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IMPROVING FEMALE STUDENTS' PHYSICAL FITNESS INDEX MAY REDUCE CARDIOVASCULAR RISK

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Abstract

Objectives: Evidence suggests that lower cardiovascular disease risk is among the most important factors for decreasing premature mortality rates in non-communicable diseases. Physical fitness is a potentially important factor for cardiovascular disease prognostication. We aim to analyze the correlation between physical fitness and the risk of cardiovascular disease in female students.

Materials and Methods: 76 participants completed all examinations. Cardiovascular disease risk factors were assessed by measuring body fat percentage, blood pressure, and lipid profiles. Physical fitness was measured using the modified Harvard step test to compute the physical fitness index., Spearman correlation was used to determine the correlation between variables in this study.

Results: A negative correlation between physical fitness index with body mass index, fat percentage, systolic blood pressure, and diastolic blood pressure (r = -0.443; r = -0.409; r = -0.370; r=-0.280). We also found that the physical fitness index did not significantly correlate with the lipid profile.

Conclusion: The physical fitness index might predict individual cardiovascular disease risk. Physicians should encourage patients to exercise regularly to maintain or improve their fitness levels to prevent cardiovascular disease.

Keywords: Cardiorespiratory fitness, dyslipidemia, fatness, screening, sustainable development goals.

Introduction

Cardiovascular disease (CVD) is the major contributor to premature mortality in non-communicable diseases, as stated in Sustainable Development Goals (SDGs) indicator 3.4.[1] According to data from Global Burden Diseases (GBD) 2019, there are nearly two-fold prevalent cases, from 271 million total CVD in 1990 to 523 million in 2019.[2] Cardiovascular disease deaths grew steadily from 12.1 million in 1990 to 18.6 million in 2019; 58% of CVD death in 2019 occurred in Asia.[2,3] In high-income Asian nations, the percentage of premature CVD fatalities to total CVD deaths was notably lower but considerably higher in several low- and middle-income Asian nations, including Indonesia.[3] Roughly one-third of deaths in Indonesia are caused by cardiovascular disease.[4]

In descending order, several modifiable risk factors for CVD include hypertension, dietary risk, dyslipidemia, smoking behavior, diabetes, obesity, and a lack of physical activity.[5] Low cardiorespiratory fitness (CRF) levels have been strongly linked to an increased risk of cardiovascular disease and a more accurate predictor of mortality than other CVD risk factors. Integrating CRF into risk classification offers opportunities to improve patient management and encourage lifestyle-based strategies for reducing cardiovascular risk.[6] A 17% reduction in risk for every 1-MET increase in CRF supports the idea that it effectively predicts mortality risk in women.[7] CRF-improving initiatives must be regularly integrated into the physical examination .[6]

Limited studies assessed cardiovascular risk and physical fitness in female students; therefore, this study focused on female university students for several reasons. Globally, the prevalence of less physical activity is higher in women than men.[8] Research in Qatar shows that female students tend to be less active than male students and do not enjoy doing exercise regularly.[9] Awareness of the risks and dangers of CVD is also required to prevent it in the future, but awareness among women in this age group remains low. According to an American Heart Association (AHA) survey, approximately 41% of women aged 25-34 did not know that CVD was the leading cause of death in women.[10] In the following AHA survey of women between the ages of 15 and 24, only 10% of participants knew that CVD is the top cause of death in women.[11]

The American Heart Association (AHA) recommends that young adults over 20 assess their CVD risk factors every 4-6 years.[12] However, Indonesia has not yet adopted this recommendation in primary health centers. Measuring the physical fitness index is one tool for assessing cardiorespiratory fitness as screening CVD risk. This study aims to assess the correlation between physical fitness and the risk of cardiovascular disease in female students. This study's findings will contribute to implementing physical fitness as one of the inexpensive tools for screening individual cardiovascular risk.

Materials and Methods

Participants

The research participants were students at the Faculty of Medicine Universitas Andalas who voluntarily participated by filling out a Google form. We distributed the Google form via WhatsApp to the students' chairman in every grade. The recruitment is open to participants with the following criteria: female students at the Faculty of Medicine Universitas Andalas who are not pregnant and are not currently taking anti-hypertension and cholesterol-lowering drugs. Eighty-one female students enrolled in this study, but only 76 students completed all examinations.

