

Analysis of the Effects of Martial Arts Extracurricular Activities on the Physical Fitness of Junior High School Students

Tasta Puspa Tastia¹, Alen Rismayadi², Ivan Rivan Firdaus³

¹²³ Study Program of Sport Coaching Education, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Dr. Setiabudi St. No. 229, Bandung, 40154, West Java, Indonesia.

Corresponding author. Email : rismayadi.alen@upi.edu

(Submission Track: Received: 01-01-2026, Final Revision: 29-05-2026, Available Online: 13-06-2026)

Abstract. This study aimed to analyze the effect of martial arts extracurricular activities on the physical fitness of junior high school students. The research used a quantitative approach with a pre-experimental one-group pretest–posttest design. The participants consisted of 30 students aged 12–14 years who actively participated in karate, pencak silat, and taekwondo extracurricular activities at SMP Kemala Bhayangkari Bandung. The sampling technique used was purposive sampling. Physical fitness data were collected using a physical fitness test battery for adolescents, including handgrip strength, sargent jump, sit and reach, sit-ups, beep test, and body mass index. Data analysis was conducted using the Shapiro–Wilk normality test, Levene homogeneity test, and one-way ANOVA with a significance level of 0.05. The results showed that all martial arts extracurricular activities improved students' physical fitness. The one-way ANOVA test showed a significance value of 0.047 ($p < 0.05$), indicating a significant difference in physical fitness improvement among the three martial arts groups. The karate group demonstrated the highest increase in average scores compared to pencak silat and taekwondo. The differences in improvement were influenced by variations in training frequency, intensity, and movement characteristics in each martial art. Therefore, martial arts extracurricular activities can be considered an effective physical activity program for improving the physical fitness of junior high school students.

Keywords: martial arts extracurricular activities; physical fitness; karate; pencak silat; taekwondo



INTRODUCTION

Physical fitness is a key component in supporting an individual's ability to engage in physical activity optimally and maintain good health, particularly during adolescence, a period of rapid physical growth and development (Ezar et al., 2025; Ferozi et al., 2024). Adequate levels of physical fitness in children and adolescents are also associated with a better quality of life, improved readiness for learning, and a reduced risk of future health problems (Bielik et al., 2025; Laitinen et al., 2025). However, various studies indicate that current levels of physical fitness among children and adolescents are declining due to increasing sedentary behaviors, such as excessive screen time, prolonged sitting, and low participation in structured physical activities (Saevarsson et al., 2021; World Health Organization, 2020). This situation has a negative impact on the cardiorespiratory endurance, muscle strength, and body composition of children and adolescents (Ludwig-Walz et al., 2025; Vanhelst et al., 2024).

One way to increase physical activity among adolescents is through school sports extracurricular activities. Extracurricular activities provide students with opportunities for regular, structured, and sustained physical activity outside of formal class hours (Demetriou et al., 2017; Li & Kwok, 2021). Previous research has shown that participation in extracurricular sports is positively associated with improved physical fitness and cardiometabolic health in children and adolescents (Batista et al., 2024; Bengtsson et al., 2025). Students who actively participate in sports after school also tend to have better physical fitness levels compared to students who do not participate in organized sports activities (Meiner et al., 2025; Zhao et al., 2025). These findings align with a systematic review conducted by Zouhal et al., (2020), which states that game-based physical activities as well as moderate-to-vigorous intensity exercises can have positive effects on physical fitness, physiological responses, and health indicators in adolescents and individuals who are not accustomed to exercising. Extracurricular martial arts activities, such as pencak silat, taekwondo, and karate, are forms of physical activity that involve strength, speed, flexibility, agility, and physical endurance, thereby potentially improving students' physical fitness (Saraiva et al., 2025; Stamenković et al., 2022). Additionally, martial arts training has been linked to improvements in adolescents' motor skills and physiological functions (Dias de Jesus et al., 2025; Gawel & Zwierzchowska, 2024). Previous research indicates that training in taekwondo, pencak silat, and karate can have a positive impact on the physical fitness of children and adolescents (Kim et al., 2011; Nam & Lim, 2019; Nugroho et al., 2024; Piepiora, 2025).

