Original article

Physical fitness of fourth-year medical students at Chiang Mai University

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Objective To evaluate the physical fitness level of fourth-year medical students at Chiang Mai University.

Methods The physical fitness level of fourth-year medical students was measured by the following methods: 1) body composition including body mass index and waist to hip circumference ratio, 2) lung function measurement, i.e. forced vital capacity, 3) maximal oxygen consumption, 4) flexibility, 5) hand grip strength, 6) leg strength, and 7) standing board jump. The physical fitness results of all the medical students were compared with Thai normative values.

Results The number of subjects in this study was 341 students; comprising 168 males and 173 females. Physical fitness results from the methods mentioned above revealed that the medical students at Chiang Mai University had a lower level of physical fitness than the average Thai person, except for forced vital capacity and leg strength.

Conclusion The findings of relatively low levels of physical fitness in medical students at Chiang Mai University possibly indicate a lack of regular physical exercises. A well-designed medical curriculum to promote more physical activities for students should be developed. **Chiang Mai Medical Journal 2014;53(1):7-14**.

Keywords: Physical fitness, medical students, Chiang Mai University

Introduction

Physical fitness is a set of attributes or characteristics that people have or achieve, and it is related to the ability to perform physical activities[1]. Adequate physical activity is needed to improve health, lower susceptibility to disease (morbidity), and decrease mortality [2]. However, the amount of physical activity needed to benefit health is questionable. In 2007, the American College of Sports Medicine (ACSM) and American Heart Association (AHA) recommended the types and amounts of physical activity needed to maintain and improve the health of adults[3]. Even though the benefits of adequate physical activity are well recognized, some people may find their sedentary or workaholic lifestyles preclude exercise.

Similar to other groups of people, medical students should be physically fit and mentally alert in order to be a competent physician in the future. Unfortunately, a heavy academic workload in medical school evidently causes medical

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students difficulty in maintaining a regular exercise regimen, and impacts their quality of life[4,5]. Not only less or no exercise at all, but also an imbalanced diet leads medical students to experience both physical and mental stress, resulting in deterioration in almost all aspects of health[6].

The Consortium of Thai medical schools has been aware of the health of medical personnel and medical students. The question of how a doctor, who has never exercised, can recommend exercise for health leads to the notion of instilling the values of health promotion into medical students and doctors, via exercise and a developed health promotion leadership program for Thai medical schools. This program focuses on developing the health promotion attitudes of graduate medical students by encouraging them to incorporate the intervention of health promotion into teaching and learning[7].

The six-year medical school curriculum at Chiang Mai University comprises 3 courses of health promotion, and it integrates the health promotion concept into any facet of medicine. The Faculty of Medicine also provides extracurricular activities and facilities leading to health promotion and a healthy environment, e.g. a sports and recreation complex. Furthermore, the Department of Rehabilitation Medicine has been concerned about the importance of exercise in health promotion. It provides fitness testing for medical students during their Rehabilitation Medicine Course for Medical Students. This fitness testing is conducted to assess the fitness level of medical students and report feedback to each one, with the aim of encouraging them to design an appropriate exercise program. Therefore, the aim of this study was to assess the physical fitness levels of medical students at Chiang Mai University, and use them as a guideline to enhance their physical fitness in the future.

Materials and methods

This retrospective study collected data from the database of fourth-year medical students, who attended the Rehabilitation Medicine Course at the Department of Rehabilitation Medicine, Faculty of Medicine, Chiang Mai University in the academic years of 2009 and 2010. Physical fitness of all the medical students was tested routinely on the second day of a 5-day teaching schedule, as a part of the course curriculum. Physical fitness performance tests were carried out according to the guidelines of the Sports Authority of Thailand (SATST)[8]. These tests included the following.

Measurement of body composition

Body mass index (BMI) and waist to hip circumference ratio (WHR) were used to assess body composition. BMI was calculated as body weight in kilograms/(height in meters)^2.

