Original article
The physical fitness evaluation of medical student in Semarang : a cross sectional study
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Abstract
Objective: Physical activity (PA) is one of the most important determinants for physical fitness (PF) in adolescence and young age. The previous study showed that most medical students as part of young population were found to be physically inactive. Our study aims to evaluate the correlation between PA and PF status among medical students. Materials and methods: One hundred and twenty five medical students of UNISSULA were enrolled in this study. PA level was measured using international physical activity questionnaire (IPAQ)-short form. PF status was evaluated by cardiorespiratory capacity (VO\textsubscript{2} max score), handgrip muscle strength (HGS), and body composition (fat percentage and BMI). The data were analyzed using pearson correlation analysis. Results and discussion: The majority of PA level among participants were low. There was a correlation between PA level and sex (p= 0.001, r = 0.272), PA level and BMI (p = 0.001, r = 0.264), PA level and HGS score (p=0.000, r = 0.345). However, there was no correlation between PA level and VO2max or fat percentage. Conclusion: The PA level and PF status among participants were considered to be low and fair, respectively. Only one component of PF status (HGS) was correlated with PA level. Further investigations on the correlation between PA level and PF status using more objective methods are needed especially when involving medical students.

Keywords: physical activity; physical fitness; cardiorespiratory capacity; HGS

Introduction
Physical fitness (PF) is defined as a structured and integrated measurement of all functions/components in which including physical activity (PA). The measured components consist of musculoskeletal, cardiorespiratory, circulatory, metabolic, and neurological aspects 1. PF status is determined partly by genetic factor and strongly correlated with environmental aspect 2. Physical fitness can be grouped into health related fitness and skilled related fitness. The aspects in health related fitness include body composition, muscular strength, flexibility, and aerobic fitness/cardiorespiratory fitness. As for the skill-related fitness, the agility, explosive strength, and balance are measured 3. Fitness is suggested as an indicator of health status at all ages and has been shown to be correlated with obesity and cardiometabolic risk 1,4,5. PA is defined as anykind of body movements resulted from muscle contraction to produce energy. The energy quantity needed to carry out an activity is expressed in kilojoules 6. Thus, PA can be in form

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of daily activities such as playing, formal exercise, dancing, physical education. An adequate PA is one of determinants of PF in adolescence and young adult. High PA especially moderate-to-vigorous physical activity (MVPA) is closely related to the fitness improvement such as body composition, bone health, cardiorespiratory function, and fat formation prevention in adolescence. Physical inactivity solely contributed to 3% of morbidity in developing countries and more than 20% cardiovascular risk, 10% stroke incidence, and also 3.2 million death each year. 

Recently, there have been studies evaluating the correlation between fitness status and physical activity level in adolescence and school children. PA has been shown to be positively correlated with motor skill in school and pre-school children. Another study on physical activity in young adult were conducted in Thailand among medical students showing that the majority of the students were physically inactive. Some other studies showed that medical students have inadequate level of physical activity. However, to the best of our knowledge, there have been few studies on the correlation between physical activity and physical fitness in Indonesia. The aim of this study is to evaluate the correlation between physical activity level and several physical fitness components (cardiorespiratory capacity, muscle strength, and body fat composition).

**Materials & Methods**

This was a cross sectional study conducted during May to August 2019 in Department of Physiology, Faculty of Medicine UNISSULA. This present study included 175 participants at first, but 46 of them did not complete the data, and 4 participants were dropped out during VO$_2$$_{max}$ measuring test. Thus, we included 125 participants in total and all the informed consents were collected before the test.

The detailed PA of the participants were measured by International physical activity questionnaire (IPAQ) - short form. The form recorded the past seven days of their physical activities including vigorous-intensity activities, moderate-intensity activities, and walking. The level of PA was classified using an automatic easy-to-use spread sheet. The PA level were categorized into low, moderate, and high.

The cardiorespiratory capacity were represented by VO$_2$$_{max}$ score. The VO$_2$$_{max}$ was determined using Queen’s college stepping test on 16.25 inches stool. The step rate was determined by metronome. The rhythm of steps consisted of 4 cadences, up-up (the right foot then followed by left foot) and down-down (the right then followed by the left). The rate for male was 24 cycles per minute and 22 cycles per minute for female. The total duration of the test was 3 minutes. The fifteen-second carotid artery palpation was performed after the participants completed the test in the fifth to twentieth second of recovery period. The rate then was converted into beats per minute by multiplying by four. The heart rate (HR) then was calculated by using internationally accepted Mc Ardle equations to get the VO$_2$$_{max}$ estimation score.

