



The Impact of Physical Activity Intensity on Multidimensional Physical Fitness in College Students

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ABSTRACT

Insufficient physical activity and low exercise intensity remain persistent threats to student health during the transition to adulthood, yet evidence from Southeast Asian universities linking activity intensity to multidimensional physical fitness is limited. This study examined the correlation between physical activity intensity and physical fitness among university students at Universitas Negeri Makassar, Indonesia. A quantitative cross-sectional correlational design was used. Thirty-four students aged 18–22 years completed the International Physical Activity Questionnaire–Short Form, while physical fitness was assessed through a standardized battery comprising the 20-m shuttle run to estimate VO₂max, handgrip dynamometry, sit-and-reach flexibility, and body mass index (BMI). Descriptive statistics summarized activity and fitness profiles, and Pearson’s product-moment correlation was used to test associations between MET-minutes/week and each fitness component. The mean total physical activity was $2,746 \pm 1,120$ MET-min/week; 11.8% of participants were low active, 55.9% were moderately active, and 32.3% were highly active. Higher activity intensity was significantly associated with better aerobic capacity ($r = .614$, $p = .001$), greater handgrip strength ($r = .498$, $p = .004$), better flexibility ($r = .362$, $p = .034$), and lower BMI ($r = -.421$, $p = .019$). The strongest relationship was observed for VO₂max, indicating that intensity-sensitive activity is particularly important for cardiorespiratory fitness. The study’s originality lies in the integration of validated self-reported intensity assessments with objective, multidimensional fitness metrics in an Indonesian university setting. The findings show that being active alone is insufficient; activity must reach adequate intensity to support meaningful fitness adaptation. These results offer actionable implications for curriculum design, campus wellness initiatives, and quality physical education in higher education.

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I. INTRODUCTION

Regular physical activity is a foundational determinant of population health because it improves cardiovascular function, musculoskeletal integrity, metabolic regulation, and psychological well-being across the life course (World Health Organization, 2020; van der Ploeg & Bull, 2020). The university years are especially consequential because they coincide with the transition from late adolescence to young adulthood, a period in which lifestyle practices become habitual and often persist into later life. In principle, higher education institutions should provide an ideal setting for active living through organized sport, physical education, peer networks, and access to fitness infrastructure. In practice, however, students' daily routines are increasingly shaped by academic load, screen-based study, social media use, and irregular schedules that reduce purposeful movement and displace vigorous exercise. Recent evidence continues to show that many university students do not consistently achieve recommended levels of moderate-to-vigorous physical activity and spend prolonged periods sedentary, even when they perceive themselves as active (Roberts et al., 2024; Junger et al., 2025). This mismatch matters because insufficiently intense activity may result in minimal movement and fail to provide the physiological stimulus needed for measurable improvements in health-related fitness.

Physical fitness remains one of the clearest integrative indicators of whether habitual activity is translating into meaningful health benefits. Rather than a single trait, health-related fitness encompasses cardiorespiratory endurance, muscular strength, flexibility, and body composition, each of which is linked to immediate function and longer-term disease risk (Ortega et al., 2008). Among university students, higher fitness has been associated not only with better physiological status but also with improved mental health, lower perceived stress, and more favorable academic self-management (Herbert et al., 2020; Teuber et al., 2024). Systematic review evidence likewise shows that more active students tend to display better overall fitness profiles than less active peers, although the magnitude of these relationships varies by sex, outcome measure, and context (Kljajević et al., 2022). For universities in low- and middle-income settings, the issue is therefore not simply whether students move, but whether their activity patterns are sufficient to preserve or improve the multidimensional fitness base needed for lifelong health. From an educational perspective, this gives physical education programs a dual mission: to encourage participation and to ensure that participation reaches intensities capable of eliciting adaptation.

The central research problem, then, is that contemporary student activity patterns are often quantified by frequency or total duration, while the qualitative feature most closely tied

to adaptation receives less analytic attention. This is a critical omission. Students may accumulate low-intensity walking, commuting, or incidental movement and still fail to stimulate significant improvements in aerobic capacity, strength, or body composition. Post-pandemic evidence suggests that although many campuses have reopened, students continue to report elevated sedentary time, inconsistent exercise habits, and motivational barriers shaped by stress, time pressure, and environmental constraints (Yapar et al., 2025; Akil et al., 2025). Cross-sectional evidence from the United Kingdom similarly indicates that many students fall short of aerobic and strength guidelines, with time, stress, and financial factors acting as recurrent barriers to participation (Roberts et al., 2024). A general solution proposed in the literature is to shift institutional attention away from activity volume alone and toward promoting moderate-to-vigorous physical activity through feasible campus-based programs. Such a shift is theoretically justified because intensity is the parameter most directly associated with overload, adaptation, and the maintenance of cardiorespiratory and musculoskeletal function.

