Sport development index as a predictor of physical activity and aerobic fitness: evidence from Indonesian universities with regional contrasts

Índice de desarrollo deportivo como predictor de la actividad física y la aptitud aeróbica: evidencia de universidades indonesias con contrastes regionales

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Abstract

Introduction: Institutional support has a significant impact on physical activity and fitness of University Members in Indonesia, but there is limited empirical data linking SDI metrics to health outcomes in low- and middle-income countries.
Objective: This study examines the correlation between SDI scores and aerobic fitness and physical activity levels of University Members in Indonesia.
Methodology: A cross-sectional analysis was conducted across 14 Indonesian universities (42.86% Java, 57.14% non-Java). SDI was evaluated via a 75-item checklist (α = 0.89). Physical activity (MET-minutes/week) was measured using the IPAQ-SF, while aerobic fitness (VO_2 max) was assessed via the 20-meter (MFT).
Results: Universities with higher SDI demonstrated stronger physical activity (mean MET-minutes = 1,728 ± 1,182) and fitness levels (VO_2 max = 35.8 ± 4.63 ml/kg/min). Significant positive correlations emerged between SDI and physical activity (*r* = 0.910, *p* < 0.001) and fitness (*r* = 0.906, *p* < 0.001). Non-Java institutions outperformed Java counterparts in inclusive policies (57.14% scored ≥20/25), despite lower budgets.
Discussion: SDI elements like staff training, inclusive policies, and accessible facilities enhance student engagement, aligning with international research. Decentralized governance could improve inclusivity in resource-limited environments, but budget disparities worsen participation gaps.
Conclusions: SDI is a crucial indicator of student health outcomes in Indonesian universities. Policymakers should prioritise mandatory sports budgets, equitable resource distribution, and region-specific approaches to reducing inequities.

Keywords

Sport development index; physical activity; aerobic fitness; regional disparities; university.

Resumen

Introducción: El apoyo institucional tiene un impacto significativo en la actividad física y la aptitud física de los miembros universitarios en Indonesia, pero hay datos empíricos limitados que vinculen las métricas del SDI con los resultados de salud en países de ingresos bajos y medios.
Objetivo: Este estudio examina la correlación entre las puntuaciones SDI y la aptitud aeróbica y los niveles de actividad física de los miembros universitarios en Indonesia.
Metodología: Se realizó un análisis transversal en 14 universidades indonesias (42,86 % con Java, 57,14 % sin Java). El SDI se evaluó mediante una lista de verificación de 75 ítems (α = 0,89). La actividad física (MET-minutos/semana) se midió con el IPAQ-SF, mientras que la capacidad aeróbica se evaluó mediante la prueba de fuerza muscular de 20 metros (MFT).
Resultados: Las universidades con un SDI más alto mostraron una actividad física más intensa (media de MET-minutos = 1728 ± 1182) y una mejor condición física (VO_2 máx. = 35,8 ± 4,63 ml/kg/min). Se observaron correlaciones positivas significativas entre el SDI y la actividad física (*r* = 0,910, *p* < 0,001) y la condición física (*r* = 0,906, *p* < 0,001). Las instituciones que no utilizan Java superaron a las que sí lo hacen en cuanto a políticas inclusivas (el 57,14 % obtuvo una puntuación ≥20/25), a pesar de contar con presupuestos más reducidos.
Discusión: Los elementos del SDI, como la formación del personal, las políticas inclusivas y las instalaciones accesibles, mejoran la participación estudiantil, lo que coincide con la investigación internacional. La gobernanza descentralizada podría mejorar la inclusión en entornos con recursos limitados, pero las disparidades presupuestarias agravan las brechas de participación.
Conclusiones: El SDI es un indicador crucial de los resultados de salud estudiantil en las universidades indonesias. Los responsables políticos deberían priorizar los presupuestos deportivos obligatorios, la distribución equitativa de recursos y los enfoques regionales para reducir las desigualdades.

Palabras clave

Índice de desarrollo deportivo; actividad física; aptitud aeróbica; disparidades regionales; universidad.

Introduction

University students' academic performance and health are significantly influenced by their levels of fitness and physical activity (Le Rossignol et al., 2016; Leal et al., 2020). Not only among university students, physical activity patterns and fitness levels are also important for the academic community of higher education institutions, such as lecturers and academic staff (Aguilar et al., 2008; Blázquez Manzano et al., 2015). It is acknowledged that physical activity is essential for promoting health and preventing disease. Global trends indicate a worrying decline in physical activity levels, despite its well-established benefits, particularly among university students—a demographic experiencing significant lifestyle changes (Hariyanto et al., 2023). Other studies have also found that there are still many lecturers and academic staff in the university environment who have low levels of physical activity and high sedentary behaviors (Akodu et al., 2016; Marques et al., 2023; Samson-Akpan et al., 2013). Not only students experience the hectic activities in university, ranging from studying in class, self-study, doing assignments, research, and others (Gonçalves et al., 2024; Kosonen et al., 2023), which makes them lack physical activity and poor physical fitness (Kljajević et al., 2021). University lecturers and administrative staff also have a heavy workload that limits their time to relax and rest (Soetan & Popoola, 2018). This kind of campus life exposes them to work-specific stressors and increases their perceived stress levels (Arslan et al., 2019; Soetan & Popoola, 2018). Studies also show that there is still a high concern in the university population with minimal physical activity as the correlation with work stress levels is strong (Akobundu et al., 2025).

Sedentary behaviour remains prevalent in academic settings despite international efforts to promote active lifestyles (Hallal et al., 2012; Rusdiawan et al., 2024). Higher education institutions play a key role through policies, programs, and infrastructure, yet disparities in program quality and resource allocation often create unequal opportunities (Ding et al., 2016; Sallis et al., 2006). To address this issue, frameworks such as the Sport Development Index (SDI) have emerged as tools for assessing the capacity of institutions to promote physical activity and sports (Mutohir et al., 2022). Previous studies have shown that facility availability and program diversity are positively associated with student health outcomes (Lee et al., 2016; Robbins et al., 2019).

