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CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY PATTERNS AMONG INDONESIAN MEDICAL STUDENTS: A CROSS-SECTIONAL STUDY AT UNIVERSITAS PADJADJARAN

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КАРДИОРЕСПИРАТОРНА ГОДНОСТ И МОДЕЛИ НА ФИЗИЧЕСКА АКТИВНОСТ СРЕД ИНДОНЕЗИЙСКИ СТУДЕНТИ ПО МЕДИЦИНА: КРЪСТОСАНО ПРОУЧВАНЕ В УНИВЕРСИТЕТА „ПАДЖАДЖАРАН“

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Abstract.

Background: Cardiorespiratory fitness (CRF) and physical activity are important indicators of long-term health. However, evidence regarding these measures among medical students in Indonesia following COVID-19 social restrictions remains limited. This study aimed to describe CRF, physical activity levels, and sedentary behavior among medical students enrolled in 2021. **Methods:** This descriptive cross-sectional study involved 84 medical students, including 48 women and 36 men. CRF was assessed using predicted maximal oxygen uptake (VO_2max) derived from the 6-minute walk test (6-MWT). Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ) and expressed as metabolic equivalent minutes per week (MET-min/week). Daily sedentary time was also recorded. **Results:** The median 6-MWT distance was 518.5 m, corresponding to a median predicted VO_2max of 19.5 mL/kg/min. All participants were classified as having low or very low CRF based on predicted VO_2max. Mean weekly physical activity was 3,808 MET-min/week among men and 2,227 MET-min/week among women. Work/study-related activities contributed the largest proportion of overall physical activity, followed by recreational and transport-related activities. Mean daily sedentary time was 428 minutes among men and 463 minutes among women. Although most participants had moderate or high physical activity levels, low CRF and prolonged sedentary time were common. **Conclusion:** Medical students exhibited low CRF and prolonged sedentary time despite predominantly moderate-to-high physical activity levels. These findings suggest that total physical activity volume alone may not ensure adequate CRF. Structured aerobic exercise and strategies to reduce sedentary time may help improve fitness in this population. Future longitudinal studies should examine the associations between exercise modalities, body composition, nutritional factors, and changes in CRF.

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Key words: cardiorespiratory fitness, medical students, metabolic equivalent, sedentary behavior, walk test

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Резюме. **Въведение:** Кардиореспираторната издръжливост (cardiorespiratory fitness – CRF) и физическата активност са важни показатели за дългосрочното здраве. Въпреки това данните относно тези показатели сред студентите по медицина в Индонезия след социалните ограничения, наложени поради COVID-19, остават ограничени. Целта на настоящото проучване беше да се опишат КРФ, нивата на физическа активност и заседналият начин на живот сред студентите по медицина, записали се през 2021 г. **Методи:** В това описателно напречно проучване участваха 84 студенти по медицина, включително 48 жени и 36 мъже. Физическата издръжливост беше оценена въз основа на прогнозирания максимален кислороден прием (VO_2max), изчислен по резултатите от 6-минутния тест за ходене (6-MWT). Физическата активност беше оценена чрез Global Physical Activity Questionnaire (GPAQ) и изразена в метаболитни еквиваленти на минута на седмица (MET-min/week). Беше регистрирано и ежедневното време, прекарано в седене. **Резултати:** Медианното разстояние при 6-MWT беше 518,5 m, което съответства на медианно прогнозирано VO_2max от 19,5 ml/kg/min. Всички участници бяха класифицирани като имащи ниска или много ниска физическа издръжливост въз основа на прогнозираното VO_2max. Средната седмична физическа активност беше 3808 MET-min на седмица при мъжете и 2227 MET-min седмично при жените. Дейностите, свързани с работата/учебата, съставляваха най-голямата част от общата физическа активност, следвани от развлекателните дейности и тези, свързани с транспорта. Средното дневно време, прекарано в седене, беше 428 min при мъжете и 463 min при жените. Въпреки че повечето участници имаха умерени или високи нива на физическа активност, ниската CRF и продължителното време, прекарано в седене, бяха често срещани. **Заключение:** Студентите по медицина показаха ниска CRF и продължително време, прекарано в седене, въпреки преобладаващо умерени до високи нива на физическа активност. Тези резултати сочат, че общият обем на физическата активност сам по себе си може да не гарантира адекватна CRF. Структурираните аеробни упражнения и стратегиите за намаляване на времето, прекарано в седене, могат да спомогнат за подобряване на физическата форма при тази популация. Бъдещи проучвания с проследяващ характер следва да изследват връзките между видовете упражнения, телесния състав, хранителните фактори и промените в CRF.