However, the physical fitness levels of students participating in martial arts extracurricular activities are not always optimal, as they are influenced by the characteristics, frequency, and duration of training, which vary across different martial arts disciplines (Dwi Kurniawan & Hariyanto, 2024; Nyrć & Lopuszanska-Dawid, 2023). Additionally, Zouhal et al., (2020) explain that variations in exercise form, activity intensity, and training program duration can influence physiological responses as well as improvements in participants' physical fitness. Therefore, analyzing physical fitness based on martial arts extracurricular disciplines is crucial for obtaining an objective picture of the physical condition of junior high school students. Physical fitness measurements were conducted using a series of physical fitness tests for adolescents aged 12–14 years, which are appropriate for the students' age characteristics (Khattak & Scholar, 2023). Based on this, this study aims to analyze the physical fitness of junior high school students participating in pencak silat, taekwondo, and karate extracurricular activities.

METHOD

This study employed a quantitative approach using a single-group pretest–posttest pre-experimental design aimed at determining differences in students' physical fitness levels before and after participating in martial arts extracurricular activities (Caliston, 2025). This study was conducted at SMP Kemala Bhayangkari Bandung over a one-month period during school-based extracurricular activities. The training program provided utilized the specific training regimens designed by the respective sports coaches, so there were variations in training frequency and program content tailored to each coach's approach. The participants in this study consisted of 30 students from SMP Kemala Bhayangkari Bandung who actively participated in martial arts extracurricular activities, including taekwondo, pencak silat, and karate. The participants comprised 15 male students and 15 female students. The sampling technique used was purposive sampling with the following inclusion criteria: (1) students aged 12–14 years, (2) actively participating in martial arts extracurricular activities during the study period, (3) attending regular training sessions according to the school schedule, and (4) having recently joined the extracurricular program. After the routine training was completed, the students received a questionnaire in the form of a Google Form to determine the frequency of training for each sport. The questionnaire was administered during the final session, specifically after the posttest was conducted.

The research instrument used a physical fitness battery test for adolescent aged 12-14 years, based on Khattak & Scholar (2023). Additionally, a questionnaire was used to collect

data on subject characteristics, including age, gender, grade level, weekly training frequency, and the duration of each training session.

Table 1. Physical Fitness Test Items (Khattak & Scholar, 2023)

No	Health Component	Test Type	Unit
1	Muscular Strength	Handgrip Strength Test	kg
2	Power	Sargent Jump	cm
3	Flexibility	Sit & Reach Test	cm
4	Muscular Endurance	Sit-Ups	sec
5	VO ₂ max	Beep Test	level/shuttle
6	Body Composition	Body Mass Index	kg/m ²

In the initial phase of the study, the researchers explained the study's objectives and procedures to the participants. Subsequently, a baseline assessment was conducted using a series of physical fitness tests to evaluate the students' initial physical fitness levels. During the study period, the participants attended extracurricular training sessions in taekwondo, pencak silat, and karate according to each sport's respective training program for one month without any specific intervention from the researchers. The researchers only observed and documented the activities taking place. The training period was conducted entirely by the respective sports' extracurricular coaches. After the training period ended, a post-test was conducted using the same instruments and procedures as the pre-test to assess changes in the students' physical fitness levels.

Research data were collected from the results of the physical fitness pretest and posttest, as well as questionnaires regarding subject characteristics and the frequency of training in their respective sports. All data were analyzed using the Statistical Package for the Social Sciences (SPSS). Before hypothesis testing, the data were first tested for normality using the Shapiro–Wilk test because the sample size was less than 50. Subsequently, differences in pretest and posttest results were analyzed using one-way ANOVA with a significance level of <0.05.

RESULT AND DISCUSSION

Result

This study aimed to analyze the effect of extracurricular activities on the physical fitness of junior high school students aged 12–14 years.

