity 123) of reference values for Bangkok children. They underwent physical fitness tests which included measurement of speed (50 meters run), flexibility (sit-reach), abdominal strength and endurance (30 seconds sit-up), vital capacity (spirometer), and indirect maximum oxygen uptake (VO_2 max-submaximal bicycle ergometer). The results showed that all physical fitness tests were statistically significantly different ($p < 0.05$) between groups, except for flexibility in boys. But for the girls, only 50 meters run, sit-up and VO_2 max showed statistically significant differences ($p < 0.05$). In the comparison of physical fitness tests between sexes, normal weight boys did better than girls ($p < 0.05$) for all tests except flexibility. There were no statistically significant differences between sexes in overweight and obese children.

This study demonstrated that physical fitness of obese children was worse than that of normal children in both sexes, especially as measured by 50 meters run, sit-up and VO_2 max tests. Thus, promotion of exercise in obese children should be stimulated to develop better physical fitness and weight reduction. In comparison of physical fitness between the sexes, boys had better physical fitness than girls, significant in the normal weight group only. There is no definite explanation as to why increase in weitght results in no difference of physical fitness between sexes. Lifestyle, physical skills, and genetic determinants should be considered for interpretation of physical fitness.

INTRODUCTION

Obesity among children and adolescents is a current worldwide health problem, especially in big cities. It increases the risk of a variety of physical and psychological problems (Coates and Thoresen, 1978; Cohen *et al,* 1980), such as depressed growth hormone release, hyperinsulinemia, carbohydrate intolerance, elevated blood pressure, coronary artery disease, poor self-image, sense of failure and rejection, and poor interpersonal relationships.

Jopling's (1988) review has shown that approximately 10% of prepubertal children and 15% of adolescents in the United States are considered to be overweight. These children average 25 hours per week in front of the television set, and usually consume some type of snack food while watching TV. Only 36% of the overweight children have daily physical education classes. A survey of primary school children in Hat Yai, southern Thailand has shown that 12.2% of them were obese (Mo-suwan *et al,* 1993).

Effective interventions for weight control are dieting, aerobic exercise, and proper lifestyle (Coates and Thoresen, 1978; Ebstein *et al,* 1982). Aerobic exercise can increase energy expenditure and fitness level. Physical fitness defined functionally is "the state of adaptation that permits an organism to successfully respond to exercise loads"; that is a physically fit individual can respond to the same stress with less effort and can sustain the activity for a longer time before fatigue becomes limiting (Rowlant, 1981). A number of tests have been devised to measure the various aspects of physical fitness: physique, organic fitness, and motor fitness. Physic refers to physical appearance, which is assessed by anthropometric measurements of height, weight, and subcutaneous fat thickness. Organic fitness is usually assessed by measurement of the cardiovascular and pulmonary systems, such as pulse rate, blood pressure, and vital capacity. Motor fitness consists of strength, edurance, power, agility, flexibility, and balance (Baley and Field, 1976).

There are several reports on physical fitness of

normal school children in Thailand, but none about obese children. The purposes of this study were:

1. to demonstrate physical fitness in normal weight, overweight, and obese primary school children;

2. to compare physical fitness among these 3 groups;

3. to compare physical fitness between the sexes in each group.

MATERIALS AND METHODS

Subjects : 2,255 primary school children were selected by two-stage cluster sampling from primary school in Hat Yai southern Thailand. They included both boys and girls of age range 6 - 12 years old. Baseline data, including demographic and anthropometeric data (weight and height), educational level, physical activities, parental occupation, family income, and family history of diseases related to obesity were collected.

From anthropometeric measurements, the children were classified as normal, overweight and obese if their weight for heights were 90-110, > 110 - 120 and > 120% of reference values of Bangkok children. (Wichaidet, 1990). Random samples of half of the obese, 10% of the normal and 5% of the overweight, a total of 259 children, were tested for physical fitness.