Recent studies highlight facility accessibility and coherent policies as key determinants of physical activity in higher education (Giulianotti, 2021; Hu et al., 2021; Yu, 2025). Inclusive policies and the presence of certified trainers have been shown to increase participation rates (Barros et al., 2025; Sakalidis et al., 2023). However, most of this evidence comes from Western contexts, while empirical studies in low- and middle-income countries remain scarce. In Indonesia, although the national Sport Development Index (SDI) framework has been introduced (Kemenpora RI, 2018), little is known about how institutional SDI scores relate to student health outcomes. Furthermore, regional disparities, such as differences between universities in Java and those outside Java, have not been systematically examined (McLennan & Thompson, 2015).

This study addresses the research gap by examining the relationship between institutional Sport Development Index (SDI) scores, physical activity, and aerobic fitness (VO_2 max) among academic communities in Indonesian universities. It also compares universities in Java and non-Java regions to explore potential regional disparities. By doing so, the study provides empirical evidence on the role of SDI in higher education, offering insights for policymakers and institutions in low- and middle-income countries to design more inclusive and effective sport development strategies.

The SDI includes indicators such as facilities, policy support, human resources, and community involvement (Kemenpora, 2020). Although the SDI has demonstrated its usefulness at both regional and national levels, its applicability and relevance in academic contexts have yet to be thoroughly explored. According to a systematic review by Morningstar et al., (2023), university students in developing nations have higher levels of physical activity and psychological well-being when they have access to sports facilities and institutional support. Additionally, school-based interventions that enhance sports infrastructure and policies have significantly improved cardiovascular fitness among students in LMIC countries (Andermo et al., 2020). These results underscore the importance of incorporating SDI indicators as a strategic measurement tool when assessing disparities in sports development and their impact on the health outcomes of campus populations. This study addresses this knowledge gap by evaluating the use of the SDI in a higher education setting and examining its correlation with students' actual levels of

physical activity and sport participation. It is anticipated that the findings will provide empirical insights to university administrators and policymakers seeking to promote a more active and health-conscious student population.

Method

Participants

The 14 Indonesian universities that had accredited sports science programs were selected using a method that ensured a mix of locations (57.14% from outside Java, 42.86% from Java) and different sizes of institutions for this study that looked at multiple sites. Through institutional agreement forms, participating institutions formally consented and agreed to submit detailed reports on their fitness metrics, physical activity levels, and Sport Development Index (SDI).

The study focused on actively employed academic staff members (e.g., lecturers, administrative staff, and university students) between the ages of 20 and 60 to ensure alignment with the working-age population most directly impacted by university sports policies. Participants had to meet eligibility requirements, which included being officially affiliated with their institution and being free of long-term illnesses that limit physical activity.

Table 1. Data of Universities/Colleges that are Research Participants

Code	University/Colleges	Province (Java or Outside Java Island)	n
A	Universitas Negeri Medan	Outside Java	740
B	STKIP PGRI Sumenep	Java	384
C	Universitas Muhammadiyah Luwuk Banggai	Outside Java	315
D	Universitas PGRI Adi Buana Surabaya	Java	665
E	STKIP PGRI Bangkalan	Java	343
F	Balikpapan University	Outside Java	410
G	Tadulako University	Outside Java	701
H	Universitas Sultan Ageng Tirtayasa	Java	704
I	Universitas Al-Asyariah Mandar	Outside Java	309
J	Universitas Negeri Surabaya	Java	996
K	Cenderawasih University	Outside Java	625
L	Mandalika University of Education	Outside Java	565
M	College of Sports Science Binaguna	Outside Java	349
N	STKIP PGRI Trenggalek	Java	373

Note: STKIP PGRI is PGRI Teachers' College.

Procedure

Data collection followed a standardized multiphase protocol between July and December 2024. Initially, 25 Indonesian universities with accredited sports science programs were invited via formal email; 14 institutions provided written institutional consent and agreed to participate. Ethical approval was obtained from each institution prior to the study.

To ensure consistency, a preparatory virtual workshop was conducted with institutional representatives. The workshop outlined study objectives, ethical standards, and standardized procedures for administering the instruments. The Sport Development Index (SDI), adapted from the Kemenpora RI framework (2018), was pilot tested with 50 participants to confirm clarity and feasibility before full implementation.

Each participating university was required to report Sport Development Index (SDI) scores, fitness metrics (via the standardized Multistage Fitness Test [MFT]), and physical activity levels (via the validated Indonesian version of the IPAQ-SF) (Dharmansyah & Budiana, 2021; Suyoto et al., 2016). Data were collected through a secure online platform (Qualtrics), allowing real-time monitoring and quality control. All datasets were anonymized before submission to the central research team for subsequent analysis.

Instrument and Data Collection

Using a 75-item checklist adapted from Kemenpora RI (2018), three impartial sports experts, unaware of institutional identities, evaluated each university's Sport Development Index (SDI). The SDI covered four areas: human resources (training, health support, and staff qualifications), sports programs (diversity, participation rates, and innovation), infrastructure (quality, accessibility, and availability), and policies (budget, inclusivity, and governance). A scale of 0–25 was used to score each dimension, and the overall SDI was determined as follows:

SDI = (Σ dimension score) x (100/300)

Inter-rater reliability was confirmed through Krippendorff's alpha (α = 0.89). Discrepancies were resolved via consensus meetings.