Handgrip strength (HGS) measurement was done using CAMRY-EH101 hand dynamometer (Henqi, Guangdong, China) expressed in kg. Camry hand dynamometer is able to detect the hand grip strength up to 90 kg with the accuracy of 0.1 kg. The HGS measurement was as follow, participant sat down with the feet were right on the floor as recomendation of the American Society of Hand Therapists (ASHT). The knee and hip joint formed a 90 degree of angle, shoulder was in neutral position, the elbow joint was in 90 degree of flexion, upper arm was closed to chest, lower arm was in neutral position, the wrist was scarcely in dorsoflexion position between 0 and 30 degree of angle with 0 and 15 degree of ulnar deviation. The participants were asked to grab the dynamometer as strong as they could and hold on for 3 seconds. Each participants had to do the trial twice and took a one minute rest between the trial. The score of hand grip strength (HGS) was the highest mean of the test (score in kg). The test of the other hand grip strength were done in other different day.

The body composition, BMI and body fat percentage, was evaluated using Karadascan (OMRON HBF-358) after body height measurement. The tool was setted based on sex, height, and age. Partisipants were then asked for standing upright barefoot without brought anystuff inside of their pocket. Both feet were attached to the electrode plat, both hands grasped the grip straight forward. The tool would automatically detect some indicators such as BMI, fat persentage, body age, etc.

The Pearson correlation analysis were done to evaluate the correlation among the variables. The variables were sex, VO$_2$$_{max}$ score, HGS score, BMI, fat percentage, and PA level. Sex and PA level were in categorical scale. Meanwhile, BMI, fat percentage, VO$_2$$_{max}$ score and HGS score were in nominal scale.
**Ethical clearance:** This study was approved by ethics committee of Universitas Islam Sultan Agung (UNISSULA). Jalan Kaligawe Raya KM.04, Terboyo Kulon, Genuk, Semarang, Indonesia.

**Results**

Out of 125 participants, 78 were female and the rest were male. The descriptive data of age, fat percentage, BMI, HGS score, and VO$_{max}$ score of the participants were presented in table III.1. The PA level distribution was dominated by low level activity in 77 participants (53 were female and 24 were male). The moderate level of activity were found in 28 participants (20 among them were female and 8 were male). The 20 participants (15 were male and 5 were female) had a high level of activity.

**Table III.1. The descriptive data of all variables**

|                  | N   | Minimum | Maximum | Mean   | Std. Deviation |
|------------------|-----|---------|---------|--------|----------------|
| Age              | 125 | 16.00   | 20.00   | 18.47  | 20 .76         |
| Fat percentage   | 125 | 6.50    | 37.60   | 25.61  | 7.01           |
| BMI              | 125 | 15.40   | 41.70   | 23.15  | 4.65           |
| HGS score        | 125 | 14.75   | 54.70   | 29.00  | 8.76           |
| VO$_{max}$ score | 125 | 20.74   | 76.05   | 37.71  | 8.81           |
| Valid (listwise)| 125 |         |         |        |                |

The comparative result of VO$_{max}$ score among male and female participants was presented in table III.2. It showed that male had a higher score than female.

**Table III.2. The comparative result of VO$_{max}$ score among male and female participants**

| SEX         | Mean   | N   | Std. Deviation | Minimum | Maximum |
|-------------|--------|-----|----------------|---------|---------|
| Female      | 34.30  | 78  | 5.27           | 20.74   | 51.03   |
| Male        | 43.38  | 47  | 10.50          | 27.33   | 76.05   |
| Total       | 37.71  | 125 | 8.81           | 20.74   | 76.05   |

The result of all variables analysis using Pearson were presented in table III.3 In this present study, we found a correlation between PA level and sex (p= 0.001, r = 0.272), PA level and BMI (p = 0.001, r = 0.264), PA level and HGS score (p=0.000, r = 0.345). However, there was no correlation between PA level and VO$_{max}$ or fat percentage. This study also showed a correlation between sex and BMI, sex and fat percentage, sex and HGS score, sex and VO$_{max}$, fat percentage and BMI, fat percentage and HGS score, fat percentage and VO$_{max}$ and BMI and HGS score.

