

Cardiovascular risk of students with mental retardation at Rajanukul School, Bangkok

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- Background** : *Individuals with mental retardation (MR) are usually inactive.*
- Objective** : *To evaluate the level of cardiorespiratory fitness and body composition of adolescents with mental retardation.*
- Setting** : *Exercise Laboratory, Department of Physiology, Faculty of Medicine, Chulalongkorn University.*
- Research design** : *Cross sectional analytical study.*
- Subjects** : *Twenty-eight mild to moderate MR students (mean age = 16.25, mean IQ = 43) without physical disability from Rajanukul School, Bangkok, were evaluated compared to 14 sedentary normal students (mean age = 16.5).*
- Methods** : *All subjects were evaluated for their cardiorespiratory functions using graded exercise testing and Quinton gas analyzer. Body mass index (BMI) and percent of body fat (% BF) were calculated.*
- Results** : *Compared with normal subjects, the MR students had significantly lower $\dot{V}O_2$ peak (24.5 vs. 35.1 ml/kg/min) at $p < 0.01$. Eight of 28 (28.5%) MR subjects had BMI >27 kg/m² and high body fat. Only 1 of 14 (7.1%) normal subjects had high BMI. The $\dot{V}O_2$ peak had negative correlation with % BF ($r = -0.47$, $p = 0.01$), and positive correlation with IQ ($r = 0.54$, $p = 0.01$).*

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Conclusion : *The MR students had cardiorespiratory capacity about 70 % of normal, and had 4 times more prevalence of obesity. Appropriated physical activities should emphasized for health promotion and disease prevention.*

Key words : *Cardiorespiratory fitness, Mental retardation, Exercise test, Obesity.*

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- วัตถุประสงค์** : เพื่อศึกษาสมรรถภาพของหัวใจและปอด และสัดส่วนไขมันของเด็กนักเรียน
วัยรุ่นปัญญาอ่อน เปรียบเทียบกับเด็กนักเรียนปกติ
- ประชากร** : เด็กนักเรียนปัญญาอ่อนระดับน้อยถึงปานกลาง ของโรงเรียนราชานุกูล อายุ
เฉลี่ย 16.25 ปี IQ เฉลี่ย 43 จำนวน 28 คน และเด็กนักเรียนปกติอายุเฉลี่ย
16.5 ปี จำนวน 14 คน
- วิธีการศึกษา** : ประเมินสมรรถภาพของหัวใจและปอด โดยการทดสอบออกกำลังกายด้วยลู่วิ่ง
สายพานและเครื่องวิเคราะห์ก๊าซ ประเมินสัดส่วนร่างกายด้วยค่าดัชนีมวลกาย
และเปอร์เซ็นต์ไขมันในร่างกาย
- ผลการศึกษา** : เด็กนักเรียนปัญญาอ่อนมีค่าการใช้ออกซิเจนสูงสุดต่ำกว่านักเรียนปกติที่ $p < 0.01$ (24.5 : 35.1 มล./กก.นาที) มีเด็กปัญญาอ่อนที่ค่าดัชนีมวลกายมากกว่า
27 กก./ m^2 และไขมันในร่างกายสูง จำนวน 8 ใน 28 คน (28.5 %) ขณะที่เด็ก
ปกติมีค่าดัชนีมวลกายสูงเพียง 1 ใน 14 คน (7.1 %) พบความสัมพันธ์เชิงลบ
ระหว่างการใช้ออกซิเจนสูงสุด กับเปอร์เซ็นต์ ไขมันในร่างกาย ($r = -0.47, p = 0.01$) และความสัมพันธ์เชิงบวกระหว่างการใช้ออกซิเจนสูงสุดกับระดับสติ
ปัญญา ($r = 0.54, p = 0.01$)
- สรุป** : เด็กปัญญาอ่อนมีสมรรถภาพหัวใจและปอดประมาณ 70 % ของเด็กปกติ และ
มีภาวะอ้วนมากกว่าประมาณ 4 เท่า ควรให้โปรแกรมส่งเสริมการออกกำลังกาย
ที่เหมาะสม

Individuals with mental retardation (MR) are born with cognitive and behavioral deficits. The aims of habilitation for this population are not only to develop independence of self-care ability, but also to maximize their work capacity and prevent the potential comorbid diseases.