Table 2. Instrument of Sport Development Index (SDI)

Dimension	Indicator	Sub-Indicator	Scoring method	Scoring
Infrastructure	Availability of Sports Facilities	Number of sports facilities	Administrative data	Score 0–25 per indicator (maximum total 75 per dimension)
		Type of facility (team sports, individual, recreational).		
	Quality of Facilities	Safety standards (SNI/ISO certification).	Field observation, maintenance report	
		Condition of facilities (maintenance, cleanliness, damage).		
	Accessibility	Facility hours of operation (average per week).	Observation and interviews with staff	
		Availability of access for students with disabilities.		
Human Resources	Staff Qualifications	Percentage of national/internationally certified trainers/staff.	HR document analysis, interviews	
		Trainer-to-student ratio (1:50 ideal).		
	Human Resources Training and Development	Frequency of staff training per year.	Training reports, staff questionnaires.	
		Participation in professional development programs.		
	Health Support	Availability of nutritionists/physiotherapists.	Observation, interview.	
		Preventive health programs		
Sports program	Program Diversity	Program type (intramural, competitive, recreational, fitness).	Analysis of activity calendar, student questionnaire.	
		Inclusivity (gender, disability, non-athlete).		
	Frequency and participation in programs	Average program sessions per week.	Data registrasi dan kuesioner	
		Percentage of students participating (min. 30% is ideal).		
	Program innovation	Partnerships with external organizations (e.g., professional clubs).	Administrator interviews, documentation.	
		Use of technology (e.g., fitness apps).		
Policies that support sports activities	Budget	Percentage of university budget for sports (min. 5% is ideal).	Financial analysis report.	
		Transparency of fund allocation.		
	Inclusion policy	Affirmative action policies for marginalized groups	Policy document analysis, interviews	
		Integration of sports into the curriculum (mandatory credits).		
	Partnerships and governance	Stakeholder involvement (students, community, government).	MoU documents, evaluation reports.	
		Periodic evaluation of sports programs.		

Participants reported how many MET minutes they spent each week on work, leisure, and transportation activities using the International Physical Activity Questionnaire-Short Form (IPAQ-SF), which is an online tool for measuring physical activity levels (Dharmansyah & Budiana, 2021; IPAQ, n.d.). Responses were cross-checked with activity-tracking applications (if available) and institutional attendance records.

The Multistage Fitness Test (MFT) was employed to assess fitness, with the results converted into VO2 max values (Paradisis et al., 2014) To estimate the participants' maximal oxygen uptake (VO_2 max), a validated method for evaluating aerobic capacity known as the 20-meter multi-stage shuttle run (beep test) was conducted. The test took place on a flat indoor surface using two parallel lines spaced 20 meters apart. Following the standard beep test protocol, participants were instructed to run between the lines in sync with an audio signal that played at progressively shorter intervals. The test commenced at

a speed of 8.5 km/h, which increased by 0.5 km/h each minute (one level). It concluded when participants failed to reach the line before the beep twice in succession.

Participants completed a 10-minute dynamic warm-up and attended a briefing session to familiarize themselves with the protocol before testing. A PAR-Q (Physical Activity Readiness Questionnaire) and other health screenings ensured there were no medical conditions that would preclude vigorous exercise. All equipment, including measuring tapes, mats, and stopwatches, was standardized and calibrated across all locations. The day prior to the test, participants were instructed to avoid any physically demanding activities. To minimize human error, results were electronically recorded on secure tablets and double-checked by two independent assessors. After being anonymized, the data were consolidated and stored in a central database for analysis.

Data analysis

The SDI, VO_2 max, and MET-minutes per week (physical activity) scores were summarized using descriptive statistics. Pearson correlation was used to test for linear relationships between variables, revealing a strong positive correlation between SDI and fitness (*r* = 0.906, $p < 0.001$) as well as physical activity (*r* = 0.910, $p < 0.001$). Data were analyzed using SPSS v.28 after confirming normality through the Kolmogorov-Smirnov test (*p* > 0.05). Ethical practices included obtaining institutional approval, anonymizing data, and avoiding physically demanding activities before testing.

Results

This study involved 14 universities in Indonesia, with a total of 7479 participants. Of these, 42.86% were located in Java, while 57.14% were situated outside Java. Overall, the participants were predominantly male, comprising 61.81%, whereas females accounted for 38.19%. The age distribution revealed that 22.64% were aged between 20 and 30 years, 38.19% were aged between 31 and 40 years, 29% were aged between 41 and 50 years, and 10.18% were aged between 51 and 60 years.

SDI scores varied between 26.67 and 90.67 across different universities. Those with the highest scores exhibited effective governance, solid infrastructure, and significant participation in student sports programs.

Table 3. University Rankings Based on Sport Development Index (SDI) Dimensions

University	Infastructure			Human Resources			Sports Programs			Policies that support sports activities			SDI Score	Ranking
	Availability of Sports Facilities	Quality of Facilities	Accessibility	Staff Qualifications	HR Training and Development	Health Support	Program Diversity	Frequency and participation in programs	Program innovation	Budget	Inclusion policy	Partnerships and governance		
A	24	22	24	20	22	20	20	22	20	20	18	22	84.67	2
B	12	10	10	15	12	10	15	12	15	12	12	12	49.00	10
C	12	12	12	10	10	10	10	10	10	10	12	10	42.67	12
D	20	18	20	18	20	20	18	18	15	18	15	18	72.67	5
E	5	5	5	5	8	5	8	8	10	8	8	5	26.67	14
F	12	15	10	10	10	10	8	10	10	12	10	8	41.67	13
H	12	12	10	12	10	10	12	12	10	12	10	10	44.00	11
I	18	15	12	18	12	12	12	15	15	12	12	12	55.00	7
J	12	14	12	15	12	12	15	15	15	12	12	12	52.67	9
K	24	22	24	24	22	24	22	24	20	24	20	22	90.67	1
L	22	22	20	18	20	18	20	18	18	22	18	20	78.67	3

M	22	18	20	18	20	18	20	18	22	22	18	18	78.00	4
N	17	15	15	17	17	15	20	17	15	17	15	15	65.00	6
O	15	15	12	15	12	12	12	15	15	12	12	12	53.00	8

Note: A is Universitas Negeri Medan, B is STKIP PGRI Sumenep, C is Universitas Muhammadiyah Luwuk Banggai, D is Universitas PGRI Adi Buana Surabaya, E is STKIP PGRI Bangkalan, F is Balikpapan University, G is Tadulako University, H is Universitas Sultan Ageng Tirtayasa, I is Universitas Al-Asyariah Mandar, J is Universitas Negeri Surabaya, K is Cenderawasih University, L is Mandalika University of Education, M is College of Sports Science Binaguna, N is STKIP PGRI Trenggalek. STKIP PGRI is PGRI Teachers' College.