Previous scholarship offers more specific guidance on what such a solution might look like. Meta-analytic evidence indicates that structured physical activity interventions conducted in university settings can significantly increase total physical activity, moderate-to-vigorous physical activity, and step counts, particularly when behavior change strategies and hybrid delivery models are employed (Yuan et al., 2024). When the goal is physical fitness rather than activity behavior alone, the strongest effects are often observed for programs that deliberately emphasize moderate-to-vigorous or high-intensity workloads. A recent systematic review and meta-analysis concluded that high-intensity interval training improves VO_2max , muscle strength, speed, agility, and BMI in university students, with especially consistent benefits in interventions lasting longer than eight weeks (Yin et al., 2025). Evidence from resistance-based student interventions also shows favorable changes in BMI, body fat percentage, and flexibility when training is implemented progressively and with adequate volume (Pamungkas et al., 2024). Similarly, network meta-analytic findings suggest that several exercise modalities, especially aerobic, combined, calisthenic, and HIIT-based formats, can improve body composition in university populations when the weekly exercise dose is sufficient (Li et al., 2025).

Despite these advances, three gaps remain salient. First, much of the current evidence derives from intervention studies designed to change behavior rather than from observational studies clarifying how naturally occurring intensity patterns relate to multiple fitness components within the same student cohort. Second, the literature remains geographically

uneven. Reviews synthesize data largely from Europe, North America, and China, while evidence from Southeast Asian universities—where infrastructure, curricular emphasis, and health cultures may differ—is still comparatively sparse (Kljajević et al., 2022). Third, measurement strategies often privilege either self-reported behavior or isolated physiological outcomes, but seldom combine validated self-report estimates of activity intensity with objective assessments of cardiorespiratory endurance, strength, flexibility, and body composition in a single design. This matters methodologically because the International Physical Activity Questionnaire–Short Form (IPAQ-SF) is practical and widely used, yet its validity as an absolute estimator of physical activity is imperfect and may be strengthened when interpreted alongside objective fitness measures rather than in isolation (Craig et al., 2003; Lee et al., 2011). Recent university-based research has further shown that physical activity interacts with body composition, cardiorespiratory fitness, mental health, and behavioral barriers in complex ways, reinforcing the value of integrated multidimensional assessment (Kwilosz et al., 2025; Xu et al., 2025).

Against this background, the present study aims to examine the correlation between physical activity intensity and physical fitness levels among university students at Universitas Negeri Makassar, Indonesia. Specifically, it evaluates whether higher self-reported activity intensity, expressed in MET-minutes per week, is associated with superior aerobic capacity, greater muscular strength, better flexibility, and more favorable body composition. The study's novelty lies in three features: its focus on an Indonesian higher education context that remains underrepresented in the international literature; its concurrent use of a validated behavioral instrument and objective field-based fitness measures; and its multidimensional treatment of physical fitness rather than reliance on a single proxy such as $\text{VO}_{2\text{max}}$ or BMI. By clarifying how activity intensity aligns with distinct fitness domains, the study seeks to generate evidence that is not only theoretically relevant to exercise science but also directly useful for curriculum design, campus health promotion, and more effective quality physical education practice in higher education

II. METHODS

This study used a quantitative cross-sectional correlational design to examine the relationship between physical activity intensity and physical fitness among university students. Data were collected during the 2024/2025 academic year at Universitas Negeri Makassar, Indonesia, among undergraduate students enrolled in general physical education courses. Using purposive sampling, 34 students aged 18–22 years participated voluntarily after receiving an explanation

of the study and providing informed consent. The sample included 17 male and 17 female students. Ethical clearance was obtained from the institutional ethics committee before data collection, and all procedures were in accordance with the principles of the Declaration of Helsinki.