Descriptive Statistics

Table 2. Results of the Descriptive Analysis of the Pretest and Posttest

	N	Min	Max	Mean	Std. Dev
Pretest Karate	10	2	6,4	4,280	1,449
Posttest Karate	10	3,2	7,2	4,800	1,473

Pretest Pencak Silat	10	2	6,4	4,320	1,663
Posttest Pencak Silat	10	2,8	6,8	4,720	1,695
Pretest Taekwondo	10	3,2	7,2	5,080	1,485
Posttest Taekwondo	10	3,6	7,6	5,360	1,487

Table 2 presents the pretest and posttest results for three sports using five different physical tests. Based on Table 2, it can be seen that for the karate group, the pretest and posttest consisted of 10 participants with a minimum pretest score of 2.0, which increased to 3.2 in the posttest. The maximum score increased from 6.4 to 7.2, while the mean score increased from 4.280 to 4.800 with a standard deviation of 1.449 to 1.473. In the pencak silat group, the sample size was 10 students with a minimum pretest score of 2.0, which increased to 2.8 on the posttest. The maximum score increased from 6.4 to 6.8, while the mean score increased from 4.320 to 4.720 with a standard deviation of 1.663 to 1.695. Meanwhile, in the taekwondo group with a sample size of 10 students, the minimum score increased from 3.2 on the pretest to 3.6 on the posttest. The maximum score increased from 7.2 to 7.6, while the mean score increased from 5.080 to 5.360 with a standard deviation of 1.485 to 1.487. This increase in the average score indicates an improvement in physical fitness among students participating in martial arts extracurricular activities; although the changes shown varied, the maximum and minimum scores also indicate an improvement in students' physical fitness.

Normality Test

The normality test was conducted using the Shapiro-Wilk test, which is used for small samples ($n < 50$).

Table 3. Results of the Shapiro-Wilk Normality Test

	Shapiro-Wilk			
	Statistic	df	Sig.	Ket
Pretest Karate	0,915	10	0,313	Normal
Posttest Karate	0,903	10	0,237	Normal
Pretest Pencak silat	0,915	10	0,314	Normal
Posttest Pencak silat	0,889	10	0,167	Normal
Pretest Taekwondo	0,912	10	0,294	Normal
Posttest Taekwondo	0,919	10	0,352	Normal

Based on Table 3, which shows the results of the data normality test using the ShapiroWilk test, it can be seen that the pretest and posttest results can be considered normally distributed, with significance values greater than 0.05. In the karate group, the significance value for the pretest was 0.313 and for the posttest was 0.237. In the pencak silat group, the significance value for the pretest was 0.314 and for the posttest was 0.167. Meanwhile, in the

taekwondo group, the significance value for the pretest was 0.294 and for the posttest was 0.352. Thus, since the significance values for both the pretest and posttest are greater than 0.05 ($p > 0.05$), the data are considered to be normally distributed.

Homogenitas Varians

The homogeneity test was conducted using the Levene test with a significance level greater than 0.05 ($p > 0.05$) to determine the equality of variances among the study groups.

Table 4. Results of the Homogeneity

	Levene Statistic	df1	df2	Sig.
Gain Pretest Posttes	0,130	2	29	0,878
	0,087	2	29	0,917
	0,087	2	28,976	0,917
	0,085	2	29	0,919

Based on Table 4, the results of the homogeneity test indicate that the data have a significance value greater than 0.05 ($p > 0.05$). The significance values obtained were 0.878; 0.917; 0.917; and 0.919, respectively. These results indicate that the variance of the data across the research groups is homogeneous or has equal variances. Thus, the research data meets the requirements to proceed to hypothesis testing using a parametric test, namely one-way ANOVA.

Hipotesis Test

Hypothesis testing was performed using one-way ANOVA because the study involved three different sports, and the results showed a significance level below 0.05 ($p < 0.05$).

Table 5. Results of the One-way ANOVA

Gain Pretest Posttest	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0,331	2	0,165	3,444	0,047
Within Groups	1,296	27	0,048		
Total	1,627	29			

Based on Table 5, the results of the hypothesis test using one-way ANOVA showed a significance value of 0.047 ($p < 0.05$). This value indicates that there is a significant difference in the improvement of physical fitness among the three martial arts extracurricular activities, namely karate, pencak silat, and taekwondo. Thus, it can be concluded that martial arts extracurricular activities have different effects on the improvement of physical fitness among junior high school students.

