Relationship between BMI, Energy Intake, Macro Nutrient Intake and Cardiorespiratory Fitness among Female College Students in Jakarta

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Abstract: Scientific evidence has shown a relationship between cardiorespiratory fitness in young adults and health status in later life. In the past decade, there has been a global decline in cardiorespiratory fitness at a young age, especially among college students. This study aims to examine the level of cardiorespiratory fitness among UHAMKA female students and their relationship with various factors such as nutritional status, calorie intake and macro nutrients. With a cross-sectional design, this study tested different proportions of low fitness level in various groups with the chi square test. A total of 164 samples participated in this study where body mass index, calorie intake, carbohydrates, protein and fat were measured. The results showed that the proportion of low cardiorespiratory level was higher among respondents with higher and lower BMI and an excessive fat intake. It suggested to the young women to have a normal BMI and a non-excessive fat intake.

1 INTRODUCTION

Fitness status, especially at a young age, is important to be monitored regularly because it has implications for health status ((Nassif et al., 2012); (Cale, Harris and Chen, 2014). Several types of fitness related to health include cardiorespiratory fitness (Caspersen, Powell and Christenson, 1985. A Meta-analysis showed that cardiorespiratory fitness is associated with the incidence of coronary heart disease, cardiovascular diseases and all-cause mortality in healthy adults ((Kodama et al., 2009); (Barry et al., 2014). Cardiorespiratory fitness is also associated with bone health (Hervás et al., 2018). Moreover, cardiorespiratory fitness is also associated with cognitive function in all age groups (Pinilla & Hillman, 2013) and academic performance at a young age (Ariza et. al., 2017).

However, although various studies show a relationship between fitness and health status, there has been a decline in fitness levels at a young age across the globe. Meta-analysis showed a significant decline in cardiorespiratory fitness in children and young adults by 43% per year from 1981-2000 in developed countries ((Tomkinson and Olds, 2003). The same thing happened in Korea, where since 1968-2000 there has been a decline cardiorespiratory fitness level among children and young people (Olds, Kang and Kim, 2007). In the United States, it has been shown that there has been a decline in the level of cardiorespiratory fitness of young people from the 1960s-1990s (Hoeger and Hoeger, 2011). Previous research among college students in Depok, West Java, Indonesia showed that 86.3% of subjects were unfit (Indrawagita, 2009). Four years later in the same location, a study showed that 67.9% of students were unfit (Komala and Achmad , 2013).

Several factors affect fitness status, including: caloric intake (Marco et al., 2017), macronutrient intake (Marco et al., 2017) and micronutrient intake (Cao et al., 2012) and body mass index ((Ortlepp et al., 2003); (Chen et al., 2020). Other factors include gender (Busing and West, 2016) and age (Milanović et al., 2013).

Based on the data of the low level of fitness at the young age, both at the global level and in Indonesia, especially in college students, the authors were interested to examine the factors that are related to cardiorespiratory fitness among female college students in Jakarta.

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2 METHOD

2.1 Design

This study used a cross-sectional study design. In this study, primary data was collected once at a time to measure the dependent variable, namely cardiorespiratory fitness and the independent variable, namely nutritional intake, physical activity, and nutritional status. The research is located on the Limau campus of the Faculty of Health Sciences, UHAMKA Jakarta during December 2018 to December 2018. February 2019.

2.2 Subject

The target population in this study were Semester 3 students of the Nutrition Science Study Program, FIKES UHAMKA for the academic year 2018/2019, amounting to 245 people. By using the 80% test power, a minimum sample size of 164 people was obtained. Sampling was carried out purposively with the condition that it met the inclusion criteria (healthy, had no history of cardiovascular disease and followed all fitness test protocols). The entire sample participated in this study from beginning to end.

2.3 Cardiorespiratory Fitness Test Protocol

In this study, the measurement of cardiorespiratory fitness was carried out using the YMCA 3 minute step test method. Respondents were asked to go up and down the board with a height of 31 cm in a duration of 3 minutes with a specified rhythm. After that, the pulse is measured for 1 minute and matched against the norm table.

The protocol test are:

1) Preparation of tools: 31 cm high YMCA step test bench, timer, metronome
2) Subjects measured their own pre-test RHR. RHR was measured for 1 minute.
3) Subjects were asked to go up and down the YMCA bench for 3 minutes with an up and down rhythm according to the beat of the metronome which was set to 96 beats/minute. The timer is set to 3 minutes.
4) Exactly 3 minutes timer, the test is over and the subject is asked to rest by sitting in a chair comfortably. Turn on the 1 minute timer for rest time.
5) Exactly 1 minute timer, the subject measures the post-test pulse by himself. The pulse is measured for 1 minute.
6) Post-test pulses were recorded and compared with the norm table.