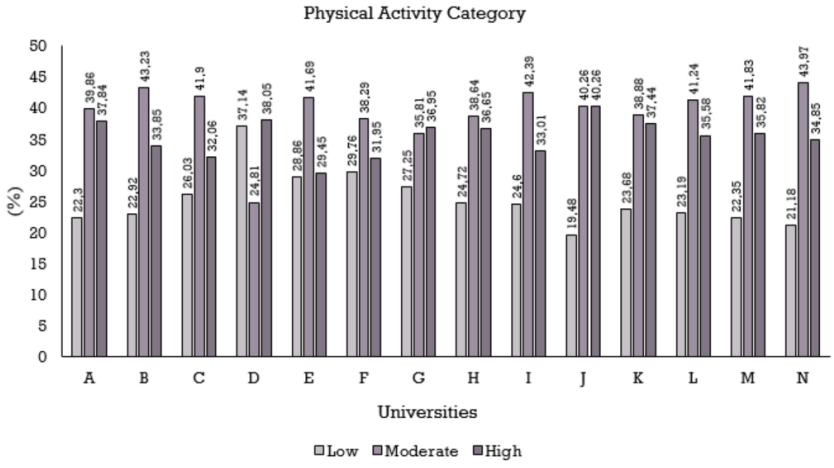
Table 2 shows that the SDI scores of universities range from 26.67 to 90.67. Universitas Negeri Surabaya is ranked highest with an SDI of 90.67, which is backed by robust infrastructure (infrastructure score: 24/25), high-quality human resources (staff qualification score: 24/25), and extensive supporting policies. However, STKIP PGRI Bangkalan received the lowest score (SDI = 26.67), primarily as a result of inadequate budget allocation (8/25) and limited infrastructure (facility availability score: 5/25).

High-ranking universities (e.g., Universitas Negeri Medan [ranked 2, SDI = 84.67]) routinely perform well in policy governance and sports program diversity (program innovation score: 22/25), according to sub-dimension analysis. Conversely, lower-ranked universities (like Balikpapan University [ranked 13], SDI = 41.67]) demonstrated deficiencies in student participation (<30%) and facility accessibility (score: 10/25).

Additionally, a regional trend emerged: 57.14% of non-Java universities (such as Cenderawasih University [ranked 3], SDI = 78.67) outperformed several Java universities in the inclusive policy dimension (score: 22/25). This research illustrates that the advancement of sports in higher education relies on various factors, including program innovation, policy integration, and a commitment to open governance, alongside financial resources.

The physical activity levels measured using the IPAQ-SF instrument yielded the following results:

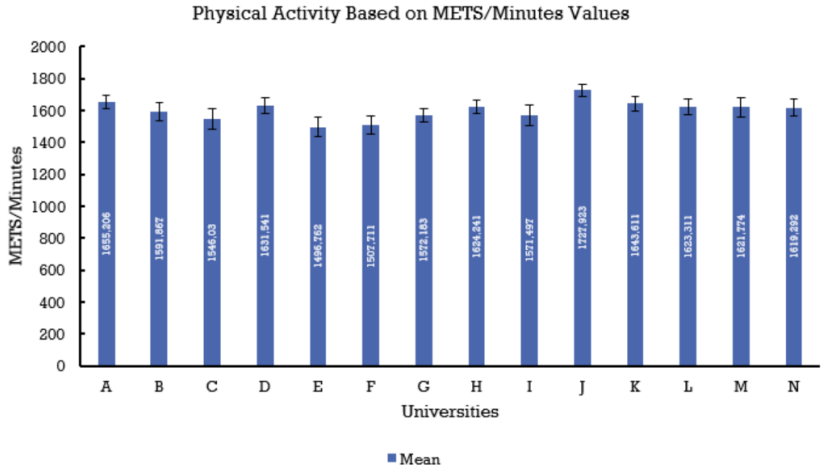
Figure 1. Physical Activity Level Category Results.



A is Universitas Negeri Medan (n=740), B is STKIP PGRI Sumenep (n=384), C is Universitas Muhammadiyah Luwuk Banggai (n=315), D is Universitas PGRI Adi Buana Surabaya (n=665), E is STKIP PGRI Bangkalan (n=343), F is Balikpapan University (n=410), G is Tadulako University (n=701), H is Universitas Sultan Ageng Tirtayasa (n=704), I is Universitas Al-Asyariah Mandar (n=309), J is Universitas Negeri Surabaya (n=996), K is Cenderawasih University (n=625), L is Mandalika University of Education (n=565), M is College of Sports Science Binaguna (n=349), N is STKIP PGRI Trenggalek (n=373).

The results, as seen in Figure 1, show that the majority of participating universities in this study had moderate physical activity levels. To see the difference in physical activity based on the average METS-minute/week, see Figure 2.

Figure 2. Physical Activity Analysis Results Based on METS/Minute Values.



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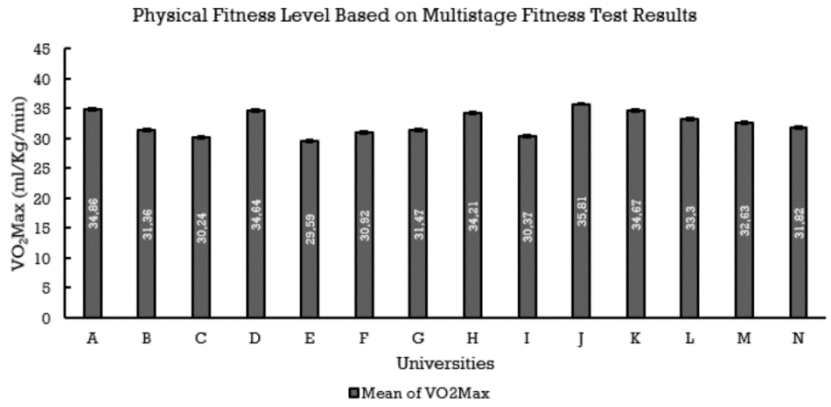
Then, the results of the descriptive statistical analysis on the fitness level aspect reviewed from the VO2Max results can be seen in Figure 3 below.

Figure 3. Physical Fitness Results Based on VO_2max.