Physical activity intensity was assessed with the International Physical Activity Questionnaire–Short Form (IPAQ-SF), which records walking, moderate physical activity, vigorous physical activity, and sitting over the previous seven days (Craig et al., 2003). Responses were converted into MET-minutes per week, a metric consistent with compendium-based conventions for quantifying activity energy expenditure (Ainsworth et al., 2011; Herrmann et al., 2024). For descriptive purposes, students were categorized as low active (<600 MET-min/week), moderately active (600–2,999 MET-min/week), or highly active ($\geq 3,000$ MET-min/week), in line with common IPAQ- and WHO-based classification practices (World Health Organization, 2020). Because IPAQ-SF can overestimate absolute activity when used alone, it was interpreted here in combination with objective fitness outcomes rather than as a stand-alone indicator of physiological status (Lee et al., 2011). The operational definition of each variable is presented in Table 1.

Physical fitness was measured using a standardized battery covering aerobic endurance, muscular strength, flexibility, and body composition. Aerobic capacity was estimated with the multistage 20-m shuttle run test, a field protocol widely used to estimate $\text{VO}_{2\text{max}}$ in adolescents and young adults (Léger et al., 1988). Muscular strength was measured using a handgrip dynamometer and recorded in kilograms. Flexibility was evaluated using the sit-and-reach test in centimeters, and body composition was assessed by BMI, calculated from measured body mass and stature (kg/m^2). The use of a multidimensional battery was intentional because fitness is best interpreted as a composite health construct rather than a single variable, and field-based test batteries remain appropriate for educational and population research when standardized procedures are followed (Ortega et al., 2008; Bianco et al., 2015).

All measurements were collected under standardized conditions by trained research assistants. Participants first completed the IPAQ-SF, followed by anthropometric and fitness testing in a fixed order to limit fatigue effects. Height and weight were recorded before performance testing, after which the handgrip and sit-and-reach tests were administered, and the shuttle run was completed last because it imposed the greatest physiological demand. Instruments were calibrated before use, instructions were standardized, and scores were recorded immediately at the point of assessment. Data were analyzed using SPSS version 26. Descriptive statistics (mean, standard deviation, frequency, and percentage) summarized

participant characteristics, activity categories, and fitness scores. Pearson's product-moment correlation coefficient (r) was used to examine the relationship between MET-minutes/week and each fitness component, with statistical significance set at $p < .05$. The analytical focus was the pattern of associations across fitness domains rather than any single outcome.

Before hypothesis testing, the dataset was screened for completeness and distributional suitability so that the chosen statistics matched the scale and quality of the observations. The use of MET-minutes/week as a continuous exposure variable was appropriate because the IPAQ scoring protocol is intended to preserve variation in walking, moderate, and vigorous activity rather than collapsing responses too early into broad categories (Craig et al., 2003; Lee et al., 2011). Likewise, interpreting fitness as a four-component profile aligns with recommendations that health-related fitness should be evaluated using complementary outcomes rather than a single indicator (Ortega et al., 2008; Bianco et al., 2015). Normality was checked through the Kolmogorov–Smirnov test and visual inspection of score distributions, after which Pearson's r was retained because the variables were continuous and approximately linear. This procedure strengthened internal consistency by ensuring that descriptive summaries, correlation estimates, and the operational framework in Table 1 were analytically aligned.

Table 1. Operational definitions and measurement indicators

Variable	Instrument	Unit of measurement	Output indicator
Physical activity intensity	IPAQ-SF (Craig et al., 2003)	MET-min/week	Low, Moderate, High
Aerobic endurance	20-m shuttle run	VO ₂ max (ml/kg/min)	Continuous variable
Muscular strength	Handgrip dynamometer	Kilograms (kg)	Continuous variable
Flexibility	Sit-and-reach test	Centimeters (cm)	Continuous variable
Body composition	BMI	kg/m ²	Continuous variable

Note. MET = metabolic equivalent of task; VO₂max = maximal oxygen uptake; BMI = body mass index

III. RESULTS

The sample displayed moderate overall physical activity but considerable dispersion across intensity categories. Mean total physical activity was $2,746 \pm 1,120$ MET-min/week, placing the group in the moderate range overall. When classified categorically, four students (11.8%) were low active, 19 (55.9%) were moderately active, and 11 (32.3%) were highly active. Figure 1 shows this distribution. Although most participants exceeded the minimum threshold for basic

activity classification, only about one-third accumulated workloads high enough to enter the high-activity category. In substantive terms, the cohort was more accurately characterized as moderately active than vigorously active.