Ключови думи: кардиореспираторна издръжливост, студенти по медицина, метаболитен еквивалент, заседнал начин на живот, тест с ходене

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Introduction

Cardiorespiratory fitness (CRF) is a key component of physical fitness. It reflects the function of the cardiovascular and respiratory systems, which play a role in the body's oxygen utilization during physical activity. A high CRF reflects good aerobic performance and can indicate long-term health. CRF can also indicate a reduced risk of various non-communicable diseases such as cardiovascular disease, diabetes mellitus, and even some cancers. Studies have shown that individuals with low CRF have higher risks of mortality and morbidity compared to those with better fitness levels [1-3].

Physical activity is a significant determinant of CRF [4, 5]. Adequate physical activity, as recommended by the World Health Organization (WHO), which is ≥ 150 minutes of moderate-intensity aerobic activity per week or equivalent, is associated with increased maximal oxygen uptake (VO_2max) and better cardiometabolic health [6, 7]. Nevertheless, many student populations have been reported to exhibit suboptimal physical activity and high levels of sedentary behavior, which in turn may negatively affect CRF [8-10].

Medical students represent a unique population due to high academic workload, intensive study schedules, and psychosocial stress, making them at risk of adopting physically inactive lifestyles [11, 12]. A study among medical students in Nepal found that approximately one-third of respondents did not meet recommended physical activity levels (PAL), and the majority had VO_2max categorized as average [13]. Furthermore, several studies in other universities also reported associations between physical activity and CRF among medical students, although evidence remains limited and context-specific [10, 11].

While some studies have evaluated CRF and physical activity in university students in general, evidence specifically focusing on medical students, particularly in Indonesia, is scarce. Moreover, post-hybrid learning or post-COVID-19 social restriction data are limited in the literature [8, 14]. Knowledge of CRF and PAL among medi-

cal students is important as it provides insight into potential long-term health risks and informs the need for targeted health promotion within medical education settings [12].

Therefore, this study aimed to describe CRF and PAL among the medical students in the class of 2021 at the Faculty of Medicine, Universitas Padjadjaran (FK-Unpad), Indonesia, following the COVID-19 social restriction period. The findings are expected to serve as a foundation for designing health interventions to improve CRF and PAL, as well as to guide decision-making in medical education institutions to support healthy lifestyles among university students.

Methods

Study Design and Setting

This is a descriptive cross-sectional study to assess CRF and PAL among undergraduate medical students at the FK Unpad.

Population and Sampling

The population of this study consisted of students enrolled in the class of 2021 at the Faculty of Medicine, Universitas Padjadjaran (FK-Unpad), Bandung, Indonesia. The entire population was selected using a sampling method based on predetermined eligibility criteria. Eligible students were FK-Unpad students from the 2021 intake who had provided written consent to participate in the study. Students were excluded if they had medical conditions that would contraindicate the physical fitness test, had a history of chronic diseases such as cardiovascular, pulmonary, or renal disease, metabolic disease, bleeding disorders, neuromuscular or musculoskeletal disorders affecting the lower extremities, uncorrected metabolic disorders, or were unable to understand Indonesian or had not completed the CRF assessment. Before taking the CRF test, participants were allowed to eat a light snack before the morning and afternoon test sessions. Participants were also asked to avoid strenuous physical activity for at least 2 hours before the test and were asked to wear comfortable clothing and appropriate footwear during the CRF test.

Variables and Measurements

The primary variables of this study were CRF and PAL. CRF was assessed using predicted VO_2max derived from the total distance traveled on the 6-Minute Walk Test (6-MWT). PAL was assessed using the Global Physical Activity Questionnaire (GPAQ), which covers physical activity across occupational, transportation, and leisure-time settings.