Height was measured with a stadiometer and a balance beam scale was used for assessing weight. The data were interpreted by using World Health Organization (WHO) criteria. A BMI of between 18.5 and 25 was considered as normal. A BMI of less than 18.5 and more than 25 was considered as underweight and overweight, respectively[8,9]. Waist to hip circumference ratio (WHR) was obtained by dividing the circumference at the waist (the smallest circumference above the umbilicus and below the xiphoid process) by that around the hip (at the greater trochanter). A waist to hip ratio of between 0.87 and 0.90 in males and 0.81 and 0.85 in females was considered as high. A WHR of 0.91 and over in males and 0.86 and over in females was considered as extremely high[8].

Measurement of lung function

Lung function was assessed with a spirometer. Each subject performed maximal inhalation, followed by maximally exhaling as rapidly as possible. Forced vital capacity (FVC) in milliliters was then obtained and divided by the subject's bodyweight in kilograms. The ratio was compared with Thai normative data[8].

Measurement of cardiovascular strength

The level of cardiovascular strength was evaluated by maximal oxygen consumption (VO_2max) calculated after a sub-maximal exercise test on a bicycle ergometer by Astrand-Rhyming protocol. Resting heart rate and resting blood pressure were measured before the test. The bike seat was adjusted so that the pushing knee was almost fully extended as the foot went through the bottom of the pedaling cycle. Test duration was 6 minutes and pedal revolutions were kept at around 50 revolutions per minute. The preliminary workload was selected for the bike, based on gender and age. Then the load was adjusted until the heart rate reached over 120 beats per minute. Exercise heart rates were recorded during the last 10 seconds of each minute, and the final two recorded heart rates (5th and 6th minutes) were averaged. If the heart rate continued to climb significantly after the 5th minute then the test was terminated. Based on the average heart rate for the final 2 minutes and known work-

load, maximal oxygen uptake (VO_2max) could be estimated. This VO2max value was corrected using published correction factors and expressed in mL/kg/min.

Measurement of flexibility

Flexibility was assessed using the sit-and-reach test. Each subject sat on the floor in the long sitting position (fully extended knees), with the soles of the feet flat against the sit-and-reach box. The subject slowly reached forward as far as possible with both hands, and holding this position for approximately 2 seconds. The flexibility score was the furthest point (centimeter) reached with the fingertips. The best score of two trials was recorded.

Measurement of muscle strength

Muscle strength including grip and leg strength was measured using dynamometers. For grip strength, the subjects held the handgrip dynamometer parallel to the side of their body and then squeezed the dynamometer with maximal effort without holding their breath. The tests were performed twice in each hand. The best of four trials was recorded in kilograms and then divide by bodyweight. For leg strength, the subjects held the bar of the leg dynamometer with both hands and pulled the chain as hard as possible with their back straight. The best scores of two trials was recorded in kilograms and then divided by bodyweight.

Measurement of power

Standing broad jump was used to assess explosive leg power. The subjects stood astride behind a line marked on the ground. Two-foot takeoff and landing combined with arm swinging and initial knee bending were performed to give maximal plunge. The subjects attempted to jump as far as possible and landing on both feet without falling backwards. Three attempts are allowed. The farthest point of three trials was recorded to the nearest 0.01 meter.

The physical fitness results of all the medical students were compared with Thai normative values, according to the SATST standard[8].

This study was reviewed and approved by the research ethics committee, Faculty of Medicine, Chiang Mai University.

Statistical analysis

All statistical analyses were performed using SPSS for window version 16.0 (SPSS Inc., Chicago, IL). The demographic characteristics were described and compared between males and females by the independent samples t-test. Categorical data were presented as frequencies (%) and continuous data as mean and standard deviation (SD). The physical fitness parameters were compared between groups by using the Chi-square test. p <0.05 was considered statistically significant.