Adequate physical activity is recognized as essential requirement for good health.^(1,2) Most MR has low level of physical activity, which is an important risk factor of hypercholesterolemia, obesity, hypertension, hyperinsulinemia, and coronary artery disease.⁽²⁻⁴⁾ Previous study demonstrated low cardiorespiratory capacity⁽⁵⁻⁷⁾ and increased obesity^(8,9) in adults with mental retardation, thus makes them an at risk population.⁽¹⁰⁾ Since incubation period of atherosclerosis begins during early years of childhood, and childhood obesity or physical inactivity can lead to adulthood comorbidities,^(11,12) disease prevention should be emphasized to start from the family and in the school.^(2,13) This study was designed to evaluate the cardiorespiratory fitness and prevalence of obesity in Thai MR adolescent students. The results will be useful in future plans for health promotion, disease prevention, and quality of life improvement in this group.

Subjects and Methods

A cross sectional analytical study was performed at The Exercise Laboratory, Department of Physiology, Faculty of Medicine, Chulalongkorn University during July - September 1999. Twenty-eight mild to moderately mentally retarded students without physical disability, aged 15 -18 years from Rajanukul School, Department of Mental Health, Bangkok, were enrolled into the study. They had been physically

examined to assure that there were no contraindications for entry into exercise testing. Fourteen sedentary normal students from Wimuttitarampitayakorn School with same socioeconomic status volunteered to be the control group. All subjects were willing to be tested and had their parents' informed consent.

Demographic data included age, sex, body weight, height, IQ, and comorbid diseases of both groups were recorded. Cardiorespiratory function was evaluated by an exercise test using Fernhall and colleagues' treadmill walking protocol,^(14,15) which used a constant speed of 4.8 km./hour, started with 0 % grade for 2 minutes, followed by 2.5 % grade for 2 minutes, and then increased the grade by 2.5 % every minute until exhaustion. During the test, electrocardiographs were obtained via Quinton 4500 ECG monitoring, and metabolic data were collected using Quinton metabolic cart breath by breath gas analyzer. The parameters recorded were; peak oxygen consumption ($\dot{V}O_{2peak}$), maximum heart rate (HRmax), exercise time, minute ventilation ($\dot{V}E$), and respiratory exchange ratio ($RER = \dot{V}CO_2 / \dot{V}O_2$).

Body mass index (BMI) was defined as (body weight in kg) / (height in meter)². Percent of body fat (% BF) was calculated from skin fold thickness at the triceps, subscapula, and abdominal regions⁽¹⁶⁾ (Table 1).

The results obtained from both groups were compared. Distributions of data were tested with a histogram and a probability plot. The descriptive results were reported in mean \pm SD; the unpaired t-test and the Pearson correlation test were used where appropriate, with 95 % confidence interval and significance at $P < 0.01$.

Table 1. Formula for body fat calculation.⁽¹⁶⁾

Body density (Db) = 1.0982 - 0.000815 (sum of 3) + 0.000000842 (sum of 3)²
Sum of 3 = skin fold thickness at triceps + subscapula + abdominal (mm.)

Age	Gender	% Body Fat
15-16	M	$[(5.03 / Db) - 4.59] \times 100$
	F	$[(5.07 / Db) - 4.64] \times 100$
17-19	M	$[(4.98 / Db) - 4.53] \times 100$
	F	$[(5.05 / Db) - 4.62] \times 100$

Results

General data of both groups is shown in table 2. There were 9 Down syndrome (DS) in the MR group. The mean IQ of MR subjects was 43, range from 34 to 55. The mean age, sex ratio, weight and height of both groups were not significantly different.

Every subject completed the exercise stress test. One MR boy had difficulty in walking while the grade was increased. Even though he was able to reach an RER of 0.98, his data were excluded from the analysis. Table 3. shows comparisons of the parameters representing cardiorespiratory function

Table 2. General data ($\bar{X} \pm SD$).

		MR (n = 28)	Normal (n = 14)
Age	(yr.)	16.2 ± .7	16.5 ± .9
Sex	(M:F)	14 :14	7:7
Down syn.	(M:F)	7:2	0
IQ		43 ± 7	normal
Weight	(kg)	57 ± 14	55 ± 10
Height	(cm)	157 ± 10	161 ± 8

resulted from exercise stress test between MR and normal subjects. The MR students had a significantly lower value of all parameters. It was found that the $\dot{V}O_{2peak}$ had weak negative correlation with %BF ($r = -0.47$ at $p=0.01$), and positive correlation with IQ ($r = 0.54$ at $p = 0.01$)

Table 4 displays differences of cardio-respiratory function between MR and normal subjects for both sexes. Mentally retarded males had lower value of all parameters compared to controls, but MR females differed from normal females only in HRmax, and exercise time.