Methods : Parental permission, informed consent, and medical clearance were obtained for 259 school children. Physical fitness tests modified from the Standard Physical Fitness Test of the Sport Science Center, Sport Authority of Thailand (Sport Science Center, 1984) were carried out for these children. The tests included measurement of:

1. speed by 50 meters run

2. flexibility by sit and reach

3. strength and endurance by 30 seconds sit-up

4. indirect maximum oxygen uptake with bicycle ergometer

5. vital capacity with spirometer

The procedure was conducted during 9.00 - 12.00 AM and 13.30 - 16.30 PM with restricted food intake for at least 2 hours before the study. Each test was performed twice, with the better value used for statistical analysis, except that bicycle ergometry was tested only once for each child because it was time consuming. The physical fitness protocol and details are outlined in the Appendix.

Statistical analysis : Means and standard deviations of physical fitness tests were calculated. The comparisons of physical fitness among normal weight, overweight, and obese children were analyzed by one-way ANOVA, and between sexes by student's *t*-test. The 0.05 probability level was used for all tests of statistical significance. The SPSS statistical package was used.

This study was approved by the Ethics Committee of Faculty of Medicine, Prince of Songkla University.

RESULTS

259 children underwent physical fitness tests. 123 children were classified as obese, 25 children were overweight, and III children were normal weight (Table 1). The mean age and height of all 3 groups are shown in Table 2.

For the boys, all physical fitness parameters were statistically significantly ($p < 0.05$) different between groups except flexibility. But for the girls, only 3 parameters (50 meters run, sit-up and maximum oxygen uptake (VO_2 max) showed statistically significant difference ($p < 0.05$) between groups. The results of the physical fitness tests of both sexes are shown in Tables 3 and 4.

Table 1

Number of children who underwent physical fitness tests.

Anthropometeric class	Boys	Girls	Total
Normal	60	51	111
Overweight	8	17	25
Obese	57	66	123
Tatal	125	134	259

Table 2

Means (± SD) for age and height of normal, overweight, and obese children.

Anthropometeric class	Age (year)	Height (cm)
Normal	8.61 ± 1.72	127.70 ± 8.29
Overweight	8.76 ± 1.69	129.92 ± 11.06
Obese	9.02 ± 1.81	132.54 ± 10.12

For normal weight children. significant differences ($p < 0.05$) were found between boys and girsl in all paramenters except flexibility (Table 5).

No significant differences of fitness outcome were found between the sexes in overweight children (Table 6). Only 2 parameters were significantly different ($p < 0.05$) between the sexes in obese children; these were sit-up and vital capacity (Table 7).

DISCUSSION

The present study demonstrated that physical fitness of obese boys was worse than that of nor-

Table 3

Physical fitness in boys.

Physical fitness test	Normal (N = 60)	Overweight (N = 8)	Obese (N = 57)	ANOVA
50 meters run (sec)	9.37 ± 1.28	9.75 ± 1.04	10.37 ± 1.60	$p < 0.05$
Flexibility (cm)	1.9 ± 5.7	1.4 ± 4.7	0.1 ± 6.3	NS*
Sit-up (time/30 sec)	15 ± 6	10 ± 6	7 ± 7	$p < 0.05$
Vital capacity (ml)	1,454 ± 272	1,235 ± 136	1,592 ± 403	$p < 0.05$
VO_2 max (ml/kg/min)	58.0 ± 7.0	50.4 ± 8.3	38.7 ± 6.2	$p < 0.05$
	(N = 23)	(N = 7)	(N = 39)	

NS* = nonsignificant

Table 4

Physical fitness in girls.