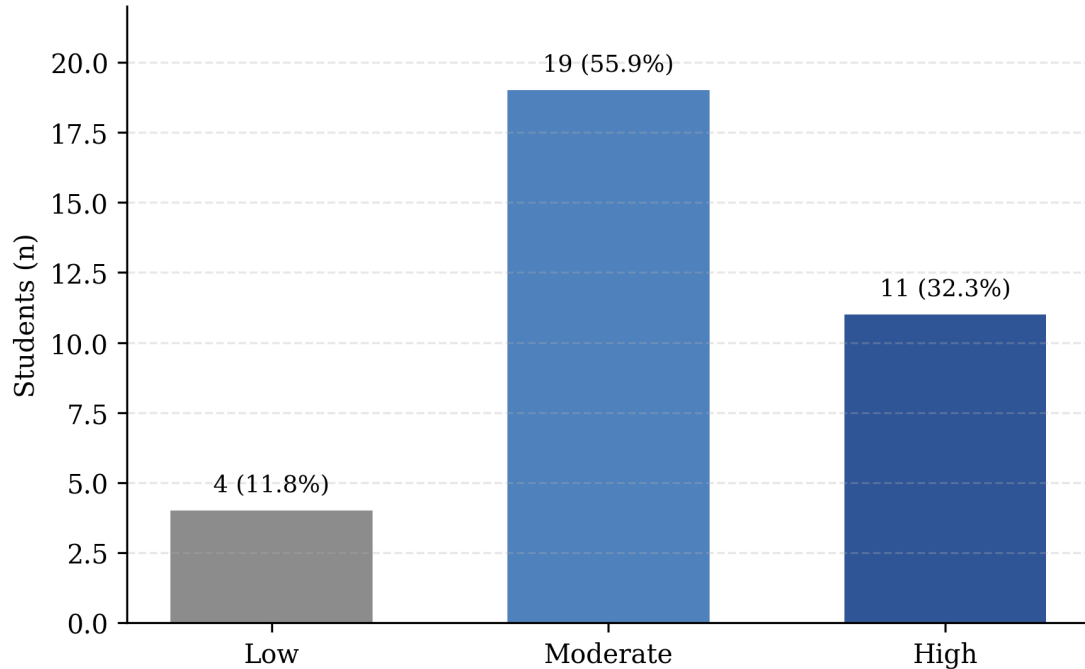


Figure 1. Distribution of physical activity intensity levels (low, moderate, high) among university students (N = 34)

Descriptive statistics for the four physical fitness indicators are presented in Table 2. Mean VO₂max was 38.25 ± 4.12 ml/kg/min, with values ranging from 30.80 to 46.40. Mean handgrip strength was 34.76 ± 6.21 kg, mean flexibility was 27.48 ± 7.09 cm, and mean BMI was 23.16 ± 2.68 kg/m². These values indicate a cohort with moderate cardiorespiratory fitness, acceptable upper-body strength, average flexibility, and, on average, BMI values within the normal range. At the same time, the observed ranges indicate meaningful inter-individual variation across all outcomes, especially for handgrip strength and flexibility, which is important for interpreting the correlational pattern.

Table 2. Descriptive Statistics of Physical Fitness Variables (N = 34)

Variable	Mean $\pm$ SD	Minimum	Maximum
VO ₂ max (ml/kg/min)	38.25 ± 4.12	30.80	46.40
Handgrip strength (kg)	34.76 ± 6.21	24.50	47.20
Flexibility (cm)	27.48 ± 7.09	15.20	41.60
BMI (kg/m ²)	23.16 ± 2.68	18.30	27.90

A secondary descriptive inspection suggested expected sex-related patterning in the fitness profile. Male students showed higher mean VO₂max (40.12 ml/kg/min) and handgrip

strength (38.40 kg) than female students (36.32 ml/kg/min and 31.12 kg, respectively), whereas female students recorded slightly higher flexibility (29.58 cm) than male students (25.42 cm). Because the study was not designed or powered for sex-stratified hypothesis testing, these values are reported descriptively rather than inferentially. Even so, they contextualize the overall sample means and indicate that the cohort reflected familiar physiological differentiation across selected fitness components.

