

นิพนธ์ต้นฉบับ (Original articles)

สรีรวิทยาการออกกำลังกายและกีฬา (Sports and Exercise Physiology)

PHYSICAL FITNESS PERFORMANCE AS DETERMINED BY THE EUROFIT TEST BATTERY IN THAI OVERWEIGHT/OBESE CHILDREN

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ABSTRACT

Introduction: In Thailand, the prevalence of overweight/obese (OW/OB) children is rapidly increasing. Those children are likely to continue obese when getting older which obesity status can affect their physiological functions in later life. For physical fitness testing in children, the Eurofit Physical Fitness (Eurofit) Test Battery has shown adequate reliability, validity and widely used. Unfortunately, there are no data on physical fitness in OW/OB children as determined by this test in Thailand. Therefore, the purpose of this study was to investigate differences in physical fitness performances between normal-weight (NW) and OW/OB children (both the boys and the girls) by using the Eurofit test battery. **Methods:** A total of 85 children between the ages of 10 and 12 years voluntarily participated in this study. They were further divided into 2 groups according to their body mass index (BMI); 43 children for NW group (14 boys and 29 girls) and 42 children for OW/OB group (14 boys and 28 girls). The Eurofit test battery was used to assess 5 aspects of physical fitness test including grip strength test, standing long jump test, sit and reach flexibility test, shuttle run test and 20 m endurance shuttle test. **Results:** In the boys, data of standing board jump, shuttle run test, 20 m endurance shuttle test were significantly different between NW and OW/OB group ($p < 0.05$). The standing board jump shuttle run test, and 20 m endurance shuttle test in NW group were greater than OW/OB group. Except the data of flexibility and grip strength test were not significantly different between groups. In the girls, data of grip strength was significant difference between groups ($p < 0.05$), whereas there were no significant differences in standing board jump, flexibility, shuttle run and endurance shuttle run tests. **Conclusion:** As determined by the Eurofit Test Battery, dynamic performances including power, agility and endurance in the overweight/obese boys were worse than the NW groups. Whereas the overweight/obese girls had greater hand and forearm muscles strength than the NW groups.

Keywords: The Eurofit Physical Fitness Test Battery / Body mass index / Dynamic performances / 20 m. endurance shuttle test

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สรีรวิทยาการออกกำลังกายและกีฬา (Sports and Exercise Physiology)

สมรรถภาพทางกายในเด็กไทยที่มีภาวะน้ำหนักเกิน/อ้วน โดยใช้รูปแบบ การทดสอบสมรรถภาพทางกาย Eurofit

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วิทยาลัยวิทยาศาสตร์และเทคโนโลยีการกีฬา มหาวิทยาลัยมหิดล อ.พุทธมณฑล จ.นครปฐม ประเทศไทย 73170