Comparisons of body composition are shown in table 5. The mean BMI, and %BF of MR group were higher than normal group without statistic significance, but subjects whose BMI was more than 27 kg/m² and subjects with high body fat were found more frequently in the MR group. The BMI and %BF were strongly correlated with $r = 0.85$ at $p = 0.01$.

Discussion

The maximum ventilatory oxygen consumption ($\dot{V}O_{2max}$) is an important parameter used to assess the cardiorespiratory function. Individual with low $\dot{V}O_{2max}$ is defined as unfit and risk of cardiovascular disease.⁽¹⁷⁾ Gas analysis is the direct method used to measure the oxygen consumption during exercise test. In evaluation of the cardiorespiratory function of an individual with mental retardation, the test reliability is mostly dependent on subject motivation. Previous researchers had reported the validity and reliability of cardiovascular fitness tests in MR population using field tests and exercise tests with gas analysis.⁽¹⁸⁻²⁰⁾ Fernhall et al^(14,15) demonstrated the feasibility and reliability of laboratory maximal exercise testing in

Table 3. Mean \pm SD of cardiorespiratory function between MR and normal subjects.

Variable	MR (n = 27)	Normal (n = 14)
$\dot{V}O_2$ peak (ml/kg/min)	24.5 \pm 5.8 *	35.1 \pm 10.7
HRmax (bpm)	153.5 \pm 15.7 *	184.7 \pm 6.3
$\dot{V}E$ (L/min)	47.1 \pm 14.4 *	62.2 \pm 20.9
Exercise time (min)	6.6 \pm 3.5 *	15.6 \pm 4.0
RER (VCO_2/VO_2)	1.01 \pm .07 *	1.09 \pm .06

* significantly different at $p < 0.01$

Table 4. Cardiorespiratory parameters ($\bar{X} \pm SD$) of MR and normal subjects showed in different sex.

Variables	Male		Female	
	MR	Normal	MR	Normal
$\dot{V}O_2$ peak (ml/kg/min)	25.0 \pm 5 *	44.5 \pm 6	23.9 \pm 6	25.6 \pm 1
HRmax (bpm)	158.7 \pm 14 *	186.7 \pm 7	148.7 \pm 15*	182.7 \pm 5
$\dot{V}E$ (L/min)	49.9 \pm 12 *	80.9 \pm 9	44.4 \pm 15	43.5 \pm 6
Exercise time (min)	7.1 \pm 3 *	19.1 \pm 1	6.1 \pm 3*	12.1 \pm 1

* significantly lower than normal subjects at $p < 0.01$

Table 5. Comparisons of body composition between MR and normal subjects.

	MR (n = 28)	Normal (n = 14)
BMI ($\bar{X} \pm SD$)	23 \pm 4	21 \pm 3
% BF ($\bar{X} \pm SD$)	20.6 \pm 9.4	16.0 \pm 7.2
BMI >27 kg/m ²	8 (M = 3, F = 5)	1 (F)
High % BF (M>25, F>30)	8 (M = 3, F = 5)	0

mild to moderate MR subjects. The criteria employed to evaluate the state of maximal exercise are: 1) a plateau in $\dot{V}O_2$ where the work load is increased, 2) no increase in HR during increase in work load, and 3) a RER value greater than 1.0.^(21,22)

In the present study, we used Fernhall's treadmill walking protocol, enabled the subjects to

become familiar with the instruments, machines, and the laboratory, and allowed them to practice until they had confidence and motivation before being tested. All subjects were tested to volitional exhaustion, 73 % of them achieved an RER > 1.0 (mean RER = 1.05), not all of them reached the plateau $\dot{V}O_2$. Therefore the highest $\dot{V}O_2$ obtained from the test was

reported as " $\dot{V}O_2$ peak " ^(6,10,23) instead of $\dot{V}O_2$ max.