Pearson correlation analysis revealed statistically significant associations between physical activity intensity and each physical fitness component examined (Table 3). The strongest relationship was observed for VO₂max, with a significant positive correlation between MET-minutes/week and aerobic capacity ($r = .614$, $p = .001$). This coefficient indicates that higher activity intensity was associated with higher estimated aerobic fitness and that activity intensity accounted for approximately 37.7% of the variance in VO₂max ($r^2 = .377$). The magnitude of this association was materially greater than that of the other outcomes, suggesting that cardiorespiratory endurance was the fitness component most responsive to differences in reported activity intensity within the sample.

Table 3. Correlation between physical activity intensity and physical fitness components

Variable	Pearson's r	p-value	Interpretation
VO ₂ max	0.614	0.001	Significant positive correlation
Handgrip Strength	0.498	0.004	Moderate positive correlation
Flexibility	0.362	0.034	Weak but significant positive correlation
BMI	-0.421	0.019	Moderate negative correlation

Note. Statistical significance was determined at $p < .05$.

A second significant positive relationship was found between activity intensity and handgrip strength ($r = .498$, $p = .004$), accounting for approximately 24.8% of the variance. Flexibility also showed a positive and statistically significant association ($r = .362$, $p = .034$), although the effect size was smaller ($r^2 = .131$). In contrast, BMI showed a significant negative association with activity intensity ($r = -.421$, $p = .019$), indicating that students who reported more intense activity tended to have lower BMI; the explained variance was 17.7%. Taken together, the coefficients support a coherent pattern in which greater activity intensity is associated with better performance-based fitness and a more favorable body mass status.

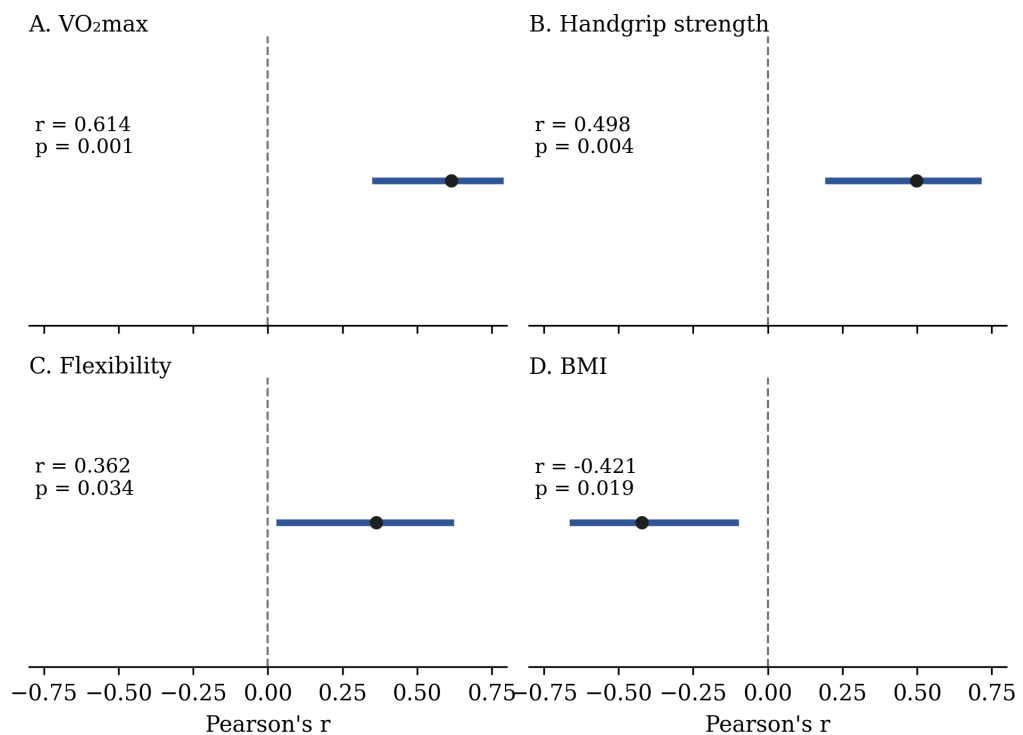


Figure 2. Association profiles between physical activity intensity and (A) VO₂max, (B) handgrip strength, (C) flexibility, and (D) BMI

Figure 2 summarizes the magnitude and direction of the four observed relationships as Pearson correlation coefficients with 95% confidence intervals based on the sample size. The VO₂max interval remained clearly above zero, reinforcing the robustness of the aerobic finding. Handgrip strength also retained a distinctly positive interval, whereas flexibility and BMI exhibited wider intervals, consistent with weaker though still statistically meaningful relationships. Overall, the results indicate that physical activity intensity was not selectively related to only one aspect of fitness; rather, it showed a multidimensional pattern of association, strongest for cardiorespiratory endurance, moderate for strength and BMI, and weakest for flexibility. This distribution of effect sizes provides the empirical basis for the interpretive arguments developed in the discussion.