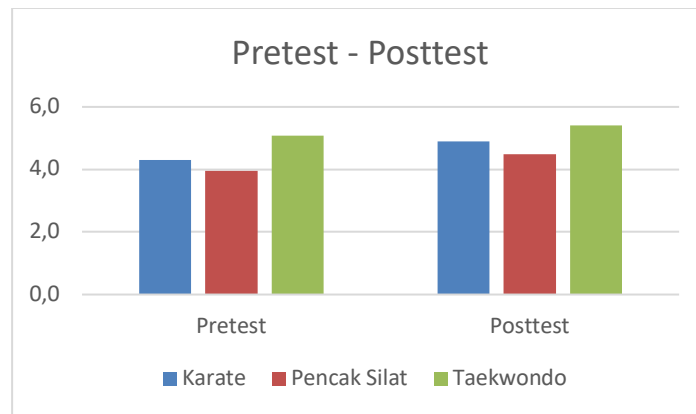


Figure 1. Graphic

Based on the diagram, all sports disciplines showed an increase in average scores on the posttest compared to the pretest. The karate group experienced an increase in average scores from approximately 4.3 on the pretest to 4.8 on the posttest. The pencak silat group increased from approximately 4.0 to 4.5. Meanwhile, the taekwondo group showed the highest average score, increasing from approximately 5.1 on the pretest to 5.4 on the posttest. These results indicate that martial arts extracurricular activities have a positive impact on improving students' physical fitness. Additionally, the differences in improvement across each sport may be influenced by the distinct training characteristics, intensity, and frequency of each sport, as indicated by the questionnaire.

Discussion

The results of the study on these three sports showed varying results, which were caused by differences in the sports themselves. Although the selected sports were all martial arts, each sport had different training focuses or durations.

The karate group holds practice sessions three times a week: twice at school and once on the weekend outside of school. Each session lasts two hours, for a total of 12 practice sessions per month. This resulted in an average score of 4.208 on the pretest and 4.800 on the posttest. The maximum score on the pretest was 6.4, while on the posttest it was 7.2, resulting in a score difference of 0.8. This indicates an increase of approximately 11.1% from the initial test'. This improvement was also influenced by karate training movements that involve agility, endurance, muscle strength, and body flexibility (Aziz et al., 2025; Piepiora, 2025; Rutkowski & Chwałczyńska, 2025). Performance in karate is also closely related to aerobic and anaerobic capacity, as well as overall physical condition, thereby supporting improvements in students' physical fitness (Nema et al., 2024). Additionally, karate training can enhance lower-body muscle strength and power, which are key components of physical fitness (Mahmudah et al., 2024).

The pencak silat group's questionnaire results indicated that training sessions were conducted twice a week, with each session lasting 2 hours. The total number of training sessions conducted in one month was 7. This resulted in an average score of 4.320, which increased to 4.720 on the posttest. The maximum score also increased from 6.4 to 6.8, resulting in a score difference of 0.4. This indicates an improvement of approximately 5.8% from the pencak silat group's initial test. This improvement occurred because pencak silat training involves moderate-to-high-intensity physical activities performed repeatedly through kicks, strikes, blocks, evasion, throws, and body positions that utilize nearly the entire body, particularly the muscles of the legs, arms, abdomen, and back, thereby improving endurance, muscle strength, agility, coordination, flexibility, and overall physical fitness (Hidayatullah et al., 2024; Nugroho et al., 2024; Pratama, 2017; Umarushalih & Hamdani, 2022). Additionally, regular and structured pencak silat training has been shown to improve aerobic capacity and VO₂max values, as the body works continuously for a certain duration during training, thereby contributing to improved student fitness (Kardianus et al., 2020; Nofriyantoni et al., 2025; Nohan & Wahyudi, 2021; Qasash Hasyim, 2026). Pencak silat training can also improve strength, endurance, speed, and agility because the training program combines attacking movements, defensive maneuvers, changes of direction, and quick reaction movements in each session, thereby improving physical condition and better preparing the body to perform physical activities optimally (Mardius et al., 2025; Perwirawati et al., 2023; Rizky et al., 2025; Umarushalih & Hamdani, 2022).