บทคัดย่อ

บทนำ ในประเทศไทย พบว่าภาวะ น้ำหนักเกิน/อ้วนในเด็ก มีอัตราสูงขึ้นอย่างต่อเนื่อง ซึ่งเด็กอ้วนเหล่านี้มีแนวโน้มจะเติบโตเป็นผู้ใหญ่อ้วนได้ และพบว่าภาวะอ้วนสามารถส่งผลกระทบต่อระบบร่างกายในอนาคต The Eurofit Physical Fitness (Eurofit) Test Battery คือรูปแบบการทดสอบสมรรถภาพทางกายในเด็ก ซึ่งพบว่า มีความเที่ยง ความน่าเชื่อถือและนำมาใช้ในการทดสอบสมรรถภาพทางกายอย่างแพร่หลาย อย่างไรก็ตามในประเทศไทย ยังไม่มีการนำรูปแบบการทดสอบสมรรถภาพทางกาย Eurofit มาใช้ในการทดสอบสมรรถภาพทางกายของเด็ก โดยเฉพาะในกลุ่มเด็กอ้วน/น้ำหนักเกิน ดังนั้น การศึกษานี้จึงสนใจศึกษาความแตกต่างของสมรรถภาพทางกายในเด็ก โดยใช้รูปแบบการทดสอบสมรรถภาพทางกาย Eurofit ระหว่างเด็กปกติและเด็กอ้วน/น้ำหนักเกินทั้งเพศชาย และเพศหญิง **วิธีการดำเนินการวิจัย** ผู้เข้าร่วมวิจัยเป็นเด็ก อายุระหว่าง 10-12 ปี จำนวน 85 คน และแบ่งออกเป็น 2 กลุ่ม แบบเฉพาะเจาะจง โดยใช้อ้างอิงจากค่าจากค่าดัชนีมวลกาย ออกเป็น กลุ่มเด็กน้ำหนักปกติ จำนวน = 43 คน (เพศชาย 14 คน, เพศหญิง 29 คน) และกลุ่มเด็กอ้วน จำนวน = 42 คน (เพศชาย 14 คน, เพศหญิง 28 คน) ผู้เข้าร่วมวิจัยจะได้รับการทดสอบสมรรถภาพทางกาย Eurofit ซึ่งประกอบด้วย การทดสอบแรงบีบมือ การทดสอบกระโดดไกล การทดสอบนั่งงอตัวไปด้านหลัง การทดสอบวิ่งเก็บของ และการทดสอบวิ่งเพิ่มระยะ 20 เมตร **ผลการศึกษา** ในกลุ่มเด็กชายพบความแตกต่างอย่างมีนัยสำคัญของค่าทดสอบกระโดดไกล การทดสอบวิ่งเก็บของ การทดสอบวิ่งเพิ่มระยะ 20 เมตร เมื่อเปรียบเทียบระหว่างเด็กน้ำหนักปกติ และเด็กน้ำหนักเกิน/อ้วน ที่ค่านัยสำคัญ 0.05 โดยค่าทดสอบการกระโดดไกล การทดสอบวิ่งเก็บของ และการทดสอบวิ่งเพิ่มระยะ 20 เมตร เด็กน้ำหนักปกติมีผลการทดสอบที่ดีกว่าเด็กน้ำหนักเกิน/อ้วน อย่างไรก็ตามไม่พบความแตกต่างระหว่างเด็กน้ำหนักปกติ และเด็กน้ำหนักเกิน/อ้วน ของค่าการทดสอบความอ่อนตัวและค่าแรงบีบมือ ในกลุ่มเด็กหญิงพบความแตกต่างระหว่างเด็กน้ำหนักปกติและเด็กอ้วน เพียงการทดสอบแรงบีบมือ เท่านั้น ไม่พบความแตกต่างระหว่างกลุ่ม ของค่าการกระโดดไกล ความอ่อนตัว การทดสอบวิ่งเก็บของ และการทดสอบวิ่งเพิ่มระยะ 20 เมตร **สรุปผลการวิจัย** การทดสอบสมรรถภาพทางกาย โดยใช้รูปแบบการทดสอบสมรรถภาพทางกาย Eurofit พบว่ากลุ่มเด็กชาย ที่ น้ำหนักเกิน/อ้วน มีสมรรถภาพทางกายด้านกำลัง ความคล่องตัว และความทนทาน ต่ำกว่ากลุ่มเด็กชายน้ำหนักปกติ ขณะที่ในกลุ่มเพศหญิง พบว่า เด็กหญิงที่ น้ำหนักเกิน/อ้วน มีสมรรถภาพทางกายด้านกำลังแขนสูงกว่า กลุ่มเด็กหญิงน้ำหนักปกติ

คำสำคัญ รูปแบบการทดสอบสมรรถภาพทางกาย Eurofit / ค่าดัชนีมวลกาย / การทดสอบวิ่งเพิ่มระยะ 20 เมตร

INTRODUCTION

The current worldwide health problem is obesity among children. This situation is similar in both developed and developing countries. In Thailand, the prevalence of overweight children is also rapidly increasing. The Institute for Population and Social Research of Thailand reported that 36.6 % of pre-school children and 15.57% of school age children, 6-13 years old, are suffering from obesity and tend to increase continually¹.

The overweight/obesity (OW/OB) are defined as excessive fat accumulation that may decrease quality of life and may impair health⁵. Although there are more accurate methods for measuring body fat, body mass index (BMI) is the only method that is feasible outside the realms of research. BMI is calculated from the formula; $BMI = \text{weight (kg)} / \text{height (m)}^2$ ². Following the World Health Organization (WHO) child growth characteristics for defined normal weight and obese/overweight groups; the BMI for normal weight group was $>50^{\text{th}} - 85^{\text{th}}$ percentile, for the obese/overweight group was $>85^{\text{th}}$ percentile²². The previous studies found that the OW/OB children were likely to continue obese when getting older and the obesity status can affect their physiological functions including pulmonary, gastroenterological, endocrine, cardiovascular, and psychosocial behavioral functions in later life³⁻⁹. For physical fitness testing in children, the Eurofit Test of Physical Fitness (Eurofit) test battery have shown adequate reliability and validity and widely used²⁸. The Eurofit test is a set of nine physical fitness tests covering flexibility, speed, endurance and strength. The standardized test battery was devised by the Council of Europe, for children of school age and has been used in many European schools since 1988¹⁰. In this study, the Eurofit test was consisted of 1) grip strength for strength testing, 2) standing long jump test for power testing, 3) sit and reach flexibility test for flexibility testing, 4) shuttle run test for agility testing, and 5) 20 m endurance shuttle test for cardiovascular testing.