Physical Fitness Index

Physical activity and fitness are inextricably linked. A person's ability to perform physical activities is called physical fitness. Physical activity assessments using a simple, self-reported questionnaire are prone to measurement errors or misclassification.[13,14] Physical fitness provides more objective data about one's health and is more reproducible than physical activity.[14,15] Physical fitness is a stronger predictor of adverse health outcomes and mortality than smoking, hypertension, high cholesterol, and diabetes.[6]

Physical fitness consists of several components: flexibility, muscle strength, cardiorespiratory fitness (CRF), and body composition. We measured the physical fitness index using a modified Harvard step test to assess cardiorespiratory fitness. The test requires minimal tools and can be done in limited indoor space, so it can be applied to screening cardiovascular risk in a primary health care setting.[16] We asked participants to step on 30 cm high stairs with each click sound from the step test timer, and the stepping rate is 96 beats per minute (4 clicks = one cycle, step up and down) for 5 minutes. The participant counted their pulse rate at minutes 1, 3, and 5 after the step test for one minute full. The physical fitness index formula is 100 x step test duration (300 seconds) / the sum of pulse rate at minutes 1, 3, and 5. We divided PFI into tertile based on the PFI range of the participants: lowest (71.43–89.63), middle (89.64–107.84), and highest (107.85–126.05)

Cardiovascular Risk Factors

Cardiovascular risk factors assessed in this study are family history of cardiovascular diseases, body mass index, body fat percentage, blood pressure, and lipid profile. Family history of cardiovascular was assessed by an online questionnaire consisting of six questions: are there any in your family history of heart disease, obesity, diabetes Mellitus, dyslipidemia, hypertension, and stroke? Enumerators using standard procedures examined body mass index, body fat percentage, and blood pressure. Height was measured using a stadiometer, and the data was input to BIA TANITA BC-418 to get body mass index and body fat percentage. Blood pressure using Omron automatic blood pressure monitor.

Blood samples were taken from each participant to examine lipid profiles in the morning with subjects fasting 8-10 h since evening. An accredited laboratory examines lipid profiles. The traditional approach for CVD risk assessment is LDL-C and triglycerides, but a recent study found that the concentration of non-high-density lipoprotein cholesterol (non-HDL-C) is superior to LDL-C in predicting CVD.[17] Therefore, we measured non-HDL-C (total cholesterol minus HDL-C) and non-HDL-C to HDL-C ratio (atherogenic coefficient).

Statistical analysis

We performed data analysis using the IBM SPSS 29.0.1.0 trial version (until 25 June 2023). We run a normality test on all numerical data. Normal distribution data are presented in mean ± standard deviation, and non-normal distribution data are presented in median (minimum-maximum). Spearman rank correlation was used to measure the correlation between variables in this study.

Results

Subject Characteristic

We analyzed data from 76 female students who participated in this study. Table 1 provides descriptive data for subject characteristics and family history of cardiovascular diseases. We found that the average age was 19.9 years old, with a range of 18–23 years old. The mean body weight was 61.73 kg with a range of 39.50–97.60 kg, and the mean height was 1.56 m with a range of 1.46–1.69 m. A family history of diabetes and hypertension were higher than others, 42.11% and 38.16%, respectively.

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Table 1. Subject Characteristic

Characteristic*	Total (n=76)
Age	19.91 ± 1.04 years old
Body Weight	61.73 ± 13.96 kg
Body Height	1.56 ± 0.05 m
Family History*	
1. Heart Disease	
Absent	63 (82.89%)
Present	13 (17.11%)
2. Obesity	
Absent	57 (75.00%)
Present	19 (25.00%)
3. Diabetes Mellitus	
Absent	44 (57.89%)
Present	32 (42.11%)
4. Dyslipidemia	
Absent	66 (86.84%)
Present	10 (13.16%)
5. Hypertension	
Absent	47 (61.84%)
Present	29 (38.16%)
6. Stroke	
Absent	70 (92.11%)
Present	6 (7.89%)

*Values are presented as mean ± standard deviation or number (%)

Anthropometric and Blood Pressure

Table 2 shows that the mean body mass index was 25.59 kg/m2, with nearly half of the subjects being obese. In fat percentage, more than half of the total subjects were overfat (fat percentage > 45%). The most surprising aspect of the data is that 25% of these young female participants were suspected hypertension-based JNC VIII category.