Physical fitness test	Normal (N = 51)	Overweight (N = 17)	Obese (N = 66)	ANOVA
50 meters run (sec)	10.00 ± 1.46	10.77 ± 1.56	10.55 ± 1.17	$p < 0.05$
Flexibility (cm)	1.6 ± 5.6	3.3 ± 4.0	1.9 ± 5.1	NS*
Sit-up (time/30 sec)	8 ± 6	7 ± 6	5 ± 5	$p < 0.05$
Vital capacity (ml)	1,329 ± 363	1,281 ± 324	1,339 ± 409	NS
VO_2 max (ml/kg/min)	52.5 ± 8.8	46.7 ± 6.1	39.8 ± 6.1	$p < 0.05$
	(N = 15)	(N = 13)	(N = 40)	

NS* = nonsignificant

Note: The number of children who underwent VO_2 max test was less than other tests, because those with a height of less than 130 cm were unable to ride the bicyle.

Table 5

Comparison of physical fitness tests between boys and girls in normal weight children.

Physical fitness test	Boys (N = 60)	Girls (N = 51)	*t*-test
50 meters run (sec)	9.37 ± 1.28	10.0 ± 1.46	$p < 0.05$
Flexibility (cm)	1.9 ± 5.7	1.6 ± 5.6	NS*
Sit-up (time/30 sec)	15 ± 6	8 ± 6	$p < 0.05$
Vital capacity (ml)	1,454 ± 272	1,329 ± 363	$p < 0.05$
VO_2 max (ml/kg/min)	58.0 ± 7.0 (N = 27)	52.5 ± 8.8 (N = 20)	$p < 0.05$

NS* = nonsignificant

Table 6

Comparison of physical fitness tests between boys and girls in overweight children.

Physical fitness test	Boys (N = 8)	Girls (N = 17)	*t*-test
50 meters run (sec)	9.75 ± 1.04	10.77 ± 1.56	NS*
Flexibility (cm)	1.4 ± 4.7	3.3 ± 4.0	NS
Sit-up (time/30 sec)	10 ± 6	7 ± 6	NS
Vital capacity (ml)	1,235 ± 136	1,281 ± 324	NS
VO_2 max (ml/kg/min)	50.4 ± 8.3 (N = 7)	46.7 ± 8.6 (N = 13)	NS

NS* = nonsignificant

Table 7

Comparison of physical fitness tests between boys and girls in obese children.

Physical fitness test	Boys (N = 57)	Girls (N = 66)	*t*-test
50 meters run (sec)	10.37 ± 1.60	10.55 ± 1.17	NS*
Flexibility (cm)	0.1 ± 6.3	1.9 ± 5.1	NS
Sit-up (time/30 sec)	7 ± 7	5 ± 5	$p < 0.05$
Vital capacity (ml)	1,592 ± 403	1,339 ± 409	$p < 0.05$
VO_2 max (ml/kg/min)	38.7 ± 6.2 (N = 39)	39.8 ± 6.1 (N = 40)	NS

NS* = nonsignificant

mal children significantly ($p < 0.05$) in all parameters except flexibility. However, the obese girls showed only 3 parameters (50 meters run, sit-up and VO_2 max) significantly ($p < 0.05$) worse than normal children. Our study confirms that of Mocellin and Rutenfranz (1971) and that of Adams *et*

al (1961) who reported that decrease in physical work capacity was directly related to increasing overweight. Our data indicate that not all parameters in physical fitness tests can differentiate the level of obesity. We might speculate that 50 meters run, sit-up and VO_2 max are good indicators to show poor physical fitness in obese children. VO_2 max of obese children in our results was 1.5 times less than normal children in both sexes. In the sit-up test, the obese children could do only half that of normal children. In a study concerning the relationship of body weight and physical activity in children, Bruch found that inactivity was characteristic of the majority of 160 obese children examined; 76%; of the boys and 88% of the girls were physically inactive (Astrand and Rodahl, 1977) Johnson *et al* (in Astrand and Rodahl, 1977) compared obese and normal weight school girls in energy intake and activity. Their findings were that suburban high school girls were generally not very active, but nevertheless there was a marked difference between the groups, in that the obese groups were much less active than the nonobese. Thus, promotion of exercise in obese children should be stimulated to develop better physical fitness and weight reduction.