In Thailand, only one research has been published on physical fitness in obese children and the study determined fitness parameter using modified physical fitness tests from the Standard Physical Fitness Test of the Sport Science Center, Sports Authority of Thailand (Sport Science Center, 1984) which consisted of 50 meters run for speed, sit and reach for flexibility, 30 seconds sit-up for strength and endurance, bicycle ergometer indirect maximum for oxygen uptake and vital capacity with spirometer¹¹. However, no study has been done as determined by the Eurofit Test Battery in Thai children. In addition, whether this standard test could provide the similar results as seen in that of the previous study. Therefore, the purpose of this study was to investigate differences in physical fitness performances between normal-weight (NW) and OW/OB children (both the boys and the girls) by using the Eurofit test battery.

METHODS

Study design and population

A total of 85 children between the ages of 10 and 12 years voluntarily participated in this study. There were further divided into 2 groups according to their body mass index (BMI) following the Center for Disease Control and Prevention (CDC) BMI-for-age growth charts as normal-weight (NW) group included children with a BMI of 5th–84th percentile or $18.5 \leq \text{BMI} \leq 24.9$ and those in obese (OW/OB) group with a BMI above the 95th percentile or $\text{BMI} > 30 \text{ Kg/m}^2$.¹² Forty-three children for NW group (14 boys and 29 girls) and 42 children for OW/OB group (14 boys and 28 girls). Anthropometric measurements were measured including body weight (in kilogram, kg.), body height (in centimeter, cm.) and waist circumference (in centimeter, cm.). The Eurofit test battery was used to assess their physical fitness including grip strength test, standing long jump test, sit and reach flexibility test, shuttle run test and 20 m endurance shuttle test. The study was approved by the Mahidol University Central Institutional Review Board (MU-CIRB): Protocol No.: MU-CIRB 2015/068.0705.

The procedures were started from 8.00 to 10.00 AM with restricted food intake for at least 2 hours before the testing. Subjects were asked to perform three times each test and only the best data was used.

Anthropometric measurements

Body mass index (BMI): Body height was measured by using the Tanita WB380 Digital Weighing Scales with height rod to the nearest 0.5 cm. Participants stand upright without shoes, with hips and shoulders perpendicular to the central axis, feet and knees together, and the head in the Frankfurt plane. Body weight (BW) was measured by using Omron HBF-375 Karada to the nearest 0.1 kg. BMI was calculated from BW in kilogram divided by body height in square meters (m^2). Waist circumference (WC) was measured by circumference tape. The landmark of measurement is the mid between the lowest border of the ribs and the iliac crest in a horizontal plane¹³.

The Eurofit Test of Physical Fitness test battery

Grip strength test is used to measure the strength of upper body part by using the hand grip dynamometer. Participants were in standing position and held the dynamometer with the right hand, with the arm and elbow straight and rest by the side of the body. The handle of the dynamometer was adjusted for properly each of participant. The landmark for adjustment is the base rest on the first metacarpal (heel of palm). Participants squeeze the dynamometer with maximum effort and hold for 3 seconds without movement the other parts of body¹⁴.

Standing long jump test is used to measure the power. Participants stand behind a line marked on the long jump mat, which none slip place on the ground. Participants attempt to jump as far as possible, the value at the both feet landing on the jump mat without falling backwards is used for recording¹⁴.

Sit and reach flexibility test is used to measure the flexibility using sit and reach box and the ruler. Participants sit on the floor without shoes. The feet are placed flat against the box. Both knees are locked and pressed flat to the floor. Participants are instructed to reach forward along the measuring line as far as possible. The corrected positions including hands reaching forward at the same level, and no jerky movement while testing are asked to perform. During reaches out, participants hold that position for 1-2 seconds, then the score is recorded¹⁴.

The shuttle run test is used to measure the agility. The floor is marked 10 meters apart, as the starting and the ending points, using marking cones. On the signal "ready", participants place their front foot behind the starting line. On the signal "go", participants sprint to the opposite line, pick up an object, run back and place it on or beyond the starting point, then turn without rest, run back to retrieve the second block and carry back across the ending points¹⁴. The researcher records the fastest time.