**Table III.3. The Pearson bivariate correlation of all variables**

|                  | Sex          | BMI           | %fat          | HGS score     | PA level      | VO$_{max}$ |
|------------------|--------------|---------------|---------------|---------------|---------------|------------|
|                  | Pearson Correlation | .283**        | -.535**       | .808**        | .272**        | .501**     |
|                  | Sig. (1-tailed)| .001          | .000          | .000          | .001          | .000       |
|                  |              | .125          | .125          | .125          | .125          | .125       |
|                  |              |               |               |               |               |            |
|                  | Pearson Correlation | .283**        | .478**        | .286**        | .264**        | .076       |
|                  | Sig. (1-tailed)| .001          | .000          | .001          | .001          | .199       |
|                  |              | .125          | .125          | .125          | .125          | .125       |
|                  | Pearson Correlation | -.535*        | .478**        | 1             | -.468**       | -.074      |
|                  | Sig. (1-tailed)| .000          | .000          | .000          | .207          | .000       |
|                  |              | .125          | .125          | .125          | .125          | .125       |
|                  | Pearson Correlation | .808**        | .286**        | -.468**       | 1             | .345**     |
|                  | Sig. (1-tailed)| .000          | .001          | .000          | .000          | .000       |
|                  |              | .125          | .125          | .125          | .125          | .125       |
|                  | Pearson Correlation | .272**        | .264**        | -.074         | .345**        | .141       |
|                  | Sig. (1-tailed)| .001          | .001          | .000          | .000          | .058       |
|                  |              | .125          | .125          | .125          | .125          | .125       |
|                  | Pearson Correlation | .501**        | .076          | -.292**       | .459**        | .141       |
|                  | Sig. (1-tailed)| .000          | .199          | .000          | .000          | .058       |
|                  |              | .125          | .125          | .125          | .125          | .125       |

**.** Correlation is significant at the 0.05 level (1-tailed). **Correlation is significant at the 0.01 level (1-tailed).**
Discussion

In this present study, only health related fitness was evaluated. The cardiorespiratory fitness evaluated by VO\textsubscript{2}max score showed that the mean score of male participants were higher than female. This finding was similar to the previous study in Nepalese and Indian medical students. The mean score of male participants in this present study was 43.38±10.5 ml/kg/min in which showed the lower score than that of previous studies (48.8±7.3 ml/kg/min in Nepalese and 45.66±8.96 ml/kg/min in Indian)\textsuperscript{20-22}. Meanwhile, the VO\textsubscript{2}max score of female participants in this study were also shown the same tendency. This findings could be due to the decreased physical activity and sedentary lifestyle behaviours related to educational activities \textsuperscript{22}. This reason supported our finding that 61.6\% of our participants had a low level of activity. The same tendency was also found in Thailand medical students in which more than half of the respondents were physically inactive \textsuperscript{10}.

The correlation between HGS and PA level were shown in this study. BMI were also shown to be correlate with PA level. Both correlation between HGS or BMI and PA level were shown a weak correlation. The finding of this study was different from that of Fang which showed a positive correlation between some components of PF and moderate to vigorous physical activity (MVPA) \textsuperscript{3}. Other study involving Denmark population showed a dose-response correlation between cardiorespiratory fitness and health status among MVPA participants rather than in sedentary participants (OR 12.2, CI 95\% : 9.3-16.1) \textsuperscript{23}.

The correlation between cardiorespiratory capacity evaluated VO\textsubscript{2}max and PA level was not shown in this study. Meanwhile, other study showed that sex had a correlation with PA and PF. Body fat, muscle strength of extremities, agility, and aerobic fitness in male were improved when they were physically active in moderate-vigorous level \textsuperscript{3}. This different finding could be due to different method in measuring PA level and VO\textsubscript{2}max estimation. Other studies showed a significant correlation between vigorous PA level and PF level in school age children and young adult \textsuperscript{2,24,25}. However, there was also previous study that did not show a correlation between vigorous PA level and cardiorespiratory capacity \textsuperscript{11}.

In this present study, there were no correlation between body fat composition (fat percentage) and PA level. However, a significant correlation was shown between fat percentage and BMI (p<0.05, r=0.478) and between fat percentage and HGS score (p<0.05, r = -0.468) meaning that the higher the fat percentage, the lower the HGS will be. Other previous study in China showed that there were a significant correlation between body composition measured by triceps skinfold thickness (TSFT) and MVPA level particularly in male participants \textsuperscript{3}.