A is Universitas Negeri Medan, B is STKIP PGRI Sumenep, C is Universitas Muhammadiyah Luwuk Banggai, D is Universitas PGRI Adi Buana Surabaya, E is STKIP PGRI Bangkalan, F is Balikpapan University, G is Tadulako University, H is Universitas Sultan Ageng Tirtayasa, I is Universitas Al-Asyariah Mandar, J is Universitas Negeri Surabaya, K is Cenderawasih University, L is Mandalika University of Education, M is College of Sports Science Binaguna, N is STKIP PGRI Trenggalek.

Figures 2 and 3 show the results of physical activity levels (in METS-min/week) among university academics at 14 universities in Indonesia. The IPAQ-SF questionnaire was used to measure physical activity and the results show differences between universities. The university with the highest SDI ranking (90.67), University J (Universitas Negeri Surabaya) has the highest average METS-minute/week (1727.923 METS-min/week) and a relatively high VO2Max compared to other universities (35.81 ml/Kg/min), which indicates that the participation of the academic community (lecturers, students, and administrative staff) in sports is good and the institution's ability to develop sports has a positive correlation. In contrast, universities with low SDI, such as University E (STKIP PGRI Bangkalan; ranked 14th, SDI = 26.67), had the lowest level of physical activity (1496.762 METS-min/week) and the lowest fitness level (VO2Max = 29.59 ml/Kg/min) and participation was concentrated in certain subpopulations.

Although most universities displayed moderate to high levels of activity, the wide range of MET-minutes (0–5,340) further demonstrates the variability in the data and reflects the prevalence of sedentary behavior in some institutions. High-SDI universities, like K University (Cenderawasih University; ranked 3, SDI = 78.67), are notable for their accessible facilities and inclusive policies, which could promote more equitable participation.

The Pearson correlation test was performed because the data showed a normal distribution for all variables (SDI (p=0.200), IPAQ-SF (p=0.200), and fitness level (p=0.200)) based on the Kolmogorov-Smirnov test. The results of the correlation test are presented in Table 4.

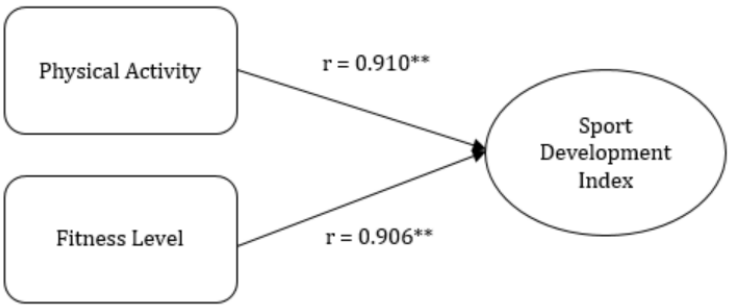
Table 4. Pearson Correlations of SDI with Physical Activity and Fitness Levels

Variable		p (2-tailed)	r
SDI	Physical activity level	0.001	0.910
	Fitness level	0.001	0.906

correlated if the p value <0.05

The results of the Pearson correlation analysis showed statistically significant, strong positive links between student outcomes and the Sport Development Index (SDI). Higher SDI scores were particularly associated with increased levels of physical activity (*r* = 0.910, p < 0.001) and better aerobic fitness (*r* = 0.906, p < 0.001). These results highlight the importance of sports infrastructure, programme support, and resource allocation in encouraging student participation in physical activities and improving overall fitness.

Figure 4. Results of Correlation Test Between Physical Activity Level and Fitness Level with Sport Development Index at University Level (**: there is a significant correlation at the 0.01 level)



The strength of the associations indicates that colleges with comprehensive sports development plans, which include easily accessible facilities, trained staff, inclusive policies, and innovative programs, are more likely to cultivate student bodies that are physically active. To lessen disparities in physical activity participation, these findings support policy changes that prioritise equitable resource distribution, especially in universities with poor performance. Future research should examine the long-term impacts on student well-being and the causal mechanisms underlying SDI-driven interventions.

Discussion

This study demonstrates strong positive correlations between Sport Development Index (SDI) scores and both physical activity and aerobic fitness among Indonesian universities. Institutions with higher SDI values consistently showed higher MET-minutes/week and VO_2 max scores, confirming the predictive value of SDI in higher education settings, confirming the SDI as a significant predictor of physical health outcomes in higher education settings. These results are consistent with global evidence highlighting the importance of structured environments in encouraging physical activity (Neil-Sztramko et al., 2021; Snedden et al., 2019).

The SDI framework provides a comprehensive assessment of an institution's capacity to promote physical activity by examining its policies, sports programs, infrastructure, and human resources. Notable universities demonstrated excellence in governance, staff qualifications, and availability of facilities. This aligns with the findings of Lee et al. (2016), who highlighted facility accessibility as a crucial driver of engagement; accessible facilities and extended operating hours, for instance, likely reduced barriers to participation. Higher fitness levels among students were also reported by institutions with certified trainers and regular staff training programs, underscoring the importance of human resource quality in delivering effective sports programs (Barros et al., 2025).

Notably, among universities outside of Java, the inclusion of marginalized groups through affirmative action policies emerged as a differentiator. This regional trend supports McLennan & Thompson, (2015) call for context-specific sports policies by suggesting that localized priorities or decentralized governance may enhance inclusivity. However, differences in budget allocation in low-SDI institutions indicate that systemic inequalities remain unresolved.. These organizations often lack the funding required to launch innovative initiatives, which perpetuates low participation cycles (Giulianotti, 2021). Additionally, Ding et al. (2016) noted that institutional-level socioeconomic and infrastructure barriers may limit opportunities for physical engagement, particularly among marginalized groups. Significantly lower MET-minutes and VO_2 max values indicate reduced physical activity, likely resulting from these discrepancies (Wiriawan et al., 2024).

The strength of the correlation supports the SDI framework as a reliable instrument for institutional benchmarking. The multidimensional SDI approach, which was adapted for this study and based on national standards (Kemenpora RI, 2018), worked well for differentiating institutional performance across important sports development domains. Given its capacity to predict health outcomes, SDI may be used as a policy lever to support academic health promotion initiatives.