Twenty-meter endurance shuttle test is used to assess the cardiovascular fitness performance. In this test, participants are asked to continuous running between two lines 20 m apart until exhaustion. Beginning of the test, participants stand behind one of the lines, face to the second line, and start running after hearing the beeps sign, then continue running between the two lines. After passing one minute, the speed of beeps sound is increased. Participants continue running until cannot reach the line following the signal's sound. When they miss 2 times of signal sound, the test is done¹⁴. The predicted VO₂max values are calculated using

$$VO_{2\max} = 31.025 + (3.238 \times \text{velocity}) - (3.248 \times \text{age}) + (0.1536 \times \text{age} \times \text{velocity}) \text{ in ml/kg/min}^{15}.$$

Statistical analysis

Descriptive statistics; physical characteristics and physical fitness performance were presented as absolute data numbers (n) and the mean with standard deviation (SD). The statistical package SPSS (SPSS version 18, MU License) was used for all statistical procedures. A Kolmogorov-Smirnov test was used to test the normal distribution of all data. A Levene's test was used to test for equality of variance of the data. Paired t-test was used to determine statistical differences between OW/OB (both the boys and the girls) and NW groups. The p-value <0.05 level of significance was used.

RESULT

Eighty-five children were enrolled in this study and further divided into two groups; NW group (14 boys and 29 girls) and OW/OB group (14 boys and 28 girls). The general characteristics of both groups were presented in Table 1. The significant differences between groups in weight, waist circumference and BMI have been detected in both groups and sexes (p <0.05).

In the boys, the physical fitness data of NW and OW/OB were found the standing board jump, shuttle run test, and 20m endurance shuttle test were significantly different between groups ($p < 0.05$), except the data of sit and reach flexibility ($p < 0.32$) and grip strength test ($p < 0.55$), as shown in Table. 2.

In the girls, the physical fitness data of NW and OW/OB found the grip strength was significantly different between groups ($p < 0.05$), whereas there was no significantly different in standing board jump, sit and reach, shuttle run and endurance shuttle run tests (Table 3).

Table 1: General characteristics of normal weight (NW; $n=43$) and overweight/obese (OW/OB; $n=42$) children between boys ($n=28$) and girls ($n=57$)

Characteristics	NW	OW/OB	p-value
Ages (yrs.)	11 ± 0.1	11 ± 0.4	0.946
- Boys	10 ± 1	11 ± 1	
- Girls	10 ± 0	10 ± 1	
Height (cm.)	140.6 ± 1.49	146.3 ± 1.08	0.752
- Boys	140.5 ± 7.7	146.1 ± 7.7	
- Girls	141.8 ± 5.3	148.9 ± 9.0	
Weight (cm.)	36.78 ± 1.08	51.84 ± 1.16	0.038*
- Boys	35.9 ± 6.9	52.7 ± 9.9	
- Girls	37.7 ± 4	50.9 ± 7.3	
Waist circumference (cm.)	57.48 ± 0.48	79.85 ± 0.78	0.001*
- Boys	56.6 ± 1.7	79.3 ± 4.7	
- Girls	58.4 ± 3	80.4 ± 5.9	
Body mass index (kg/m^2)	18.46 ± 0.22	24.11 ± 0.36	0.000*
- Boys	18.24 ± 1.11	24.10 ± 2.66	
- Girls	18.71 ± 1.27	24.14 ± 2.90	

*Significant difference between NW and OB ($p < 0.05$).

Table. 2 showed physical fitness test in boys between NW and OW/OB. In the boys, data of standing board jump, shuttle run test, 20m endurance shuttle test had significant difference between NW and OW/OB groups ($p < 0.05$), except the data of sit and reach flexibility and grip strength test.

Table 2: Physical fitness in boys between normal weight (NW) and overweight/obese (OW/OB)

Physical fitness for boys	NW (n=14)	OW/OB (n=29)	p-value
Grip strength (kg.)	19.75 ± 5.67	20.47 ± 2.66	0.546
Standing board jump (cm.)	141.79 ± 15.89	120.54 ± 15.05	0.000*
Sit and reach (cm.)	1.43 ± 7.28	3.40 ± 6.24	0.320
Shuttle run (s.)	14.47 ± 0.92	15.91 ± 1.64	0.002*
Endurance shuttle run (ml/kg/min)	24.16 ± 3.45	22.69 ± 1.00	0.012*

* Significant difference between NW and OB (p< 0.05).

Table 3 showed physical fitness test in girls between NW and OW/OB. In the girls, data of grip strength showed significant difference between groups (p <0.05), whereas there was no significant difference in standing board jump, sit and reach, shuttle run and endurance shuttle run tests (and Table 3).