2.4 BMI Measurement

Nutritional status is determined according to the body mass index (BMI) which is calculated by the formula for body weight in kg/(height in meters)2. The results were categorized into undernourished (BMI < 18.5), normal (BMI = 18.5 – 24.9), overweight (BMI 25 – 29.9) and obesity (BMI > 30) according to the Indonesian Ministry of Health. The validity of BMI in predicting health benefits such as fitness has been recognized by the American Society of Sport Medicine (Tuttle, Montoye and Kaminsky, 2016).

2.5 Dietary Assesment

The intake of calories (kcal), carbohydrates (grams), protein (grams) and fat (grams) was obtained from the results of the 3 days food record. Respondents were asked to record food and drinks consumed for 3 days consisting of 2 weekdays and 1 weekend. The results were categorized into: intake deficit (< 80% RDA), normal (80 – 110% RDA) and more (> 110% RDA).

2.6 Instruments

Measurement of cardiorespiratory fitness using the YMCA 3 minute step test instrument consisting of: a wooden box with a height of 31 cm, a timer measuring device, and a metronome. The collection of nutritional status data using the Omron brand Karada Scan digital weight measurement tool with an accuracy of 0.1 kg. Measurement of height using a microtoise with an accuracy of 0.1 cm. measurement of nutritional intake using the 3 days food record form.

2.7 Data Analysis

Data was analysed using chi square test to examine the difference in the proportion of unfit between normal and abnormal BMI (overweight and underweight) and between adequate and excessive intake.

3 RESULT

3.1 Description of Characteristics, Cardiorespiratory Fitness Level, Nutritional Status and Nutritional Intake of Respondents

Respondents were 164 students of the Nutrition Study Program, Faculty of Health Sciences, UHAMKA, with an average age of 19.26 years. The average

weight was 53.56 kg and the average height was 155.42 cm (Table 1).

Table 1: Subject's Characteristics.

Characteristic	Mean ± SD	Min – Max
Age	19.26 ± 0.774	18 – 22
Body Weight	53.56 ± 0.629	40 – 91
Height	155.42 ± 0.978	140 - 168

Cardiorespiratory fitness is classified into 7 levels from the lowest to the highest, namely: very poor, poor, below average, average, above average, good, and excellent from the American College of Sport Medicine (Blair et al., 2014). Table 2 shows a description of the respondents' cardiorespiratory fitness.

Table 2: Subjects Distribution by Cardiorespiratory Fitness Level.

Fitness Level	n	Percentage (%)
Very Poor	19	11.6
Poor	22	13.4
Below Average	31	18.9
Average	51	31.1
Good	17	10.4
Excellent	24	14.6
Total	164	100.0

If the seven levels were grouped into categories of fit (good and excellent) and not fit (very poor, poor, below average, average, above average), three quarters of respondents (75%) were not fit (figure 2).

The measurement results show that one-fifth of the respondents (19.5%) have poor nutritional status. The same thing also happened to excess nutritional status (a combination of overweight and obesity) where the proportion reached one-fifth of the respondents (20.1%).

Table 3: Subjects Distribution by BMI

Nutritional status	n	Percentage (%)
Underweight	32	19.5
Normal	99	60.4
Overweight	24	14.6
Obesity	9	5.5
Total	164	100.0

The results of data collection through 3 days food record show that a quarter of respondents have a deficit energy intake (25%). One third of respondents experienced a deficit in carbohydrate intake (32.2%), and more than half (69.5%) experienced a protein intake deficit. For fat intake, almost half of the respondents had excessive intake (47.6%).

Table 4: Subject Distribution by Dietary Intake Level

Intake	n	Persentage (%)
Energy		
Deficit	41	25.0
Normal	98	59.8
Excessive	25	15.2
Total	164	100.0
Carbohydrate		
Deficit	53	32.3
Normal	81	49.4
Excessive	30	18.3
Total	164	100.0
Protein		
Deficit	114	69.5
Normal	50	30.5
Total	164	100.0
Fat		
Deficit	1	0.6
Normal	85	51.8
Excessive	78	47.6
Total	164	100.0

3.2 Relationship between Cardiorespiratory Fitness and Nutritional Status

The different proportion test was carried out by compositing the nutritional status categories into 2 categories, namely: abnormal (combined nutritional status of less and more) and normal. The results of the analysis showed that the proportion of respondents who were not fit was higher in those with abnormal nutritional status (73.8%). This figure is almost 2 times the proportion of unfit in respondents who have normal nutritional status (44.4%). The results of the analysis show that this difference is significant with p value = 0.048.