Data Management and Statistical Analysis

All collected data were reviewed and processed using IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normal or non-normal distribution. Normally distributed data were presented as the mean and standard deviation (SD), while non-normally distributed variables were presented as the median and IQR (minimum–maximum).

CRF was reported as predicted VO_2max, derived from the 6-MWT distance. PAL was obtained using the GPAQ and expressed in metabolic equivalent (MET) minutes per week (MET-min/week), then categorized into low, moderate, and high activity levels according to WHO guidelines. Categorical variables were reported as frequencies and percentages. Due to the descriptive nature of this cross-sectional study, no inferential statistical testing was performed.

Ethical Approval

This study has received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Padjadjaran (approval number: 49/UN6.KEP/EC/2023). All respondents provided written consent to participate in the study before data collection.

Results

Participant Characteristics

The study included 84 medical students, of whom 48 (57.1%) were female, and 36 (42.9%) were male. Most participants were 19 years old (72.6%) and had a normal body mass index (BMI) (58.3%). Overall, 22.7% of participants were classified as having obesity class I or II. Participant characteristics are summarized in Table 1.

Table 1. Participant Characteristics (n = 84)

Variable	n	%
Age, years		
18	7	8.3
19	61	72.6
20	12	14.3
21	4	4.8
Sex		
Female	48	57.1
Male	36	42.9
Body Mass Index Category		
Underweight	16	19.0
Normal weight	49	58.3
Pre-obese	0	0.0
Obesity class I	14	16.7
Obesity class II	5	6.0

Pre- and Post-Exercise Test Physiological Parameters

Pre- and post-exercise physiological parameters are presented in Table 2. Median blood pressure in-

creased from 100/70 mmHg at rest to 120/80 mmHg after the 6-minute walk test (6MWT), while median heart rate increased from 86 to 100 beats/min. The median 6-MWT distance was 518.5 m (range, 402.7-720.3 m), corresponding to a median predicted VO_2max of 19.5 mL/kg/min (range, 16.1-25.6 mL/kg/min), calculated using the Nury equation [15].

Table 2. Pre- and Post-Exercise Test Physiological Parameters (n =8 4)

Variable	Median	Minimum	Maximum
Resting systolic BP (mmHg)	100	80	140
Resting diastolic BP (mmHg)	70	60	90
Post–6MWT systolic BP (mmHg)	120	100	140
Post–6MWT diastolic BP (mmHg)	80	60	100
Resting heart rate (beats/min)	86	60	110
Post–6MWT heart rate (beats/min)	100	74	130
6-minute walk distance (m)	518.5	402.7	720.3
Predicted VO_2max (ml·kg^{-1}·min^{-1})	19.5	16.1	25.6

6MWT, 6-minute walk test; VO_2max, maximal oxygen uptake.

Distribution of CRF Categories

The distribution of CRF categories based on the 6-MWT distance and predicted VO_2max stratified by sex is presented in Table 3. Most female participants were classified in the very low CRF category, while male participants were primarily distributed across the very low and regular categories. Only a small proportion of participants achieved higher CRF levels.

When CRF was classified using predicted VO_2max, all male participants were categorized as having very low CRF. In contrast, female participants were predominantly classified as having low CRF, with the remainder categorized as very low.

Table 3. Distribution of Cardiorespiratory Fitness Categories Based on 6-Minute Walk Distance and Predicted VO_2max, Stratified by Sex

3a. Based on 6-Minute Walk Distance

CRF Category	Female (n = 48)	%	Male (n = 36)	%
Very low	26	54.2	14	38.9
Low	16	33.3	9	25.0
Regular	4	8.3	11	30.6
Good	0	0.0	2	5.6
Excellent/Superior	2	4.2	0	0.0

CRF, cardiorespiratory fitness

3b. Based on Predicted VO_2max

CRF Category	Female (n = 48)	%	Male (n = 36)	%
Very low	15	31.2	36	100.0
Low	33	68.8	0	0.0
Regular	0	0.0	0	0.0
Good	0	0.0	0	0.0
Excellent/Superior	0	0.0	0	0.0

CRF, cardiorespiratory fitness

Physical Activity Levels

PAL assessed using the GPAQ is presented in Table 4. Among female participants, moderate PAL was the most prevalent category (45.8%), whereas high PAL was most common among male students (55.6%).