Results

In 2009 and 2010, 341 medical students performed the physical fitness test. The number of male and female students was comparable at 168 (49.3%) and 173 (50.7%) males and females, respectively. The mean age of all the students was 21.3±0.7 years. The average BMI in male medical students was significantly higher than that of female ones (21.92±3.10 kg/m^2 and 19.95±2.39 kg/m^2, p <0.001). According to calculated BMI, 8.1% and 0.9% of medical students were determined as overweight and obese, respectively. The high WHR found in 19.6% and 12% of the medical students was categorized as an extreme WHR group. The distribution of BMI and WHR categories are shown in Table 1. Male medical students were more likely to have higher BMI and greater WHR than female ones (p = 0.001 and p = 0.001, respectively).

The average FVC in all of the medical students was 54.05±10.68 mL/kg. Most of those (88.4%) had an FVC level that ranged from average to excellent. Conversely, the majority of medical students had a VO_2max level in the range of poor to average and a mean VO_2max of 37.67±9.31 mL/kg/min. There was no significant difference between the categorical data of

Table 1. Comparison of body mass index (BMI) and waist to hip ratio (WHR) between male and female medical students at Chiang Mai University

Parameter	Male n (%)	Female n (%)	p
BMI			
Underweight	15 (9.1%)	53 (31.4%)	
Normal	129 (78.2%)	107 (63.3%)	0.001
Overweight	18 (10.9%)	9 (5.3%)	
Obese	3 (1.8%)	0 (0%)	
WHR			
Small	12 (8.3%)	5 (3.3%)	
Normal	79 (54.9%)	106 (69.7%)	0.001
High	26 (18.1%)	32 (21.1%)	
Extreme	27 (18.8%)	9 (5.9%)	

FVC in male and female medical students, but males were more likely to have a lower VO_2max level than females (p <0.001), as shown in Table 2.

Other fitness related variables such as flexibility, hand grip strength, leg strength and leg power levels (demonstrated in Table 2), were far below the average value for Thai people of the same age, except for the leg strength level. The mean value of flexibility, hand grip strength, leg strength and leg power was 6.12±9.44 cm, 0.57±0.14, 1.64±0.65 and 1.75±0.37 m, respectively. The female medical students tended to have higher physical performance in all of these variables, except for hand grip strength.

Discussion

Results of this study showed that most of the medical students at Chiang Mai University had body composition in the normal range. However, they had a relatively low level of physical fitness when compared to the general Thai population, except for forced vital capacity and leg strength.

The average BMI in the male medical students of this study was similar to the 22.1±3.5 kg/m^2 reported for males aged 15-29 years in the Fourth National Health Examination Survey (NHES)[9]. However, the female medical students of this study had a lower BMI when compared with that of the NHES (19.95±2.39 kg/m^2 VS 22.2±3.7 kg/m^2)[9]. However, it was still in the normal range of BMI. In this survey, a relatively low proportion of medical students were overweight or obese (10%) when compared with the NHES (19.5%)[9]. Furthermore, only about 10% of the medical students were abdominally obese. These results confirm that medical students were able to maintain their body composition during study in university. This may be important beneficially

Table 2. Fitness level classification of medical students at Chiang Mai University using FVC, VO_2 max, flexibility, hand grip strength, leg strength, and leg power as indicators

