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A study of the relationship between physical fitness and health profile to academic achievement

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Abstract
Introduction: Sports education is not only beneficial for physical health but also has a proven positive effect on academic achievement.
Objective: This study aims to determine the relationship between fitness and health profiles, and academic achievement of ITB students.
Methods: The study subjects were ITB students of the Matriculation Stage. Their fitness was assessed using a 2.4 km run-test, the health profile using a National Wellness Institute questionnaire, and the learning achievement scores taken from the end of the semester GPA. The relationship between the variables was analysed using descriptive statistics.
Result: Students who participated in a sports course during a semester, and those with better fitness levels achieved better GPAs at the end of the semester. The students' fitness levels, body mass index (BMI), leg strength, and health profile influenced their GPA. Furthermore, for both the first and second semester students, their body mass index, leg strength, and health profiles influenced their fitness levels.
Conclusions: Students with better fitness levels and health profiles showed better academic achievement than those with weaker physical health.

Keywords: fitness, health profile, academic achievement.

Introduction
Offering students wider opportunities to improve their fitness can not only reduce obesity, but can also improve learning achievement (Joshi, 2011) [14]. In Indonesia, children's physical activities are typically structured through sports education lessons in schools for a duration of 120 minutes per week. Outside of school, most children, especially those living in urban areas, do not participate in any physical activities; instead their activities revolve around watching television, playing games, and being active in online media.
Media Development Foundation Children's Research in 2006 reported that school-age children watch television and play video games for durations ranging from 40-45 hours per week (Muniandy, 2013) [10]. If it is assumed that the number of hours in school is eight hours per day or 40 hours per week, then they barely have time for physical activity such as sports. Research of fitness data has shown that 37.40% of young Indonesians are categorized as having very poor fitness, 43.90% have poor fitness, 13.55% moderate fitness, and only 5.15% have good or excellent fitness (Mutohir, 2007) [9].
The very small amount of time spent on physical activities is also seen in the majority of college students, even in those whose college provides physical education lessons. Data of physical activity (exercise) of 1,108 Institut Teknologi Bandung (ITB) students of the Matriculation Stage showed that 88% of the students normally exercise for 1-3 hours, 6% for 3-6 hours, 4% for 6-9 hours, and only 2% exercise for more than nine hours per week. Meanwhile, their average fitness of can be categorized as low, at 36.6 (ml / kg / minute).These data show the importance of a structured physical education program starting from primary school and continuing through university.
Research has shown that more physical education programs are useful for improving cardiorespiratory fitness, muscular ability, body mass index, bone health, the health of organs, and improving cognitive function (Lee *et al*., 2012) [4].

Also, contrary to certain beliefs, increasing the duration of physical education lessons in school did not lower student achievement (Dwyer *et al.*, 1983; Shephard, 1996; Sallis *et al*., 1999) [2, 16, 15]. Other research confirmed that increasing physical exercise in schools had a positive effect on student achievement, evidenced by achieving better grades and higher scores on standardized tests (Hanson and Austin, 2003) [3].

Subjects and methods

The subjects of this study were ITB students of the Matriculation Stage, consisting of 695 students in the first semester in the period from August 2013 to January 2014 (399 male, 296 female) and 413 students in the second semester in the period from February to July 2014. The students attended 120 minutes of physical education per week for 15 meetings in one semester. 70% weight of the course material included a fitness workout: endurance, strength, speed, flexibility, and agility; and 30% included sports games (Extramural) such as football, indoor soccer, basketball, and volley ball. Cardiorespiratory fitness measurements were carried out at the beginning, middle, and end of the semester, while the measurement of leg strength, anthropometry, and charging health profile questionnaire was carried out at the beginning of the semester. Academic achievement was measured by the Grade Point Average (GPA) obtained from the ITB Directorate of Education.

Study design

Figure 1 shows the relationship between the independent and dependent variables observed in this study. The study was limited to focus on the relationship between the fitness and health profile to academic achievement.