Mean weekly PAL, expressed as MET-min/week, is presented in Table 5. Male participants had a mean weekly PAL of 3,808 MET-min/week, compared with 2,227 MET-min/week among female participants.

Table 4. Physical Activity Levels According to the Global Physical Activity Questionnaire (GPAQ), Stratified by Sex

Physical Activity Level	Female (n = 48)	%	Male (n = 36)	%
Low	17	35.4	4	11.1
Moderate	22	45.8	12	33.3
High (Vigorous)	9	18.8	20	55.6

Table 5. Weekly Physical Activity Volume by Sex

Sex	Mean MET-min/week
Male (n = 36)	3808
Female (n = 48)	2227

MET, metabolic equivalent

Physical Activity Domains and Sedentary Time

The distribution of physical activity across domains is presented in Table 6. Overall, the largest contribution to total physical activity was derived from work- and study-related activities. Participants with low PAL accumulated relatively more MET-minutes from transport-related activities, whereas those with moderate and high PAL accumulated more MET-minutes from work- and study-related activities.

Sedentary behavior is summarized in Table 7. Male students reported shorter daily sedentary time than female students. The graphical presentation of cardiorespiratory fitness, physical activity levels, sedentary time, and physical activity domains is shown in Figure 1.

Table 6. Mean Weekly MET-minutes by Physical Activity Domain and Activity Level

Physical Activity Level	n	Work/Study	Transport	Recreation
Low	21	156	175	72
Moderate	34	937	457	316
High	29	2,948	1,339	1,829
Overall mean	84	1,436	691	777

Values are presented as mean MET-min/week. MET, metabolic equivalent.

Table 7. Mean Daily Sedentary Time by Sex

Sex	Sedentary Time (minutes/day)	Hours/day
Male (n = 36)	428	7.1
Female (n = 48)	463	7.7

Fig. 1. Cardiorespiratory fitness, physical activity, sedentary behavior, and physical activity domains among medical students. Participants comprised 84 medical students, including 48 females and 36 males. Panel A shows cardiorespiratory fitness categories based on predicted VO_2max. Panel B presents physical activity levels assessed using the Global Physical Activity Questionnaire. Panel C shows mean daily sedentary time. Panel D presents mean weekly physical activity across work/study, recreation, and transport domains among all participants. GPAQ, Global Physical Activity Questionnaire; MET, metabolic equivalent; VO_2max, maximal oxygen uptake.

Discussion

This study aimed to describe CRF, PAL, and sedentary behavior among medical students of the FK-Unpad class of 2021. The main finding was that most students had moderate or high PAL, whereas all participants had low or very low CRF based on predicted VO_2max. Low CRF was also commonly observed based on the 6MWT distance. The discrepancy between sufficient physical activity volume and poor CRF suggests that activity quantity alone may not automatically translate into optimal physiological cardiovascular adaptations. There is a cross-sectional study in Nepal that supports this, reporting that although most students had moderate to high PAL, they still had suboptimal VO_2max, reflecting low CRF in most students [13]. Another study conducted on medical students in Europe also showed that physically active students do not always have optimal CRF, so there is a mismatch between the level of physical activity and the physiological adaptation of the individual's body [16].

Based on the results of the anthropometric examination, most of the students had a normal BMI, and some of the others had a BMI in the obesity class I and II categories [17]. Excess body fat among medical students who already have knowledge about health shows that heart disease risk factors and lifestyle are important factors in increasing cardiovascular risk and metabolic disorders [18] A recent systematic review and meta-analysis found that 24% of medical students globally are overweight or obese. This suggests that a significant number of future healthcare workers will experience the effects of excess weight, even those with a health education background [19].

Research conducted at King Khalid University also reported that 21.9% of medical students were overweight and 14.6% were obese, with dietary and lifestyle habits that caused fat accumulation in the body [20]. The same thing was reported in a study in India that 16% of medical students were overweight or obese, which further shows that obesity is common even among health science students [18] Obesity and excess weight can increase the risk of heart disease, metabolic disorders, and reduce life expectancy. Therefore, it is important to maintain a body mass index within a normal range [21].