All variables collected from the cardio-respiratory function test were significantly lower in the MR group. The mean peak $\dot{V}O_2$ was 24.5 ml/kg/min, approximately to 70 % of that of the control group. This value is lower than those previously reported, ^(5,14,15,18-20,24-27) in which $\dot{V}O_2$ peak/max were about 28 to 35 ml/kg/min. This may be due to the younger age and lower IQ of the subjects in this study. It was also demonstrated that MR individuals with DS had lower cardiorespiratory fitness compared to non-DS. ⁽²⁵⁾ This study included 9 DS subjects (7 males, 2 females) in the analysis, which could have affected the mean $\dot{V}O_2$ peak value. The positive correlation between IQ and $\dot{V}O_2$ peak supports the hypothesis of sedentary life style among MR populations. The mean HRmax of 153 bpm was about 83 % of that of the control group. This probably because the MR subjects could not reach maximum cardiac end point (the test ended from peripheral limitation, not from central limitation), or because of their poor chronotropic responsiveness to exercise. ⁽¹⁴⁾ When sex differences were analyzed, MR males showed all variables of cardiorespiratory function lower than normal subjects, but MR females were different from normal females only in HRmax, and exercise time. This reflected the low level of cardiorespiratory fitness of the normal female students (M vs.F = 44.5 vs. 25.6 ml/kg/min).

When body composition of both groups were compared, the mean BMI and % BF of MR students were higher without statistic significance. Since the U.S. National Health Institute suggests that the BMI > 27 kg/m² is considered obesity, ⁽²⁸⁾ and the American

College of Sports Medicine defines the BMI of > 27 kg/m² as a cut-off point of cardiovascular risk, ⁽¹⁷⁾ our findings showed that the MR group had more risk than the normal group about 4 times (8/28 vs. 1/14).

To identify subjects with high body fat, the % BF of greater than 25 for male and greater than 30 for female were considered. ⁽²⁹⁾ Eight of 28 (28.5 %) of MR subjects had high % BF, whereas none was found in normal group. The male: female ratio of subjects with high BMI and BF is 3:5. These findings are compatible with the studies reported by Rimmer et al, ⁽⁸⁾ Fernhall et al, ⁽²⁴⁾ and Rubbin et al, ⁽⁹⁾ that the incidence of overweight and obesity are high (28-38%) among MR population, and highest in MR females.

The high correlation between BMI and % BF ($r = 0.85$) suggests that these two parameters could be used alternatively to indicate the body composition for late adolescent population (aged 15 -18). The negative correlation between $\dot{V}O_2$ peak and % BF indicates the adverse impacts of deteriorating physical condition upon body composition and vice versa.

Conclusion

The MR adolescents in Rajanukul School had lower level of cardiorespiratory capacity and more prevalence of obesity compared to normal students. These most likely resulted from their inactive behavior and inadequately assigned physical activity. Appropriate exercise and recreational programs should be emphasized to improve the functional capacity of this group and to prevent the concurrent diseases.

References

1. Blair SN, Kohl HW 3d, Paffenbarger RS Jr, Clark DG, Cooper KH, Gibbons LW. Physical fitness and all-cause mortality: a prospective study of healthy men and women. *JAMA* 1989 Nov 3; 262(17): 2395 - 401
2. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW, King AC. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 1995 Feb 1; 273(5): 402 - 7
3. Zafari AM, Wenger NK. Secondary prevention of coronary heart disease. *Arch Phys Med Rehabil* 1998 Aug; 79(8):1006 - 17
4. Fletcher GF, Balady G, Blair SN, Blumenthal J, Caspersen C, Chaitman B, Epstein S, Froelicher ES, Froelicher VF, Pina IL. Statement on exercise: benefits and recommendations for physical activity programs for all Americans. A statement for health professionals by the Committee and Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. *Circulation* 1996 Aug 15; 94(4): 857 - 62
5. Fernhall B, Pitetti KH, Rimmer JH, McCubbin JA, Rintala P, Millar AL, Kittredge J, Burkett LN. Cardiorespiratory capacity of individuals with mental retardation including Down syndrome. *Med Sci Sports Exerc* 1996 Mar; 28(3): 366-71
6. Pitetti KH, Rimmer JH, Fernhall B. Physical fitness and adults with mental retardation: An overview of current research and future directions. *Sports Med* 1993 Jul; 16(1): 23 - 56
7. Rimmer JH, Braddock D, Fujiura G. Cardiovascular risk factor levels in adults with mental retardation. *Am J Ment Retard* 1994 Jan; 98 (4): 510 - 8
8. Rimmer JH, Braddock D, Fujiura G. Prevalence of obesity in adults with mental retardation: implications for health promotion and disease prevention. *Ment Retard* 1993 Apr; 31(2): 105-10
9. Rubin SS, Rimmer JH, Chicoine B, Braddock D, McGuire DE. Overweight prevalence in person with Down syndrome. *Ment Retard* 1998 Jun; 36(3): 175 - 81
10. Pitetti KH, Campbell KD. Mentally retarded individuals - A population at risk? *Med Sci Sports Exerc* 1991 May; 23(5): 586 - 93
11. Dennison BA, Straus JH, Mellits ED, Charney E. Childhood physical fitness test: predictor of adult physical activity levels? *Pediatrics* 1988 Sep; 82(3): 324 - 30
12. Rossner S. Childhood obesity and adulthood consequences. *Acta Paediatr* 1998 Jan; 87(1): 1-5
13. Grundy SM, Blackburn G, Higgins M, Lauer R, Perri MG, Ryan D. Physical activity in the prevention and treatment of obesity and its comorbidities: evidence report of independent panel to assess the role of physical activity in the treatment of obesity and its comorbidities. *Med Sci Sports Exerc* 1999 Nov; 31 (11): 1493 - 500
14. Fernhall B, Tymeson GT. Graded exercise testing of mentally retarded adults: a study of feasibility. *Arch Phys Med Rehabil* 1987 Jun;