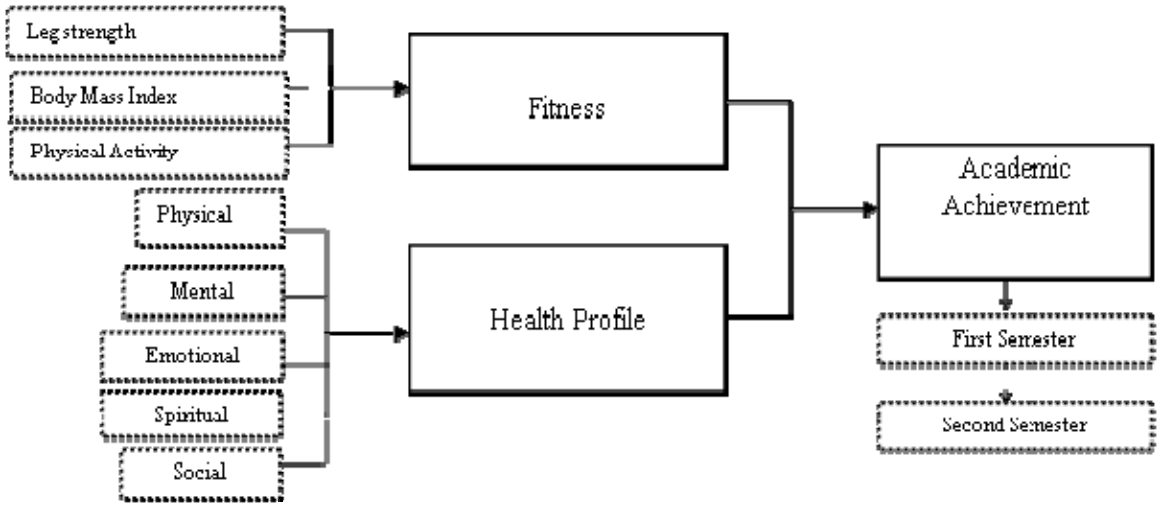

Fig 1: Research design

Research Parameters

1. Cardiorespiratory fitness

Fitness was measured by a cardiorespiratory 2.4 km run-test (Burger, *et al*., 1990) [1]. All participants lined up behind the starting line and ran around the athletics track as much as six rounds at a given command. The time taken to finish six rounds was noted, and the VO2max parameter was calculated using the following equation: VO2max = (483 / time) + 3.5. The results were then grouped into six categories: (1) very poor, (2) poor, (3) fair, (4) good, (5) excellent, (6) superior.

2. Antropometric

Antropometric measurements were conducted to determine the Body Mass Index (BMI). Participants stood upright on the measuring instrument (SECA Mod 220, height and weight measuring instruments), and their heights and weights were noted. The BMI was then calculated using the following equation: BMI = weight (kg) / height (m^2). Results of the BMI calculation were classified into five categories: (1) underweight, (2) normal, (3) overweight, (4) obesity type 1, (5) obesity type 2.

3. Leg strength

Leg strength was measured using a dynamometer (Tiwari *et al*., 2012) [18]. Participants stood on the dynamometer leg with both hands holding the handles with palms facing toward the body, both feet shoulder width apart, body straight, and knees bent 120 degrees. Participants were then instructed to pull the handle upwards as hard as possible to try to straighten their knees. The measurement result was further classified into five groups: (1) excellent, (2) good, (3) average, (4) fair, and (5) poor.

4. Health profile

Participants were asked to complete a questionnaire that had been adjusted (National Wellness Institute, Inc.). The questionnaire included six components of health: physical, social, mental, emotional, and spiritual. Each component consisted of 10 multiple choice questions with answers of different value: "always" - worth 4, "sometimes" - is worth 3, "undecided" - is worth 2, and "almost never" - is worth 1. The highest score for each component is 40, and thus the total score for all components was 200. A score of 200 was designated as a “perfectly healthy person", a score of 151 - 199 was categorized as “a normal healthy person", a score of 101 - 149 was categorized as having “health problems”, and a score of <100 was categorized as "experiencing serious health problems. "Participants were also asked to write personal identity information, including age, gender, type of sport involved in, and duration of exercise per week.

5. Academic achievement

The academic achievement of students in the form GPA was calculated on the basis of the acquisition of a number of final grades achieved by the students within a certain period of time (PAK, 2005) [12]. GPA data for first semester and second semester students of 2013 were obtained from the ITB Directorate of Education.