Lipid Profile

The lipid profile characteristics of participants are summarized in **Table 3**. Based on the NCEP-ATP III classification, we found that almost all participants have normal triglyceride, and more than one-third have normal HDL. For non-HDL, we found that more than half of the participants have less than 130 mg/dL (at risk).

Table 2. Anthropometric and Blood Pressure of Participant

Characteristic*	Total (n=76)
BMI	24.55 (17.87–35.80) kg/m^2
Underweight	5 (6.58%)
Normal	30 (39.47%)
Overweight	4 (5.26%)
Obese	37 (48.68%)
Body Fat Percentage	36.50 (23.00–49.00) %
Underfat	1 (1.3%)
Ideal	34 (44.7%)
Overfat	41 (53.9%)
Blood Pressure	
Systolic Blood Pressure	112.01 ± 13.39 mmHg
Diastolic Blood Pressure	70 (53–101) mmHg
Blood Pressure Profile	
Hypertension	19 (25.00%)
Prehypertension	5 (6.58%)
Normal	52 (68.42%)

*Values are presented as mean ± standard deviation or number (%)

Table 3. Lipid Profile of Participant

Characteristic*	Total (n=76)
Triglycerides	73.5 (35–174) mg/dL
Risk (<150 mg/dL)	2 (2.63%)
Normal (≥150 mg/dL)	74 (97.37%)
HDL-C	55.18 (10.25) mg/dL
Low (<50 mg/dL)	23 (30.26%)
Normal (≥50 mg/dL)	53 (69.74%)
Non-HDL-C	133.08 ± 33.63 mg/dL
Risk (<130 mg/dL)	39 (51.32%)
Normal (≥130 mg/dL)	37 (48.68%)
Atherogenic Coefficient	2.50 ± 0.80

*Values are presented as mean ± standard deviation or number (%)

Correlation of Cardiovascular Risk and PFI

We categorized all the variables based on the PFI tertile (**Figure 1**). We can see that most obese students are in the lowest tertile, as do the overfat students. Two-thirds of prehypertension and hypertension students were also in the lowest tertile. For the lipid profile, there was no difference in PFI in triglyceride, HDL, and non-HDL.