Table 3: Physical fitness in girls between normal weight (NW) and overweight/obese (OW/OB)

Physical fitness for girls	NW (n=14)	OW/OB (n=28)	p-value
Grip strength (kg.)	16.55 ± 2.51	22.37 ± 3.57	0.000*
Standing board jump (cm.)	117.70 ± 11.66	121.96 ± 11.97	0.357
Sit and reach (cm.)	2.85 ± 5.44	1.96 ± 5.25	0.662
Shuttle run (s.)	15.59 ± 1.06	15.66 ± 1.37	0.883
Endurance shuttle run (ml/kg/min)	22.66 ± 1.23	22.99 ± 1.22	0.573

* Significant difference between NW and OB (p< 0.05).

DISCUSSION

The current study revealed that as determined by the Eurofit Test Battery, OW/OB children with a BMI >85th percentile or > 24 kg/m² who live in Bangkok, Thailand had lower physical fitness level than that of normal weight children especially in the boys. OW/OB boys had significant lower in the physical fitness including power, agility and endurance than NW group, except the data of flexibility and upper extremities muscle strength. From the previous studies, the performance in OW/OB children also reported that they have poor dynamic performances such as power, agility and endurance and indicated that the extra load from their excess body fat, may result in difficult movement while performing the activity that required weight-baring¹⁶⁻²⁰. In addition, the study of Casonatto et al. in 2007, who assessed physical performance in normal weight and OW/OB children and found that the flexibility data was similar between both groups. This result can be

explained by the fact that sit and reach, the flexibility test, is commonly performed in behavior physical activities in children's daily life which no need to spend force for moving their body weight as seen in endurance, agility, and power test¹⁹. Therefore, children with high body weight who still attend normal physical activities, their flexibility would be similar to those of the normal weight children. However, there are many factors which can affect physical fitness in children with obesity such as genetic determinants, growth factors, lifestyle, and physical, and mental skills²¹. These confounding factors should also be considered for interpretation of physical fitness in children.

Different from the boys, in the girls, values of physical fitness tests of OW/OB girls were similar to that of normal weight girls for all of the tests except grip strength (Table 2). Furthermore, in a comparison between normal weight boys and girls, the value of physical fitness test of normal weight girls was worse than that in the boys for all test except flexibility. Verloigne et al. (2012) studied the levels of physical activity by measuring sedentary time in 10-12 years old boys and girls and found that the girls spent 500 minutes/day in sedentary time, 267 minutes/day in light PA, and 32 minutes/day in moderate-to-vigorous PA, whereas the boys spent 474 minutes/day in sedentary time, 284 minutes/day in light PA, and 43 minutes/day in moderate-to-vigorous PA²². Thus, the time of physical activity is less in the girls than the boys. Moreover, Rudroff et al. (2013) reported that when the girls change from children to puberty, the accessibility of structured activity as well as social desirability of physical activity are decreased, resulting in a reduction of physical activity in those girls when perform exercise²³. Bleeker M et al, in 2015, found that the boys had higher accelerometer intensity counts and spent more time in vigorous physical activity than the girls²⁴. Therefore, the recent study also revealed that between the boys and the girls, the boys show values of upper muscle strength, power, agility, and endurance greater than the girls whereas OW/OB girls had their physical fitness similar to NW girls.

Although, in Thailand, one research has been studied on physical fitness in obese children. However, there are many aspects used that different from our research. Firstly, they carried out in Hat Yai province, Southern part of Thailand, whereas our research carried out in Bangkok, Thailand, which we believe that the difference in two main factors (socio-cultural and dietary characteristics) may affect the difference in development of obesity status²⁵⁻²⁶. Secondly, they measured physical fitness parameters by using modified physical fitness test from Sports Authority of Thailand²⁷, whereas ours were measured by using the Eurofit test battery, which is more widely used for fitness test in children also reliability in a field-base physical fitness assessment for children²⁸. Finally, they characterized NW and OW/ OB groups using weight for height²⁹, whereas ours defined following the WHO child growth characteristics, which common used worldwide for children. Comparing between the results from our study and that of the previous study had been done in Thailand, there were consistent, indicating that Thai OW/OB children had lower of physical fitness level than normal weight children especially in the boys. The Eurofit test battery used in this study, therefore, could be used as alternative method for measuring fitness values in Thai children.

CONCLUSION

The overweight/obese boys had the dynamic performances such as power, agility and endurance worse than normal weight groups, whereas the overweight/obese girls had greater hand and forearm muscles strength than normal weight group. Between the boys and the girls, the boys had values of upper muscle strength, power, agility, and endurance greater than the girls.

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