Data analysis

First, the research subjects were characterized in terms of their gender, age, intensity of exercise per week, leg strength, BMI, heart-lung fitness, health profiles, and GPA. Independent and dependent variables were then identified, and the relationship between the variables was calculated by determining the correlation using a linear regression test with Pearson Product Moment. Lastly, the correlation results were compared between the sexes and the semester. Data were analyzed using the SPSS software version17 (SPSS, Inc., Chicago, IL, USA) within a significance level of 0.05.

Results

First semester

Characteristics of the 1st semester study subjects are presented in Table 1.

Table 1: Characteristics of the sample first semester

Characteristics	Male (*n* = 399)	Female (*n* = 296)	Total (n = 695)
Leg strength (Kg.) ($\bar{x}$ ± SD)	(99.27 ± 30.38)	(61.06 ± 23.72)	(82.99 ± 33.55)
Leg strength (n and %)			
Classification			
Poor (<84,5)	121 (30.33)	252 (85.14)	373 (53.67)
Fair (>84,5 – 127,5)	217 (54.39)	40 (13.51)	257 (36.98)
Average (>127,5 – 187,5)	55 (13.78)	4 (1.35)	59 (8.49)
Good (>187,5 – 259)	6 (1.50)	0 (0.00)	6 (0.86)
Excellent (>259)	0 (0.00)	0 (0.00)	0 (0.00)
BMI ($\bar{x}$ ± SD)	(21.28 ± 3.93)	(20.52 ± 3.78)	(20.95 ± 3.88)
BMI (n and %)			
Classification			
Underweight (<19)	123 (30.83)	110 (37.16)	233 (33.53)
Normal weight (>19 – 25)	221 (55.39)	162 (54.73)	383 (55.11)
Overweight (>25 – 30)	44 (11.03)	20 (6.76)	64 (9.21)
Obesity 1(>30 – 35)	5 (1.25)	3 (1.01)	8 (1.15)
Obesity 2(>35)	6 (1.50)	1 (0.34)	7 (1.01)
Cardiorespiratory fitness (Kg./ml/minute) ($\bar{x}$ ± SD)	(40.83 ± 4.56)	(32.72 ± 3.59)	(37.39 ± 5.77)
Cardiorespiratory fitness (n and %)			
Classification			
Very poor (<25)	35 (8.77)	1 (0.34)	36 (5.18)
Poor (>25 – 31)	65 (16.2)	81 (27.36)	146 (21.01)
Fair (>31 – 35)	214 (53.63)	147 (49.66)	361 (51.94)
Good (>35 – 39)	83 (20.80)	54 (18.24)	137 (19.71)
Very good (>39 – 42)	2 (0.50)	6 (2.03)	8 (1.15)
Excellent (>42)	0 (0.00)	7 (2.36)	7 (1.01)
Health profile ($\bar{x}$ ± SD)	(153.70 ± 13.26)	(152.40 ± 14.33)	(153.00 ± 13.89)
Health profile (n and %)			
Classification			
< 100 (Poor)	3 (0.75)	0 (0.00)	3 (0.43)
101 – 150 (Average)	164 (41.10)	180 (60.81)	344 (49.50)
151 – 200 (Good)	232 (58.15)	116 (39.19)	348 (50.07)
GPA ($\bar{x}$ ± SD)	(3.25 ± 0.47)	(3.20 ± 0.51)	(3.22 ± 0.49)

Table 2 shows the correlations between the variables studied. The multiple linear regression analysis resulted in a significance value of 0,000 which is less than 0,05; thus, the null hypothesis was rejected meaning that BMI, leg strength, and health profile simultaneously influenced fitness levels. The regression equation was found to be Y = 31.26 + 0.21x1 + 0.013x2 + 0.033x3. IMT (X1), the strength of the legs (X2), and the health profile (X3) partially influenced fitness levels. If the BMI rises by 1 unit, the fitness value will go up by 0.21; if the value of the leg strength increases by 1 unit, the fitness value would rise by 0.013; and if the value of the health profile increases by1 unit, the fitness value will increase by 0.033, assuming other variables remain constant. The R-Squared value of this regression was 0.27. This result meant that 2.7% of the fitness value is influenced by BMI, leg strength, and health profile.