- 68(6): 363 - 5
15. Femhall B, Millar AL, Tymeson GT, Burkett LN. Maximal exercise testing of mentally retarded adolescents and adults: reliability study. *Arch Phys Med Rehabil* 1990 Dec;71(13): 1065 - 8
 16. Robergs RA, Roberts SO. *Exercise Physiology: Exercise, Performance, and Clinical Applications*. St Louis: Mosby 1997: 520 - 44
 17. American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription*. 4th ed. Philadelphia: Lea & Febiger, 1991
 18. Pitetti KH, Tan DM. Cardiorespiratory responses of mentally retarded adults to air-brake ergometry and treadmill exercise. *Arch Phys Med Rehabil* 1990 Apr; 71(5): 318 - 21
 19. Rintala P, Dunn JM, McCubbin JA, Quinn C. Validity of a cardiorespiratory fitness test for men with mental retardation. *Med Sci Sports Exerc* 1992 Aug; 24(8): 941- 5
 20. Draheim CC, Laurie NE, McCubbin JA, Perkins JL. Validity of a modified aerobic fitness test for adults with mental retardation. *Med Sci Sports Exerc* 1999 Dec; 31(12): 1849 - 54
 21. Astrand PO, Rodahl K. *Textbook of Work Physiology: Physiological Bases of Exercise*. 3rded. New York: Mc-Graw-Hill 1986: 1 - 756
 22. Robergs RA, Roberts SO. *Exercise physiology: exercise, performance, and clinical applications*. St Louis: Mosby 1997: 480 - 503
 23. Rowland TW. Does peak VO₂ reflect VO₂max in children?: evidence from supramaximal testing. *Med Sci Sports Exerc* 1993 Jun; 25(6): 689 - 93
 24. Fernhall B. Physical fitness and exercise training of individuals with mental retardation. *Med Sci Sports Exerc* 1993 Apr;25(4): 442 - 50
 25. Pitetti KH, Climstein M, Campbell KD, Barrett PJ, Jackson JA. The cardiovascular capacities of adults with Down syndrome: a comparative study. *Med Sci Sports Exerc* 1992 Jan; 24(1): 13-9
 26. Pitetti KH, Tan DM. Effects of a minimally supervised exercise program for mentally retarded adults. *Med Sci Sports Exerc* 1991 May; 23(5): 594 - 601
 27. Millar AL, Fernhall B, Burkett LN. Effects of aerobic training in adolescents with Down syndrome. *Med Sci Sports Exerc* 1993 Feb; 25(2): 270 - 4
 28. American College of Sports Medicine. *ACSM's resource manual for guidelines for exercise testing and prescription* 3rd ed. Baltimore: Williams & Wilkins 1998: 466
 29. American College of Sports Medicine. *ACSM's resource manual for guidelines for exercise testing and prescription* 3rd ed. Baltimore: Williams & Wilkins 1998: 385 - 6