This study also reveals a regional pattern: several non-Java universities demonstrated stronger implementation of inclusive policies compared to their counterparts in Java. These findings suggest that leadership quality and policy coherence may play a more decisive role than financial resources. Consistent with previous research, institutional commitment and governance can partially offset resource constraints, enabling universities to achieve higher inclusivity despite logistical challenges (Eime et al., 2013; Kim & Zhang, 2021)

From a public health perspective, the results underscore the need to implement specific policies that integrate physical activity into university organisations culture. Higher education institutions must acknowledge their dual responsibility: to encourage active lifestyles among students and staff and to set an example for environments that support sustained engagement in fitness-enhancing activities. This task is especially important given the global decline in adult physical activity, particularly among sedentary professions like academia (Hallal et al., 2012).

The findings suggest that institutional SDI strongly influences patterns of physical activity among students. Structured initiatives, such as intramural leagues or the integration of fitness applications, were associated with higher levels of engagement, supporting evidence that program diversity enhances participation (Agnes et al., 2024). Conversely, low-SDI institutions often reported higher levels of sedentary behavior, which may be linked to limited program offerings or inadequate facility maintenance. These results are consistent with socioecological models, which hold that personal health behaviors are influenced by environmental and policy-level factors (Sallis et al., 2006).

The social ecology model posits that determinants at the intrapersonal (motivation, self-confidence), interpersonal (social support), institutional (campus policy), community (accsess to facilities), and public (allocation of sports budgets) levels impact individual behaviour in this case, student physical activity. At the institutional and community levels, SDI, a composite index that incorporates aspects of programs, policies, infrastructure, and human resources, can be seen as the primary force behind creating opportunities for students to engage in physical activity in a planned and sustainable manner (Neil-Sztramko et al., 2021). High SDI infrastructure scores indicate the availability and maintenance of sports facilities, which serve as determinants of the physical environment and promote active behaviour. In line with international research on the benefits of facility access for physical activity, universities with high SDI scores also demonstrated higher mean VO_2 max and MET-minutes/week (Kondo et al., 2018; Lee et al., 2016). According to the Theory of Planned behaviour (Ajzen, 1991), the presence of certified

coaches and affirmative policies also helps foster a positive social environment, which is crucial for developing positive norms and attitudes regarding physical activity.

Universities outside of Java have successfully implemented inclusive policies, demonstrating that institutional dedication and flexible governance can overcome resource limitations. This conclusion is consistent with the findings of McLennan & Thompson (2015), who claimed that decentralised strategies and locally relevant policies can enhance access and participation. The way supportive or unfavourable campus policies impact perceived advantages and obstacles to physical activity can also be explained by the Health Belief Model (Alyafei & Easton-Carr, 2024).

Additionally, the large range of MET and VO_2 max scores illustrates how unequal campus environments are in terms of offering equal physical opportunities. According to Swinburn et al. (2011), institutions with low SDI scores, have little infrastructure and policies that could lead to an "obesogenic environment," which is a term used to characterise an atmosphere that systematically discourages active lifestyles. These results demonstrate that individual-based interventions are insufficient to overcome institutional barriers, and environmental and structural factors are necessary preconditions for establishing long-term health behaviour change (Bauman et al., 2012).

These findings also lend credence to the use of SDI as a tool for institutional and policy evaluation in middle-income nations like Indonesia. According to a systematic study by Andermo et al. (2020), university students in developing nations now participate in physical activity and are much more fit thanks to institutional interventions like sports policies and increased coach capacity. Thus, incorporating SDI into higher education institutions funding incentives or accreditation processes could hasten systemic change in campus health promotion.

Although this study provides strong cross-sectional evidence, it is not possible to make causal inferences due to its design. Longitudinal studies are necessary to evaluate the relationship between improvements in SDI and long-term health outcomes. Additionally, self-reported physical activity data (measured by IPAQ-SF) may introduce recall bias; however, this risk was mitigated by triangulating with activity trackers. Future research should investigate how socioeconomic and cultural factors influence regional disparities, particularly regarding the superior performance of non-Java universities in implementing inclusive policies. A more comprehensive understanding of the institutional impact on the wider campus population could be achieved by expanding the sample to include instructors and students from non-sport disciplines.

Conclusions

The Sports Development Index (SDI) in Indonesian Universities significantly influences university members' physical activity level and cardiorespiratory fitness. Institutions with a high SDI, characterized by robust infrastructure, qualified staff, inclusive policies, and innovative programs, demonstrate superior health outcomes. Non-Java universities excelled in policy inclusivity compared to their Java counterparts, suggesting that decentralized governance and localized strategies may alleviate resource limitations. Low-SDI institutions, frequently hindered by inadequate budgets and infrastructure, experience diminished participation and fitness levels. Policymakers and universities ought to prioritize equitable resource allocation, including mandatory sports budgets and transparent governance frameworks, to bridge institutional disparities. Regional adaptations, such as affirmative action policies and technology-driven programs, can enhance accessibility and engagement. Future longitudinal research is essential to establish causality between improvements in SDI and health outcomes.

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References

Agnes, T., Nayak, U. U., Kulakarni, M. M., & Maiya, G. A. (2024). Physical activity promotion through digital technology among older adults with type 2 diabetes mellitus: A scoping review. *Journal of Taibah University Medical Sciences*, *19*(5), 1024. https://doi.org/10.1016/J.JTUMED.2024.10.001

Aguilar, E. E. R., Zapata, M. H. L., Giraldo, F. J. L., Tejada, J. L. C., & Vidales, S. A. Z. (2008). Análisis descriptivo de las variables: nivel de actividad física, depresión y riesgos cardiovasculares en empleados y docentes de una institución universitaria en Medellín (Colombia). *Apunts. Medicina de l'Esport*, *43*(158), 55–61. https://doi.org/10.1016/S1886-6581(08)70072-0

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Akobundu, U. N., Obiekwe, S. J., Ezeigwe, J., Adaigwe, A. I., Okonkwo, U. P., Daniel, A. J., & Akosile, C. O. (2025). The Correlation of Work-Related Stress, Sleep Quality, and Physical Activity Among Academic Staff in a Nigerian Medical School: A Cross-Sectional Study. *Lifestyle Medicine*, *6*(3), e70027. https://doi.org/10.1002/LIM2.70027

Akodu, A., Owoeye, O., & Raufu, A. (2016). Exercise, Recreation and Sport Participation among Lecturers in University of Lagos. *University of Lagos Journal of Basic Medical Sciences*, *4*(8), 26–32.