Table 2: The correlations between variables first semester (N =695)

Variable	Female					Male				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
1. BMI	1	.053	.006	-.216**	-.005	1	.225**	-.085	-.368**	.064
2. Leg strength		1	.167**	.091	.028		1	.165**	.142**	.064
3. Health profile			1	.134*	.010			1	.132**	-.018
4. Cardiorespiratory fitness				1	.147*				1	.019
5. First semester GPA					1					1

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Second semester

Characteristics of the second semester study subjects are presented in Table 3.

Table 3: Characteristics of the sample second semester

Characteristics	Male (*n* = 280)	Female (*n* = 133)	Total (n = 413)
Leg strength ($\bar{x}$ ± SD)	(140.89 ± 51.48)	(95.37± 29.48)	(127.74± 50.08)
Leg strength (n and %)			
Poor	34 (12.14)	59 (44.36)	93 (23.66)
Fair	80 (28.57)	57 (42.86)	137 (34.86)
Average	116 (41.43)	17 (12.78)	133 (33.84)
Good	46 (16.43)	0 (0.00)	46 (11.70)
Excellent	4 (1.43)	0 (0.00)	4 (1.02)
BMI ($\bar{x}$ ± SD)	(21.81 ± 3.82)	(20.81± 2.63)	(20.77 ± 2.74)
BMI (n and %)			
Underweight	65 (23.21)	36 (27.07)	101 (25.70)
Normal weight	171 (61.07)	88 (66.17)	259 (65.90)
Overweight	34 (12.14)	9 (6.77)	43 (10.94)
Obesity 1	7 (2.50)	0 (0.00)	7 (1.78)
Obesity 2	3 (1.07)	0 (0.00)	3 (0.76)
Cardiorespiratory fitness ($\bar{x}$ ± SD)	(41.34 ± 4.60)	(33.45 ± 2.74)	(38.79 ± 5.52)
Cardiorespiratory fitness (n and %)			
Very poor	15 (5.36)	1 (0.75)	16 (3.87)
Poor	49 (17.50)	15 (11.28)	64 (15.50)
Fair	111 (39.64)	80 (60.15)	191 (46.25)
Good	72 (25.71)	33 (24.81)	105 (25.42)
Very good	13 (4.64)	3 (2.26)	16 (3.87)
Excellent	20 (7.14)	1 (0.75)	21 (5.08)
Health profile ($\bar{x}$ ± SD)	(155.11 ± 13.45)	(156.53 ± 12.54)	(153.00 ± 13.89)
Health profile (n and %)			
< 100	0 (0.0)	0 (0.00)	0 (0.00)
101 – 150	110 (41.10)	94 (60.81)	344 (49.50)
151 – 200	170 (58.15)	39 (39.19)	348 (50.50)
GPA ($\bar{x}$ ± SD)	3.05 ± (0.60)	2.98± (0.66)	3.05± (0.60)

The linear regression of the second semester students resulted in a significance value of 0,000 which is also less than 0,05, meaning that, as with the first semester students, the null hypothesis is also rejected and that BMI, leg strength, and the health profile variables influence the fitness levels. The regression equation was found to be Y = 31.06 + 0.152 + 0.009 + 0.001. As with the first semester students, BMI (X1), the strength of the legs (X2), and the health profile (X3) partially influenced fitness. If the BMI rises by 1 unit, the fitness value will rise by 0.152; if the strength of the leg increases by 1 unit, the fitness value will rise by 0.009; and if the value of the health profile increases by 1 unit, the fitness value will increase by 0.001, assuming other variables remain constant. The R-squared value of this regression is 0.24, meaning that 2.4% of the fitness value is influenced by BMI, leg strength, and health profile.