Table 5: Relationship between Cardiorespiratory Fitness and BMI

BMI	Cardiorespiratory fitness Status				Total		OR (95% CI)	P value
	Unfit		Fit					
	n	%	n	%	n	%		
Underweight, overweight & obese	48	73.8	17	26.2	65	100	2.36 2.14 – 2.86	0.048
Normal	44	44.4	55	61.1	99	100		
Total	123	75.0	41	25.0	164	100		

Table 6: Relationship between Cardiorespiratory Fitness and Dietary Intake

Dietary Intake	Cardiorespiratory Fitness Status				Total		OR (95% CI)	P value
	Fit		Unfit					
	n	%	n	%	n	%		
Calorie								
Deficit	32	78.0	9	22.0	41	100	1.25 0.54 – 2.90	0.755
Normal & Excessive	91	74.0	32	26.0	123	100		
Carbohydrate								
Deficit	41	77.4	12	22.6	53	100	1.208 0.56 – 2.61	0.772
Normal & excessive	82	73.9	29	26.1	111	100		
Protein								
Deficit	94	77.0	28	23.0	122	100	1.51 0.69 – 3.28	0.409
Normal & excessive	29	69.0	13	31.0	42	100		
Fat								
Excessive	52	66.6	26	25.6	78	100	3.24 0.46 – 1.90	0.000
Normal & deficit	21	24.4	65	75.6	86	100		

3.3 Relationship between Cardiorespiratory Fitness and Dietary Intake

The difference in proportion test was carried out by compositing the categories of calorie, carbohydrate, and protein intake into 2, namely deficit and normal-over. As for fat intake, the categories were composited into more and normal-deficit. The results of the analysis for calorie, carbohydrate and protein intake showed similar results, where the proportion of non-fitters was slightly higher in respondents who had a deficit intake compared to those who were more normal. Even this slight difference in proportion was not statistically significant (Table 6).

Different results are shown in fat intake, where the proportion of respondents who are not fit is 3 times higher in those who have more intake than normal-deficit intake (Table 6). The chi square test shows that this difference is significant with an OR of 3.24, which means that respondents with more fat intake have a 3 times higher risk of being unfit than those with normal-deficit intakes.

4 DISCUSSION

The results of the analysis show that three quarters of the respondents are not fit, even though the respondents are students of the health sciences faculty. These results are in line with previous research on health science students at several campuses in Indonesia. Research (Indrawagita, 2009) found that most (86.3%) students at a public health faculty in Depok, West Java were declared unfit after doing the YMCA 3 minute step test. Research in the next 4 years, still at the same campus, research (Komala and Achmad, 2013) which also used the YMCA 3 minute step test showed that more than half (67.9%) of students were not fit. In 2016 it was reported that 93.3% of nursing students in Tanjung Pura, West Kalimantan had a low level of fitness using the multistage fitness test method (Purnomo, Samodra and Yanti, 2015). Surprising results were reported by research from (Safaringga and Herpandika, 2018) which showed that 100% of physical education and health students had low fitness using the multistage fitness test method. The latest report shows that 80% of female students who are members of the student center in Padang have very low fitness (Anggri, 2019).

For college students, low fitness is associated with academic performance, as reported in several studies ((Lipošek et al., 2019); (Zhai et al., 2020); (Hou et al., 2020)). In addition to leading to academic achievement, fitness level also affects nutritional and health status. A review shows that the level of fitness as a result of regular physical activity shows a long-term protective effect on health, which can prevent obesity and various degenerative diseases such as coronary heart disease, diabetes mellitus, Alzheimer's and dementia (Reiner et al., 2013).

One of the factors that affect cardiorespiratory fitness is nutritional status. Research on female students shows that the higher the BMI, the lower the level of cardiorespiratory fitness (Bonney, Ferguson and Smits-Engelsman, 2018). A recent study from (Chen et al., 2020) also showed a significant relationship between BMI and fitness as measured comprehensively using the Physical Fitness Index (PFI). In detail, the study (Chen et al., 2020) states that respondents who have an abnormal BMI (less, more and obese) have a lower PFI score than the normal one. This finding certainly supports the results we found in this study, where the proportion of unfit is higher in respondents with abnormal BMI compared to normal ones. This supports the theory that normal nutritional status in young adults is a protective factor for cardiovascular diseases considering that cardiovascular fitness is positively related to cardiovascular functions such as blood vessel elasticity (Davison et al., 2010).

In addition to nutritional status, cardiorespiratory fitness cannot be separated from calorie intake and macronutrients. The results of this study are in line with previous research by (Rahmawati, 2020) which also did not show a significant relationship between cardiorespiratory fitness and calorie, carbohydrate, protein intake. Cardiorespiratory fitness actually correlated significantly with fat intake, where the proportion of those who consumed excess fat was not fit more than the normal-deficit. The explanation of how fat intake affects cardiorespiratory fitness begins with the theory that total fat intake affects obesity rates as summarized in a systematic review by (Hooper et al., 2015) and research by (Raatz et al., 2017). The high intake of total fat and saturated fatty acids will trigger adiposity which in turn causes obesity (Raatz et al., 2017). Obesity is what will ultimately reduce the level of cardiorespiratory fitness as previously discussed.

5 CONCLUSIONS

This study showed that cardiorespiratory fitness in female students was significantly associated with BMI and total fat intake, but not with calorie, carbohydrate and protein intake. Future research should investigate fitness levels more comprehensively, not only cardiorespiratory fitness but also muscle strength, muscle endurance and flexibility.

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