In this study, after the 6-MWT was carried out, an increase in heart rate and blood pressure was found, indicating that the cardiovascular response to submaximal exercise was still within normal limits [22]. Heart rate response during submaximal exercise is an important assessment indicator that can indicate cardiovascular adaptability and is used in predicting

VO_2max values. Heart rate measurements can also be influenced by external and individual factors, such as ambient temperature at the time of measurement, caffeine intake, psychological factors, smoking history, and physical activity, which can affect the estimated VO_2max results [7].

This study also showed differences in physical activity by gender among medical students. Most students had moderate PAL, with most female students falling into the moderate category, and male students engaging in more vigorous physical activity. One study showed that overall activity intensity was greater in males than females, as males spent more time engaged in moderate and vigorous activity than female students [23, 24]. The previous study also supports differences in activity intensity levels based on gender, which accumulate weekly physical activity with moderate to vigorous intensity and MET values with higher results in male students compared to female students [25]. However, most students (75.0%) achieved ≥ 600 MET-min/week and therefore met the WHO recommendations for physical activity [6].

In a cross-sectional study of physical activity among college students, males showed significantly higher total weekly MET-minutes across all activity domains compared to females. This indicates greater overall energy expenditure in male than female students [23]. A similar finding was also reported in a study on physical activity and sedentary behavior, which found that male college students had a higher total weekly MET value than female college students. This indicates gender differences in activity engagement and energy expenditure among college students [25]. Other research shows that male students have higher MET-min/week than female students. This indicates that male students' energy expenditure is greater than that of female students [26].

In a large cross-sectional study conducted at universities in ASEAN, it was shown that the largest contribution to the activity domain, and the largest total MET expenditure, was in study and recreation, which were the dominant components of total physical activity among students [27].

The high sedentary behavior observed in this study, with an average daily sitting time exceeding seven hours, is consistent with international findings showing an increase in sitting time among university students during the COVID-19 pandemic. A cross-sectional study assessing physical activity and sitting behavior before and during the pandemic isolation period showed a significant increase in daily sitting time among students during the pandemic compared to the pre-pandemic period [28]. High duration of sitting time every day is related to poor sleep quality, so sedentary behavior has a negative impact on health, especially if accompanied by low physical activity [29].

Despite adequate physical activity in college students, low CRF remains a concern, as it is a strong predictor of all-cause cardiovascular disease and cardiovascular mortality. Epidemiological studies have shown that individuals with low CRF have a significantly higher risk of death compared to individuals with high CRF, supporting the clinical importance of improving aerobic capacity [30].

Limitations of The Study

This study has several limitations. First, its cross-sectional design prevents direct causal inferences between physical activity, sedentary behavior, and CRF. Second, respondents were from only one medical school student cohort at one university, which may limit the generalizability of the study findings. Third, CRF was not derived from direct measurements but rather from estimates derived from the 6-MWT results. Furthermore, the physical activity results were self-reported by the respondents, potentially introducing measurement bias. Furthermore, other potentially influencing factors, such as diet, sleep patterns, and mental health, were not assessed in this study. Therefore, the authors recommend future longitudinal studies with larger and more diverse student populations, and objective measurements of physical activity and CRF.

Conclusion

Medical students at Universitas Padjadjaran generally had very low CRF despite most having moderate-to-high PAL, while daily sedentary time remained prolonged. This suggests the need for interventions to promote structured aerobic exercise, reduce sitting time, and improve students' knowledge about the importance of effective exercise to improve CRF. Future research should examine longitudinal associations between exercise modalities, body composition, nutritional factors, and changes in CRF in this population.

Author contributions: AN conceptualized and designed the study. AN and MHB supervised data collection. AN, MHB, and LK contributed to data analysis and interpretation. AN and LK contributed to data collection and data management. AN, LK, SR, and HAN contributed to drafting the manuscript. All authors critically revised the manuscript and approved the final version.

Ethics approval and consent to participate
This study was approved by the Research Ethics Committee (Approval No.: 49/UN6.KEP/EC/2023, issued on January 12, 2023). All participants were informed about the purpose and procedures of the study, and written informed consent was obtained before participation.

Consent for publication Not applicable.

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