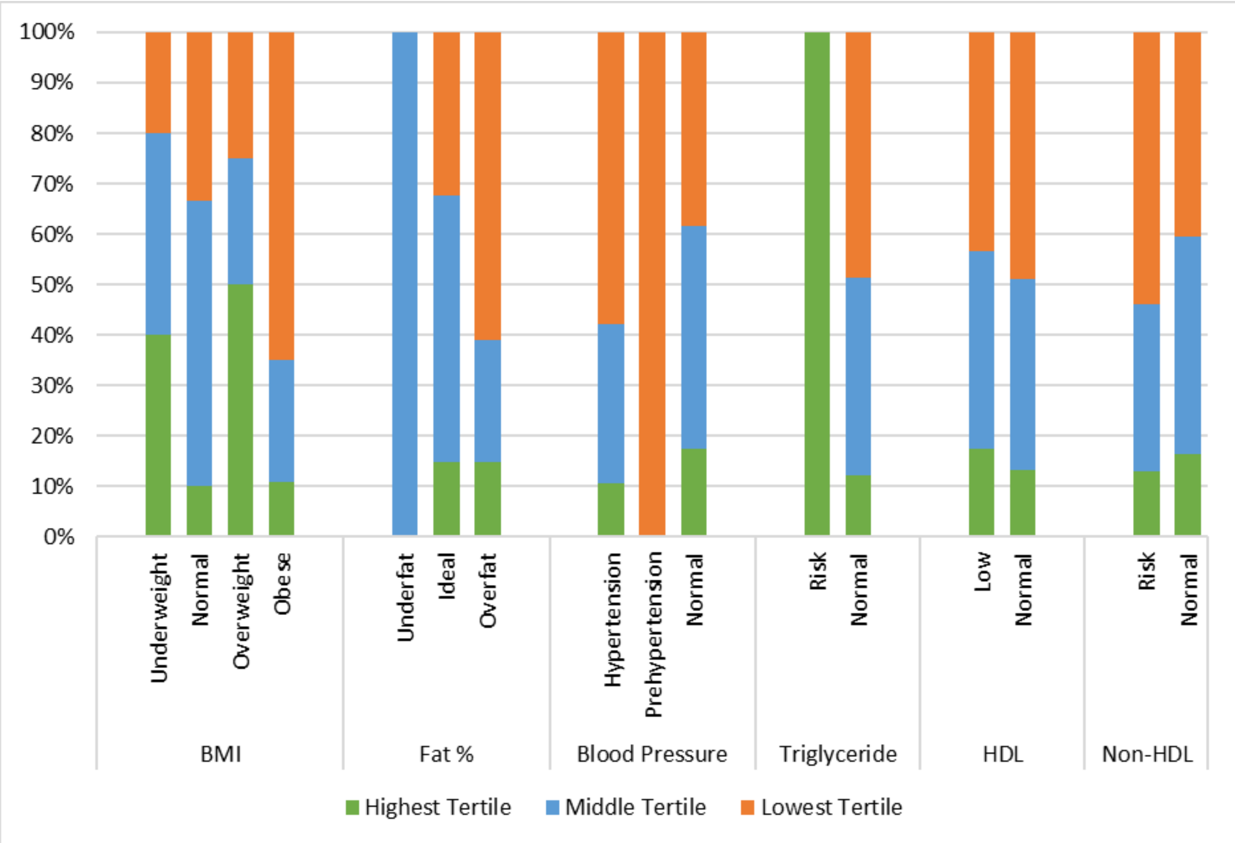


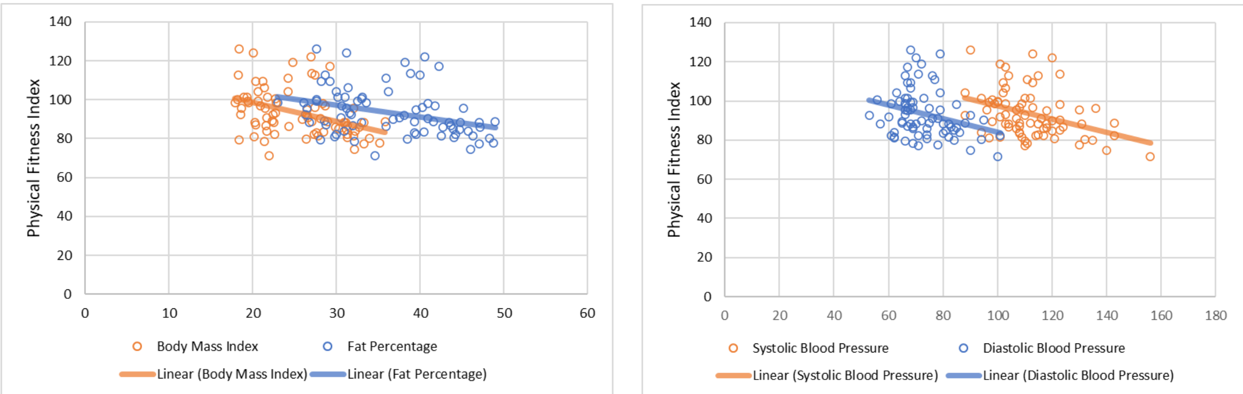
Figure 1. Cardiovascular risk based on PFI tertile

Further analysis determined the correlation between variables (**Table 4**). We found that PFI negatively correlates with BMI, body fat percentage, systolic blood pressure, and diastolic blood pressure (r = -0.443; r = -0.409; r = -0.370; r = -0.280), as shown in **Figure 2**. Increasing the physical fitness index led to a reduction in BMI, fat percentage, and blood pressure. The Spearman rank correlation did not show any correlation between PFI and all lipid profiles.

Table 4. Correlation between physical fitness index, fat percentage, blood pressure, and lipid profile

	PFI	BMI	Fat %	SBP	DBP	TG	Non-HDL-C	HDL-C	AC
PFI	1.000								
BMI	-0.443†	1.000							
Fat %	-0.409†	0.971†	1.000						
SBP	-0.370†	0.526†	0.549†	1.000					
DBP	-0.280†	0.475†	0.515†	0.708†	1.000				
TG	0.146	0.137	0.086	0.055	0.109	1.000			
Non-HDL-C	-0.04	0.163	0.182	0.169	0.166	-0.363†	1.000		
HDL-C	0.085	-0.250*	-0.213	-0.110	-0.012	0.487†	-0.099	1.000	
AC	-0.074	0.278*	0.267*	0.176	0.137	0.611†	0.804†	-0.613†	1.000

P-values were calculated by Spearman rank correlation.
PFI, Physical Fitness Index; SPB, Systolic Blood Pressure; DPB, Diastolic Blood Pressure; TG, HDL-C; High-Density Lipoprotein Cholesterol; AC, Atherogenic Coefficient.
* P<0.05; † P<0.01