Viewed comparatively, the coefficient profile suggests a clear hierarchy in the strength of association across outcomes. Activity intensity explained the largest share of variance in VO₂max ($r^2 = .377$), followed by handgrip strength ($r^2 = .248$), BMI ($r^2 = .177$, inverse), and flexibility ($r^2 = .131$). The 95% confidence intervals displayed in Figure 2 further indicate that the aerobic association was not only statistically significant but also the most stable estimate in the model, whereas the interval for flexibility was wider and closer to zero, implying greater uncertainty around the size of that relationship. Even so, all coefficients remained directionally consistent with the descriptive profile in Tables 2 and 3: students reporting more demanding

weekly activity tended to present better endurance and strength, somewhat better range of motion, and leaner body composition. From a purely empirical standpoint, the results therefore show that intensity-related differences were evident across all four health-related fitness dimensions rather than being confined to a single outcome.

IV. DISCUSSION

The present study demonstrates that physical activity intensity is systematically associated with the multidimensional fitness profile of university students. Higher MET-minutes/week were associated with better aerobic capacity, greater handgrip strength, greater flexibility, and lower BMI, with the largest effect on VO_2max . This pattern is theoretically coherent because intensity governs the overload stimulus that drives adaptation across cardiovascular, neuromuscular, and metabolic systems. The findings also refine a common assumption in student health promotion: simply accumulating movement is not equivalent to engaging in an activity that is sufficiently challenging to improve fitness. Within this cohort, most students were classified as moderately active, yet only about one third were in the high-activity category, suggesting a gap between routine movement and truly intensity-sensitive exercise. In that sense, the study supports a more discriminating interpretation of campus activity behavior, one that treats intensity as a central explanatory variable rather than an incidental characteristic of exercise.

The strongest association was between activity intensity and VO_2max . This finding aligns with exercise physiology models in which cardiorespiratory fitness is especially sensitive to workloads that increase stroke volume, peripheral oxygen extraction, mitochondrial density, and ventilatory efficiency. Recent evidence in university populations is highly consistent with this interpretation. Li et al. (2022) reported that exercise behavior partially mediates the relationship between student motivation and cardiovascular fitness, indicating that the gains associated with active behavior are not merely psychological but physiologically detectable. Yu et al. (2022) likewise found that higher physical activity levels were associated with better overall physical fitness after the COVID-19 lockdown period, with endurance-related outcomes showing particular sensitivity to activity-level differences. Most directly, Yin et al. (2025) concluded in a meta-analysis that high-intensity interval training significantly improves VO_2max among university students. The current correlation of $r = .614$ and its corresponding explained variance of 37.7% suggest that aerobic capacity is the domain most tightly coupled to intensity in this sample. For higher education practice, this matters because VO_2max is not merely a performance variable; it is also a clinically meaningful index of health and future risk.

The positive relationship between intensity and handgrip strength further indicates that the benefits of more demanding activity extend beyond the cardiorespiratory system. Although the IPAQ-SF captures broad activity patterns rather than resistance training per se, students who regularly engage in vigorous exercise are more likely to participate in sports, circuit training, calisthenics, or other activities that increase neuromuscular recruitment and loading. That interpretation is compatible with Kljajević et al.'s (2022) review, which concluded that more active university students tend to demonstrate superior strength-related outcomes. It is also consistent with Yin et al. (2025), who reported significant strength gains following HIIT-based programs, and with Pamungkas et al. (2024), who documented favorable changes in body composition and flexibility following resistance training interventions in college students. Handgrip strength should not be treated as a narrow upper-body measure alone. In field settings, it functions as a pragmatic marker of overall strength status because it is easy to administer, reproducible, and meaningful in population research. The present findings, therefore, suggest that institutions aiming to improve students' strength should not rely solely on light recreational activity; they should provide workloads that meaningfully challenge the neuromuscular system.