Table 4: The correlations between variables second semester (N =413)

Variable	Female					Male				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
1. BMI	1	.241**	-.018	.122	-.330**	1	.156**	.042	-.254**	-.054
2. Leg strength		1	-.223**	-.064	-.168		1	-.086	-.076	.181**
3. Health profile			1	.022	-.003			1	.114	.002
4. Cardiorespiratory fitness				1	.100				1	.159**
5. Second semester GPA					1					1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5 shows that the first semester group of female students experienced a decline in their GPA after not participating in a sports course, from an average of 3.33to 3.31. This shows that the average GPA increased due to participation in a sports course. The same trend was also seen for the second semester group of female students where there was an increase of GPA from an average of 3.05 to 3.11. Additionally, the student health profile of female students who participated in a sports course in the first semester was lower than that of students who participated in a sports course in the second semester (154.00 vs. 155.47). Also, the VO_2max value of the former was lower than that of the latter (32.78 vs. 33.24). The same pattern was also observed among the male students. Their GPA increased after participating in a sports course, both in the first (from 3.28 to 3.31) and second (from 3.11 to 3.17) semesters, and the health profile of the first semester students was lower than that of the second semester students (153.00 vs. 154.50), as were their VO_2max values (40.29 vs. 42.05).

Table 5: The average value of VO_2max, Health Profile, and student GPA by semester

Variable	Gender	First semester		Second semester		Total n
		Sports course	Non-Sports course	Non-Sport course	Sport course	
VO_2Max	Female	32.78 ± 3.59		33.24 ± 2.74		413
Health profile		154.00 ± 13.31		155.47 ± 12.48		
GPA		3.33 ± 0.47	3.31 ± 0.51	3.05 ± 0.66	3.11 ± 0.55	
VO_2Max	Male	40.29 ± 4.60		42.05 ± 4.60		695
Health profile		153.00 ± 14.23		154.50 ± 16.46		
GPA		3.31 ± 0.49	3.28 ± 0.56	3.11 ± 0.66	3.17 ± 0.62	

Discussion

The difference in the students' average GPA before and after participating in a physical education course indicates that it can positively impact students' academic achievement and learning outcomes in a single semester. Results of this study show that the students' GPA increased after participating in a sports course, meaning that students who participate in physical activities, in this case a sports course, coupled with activities done individually out of interest, have increased academic achievement. Their findings are in line with previous studies carried out in other countries. Fourteen previously published studies analysed approximately 58000 students between the years 1967 and 2006 investigated the relationship between participation in physical activities and learning achievement. Eleven of those studies found that participation in regular physical activity is closely related to learning achievement. Additionally, eight health surveys involving populations that represent children and adolescents from the United States, Britain, Hong Kong, and Australia reported a positive correlation between participation in physical activities and learning achievement (Trust, 2007) [20]. Furthermore, Podulka (2006) [13] showed that high-intensity physical activity is closely related to increasing student achievement, while physical activity was not significantly associated with student achievement. The evidence supporting the relationship between physical activities and learning achievement is reinforced by relevant research that found that high physical fitness is associated with increased academic achievement. A national study in Australia found that physical fitness scores were significantly associated with student achievement. The study included students from elementary school through high school (Dwyer *et al*, 2001) [2]. The low fitness levels of ITB students are possibly caused by many factors, among others the low amount of programmed physical activity and unhealthy diet. Physical activities of less than three hours per week lead to students with fitness levels within the medium category. These results are not much different from those of a 2007 research that showed that ITB students of the Matriculation Stage were in the category of low fitness level. This is because students typically spend more time in the laboratory, library, or at the campus in general, thus they tend to be sedentary. However, there is a significant correlation between the students' levels of fitness and their performance index; students who have a low fitness level generally have a low grade point average. Staying active is a necessity of life and is a way to balance oneself physically, chemically, electrically, and emotionally. Physical exercise allows the brain and body to achieve balance and be in a condition that is beneficial to learning activities. Accordingly, the quality of the physical education course at ITB is very important to produce optimal academic achievement. These results indicate that sport, in a structured course curriculum, is strongly related to academic achievement.

Conclusion

The main finding in this study is that the fitness and health profile of ITB students of the Matriculation Stage simultaneously have a definite effect on their academic achievement, both in the first or second semester. The existence of a structured sports course in the curriculum encourages students to spend more time carrying out physical activities, either individually or through the course, increasing their fitness and health profiles.

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