The taekwondo group had the same schedule as the pencak silat group, namely two training sessions per week. Each session lasts two hours, totaling 7 sessions per month. This resulted in an average score of 5,080 on the pretest, which increased to 5,360 on the posttest. Additionally, the maximum score rose from 7.2 to 7.6, yielding a score difference of 0.4. This indicates an improvement of approximately 5.2% from the initial test. This improvement occurred because taekwondo training involves high-intensity physical activities such as kicks, jumps, blocks, footwork, sparring, and rapid, repetitive changes in direction, thereby enhancing cardiovascular endurance, muscle strength, agility, flexibility, coordination, and overall physical fitness (Apriantono et al., 2020; Wahyuni & Donie, 2020; Zhu et al., 2025; Setiawan et al., 2026). Kicking movements in taekwondo, which primarily engage the lower-body muscles and are combined with jumps and rapid reaction movements, also contribute to improvements in strength, endurance, and aerobic capacity in the lower body among athletes and students who train regularly (Kang et al., 2025; Karimullah & Atmaka, 2025).

Based on the results of the study conducted on the three martial arts disciplines, all showed a significant impact on improvements in physical fitness. In addition, the results of the hypothesis test showed a value of 0.047 ($p < 0.05$); this figure indicates that there is a significant difference in the improvement of physical fitness between the groups. However, the degree of improvement varied among the disciplines, with the karate group showing the highest improvement compared to taekwondo and pencak silat. These differences may be influenced by training frequency, training intensity, and the movement characteristics of each sport. Martial arts training essentially involves physical activities that engage nearly the entire body, thereby improving students' cardiorespiratory endurance, muscle strength, agility, flexibility, coordination, strength, and aerobic capacity. Furthermore, the higher the frequency and intensity of regular training, the greater the improvement in physical fitness that tends to occur. Thus, martial arts extracurricular activities can serve as an effective form of physical activity to enhance the physical fitness of junior high school students.

CONCLUSION

Based on the research results, martial arts extracurricular activities such as karate, pencak silat, and taekwondo have a significant effect on improving the physical fitness of junior high school students. The results of the one-way ANOVA test showed a significance value of 0.047 ($p < 0.05$), indicating a significant difference in the improvement of physical fitness among the three martial arts groups. The karate group showed the highest improvement in physical fitness compared to pencak silat and taekwondo. These differences in improvement were influenced by variations in training frequency, intensity, duration, and movement characteristics specific to each martial art. In general, martial arts training that involves strength, endurance, agility, flexibility, coordination, and aerobic activity can have a positive impact on the improvement of students' physical fitness. Therefore, martial arts extracurricular activities can serve as an effective physical activity program to improve the physical fitness of junior high school students. Further research is recommended to use a larger sample size, a longer training period, and a more controlled training program to obtain more optimal and comprehensive research results.

REFERENCES

- Aziz, M. A., Kunnabal, P., & Mohamed, N. A. (2025). Anthropometric and Physical Fitness Component Profiles in Malaysian Adolescence Recreational Karateka. *Journal of Health Science and Medical Research*, 43(3). <https://doi.org/10.31584/jhsmr.20251142>
- Batista, M. B., Freitas, M. C. M. de, Romanzini, C. L. P., Barbosa, C. C. L., Shigaki, G. B., Fernandes, R. A., Romanzini, M., & Ronque, E. R. V. (2024). Sports participation in