Alyafei, A., & Easton-Carr, R. (2024). The Health Belief Model of Behavior Change. *StatPearls*. https://www.ncbi.nlm.nih.gov/books/NBK606120/

Andermo, S., Hallgren, M., Nguyen, T. T. D., Jonsson, S., Petersen, S., Friberg, M., Romqvist, A., Stubbs, B., & Elinder, L. S. (2020). School-related physical activity interventions and mental health among children: a systematic review and meta-analysis. *Sports Medicine - Open*, *6*(1). https://doi.org/10.1186/s40798-020-00254-x

Arslan, S. S., Alemdaroğlu, I., Karaduman, A. A., & Yilmaz, Ö. T. (2019). The effects of physical activity on sleep quality, job satisfaction, and quality of life in office workers. *Work*, *63*(1), 3–7. https://doi.org/10.3233/WOR-192902;SUBPAGE:STRING:ABSTRACT;REQUESTEDJOURNAL:JOURNAL:WORA;WEBSITE:WEBSITE:SAGE;WGROUP:STRING:PUBLICATION

Barros, K., Vuillemin, A., Rostan, F., Lemmonier, F., Guillemin, F., Tezier, B., & Van Hoye, A. (2025). Defining health promoting sports coaches skills: A systematic review. *International Journal of Sports Science and Coaching*. https://doi.org/10.1177/17479541251320830;CSUBTYPE:STRING:AHEAD

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., Martin, B. W., Alkandari, J. R., Andersen, L. B., Blair, S. N., Brownson, R. C., Bull, F. C., Craig, C. L., Ekelund, U., Goenka, S., Guthold, R., Hallal, P. C., Haskell, W. L., Heath, G. W., Inoue, S., … Sarmiento, O. L. (2012). Correlates of physical activity: why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Blázquez Manzano, A., Ana León-Mejía, A., & Feu Molina, S. (2015). Intención y práctica de actividad física en maestros españoles. *Cuadernos de Psicología Del Deporte*, *15*(2), 163–170. https://doi.org/10.4321/S1578-84232015000200018

Dharmansyah, D., & Budiana, D. (2021). Indonesian Adaptation of The International Physical Activity Questionnaire (IPAQ): Psychometric Properties. *Jurnal Pendidikan Keperawatan Indonesia*, *7*(2), 159–163. https://doi.org/10.17509/jpki.v7i2.39351

Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., van Mechelen, W., & Pratt, M. (2016). The economic burden of physical inactivity: a global analysis of major non-communicable diseases. *The Lancet*, *388*(10051), 1311–1324. https://doi.org/10.1016/S0140-6736(16)30383-X

Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013). A systematic review of the psychological and social benefits of participation in sport for children and adolescents: Informing development of a conceptual model of health through sport. *International Journal of*

Behavioral Nutrition and Physical Activity, *10*(1), 1–21. https://doi.org/10.1186/1479-5868-10-98/TABLES/2

Giulianotti, R. (2021). Greening Sport for Development and Peace: A Socio-Ecological Approach. *Frontiers in Sports and Active Living*, *3*. https://doi.org/10.3389/FSPOR.2021.660743,

Gonçalves, G. S., Serra, F. A. R., Storopoli, J. E., Scafuto, I. C., & Rafael, D. N. (2024). Undergraduate Student Retention Activities: Challenges and Research Agenda. *SAGE Open*, *14*(3). https://doi.org/10.1177/21582440241249334/ASSET/F65D911F-4F7E-4ADC-ABF7-61D78C2DF095/ASSETS/IMAGES/LARGE/10.1177_21582440241249334-FIG1.JPG

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., Ekelund, U., Alkandari, J. R., Bauman, A. E., Blair, S. N., Brownson, R. C., Craig, C. L., Goenka, S., Heath, G. W., Inoue, S., Kahlmeier, S., Katzmarzyk, P. T., Kohl, H. W., Lambert, E. V., Lee, I. M., … Wells, J. C. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet (London, England)*, *380*(9838), 247–257. https://doi.org/10.1016/S0140-6736(12)60646-1

Hariyanto, A., Mustar, Y. S., Sholikhah, A. M. atus, Rusdiawan, A., Susanto, I. H., & Purnomo, M. (2023). Physical Activity Level Amongst University Students and Lecturers Across Majors and Programs in Indonesia. *Physical Education Theory and Methodology*, *23*(1), 49–57. https://doi.org/10.17309/tmfv.2023.1.07

Hu, D., Zhou, S., Crowley-Mchattan, Z. J., & Liu, Z. (2021). Factors That Influence Participation in Physical Activity in School-Aged Children and Adolescents: A Systematic Review from the Social Ecological Model Perspective. *International Journal of Environmental Research and Public Health*, *18*(6), 3147. https://doi.org/10.3390/IJERPH18063147

IPAQ. (n.d.). *International Physical Activity Questionnaire*.