Parameter	Fitness level n (%)					p
	Excellent	Good	Average	Fair	Poor	
FVC						
Male	63 (38.7%)	36 (22.1%)	45 (27.6%)	9 (5.5%)	10 (6.1%)	0.165
Female	86 (51.8%)	26 (15.7%)	35 (21.1%)	10 (6.0%)	9 (5.4%)	
VO2 max						
Male	8 (5.0%)	11 (6.9%)	44 (27.5%)	32 (20.0%)	65 (40.6%)	<0.001
Female	34 (19.9%)	26 (15.2%)	60 (35.1%)	22 (12.9%)	29 (17.0%)	
Flexibility						
Male	6 (3.6%)	3 (1.8%)	45 (26.9%)	27 (16.2%)	86 (51.5%)	0.004
Female	16 (9.2%)	13 (7.5%)	57 (32.9%)	21 (12.1%)	66 (38.2%)	
Hand grip strength						
Male	9 (5.4%)	7 (4.2%)	44 (26.5%)	32 (19.3%)	74 (44.6%)	0.05
Female	14 (8.2%)	6 (3.5%)	68 (40.0%)	27 (15.9%)	55 (32.4%)	
Leg strength						
Male	29 (17.5%)	25 (15.1%)	50 (30.1%)	21 (12.7%)	41 (24.7%)	0.001
Female	55 (32.7%)	26 (15.5%)	62 (36.9%)	17 (10.1%)	8 (4.8%)	
Leg power						
Male	20 (12.0%)	25 (15.0%)	41 (24.6%)	23 (13.8%)	58 (34.7%)	0.001
Female	28 (16.2%)	28 (16.2%)	70 (40.5%)	9 (5.2%)	38 (22.0%)	

for practicing medical doctors, because previous reports indicated that most patients sought care from non-obese physicians, which showed their greater confidence in general health counseling and treatment of illness from non-obese rather than obese physicians[10].

However, the physical fitness results such as cardiovascular strength, flexibility, hand grip strength and leg power levels showed different results to that of the body composition test. Medical students at Chiang Mai University had a relatively low level of physical fitness, which was similar to two previous studies from Siriraj Medical School in Thailand[11,12]. The probable explanation was that medical students have less chance for adequate physical activities or exercises. According to the authors' institute survey of 1,239 medical students in medical student health days 2011, 62.3% reported that they exercised less than 3 times per week[13]. No available time (62.1%), exhaustion from academic activities (53.6%), laziness (46.8%) and lack of accessible and suitable sporting facilities (26.9%) were reported as important factors among the medical students who did not exercise[13], which was similar to reports from India, Egypt and Saudi Arabia[14,15]. A previous study from Khon Kaen Medical School in Thailand revealed that having enjoyable sports and spare time were significantly associated factors for having sufficient physical activities[16].

The authors did not find any difference between medical students and the normal Thai population regarding the FVC and leg strength level. People mostly walk and use their lower limbs in their daily life, which leads to preservation of leg strength. The reason for preserved FVC in physically sedentary medical students was reported in previous study. Cheng *et al* found that response of the respiratory system to physical activity changed less than response of the cardiovascular system because of larger reserve capacity and higher lung tolerance[17]. In reality, there is no single test that measures all health-related physical fitness entities. Thus, it is important to review physical fitness as an integration of various physical components.

Interestingly, the authors found that the female medical students had a better physical fitness level than the male ones. One possible explanation for this was the higher proportion of overweight, obese and abnormally obese male medical students, whose comparable data from a previous systematic review showed an inverse relationship between physical fitness and also overweight[18].

When comparing aerobic capacity from a previous study[19] of Fifth-year medical students at Chiang Mai University in 2007, its authors found that about two thirds of medical students in their study still had fair to poor ranges of VO_2max. This result suggested that strategies for promoting physical exercise in the Faculty of Medicine, Chiang Mai University may not be effective enough to change the medical students' lifestyle. Therefore, promoting exercise and physical fitness in the medical school curriculum should be emphasized more for motivating medical students to maintain long-term exercise habits and physical fitness[20] such as the Vanderbilt Medical Student (VMS) wellness program[21] and Fit-for-Care program[22]. The VMS wellness program[21] consists of three core components: The Advisory College Program, The Student Wellness Committee, and VMS LIVE. The Student Wellness Committee uses five corresponding programming subcommittees (mentoring, community, body, social, mind) to develop and execute programs specific to each respective area. The example programs for body subcommittees are nutritional and sleep information sessions, quick and healthful cooking classes, online exercise routines and group workouts, commodore fitness challenge and personal exercise goal coaching. Student response to these programs has been highly satisfactory, although evaluation of their outcome is still ongoing. Morris *et al*[22] reported their experience with a Fit-for-care program to medical students at John Hopkins School of Medicine. They found that intervention students showed a significant improvement in their International Physical