- childhood and adolescence and physical activity intensity in adulthood. *PLoS ONE*, 19(5 MAY). <https://doi.org/10.1371/journal.pone.0299604>
- Bengtsson, D., Svensson, J., Wiman, V., Stenling, A., Lundkvist, E., & Ivarsson, A. (2025). Health-related outcomes of youth sport participation: a systematic review and meta-analysis. In *International Journal of Behavioral Nutrition and Physical Activity* (Vol. 22, Number 1). BioMed Central Ltd. <https://doi.org/10.1186/s12966-025-01792-x>
- Bielik, V., Nosál', V., Nechalová, L., Špánik, M., Žilková, K., & Grendar, M. (2025). The prediction model of academic achievement based on cardiorespiratory fitness and BMI status for ninth-grade students. *BMC Pediatrics*, 25(1). <https://doi.org/10.1186/s12887-024-05353-2>
- Caliston, N. (2025). Evaluating the Effectiveness of Mobile Game-Based Learning for Raising Adolescent Health Awareness: The Case of "AHLam Na 2.0." *IJOEM Indonesian Journal of E-Learning and Multimedia*, 4(1), 11–20. <https://doi.org/10.58723/ijoem.v4i1.349>
- Demetriou, Y., Gillison, F., & McKenzie, T. L. (2017). After-School Physical Activity Interventions on Child and Adolescent Physical Activity and Health: A Review of Reviews. *Advances in Physical Education*, 07(02), 191–215. <https://doi.org/10.4236/ape.2017.72017>
- Dias de Jesus, E. E., Cordeiro, D. L., & Cortes Morales, P. J. (2025). Comparison of the physical fitness of children who train karate in the Joinville/SC region. *Sustainability and Sports Science Journal*, 3(3), 144–149. <https://doi.org/10.55860/xrxw8143>
- Dwi Kurniawan, R., & Hariyanto, E. (2024). SURVEI TINGKAT KEBUGARAN JASMANI SISWA EKSTRAKURIKULER PENCAK SILAT PSHT DI SMP NEGERI 2 TUREN. In *Bulan 11 Tahun* (Vol. 4). <http://jurnal.anfa.co.id/index.php/PJKR>
- Ezar, A., Zahron, F., & Fadhli, N. R. (2025). HUBUNGAN TINGKAT AKTIVITAS FISIK DENGAN KEBUGARAN PADA SISWA USIA 12-15 TAHUN. *Jurnal Edukasi Citra Olahraga* ||, 511. <https://doi.org/10.38048/jor.v4i3.6259>
- Ferozi, S., Taneja, A. G., & Bakshi, N. (2024). Assessment of nutritional status, physical fitness and physical activity of school going adolescents (12–15 years) in Delhi. *BMC Pediatrics*, 24(1). <https://doi.org/10.1186/s12887-024-04733-y>
- Gawel, E., & Zwierzchowska, A. (2024). The Acute and Long-Term Effects of Olympic Karate Kata Training on Structural and Functional Changes in the Body Posture of Polish National Team Athletes. *Sports*, 12(2). <https://doi.org/10.3390/sports12020055>
- Hidayatullah, M. N. F., Harwanto, H., & Suharti, S. (2024). Pengaruh Latihan Fisik Beladiri Pencak Silat Terhadap Kebugaran Jasmani Pada Siswa Persaudaraan Setia Hati Terate. *PENJAGA: Pendidikan Jasmani Dan Olahraga*, 5(1), 6–11. <https://doi.org/10.55933/pjga.v5i1.695>
- Kang, M.-J., Xiang, Y.-Y., Won, J.-H., & Kim, J.-S. (2025). *The Effect of Taekwondo Training Period on Physical Fitness, Muscular Strength, and Respiratory Muscle Function in Youth*. <https://doi.org/10.21203/rs.3.rs-7764108/v1>
- Kardianus, Suyatmin, & Moh Kusuma Atmaja, N. (2020). *PENGARUH INTERVAL TRAINING TERHADAP VO2 MAX PADA EKSTRA KURIKULER PENCAK SILAT PERSAUDARAAN SETIA HATI TERATE RAYON KHUSUS SMKN 1 NANGA PINOH* (Vol. 7, Number 1).
- Karimullah, A., & Atmaka, D. R. (2025). The Relationship between Sitting Height with VO2max and Muscular Endurance in Junior Taekwondo Athletes. *JSES Journal of Sport and Exercise Science*, 8(2), 152–160. <https://doi.org/10.26740/jses.v8n2.p152-160>
- Khattak, A. A., & Scholar, M. S. (2023). DEVELOPING NORMS FOR THE TEST BATTERY MEASURING THE PHYSICAL FITNESS LEVEL OF THE EARLY ADOLESCENTS. In *PJER* (Vol. 6).