Kim, E., & Zhang, J. J. (2021). Sport Governance and Operations. *Sport Governance and Operations*. https://doi.org/10.4324/9781003213673

Kljajević, V., Stanković, M., Đorđević, D., Trkulja-Petković, D., Jovanović, R., Plazibat, K., Oršolić, M., Čurić, M., & Sporiš, G. (2021). Physical Activity and Physical Fitness among University Students—A Systematic Review. *International Journal of Environmental Research and Public Health*, *19*(1), 158. https://doi.org/10.3390/IJERPH19010158

Kondo, M. C., Fluehr, J. M., McKeon, T., & Branas, C. C. (2018). Urban green space and its impact on human health. *International Journal of Environmental Research and Public Health*, *15*(3). https://doi.org/10.3390/IJERPH15030445,

Kosonen, T., Annala, J., Penttinen, L., & Mäkinen, M. (2023). University Students' Approaches to Making the Most of Their Study Time. *Scandinavian Journal of Educational Research*, *67*(3), 377–390. https://doi.org/10.1080/00313831.2021.2021440

Le Rossignol, P., Boertien, M., & Wee, E. H. (2016). Health related physical activity behaviour of first year university students. *International Sports Studies*, *38*(1), 25–35. https://doi.org/10.30819/ISS.38-1.03

Leal, J. B., Montenegro, R. A., Do Nascimento Junior, J. R. A., Siqueira, L. P., Almeida, C. M. M., de Moraes, J. F. V. N., & Carvalho, F. O. (2020). Level of physical activity and associated factors in a public university. *Revista Brasileira de Cineantropometria & Desempenho Humano*, *22*, e59241. https://doi.org/10.1590/1980-0037.2020V22E59241

Lee, S. A., Ju, Y. J., Lee, J. E., Hyun, I. S., Nam, J. Y., Han, K. T., & Park, E. C. (2016). The relationship between sports facility accessibility and physical activity among Korean adults. *BMC Public Health*, *16*(1), 1–8. https://doi.org/10.1186/S12889-016-3574-Z/TABLES/3

Marques, A., Iglésias, B., Ramos, G., Gouveia, É. R., Ferrari, G., Martins, J., & Lagestad, P. (2023). Physical education teachers' knowledge of physical activity recommendations for health promotion in children and adolescents. *Scientific Reports*, *13*(1), 1–7. https://doi.org/10.1038/S41598-023-48522-6;SUBJMETA=478,692,700,784;KWRD=PUBLIC+HEALTH,QUALITY+OF+LIFE

McLennan, N., & Thompson, J. (2015). *Quality Physical Education (QPE): guidelines for policy makers*. 89. https://unesdoc.unesco.org/ark:/48223/pf0000231101

Morningstar, B., Clayborne, Z., Wong, S. L., Roberts, K. C., Prince, S. A., Gariépy, G., Goldfield, G. S., Janssen, I., & Lang, J. J. (2023). The association between social media use and physical activity among Canadian adolescents: a Health Behaviour in School-aged Children (HBSC) study. *Canadian Journal of Public Health*, *114*(4), 642–650. https://doi.org/10.17269/s41997-023-00754-9

Neil-Sztramko, S. E., Caldwell, H., & Dobbins, M. (2021). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database of Systematic Reviews*, *2021*(9). https://doi.org/10.1002/14651858.CD007651.PUB3,

Paradisis, G. P., Zacharogiannis, E., Mandila, D., Smirtiotou, A., Argeitaki, P., & Cooke, C. B. (2014). Multi-Stage 20-m Shuttle Run Fitness Test, Maximal Oxygen Uptake and Velocity at Maximal Oxygen Uptake. *Journal of Human Kinetics*, *41*(1), 81. https://doi.org/10.2478/HUKIN-2014-0035

Robbins, L. B., Wen, F., & Ling, J. (2019). Mediators of Physical Activity Behavior Change in the "Girls on the Move" Intervention. *Nursing Research*, *68*(4), 257. https://doi.org/10.1097/NNR.0000000000000359

Sakalidis, K. E., Fadeeva, A., Hettinga, F. J., & Ling, F. C. M. (2023). The role of the social environment in inclusive sports participation-Identifying similarities and challenges in athletes with and without Intellectual Disabilities through coaches' eyes: A qualitative inquiry. *PLoS ONE*, *18*(1 January). https://doi.org/10.1371/JOURNAL.PONE.0280379

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health*, *27*, 297–322. https://doi.org/10.1146/ANNUREV.PUBLHEALTH.27.021405.102100,

Samson-Akpan, P. E., Eyo, M. B. N., & Joshua, A. M. (2013). Physical activity for quality living among academic staff in Nigerian universities. *Hamdard Medicus*, *56*, 78–90.

Snedden, T. R., Scerpella, J., Kliethermes, S. A., Norman, R. S., Blyholder, L., Sanfilippo, J., McGuine, T. A., & Heiderscheit, B. (2019). Sport and physical activity level impacts health-related quality of life among collegiate students. *American Journal of Health Promotion : AJHP*, *33*(5), 675. https://doi.org/10.1177/0890117118817715

Soetan, M. K., & Popoola, B. I. (2018). WORKLOAD AND AREAS OF SPECIALISATION AS CORRELATES OF JOB STRESS AMONG UNIVERSITY LECTURERS IN SOUTHWESTERN NIGERIA. *European Journal of Education Studies*, *5*(4), 199–206. https://doi.org/10.5281/ZENODO.1476693

Suyoto, P. S. T., Huriyati, E., Susilowati, R., & Julia, M. (2016). Relative validity of administered indonesian version of the short-form international physical activity questionnaire (IPAQ-SF) among obese adolescent girl population. *Pakistan Journal of Nutrition*, *15*(9), 816–820. https://doi.org/10.3923/pjn.2016.816.820

Swinburn, B. A., Sacks, G., Hall, K. D., McPherson, K., Finegood, D. T., Moodie, M. L., & Gortmaker, S. L. (2011). The global obesity pandemic: Shaped by global drivers and local environments. *The Lancet*, *378*(9793), 804–814. https://doi.org/10.1016/S0140-6736(11)60813-1,

Wiriawan, O., -, S., Kusuma, D. A., Firmansyah, A., Nor, A. M., Rusdiawan, A., & Mohd Kadri, N. (2024). School Leadership In Addressing The Influence Of Parental Income On Physical Activity And Sedentary Lifestyle Among Junior High School Students. *MOJEM: Malaysian Online Journal of Educational Management*, *12*(2), 16–27. https://doi.org/10.22452/MOJEM.VOL12NO2.2

Yu, C.-Y. (2025). Access to Third Places: Key Determinants of Physical and Social Well-Being in Older Adults. *Urban Science 2025, Vol. 9, Page 141*, *9*(5), 141. https://doi.org/10.3390/URBANSCI9050141

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