Our finding showed a correlation between muscle strength evaluated using HGS score and PA level (p<0.05, r=0.345). Nevertheless, other previous study did not show a correlation between muscle strength and PA in which the muscle strength were also measured using dynamometer \textsuperscript{25}. This different finding might due to different measurement tools. As we know, a various type of dynamometer are available. In addition, different sample size could cause a different findings since the relatively small sample involved in this present study.

This study also found a correlation between BMI and HGS. This finding was almost similar to that of previous one showing a significant correlation between height/weight and grip strength. It seemed that weight and height were proven to be a predictor of grip strength since that BMI were the result of weight and height measurement \textsuperscript{26}. However, other study did not find any relationship between BMI and grip strength \textsuperscript{27}.

Beside samples size, our study was limited in the subjective measurement of PA level in which the IPAQ-short form tend to report a socially desirable response \textsuperscript{28}. The validity measurement of body composition was also one of the limitations. This might because KaradaScan was less accurate to evaluate body composition compared to the more invasive and expensive tools like computed tomography (CT) and magnetic resolution imaging (MRI) \textsuperscript{29}. However, KaradaScan is one of the bioelectrical impedance analysis that noninvasive, cheap, simple, quick, and safe. Thus can be used in clinical and research setting \textsuperscript{29,30}.

Conclusion

Some components of PF status did not show a correlation with PA level. However a correlation were seen between PA level and muscle strength.
Further investigations on the correlation between PA level and PF status using more objective methods are needed particularly when involving medical students.

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Conflict of Interest
The authors declared that they have no conflict of interest

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References:
1. Fonseca del Pozo F, Alonso J, Alvarez M, Orr S, Llorente Cantarero F. Physical fitness as an indicator of health status and its relationship to academic performance during the prepubertal period. Heal Promot Prospect. 2017;7(4):197–204.
2. Ortega F, Ruiz J, Castillo M, Sjostrom M. PEDIATRIC REVIEW Physical fitness in childhood and adolescence: a powerful marker of health. Int J Obes. 2008;32:1–11.
3. Fang H, Quan M, Zhou T, Sun S, Zhang J, Zhang H, et al. Relationship between Physical Activity and Physical Fitness in Preschool Children: A Cross-Sectional Study. Biomed Res Int. 2017;2017:1–8.
4. Galavíz KL, Tremblay MS, Colley R, Jáuregui E, López J, Janssen I. Associations between physical activity, cardiorespiratory fitness, and obesity in Mexican children. Salud Publica Mex. 2012;54(5):463–9.
5. Minder CM, Shaya GE, Michos ED, Keenan TE, Blumenthal RS, Nasir K, et al. Relation Between Self-Reported Physical Activity Level, Fitness, and Cardiometabolic Risk. Am J Cardiol [Internet]. 2014;113(4):637–43. Available from: http://dx.doi.org/10.1016/j.amjcard.2013.11.010
6. Caspersen CJ, Powell KE, Christenson GM. Physical activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research. Public Health Rep. 1974;100(2):126–31.
7. MA M, HCG K. Is There a Positive Relationship between Physical Fitness and Physical Activity in Children? - A Brief Review. J Exerc Sci Physiother. 2007;3(1):12–6.
8. Cohen KE, Morgan PJ, Plotnikoff RC, Callister R, Lubans DR. Fundamental movement skills and physical activity among children living in low-income communities: a cross-sectional study. Int J Behav Nutr Phys Act [Internet]. 2014;11(1):1–9. Available from: International Journal of Behavioral Nutrition and Physical Activity
9. WHO. Global status report on communicable disease 2014. Geneva, Switzerland; 2014.
10. Wattanapisit A, Fungthongcharoen K, Saengow U, Vijitpongjinda S. Physical activity among medical students in Southern Thailand: a mixed methods study. BMJ Open. 2016;6(e013479):1–7.
11. Burgi F, Meyer U, Granacher U, Schindler C, Kriemler S, Puder JJ. Relationship of physical activity with motor
skills, aerobic fitness and body fat in preschool children: a cross-sectional and longitudinal study (Ballabeina). *International J Obes.* 2011;35:937–44.

12. Niederer I, Kriemler S, Gut J, Hartmann T, Schindler C, Barral J, et al. Relationship of aerobic fitness and motor skills with memory and attention in preschoolers (Ballabeina): A cross-sectional and longitudinal study. *BMC Pediatr* [Internet]. 2011;11(1):34. Available from: http://www.biomedcentral.com/1471-2431/11/34

13. Aires L, Andersen LB, Mendonça D, Martins C, Silva G, Mota J. A 3-year longitudinal analysis of changes in fitness, physical activity, fatness and screen time. *Acta Paediatr.* 2010;99:140–4.