A

B

Figure 2. A. Correlation of physical fitness index with body mass index and fat percentage; B. Correlation between physical fitness index and blood pressure

Discussion

Our study found that more than one-third of our participants have a family history of cardiovascular disease, mainly obesity and diabetes mellitus. These results are consistent with those of Purohit et al.[18], who found that 77% of overweight medical students in Gujarat have a family history of CVD, and Costa et al.[19] found that 71.1% of female students at the University in Sao Paolo have a family history of diabetes melitus. This family history increases the participants' susceptibility to CVD in their later life.

One interesting finding is that hypertension was found in 25% of these young participants. In accordance with the present results, previous studies have demonstrated that the prevalence of hypertension in Damietta University students was 26.5% and 18.1% of students in Port-Said University.[20] This might be an alarm situation because these young populations were less aware of their blood pressure status.[21] The elevated oxidative stress from hypertension causes an inflammation response, which leads to a buildup of atherosclerotic plaque.[22] Coronary artery disease has this plaque formation within the endothelium as its primary cause. Atherosclerotic plaque may erode or rupture, causing thrombosis at first and, subsequently, a vascular closure that causes cardiovascular disease such as myocardial infarction, stroke, and limb ischemia.[23] There is, therefore, a definite need for screening blood pressure and educating students about healthy lifestyles to prevent hypertension.

The way the heart, lungs, and blood vessels effectively transport oxygen to the muscle used during continuous physical work is represented by cardiovascular fitness, which is measured by the physical fitness index in this study. Further analysis showed that the physical fitness index inversely correlates with blood pressure. This finding is consistent with the results of a previous study in men by Chase et al.[24] that found an inverse relationship between higher CRF levels and a lower risk of hypertension. Barlow et al.[25] suggested that if all unfit women in their population sample became fit, it might reduce hypertension by 22 percent. A study by Díez-Fernández et al.[26] found that adiposity mediates the association between cardiorespiratory fitness and blood pressure. A high level of cardiorespiratory fitness may attenuate the rate of progression from prehypertension to hypertension but might not neutralize the adverse effects of adiposity on blood pressure. Increasing individual fitness levels and maintaining a healthy body composition through enhanced physical activity should be a keystone of primary hypertension prevention.

Another finding from this study was that most obese students were in the lowest tertile and had a negative correlation between physical fitness index, body mass index, and fat percentage. This finding is similar to that of Chung et al.[27], who studied 124 Taiwanese youth. They found that CRF negatively correlates with body fat percentage ($r = -0.662$, $p<0.001$). Anwar et al.[28] also found a significant correlation between body fat percentage and aerobic and anaerobic performances. Apart from the percentage of fat, physical fitness also has an inverse correlation with other body composition indices like body mass index (BMI), waist circumference (WC), and waist-height ratio (WHtR).[29]

This study did not find a significant correlation between the physical fitness index with the HDL-C, non-HDL-C, and atherogenic coefficient. In contrast to earlier findings, Watanabe et al.[30] evaluated CRF and non-HDL-C in 4067 Japanese men and found an inverse relationship between CRF level and non-HDL-C. Physical activity can decrease the non-HDL-C, the numerator of the atherogenic coefficient, with several possible mechanisms: it activates the AMP-activated protein kinase in skeletal muscle, increases LPL, and improves insulin sensitivity.

These results must be interpreted cautiously due to a small sample size from a single population. These findings might not be generalized to other populations. Another limitation of this present study was using only one fitness parameter, and the cross-sectional design cannot assess the effect of physical fitness on the event of cardiovascular disease. Further research is needed to evaluate the correlation between various physical fitness parameters and the novel atherogenic coefficient with a bigger sample size in other populations.

The results of this investigation show that physical fitness is inversely correlated with body mass index, fat percentage, and blood pressure. These results suggest that the physical fitness measurement should be used as screening for cardiovascular risk factors since it is a simple and inexpensive test. Physicians should counsel their patients to engage in routine exercise to achieve higher fitness levels, maintain fitness over time, and decrease the fat percentage to prevent cardiovascular disease.

Ethical Considerations: The Research Ethics Committee of the Faculty of Medicine Universitas Andalas has approved this research.

Conflict of Interest: The authors declare no conflict of interest.

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