In a comparison of physical fitness between sexes, the scores of physical fitness testss in normal girls were significantly ($p < 0.05$) less than in normal boys for all parameters except flexibility. There were no significant differences between the sexes in overweight children. In obese children, boys were found to exceed girls significantly ($p < 0.05$) on sit-up and vital capacity tests. In terms of physical work capacity, Astrand and Rodahl (1977) reported that boys and girls before puberty showed no significant difference in this, and this was also found by Bengtsson (1956) In contrast, Adams *et al* (1961) measured physical work capacity in 196 normal Swedish country and city school children. They found that boys had significantly greater working capacities than girls for the same body size, age, and heart volume. However all these data were based on normal weight children. There is no definite explanation as to why increase in weight results in no significant difference between sexes. Nevertheless, there are several factors which affect physical fitness in children (Rowland, 1981). Genetic determinants, growth factors, lifestyle, and physical, and mental skills are main factors. These confounding factors should also be evaluated for intrepretation of physical fitness.

In conclusion, our study demonstrated that physical fitness of obese children was worse than that of normal children in both sexes, especially in the 50 meters run, sit-up and VO_2 max tests. Boys had better physical fitness than girls in the normal weight group. But there were no significant differences between sexes when children were overweight or obese. It is recommended that school-based comprehensive programs of nutrition education, aerobic exercise, and behavior modification should be applied to develop bettler physical fitness and weight reduction.

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APPENDIX

The 5 physical fitness tests measured:

1. Vital capacity
2. Flexibility
3. Strength and endurance
4. Speed
5. VO_2 max

Each child started with the measurement of vital capacity and proceeded in the above order. Each test was done twice except VO_2 max which was tested only once. Each child rested between tests for at least 3 minutes.

1. Vital capacity

Equipment : spirometer

Methods :
1. Move the pointer to zero position on the scale.
2. Ask the child to hole mouthpiece with the mouth.
3. Ask the child to inhale deeply and then exhale fully through mouthpiece.
4. Repeat 1-3 and use the better value for analysis. Let the child rest at least 3 minutes between tests.

Recording : The value was recorded in ml.

2. Flexibility

Equipment : Sit and reach bench with scale from-30 centimeters to + 30 centimeters. The zero position was at foot level.

Methods :
1. Ask the child to sit on the floor with both knees straignt and foot placed under sit and reach bench in 90° position.
2. Ask the child to bend over sit and reach bench scale with outstretched hands. When maximum reach occurs, the subject holds for 2 seconds. Then the distance is recorded in cm.
3. Repeat 1 - 2 and use the better value for analysis.

Recording : The value is recorded in cm.

3. Strength and endurance

Equipment :
1. Mat
2. Stop watch

Methods :
1. Ask the child to lie on the mat with both knees bent 90° and both hands held under the head.
2. When start signal begins, ask the child to sit up till both elbows touch both knees and lie back to starting position. This is counted as one time. Subject repeats sit up for 30 seconds timed with stop watch
3. Repeat 1 - 2 and use the better value for analysis.

Recording : The value is recorded as times per 30 seconds.

4. Speed

Equipment :
1. Stop watch
2. Running track 50 meters long

Methods :
1. Ask the child to run as fast as possible for 50 meters when start signal begins.

2. Repeat 1 and use the better value for analysis.

Recording : The value was recorded in seconds

5. **VO_2 max**

Equipment :
1. Monark bicycle ergometer
2. Stethoscope
3. Stop watch
4. Metronome

Methods :
1. Ask the child to sit on a saddle with adjustable height.
2. Set the metronome for 50 cycles per minute.
3. Set pedal resistance to 1 kilopond (50 Watts)
4. Ask the child to start pedalling at a rate of 50 spm.
5. Count the pulse rate by stethoscope every minute.
6. Finish the test when steady state is reached (the last 2 pulse rates are less than 5 beats per minute).
7. Read the Astrand table from normogram to predict VO_2 max using heart rate and work load on bicycle ergometer. The value should be corrected by age.

Recording : The value is recorded in ml/kg/minute.