- Kim, H. B., Stebbins, C. L., Chai, J. H., & Song, J. K. (2011). Taekwondo training and fitness in female adolescents. *Journal of Sports Sciences*, 29(2), 133–138. <https://doi.org/10.1080/02640414.2010.525519>
- Laitinen, E., Soininen, S., Leppänen, M. H., Waller, K., Bond, B., Lintu, N., Faigenbaum, A. D., Laitinen, T., Haapala, E. A., & Lakka, T. A. (2025). Associations of Physical Fitness During Childhood with Arterial Structure and Stiffness in Adolescence: An 8-Year Follow-up Study. *Sports Medicine - Open*, 11(1). <https://doi.org/10.1186/s40798-025-00841-w>
- Li, Y., & Kwok, A. P. K. (2021). The Effects of after-School Training of Different Sports Events on the Physical Fitness of Adolescents and Its Comparative Analysis. *Advances in Physical Education*, 11(03), 321–330. <https://doi.org/10.4236/ape.2021.113027>
- Ludwig-Walz, H., Heinisch, S., Siemens, W., Niessner, C., Eberhardt, T., Dannheim, I., Guthold, R., & Bujard, M. (2025). Trends in physical fitness among children and adolescents in Europe: A systematic review and meta-analyses during and after the COVID-19 pandemic. *Journal of Sport and Health Science*, 101101. <https://doi.org/10.1016/j.jshs.2025.101101>
- Mahmudah, M., Dirgantoro, E. W., & Arifin, S. (2024). Pengaruh Latihan Double Leg Speed Hop Terhadap Power Otot Tungkai Atlet Karate Dojo Kodim 1001 Amuntai. *Jurnal Sains Keolahragaan Dan Kesehatan*, 9(1), 100–112. <https://doi.org/10.5614/jskk.2024.9.1.9>
- Mardius, A., Sofyan, D., Hadi, R. S., Barlian, E., Ihsan, N., Astuti, Y., & Ockta, Y. (2025). Effectiveness of interval training in increasing VO₂max in pencak silat athletes. 14. <https://revistas.um.es/sportk>
- Meiner, C. B., Eckert, C., Aggestrup, C. S., Pfeiffer, K., Tarantino, G., Prisak, C., Cimenti, C., Thøgersen-Ntoumani, C., Ntoumanis, N., Krstrup, P., & Larsen, M. N. (2025). Superior health-related physical fitness and well-being in 12-15-year-old Danish adolescents who are active in organized leisure-time sports - a cross-sectional study. *PLOS ONE*, 20(9 September). <https://doi.org/10.1371/journal.pone.0330950>
- Nam, S.-S., & Lim, K. (2019). Effects of Taekwondo training on physical fitness factors in Korean elementary students: A systematic review and meta-analysis. *Journal of Exercise Nutrition & Biochemistry*, 22(2), 7–11. <https://doi.org/10.20463/jenb.2018.0010>
- Nema, K., Ruzbarsky, P., Rydzik, Ł., & Peric, T. (2024). Relationship of selected conditioning parameters and sport performance indicators in karate. *Frontiers in Sports and Active Living*, 6. <https://doi.org/10.3389/fspor.2024.1433117>
- Nofriyantoni, Pujianto, D., & Sutisyana, A. (2025). The Effect of Interval Training on Increasing VO₂ Max in Pencak Silat Athletes Fostered by ASBD Bengkulu. *Indonesian Journal of Sport, Health and Physical Education Science*, 3(3), 106–112. <https://doi.org/10.58723/inasport.v3i3.393>
- Nohan, A., & Wahyudi, A. R. (2021). 10 Vo₂Max ATLET PENCAK SILAT USIA 14-17 TAHUN DI GOLDEN SILAT CLUB.
- Nugroho, H., Gontara, S. Y., Angga, P. D., & Jariono, G. (2024). Pencak Silat as a Comprehensive Method of Mental, Physical, and Spiritual Growth: A Systematic Review. In *Physical Education Theory and Methodology* (Vol. 24, Number 6, pp. 1015–1025). OVS LLC. <https://doi.org/10.17309/tmfv.2024.6.20>
- Nyrć, M., & Lopuszanska-Dawid, M. (2023). Physical fitness and somatic structure in adolescent taekwondo athletes and untrained peers. *Biomedical Human Kinetics*, 15(1), 63–73. <https://doi.org/10.2478/bhk-2023-0009>
- Perwirawati, D. A., Bustamam, N., Supartono, B., & Heristyorini, A. (2023). HUBUNGAN BENTUK TELAPAK KAKI FLAT FEET DENGAN VO₂ MAKS PADA ATLET PENCAK SILAT TINGKAT PROVINSI DKI JAKARTA BERDASARKAN LAMA