The inverse association between intensity and BMI is equally important, particularly in university settings where sedentary study practices and irregular eating patterns often coexist. The direction of the relationship suggests that students who engage in more intense physical activity tend to maintain more favorable body mass status. Although BMI is a crude proxy that does not distinguish lean mass from fat mass, the finding remains meaningful at the population level and coherent with contemporary evidence. Li et al. (2025), in a network meta-analysis of randomized controlled trials, showed that several exercise modalities—including aerobic exercise, combined training, HIIT, and calisthenics—can improve body composition in university students when the weekly dose is sufficient. Kwilosz et al. (2025) similarly reported that physical activity and cardiorespiratory fitness are closely intertwined with body composition in university students, while Akil et al. (2025) demonstrated that barrier-rich lifestyle profiles are associated with less favorable body composition patterns. The present result, therefore, supports the view that intensity is one mechanism by which university students can resist the gradual drift toward adiposity that often accompanies academic sedentarianism. In practical terms, the negative BMI correlation suggests that campus exercise promotion is likely to be most effective when it emphasizes exercise dose and vigor rather than participation counts alone.

Flexibility showed the weakest, but still statistically significant, association with activity intensity. This smaller effect is not surprising. Unlike VO₂max or strength, flexibility is not

determined primarily by intensity; it is shaped by joint-specific mobility demands, stretching exposure, tissue extensibility, movement technique, and exercise modality. A student can participate in intense exercise with little dedicated mobility work, just as another student can improve flexibility through low-intensity stretching or mind-body exercise. Even so, the positive coefficient suggests that more active students may engage in a broader range of dynamic movements, warm-up routines, and sport-specific positions that help preserve the functional range of motion. This interpretation is broadly consistent with Pamungkas et al. (2024), who observed flexibility gains in college students following structured training, and with Kljajević et al. (2022), who emphasized that diversified participation patterns are relevant to fitness outcomes beyond endurance alone. The implication is that intensity contributes indirectly and incompletely to flexibility; comprehensive physical education should therefore combine vigorous activity with purposeful mobility training rather than assuming that one will automatically produce the other.

Taken together, the coefficient pattern reinforces a broader conceptual point: intensity is a threshold variable for meaningful adaptation. Current public health guidance emphasizes that adults should accumulate regular moderate or vigorous activity because health gains depend not only on whether movement occurs, but also on whether it meaningfully challenges physiological systems (World Health Organization, 2020; van der Ploeg & Bull, 2020). The university context is especially suited to operationalizing this principle because interventions can be embedded in timetabled courses, co-curricular sport, and campus routines. Evidence synthesis now indicates that physical activity interventions among university students can increase total activity and moderate-to-vigorous physical activity when delivery is matched to students' behavior, is theory-informed, and is feasible within academic schedules (Yuan et al., 2024). More specifically, time-efficient modalities such as HIIT are increasingly attractive because they can improve $VO_2\text{max}$, strength, and BMI without requiring long exercise sessions (Yin et al., 2025; Roberts et al., 2024). In the present Indonesian context, the implication is not that every student should engage in maximal or sport-specific training, but that university programs should deliberately create repeated opportunities for moderate-to-vigorous workloads. These may include structured interval segments in physical education classes, supervised circuit training, active campus challenges, and sport club formats that prioritize sustained exertion rather than occasional participation.

Although the present study focused on physical fitness outcomes, its implications extend into the psychological and educational domains. Regular physical activity among university students has been associated with better well-being, lower depressive and anxiety symptoms,

and a higher quality of life (Herbert et al., 2020). More recent longitudinal and meta-analytic evidence suggests that physically active students also report better stress recovery, stronger academic-functioning related parameters, and meaningful mental health benefits when exercise is sustained over time (Teuber et al., 2024; Liu et al., 2025). Importantly, Xu et al. (2025) found that cardiorespiratory fitness partially mediates the relationship between physical activity and mental health among university students, suggesting that fitness may be one pathway through which physical activity exerts psychological benefits. Viewed through that lens, the strong intensity–VO₂max relationship observed here may have relevance beyond physiology. If higher-intensity activity improves aerobic fitness and, in turn, supports mental health and stress resilience, then interventions designed to raise activity intensity may yield broader educational benefits than fitness testing alone would suggest. This strengthens the case for seeing campus exercise promotion not as an extracurricular luxury but as part of student development and learning support.