Activity Questionnaire scores and levels of irritability on the subsection of the Positive Affect and Negative Affect Scale score. They suggested that student-led fitness intervention might encourage students to exercise more. From the low physical fitness level in this study, strategies for promoting physical exercise in the Faculty of Medicine, Chiang Mai University should be reconsidered. The strategies should promote physical activities or exercises as a daily practice, with the program led by medical students and supported by the faculty or institute. Individuals usually compare themselves with reference groups of people, especially exercising physicians, who occupy the social role to which the individual aspires. Supporting evidence showed that physicians who exercise were more likely to encourage their patients to do so[23,24].

The standard physical fitness tests using highly reliable protocols in a large group of medical students was the strength of this study, however, there were two major limitations. Firstly, this study was retrospective, and some data were missing such as 2.1% in BMI, 13.2% in WHR, 3.5% in FVC, 2.9% in VO2max, 0.3% in flexibility, 0.2% in hand grip strength, 2.1% in leg strength and 0.3% in leg power and there were no data regarding exercise habits of the subjects. Secondly, this was a cross-sectional study that did not collect physical fitness data as students progressed through medical school. Further study should be performed to monitor the physical fitness of medical students at Chiang Mai University, as in previous studies like that of the US military, which found the physical fitness levels of medical students declining significantly as they progressed through medical school[25,26]

Conclusion

This study showed that the physical fitness levels of medical students at Chiang Mai University were low, although body composition was in the normal range. The curriculum should be reevaluated to support health promotion for medical students, and increase their awareness of preventive exercise, as medical students will become competent doctors of the next generation and role models for encouraging exercise in society.

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สมรรถภาพทางกายของนักศึกษาแพทย์ชั้นปีที่ 4 มหาวิทยาลัยเชียงใหม่

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วัตถุประสงค์ เพื่อประเมินสมรรถภาพทางกายของนักศึกษาแพทย์ชั้นปีที่ 4 มหาวิทยาลัยเชียงใหม่

วิธีการศึกษา นักศึกษาแพทย์ชั้นปีที่ 4 ถูกประเมินสมรรถภาพทางกายโดยการ ตรวจส่วนประกอบของร่างกาย ได้แก่ ดัชนีมวลกาย และอัตราส่วนเส้นรอบวงเอวต่อเส้นรอบวงสะโพก วัดความจุปอด วัดความสามารถในการใช้ออกซิเจนสูงสุด วัดความอ่อนตัว วัดแรงบีบมือ วัดแรงเหยียดขา และยืนกระโดดไกล โดยค่าทั้งหมดจะถูกนำไปเปรียบเทียบกับเกณฑ์มาตรฐานของคนไทย

ผลการศึกษา มีนักศึกษาแพทย์เข้าร่วมการศึกษาทั้งหมด 341 คน เป็นเพศชาย 168 คน เพศหญิง 173 คน ผลการทดสอบสมรรถภาพพบว่านักศึกษาแพทย์มีสมรรถภาพทางกายประเภทต่าง ๆ อยู่ในเกณฑ์ต่ำเมื่อเทียบกับเกณฑ์มาตรฐานของคนไทย ยกเว้นความจุปอดและแรงเหยียดขา

สรุป การศึกษานี้พบว่าสมรรถภาพทางกายของนักศึกษาแพทย์ มหาวิทยาลัยเชียงใหม่อยู่ในเกณฑ์ต่ำ ซึ่งบ่งบอกถึงการขาดการออกกำลังกาย ดังนั้นควรมีการปรับการเรียนการสอนหลักสูตรแพทยศาสตรบัณฑิตเพื่อเอื้อให้นักศึกษาสามารถพัฒนาสมรรถภาพทางกายให้ดีขึ้น **เชียงใหม่เวชสาร 2557;53(1):7-14.**

คำสำคัญ: สมรรถภาพทางกาย นักศึกษาแพทย์ มหาวิทยาลัยเชียงใหม่