- LATIHAN. *Jurnal Pendidikan Jasmani Dan Olahraga*, 8(2), 172–180. <https://doi.org/10.17509/jpjo.v8i2.60065>
- Piepiora, P. A. (2025). The Health Effects of Karate Training: A Review of 21st Century Research. In *Healthcare (Switzerland)* (Vol. 13, Number 2). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/healthcare13020118>
- Pratama, T. Y. (2017). PEMBELAJARAN SENI PENCAK SILAT TERHADAP PENINGKATAN KEBUGARAN JASMANI ANAK TUNAGRAHITA SEDANG (Studi Eksperimen Terhadap Siswa tunagrahita Di SKh X Kota Serang). *Jurnal Pendidikan Dan Kajian Seni*, 2(2).
- Qasash Hasyim, M. (2026). DAMPAK PROGRAM LATIHAN FISIK PENCAK SILAT TERHADAP PENINGKATAN VO 2 MAX DAN KESEHATAN KARDIOVASKULAR PADA ATLET BKMf PENCAK SILAT FIKK UNM. In *Jurnal Ilmiah SPIRIT* (Vol. 26, Number 1).
- Rizky, A., Arifin, S., & Mulhim, M. (2025). Pengaruh Interval Training dalam Meningkatkan Vo2max pada Atlet Remaja Pencak Silat di Perguruan Nurhati Hst. *Jurnal Porkes*, 8(3), 1403–1414. <https://doi.org/10.29408/porkes.v8i3.31699>
- Rutkowski, T., & Chwałczyńska, A. (2025). The Impact of Karate and Yoga on Children's Physical Fitness: A 10-Week Intervention Study. *Applied Sciences (Switzerland)*, 15(1). <https://doi.org/10.3390/app15010435>
- Saevarsson, E. S., Rognvaldsdottir, V., Stefansdottir, R., & Johannsson, E. (2021). Organized sport participation, physical activity, sleep and screen time in 16-year-old adolescents. *International Journal of Environmental Research and Public Health*, 18(6), 1–11. <https://doi.org/10.3390/ijerph18063162>
- Saraiva, B. T. C., Tebar, W. R., Dos Santos, A. B., Antunes, E. P., Silva, S. C. B., Furuta, D. T., Ferrari, G., Delfino, L. D., & Christofaro, D. G. D. (2025). Effects of different modalities of combat sports on the motor skills of children and adolescents. *BMC Pediatrics*, 25(1). <https://doi.org/10.1186/s12887-025-05814-2>
- Stamenković, A., Manić, M., Roklicer, R., Trivić, T., Malović, P., & Drid, P. (2022). Effects of Participating in Martial Arts in Children: A Systematic Review. In *Children* (Vol. 9, Number 8). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/children9081203>
- Umarushalih, N., & Hamdani. (2022). PENGARUH SENI PENCAK SILAT TERHADAP KEBUGARAN JASMANI SISWA DISABILITAS GRAHITA (STUDI EKSPERIMEN TERHADAP SISWA TUNAGRAHITA DI SMA MUHAMMADIYAH 10 SURABAYA). <https://ejournal.unesa.ac.id/index.php/jurnal-pendidikan-jasmani>
- Vanhelst, J., Le Cunuder, A., Leger, L., Duclos, M., Mercier, D., & Carré, F. (2024). Sport participation, weight status, and physical fitness in French adolescents. *European Journal of Pediatrics*, (12), 5213–5221. <https://doi.org/10.1007/s00431-024-05796-w>
- World Health Organization. (2020). *WHO GUIDELINES ON PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR*.
- Zhao, D., Chen, X., Zhang, A., Wang, Y., Gao, Y., He, J., Jiang, L., & Zhang, Y. (2025). A study of the relationship and drivers between participation in sports program diversity and physical fitness. *Scientific Reports*, 15(1). <https://doi.org/10.1038/s41598-025-15697-z>
- Zouhal, H., Hammami, A., Tijani, J. M., Jayavel, A., de Sousa, M., Krstrup, P., Sghaier, Z., Granacher, U., & Ben Abderrahman, A. (2020). Effects of Small-Sided Soccer Games on Physical Fitness, Physiological Responses, and Health Indices in Untrained Individuals and Clinical Populations: A Systematic Review. In *Sports Medicine* (Vol. 50, Number 5, pp. 987–1007). Springer. <https://doi.org/10.1007/s40279-019-01256-w>