14. Aggio D, Ogunleye AA, Voss C, Sandercock GRH. Temporal relationships between screen-time and physical activity with cardiorespiratory fitness in English Schoolchildren: A 2-year longitudinal study. *Prev Med* (Baltimore) [Internet]. 2012;55(1):37–9. Available from: http://dx.doi.org/10.1016/j.ypmed.2012.04.012

15. Ashok P, Kharche JS, Raju R, Godbole G. Metabolic equivalent task assessment for physical activity in medical students. *Natl J Physiol Pharm Pharmacol.* 2017;7(3):236–9.

16. Alzayani S, Hamadeh RR. Body Mass Index and Physical Activity of Medical Students: A Cross-Sectional Study at the Arabian Gulf University. *J Appl Life Sci Int.* 2015;3(1):1–6.

17. Cheng H. A simple, easy-to-use spreadsheet for automatic scoring of the International Physical Activity Questionnaire (IPAQ) Short Form. Res Gate. 2016;

18. Duan Y WN. Research progress in handgrip strength measuring. *Chin J Rehabil Theory Pr.* 2009;15(10):948–51.

19. Chen XP, Lu YM, Zhang J. Intervention study of finger-movement exercises and finger weight-lift training for improvement of handgrip strength among the very elderly. *Int J Nurs Sci* [Internet]. 2014;1(2):165–70. Available from: http://dx.doi.org/10.1016/j.jins.2014.05.001

20. Hada S, Amatya S, Gautam K. JMCJMS Cardiopulmonary fitness test among Nepalese students. *Janaki Med Coll J Med Sci.* 2013;1(1):3–8.

21. Prajapati R, Dhungel KU, Pramanik T, Ghosh A, Roychowdhury P. Assessment of some pulmonary parameters and cardiorespiratory fitness status in Nepalese medical students. *Nepal Med Coll J* 2008;10(1):28–9.

22. Nabi T, Rafiq N, Qayoom O. Assessment of cardiovascular fitness [VO 2 max] among medical students by Queens College step test. *Int Journl Biomed Adv Res.* 2015;6(05):418–21.

23. Eriksen L, Curtis T, Grønbæk M, W.Helge J, S. Tolstrup J. The association between physical activity, cardiorespiratory fitness and self-rated health. *Prev Med* (Baltim). 2013;57:900–2.

24. Dencker M, Thorsson O, Karlsson MK, Linde C, Svensson J, Wollmer P, et al. Daily physical activity and its relation to aerobic fitness in children aged 8 – 11 years. *Eur J Appl Physiol.* 2006;10:587–92.

25. Herrmann D, Buck C, Sioen I, Kouride Y, Marild S, Molnár D, et al. Impact of physical activity, sedentary behaviour and muscle strength on bone stiffness in 2 – 10-year-old children-cross-sectional results from the IDEFICS study. *Int J Behav Nutr Phys Act* [Internet]. 2015;1–12. Available from: http://dx.doi.org/10.1186/s12966-015-0273-6

26. Mitsionis G, Pakos EE, Stafilas KS, Paschos N, Papakostas T, Beris AE. Normative data on hand grip strength in a Greek adult population. *Int Orthop.* 2009;33(3):713–7.

27. Niemppoog S, Siripakarn Y, Suntharapa T. An estimation of grip strength during puberty. *J Med Assoc Thail.* 2007;90(4):699–705.

28. Teh CH, Chan YY, Lim KH, Kee CC, Lim KK, Yeo PS, et al. Association of physical activity with blood pressure and blood glucose among Malaysian adults: a population-based study. *Public Health.* 2015;15:1–7.

29. Kitchlew DR, Khan Chachar DAZ, Latif S. Body Mass Index; Visceral Fat and Total Body Fat Distribution and Its Relation To Body Mass Index in Clinical Setting Using Bio-Impedance Body Composition Monitor. *Prof Med J.* 2017;24(02):326–34.

30. Shoji K, Maeda K, Nakamura T, Funahashi T, Matsuzawa Y, Shimomura I. Measurement of visceral fat by abdominal bioelectrical impedance analysis is beneficial in medical checkup. *Obes Res Clin Pract.* 2008;2(4):269–75.