These findings also carry practical implications for how universities design physical education and health promotion under real resource constraints. Because time pressure is one of the most frequently reported barriers to student exercise, institutions may realize greater returns by prioritizing short, well-structured bouts of moderate-to-vigorous activity rather than relying exclusively on longer, lower-intensity sessions (Roberts et al., 2024; Yuan et al., 2024). In curricular terms, this means that course design should emphasize progressive overload, active lesson density, and monitoring of perceived exertion or workload, while still preserving safety and inclusivity for students with different starting fitness levels. The evidence based on HIIT and hybrid campus interventions is especially relevant here because it suggests that meaningful gains in aerobic fitness and body composition can be achieved through formats that are scalable within crowded university schedules (Li et al., 2022; Yin et al., 2025). For Indonesian universities, where infrastructure and discretionary leisure time may be constrained, the implication is not necessarily to create more sport specialization, but to organize smarter, intensity-aware opportunities that convert limited contact time into measurable health benefits.

The study also contributes something regionally specific. Reviews repeatedly note that the evidence base on physical activity and fitness among university students is dominated by Western and Chinese samples, while Southeast Asian contexts remain comparatively underrepresented (Kljajević et al., 2022). Yet the university experience is not culturally neutral. Access to facilities, commuting patterns, curriculum priorities, and social expectations differ across settings and shape how activity is accumulated. By examining Indonesian university students using a validated activity questionnaire and objective field-based fitness measures, the

present study adds contextually grounded evidence to the international literature, which remains geographically unbalanced. For curriculum policy, the message is clear: higher education institutions should not evaluate physical education solely by attendance or enjoyment. They should also consider whether programs enable students to reach workloads that improve endurance, strength, mobility, and body composition. That is the level at which quality physical education becomes a genuine health intervention rather than a symbolic institutional offering.

Several limitations should temper interpretation. First, the sample was relatively small and drawn from a single institution, which constrains generalizability and reduces precision, especially for subgroup analysis. Second, the cross-sectional design does not support causal inference; it remains possible that fitter students are more willing or able to engage in higher-intensity activity rather than intensity alone producing superior fitness. Third, physical activity was assessed by self-report. While the IPAQ-SF is widely used and practical for field research, systematic review evidence indicates that it can overestimate absolute activity volume and should be interpreted cautiously when used in isolation (Lee et al., 2011). Fourth, BMI was used as the body composition indicator; although useful in epidemiological work, it cannot distinguish fat mass from lean mass. Future studies should therefore employ larger multicampus samples, longitudinal or experimental designs, and objective monitoring tools such as accelerometers or wearable sensors, while also incorporating richer body composition indices and potentially dietary, sleep, and psychosocial variables. Even with these limitations, the study has notable strengths: it integrates subjective and objective measures, assesses multiple fitness domains simultaneously, and provides evidence from an underrepresented higher-education setting. These features make the findings both substantively relevant and practically usable for campus-based health promotion

V. CONCLUSION

This study found that physical activity intensity was significantly associated with every physical fitness component assessed among university students at Universitas Negeri Makassar. Higher intensity was associated with greater aerobic capacity, stronger handgrip strength, better flexibility, and lower BMI, with the most pronounced association observed for $\text{VO}_{2\text{max}}$. The overall pattern indicates that the health value of student activity is not determined simply by whether students are active, but by whether their activity reaches an intensity sufficient to stimulate measurable physiological adaptation. These findings support integrating moderate-to-vigorous exercise opportunities into higher education curricula and campus wellness programming as a practical means of improving multidimensional fitness in young adults.

The study is limited by its cross-sectional design, modest sample size, single institution setting, and reliance on self-reported physical activity. Future research should examine the same relationships using longitudinal or intervention designs, objective activity monitoring, and more detailed body composition indicators across multiple universities and disciplinary contexts. Even so, the study makes a meaningful contribution by providing context-specific evidence from Indonesia and combining validated behavioral and objective fitness measures within a single analytical framework. Its central contribution is both conceptual and empirical: it shows that activity intensity is a key explanatory variable for understanding student fitness and should be treated as a core target in physical education planning, campus health promotion, and future research on active lifestyles in higher education.

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