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Comparison Of Physical Condition Central Java PPLOP And Semarang Superior Dojo Karate Athletes In 2026

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ABSTRACT

Karate is a competitive martial art that requires optimal physical conditioning to support the effective execution of techniques, tactical performance, and competitive success. Differences in training systems may influence the physical fitness profiles of athletes. Therefore, this study aimed to analyze and compare the physical condition levels of karate athletes from the Central Java Student Sports Education and Training Center (PPLOP) and the Superior Dojo of Semarang Regency in 2026. This study employed a quantitative approach with a descriptive-comparative design. The population consisted of 30 karate athletes, including 15 athletes from Central Java PPLOP and 15 athletes from Superior Dojo. Total sampling was applied. Physical condition was assessed using standardized tests, including the sit-and-reach test, sit-up test, push-up test, 20-meter sprint, vertical jump, shuttle run, 300-meter run, and beep test. Data were analyzed using descriptive statistics and the Independent Samples t-test. The results revealed that PPLOP athletes demonstrated superior performance in most physical fitness components. Significant differences were found in sit-ups (85.13 vs. 61.47), 20-meter run (3.33 s vs. 4.04 s), vertical jump (53.33 cm vs. 39.00 cm), shuttle run (6.06 s vs. 11.11 s), 300-meter run (48.40 s vs. 58.30 s), and beep test (49.02 vs. 38.54), with significance values below 0.05. No significant differences were identified in flexibility and push-up performance. In conclusion, Central Java PPLOP karate athletes possess significantly better physical condition profiles than Superior Dojo athletes in several key biomotor components. These findings indicate that a structured and systematic athlete development system contributes positively to the enhancement of physical performance among youth karate athletes.

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INTRODUCTION

Karate is one of the most widely practiced martial arts and has developed into a highly competitive sport at national and international levels. Success in karate competitions is influenced by the integration of technical proficiency, tactical intelligence, psychological readiness, and physical conditioning (Chaabène et al., 2018; Tabben et al., 2022). Among these factors, physical condition serves as the fundamental

basis supporting the execution of karate techniques effectively during both training and competition. Athletes are required to perform explosive actions such as punches, kicks, evasive movements, and rapid changes of direction repeatedly within a short period, making physical fitness a critical determinant of performance (Gawel et al., 2025; Franchini et al., 2019). Modern karate competitions, particularly in kumite events, demand high levels of anaerobic power, agility, speed, muscular strength, flexibility, and cardiovascular endurance. Research has demonstrated that elite karate athletes possess superior biomotor abilities compared to non-elite athletes, highlighting the importance of systematic physical conditioning programs (Chaabène et al., 2018; Koropanovski et al., 2020). Furthermore, athletes with better physical fitness exhibit greater movement efficiency, reduced fatigue accumulation, and improved tactical execution throughout competitive matches (Hardiansyah et al., 2022).

Physical conditioning is especially important during adolescence, a period characterized by rapid physiological development and heightened responsiveness to training stimuli. According to the Long-Term Athlete Development (LTAD) framework, athletes aged 11–16 years are in the "Train to Train" phase, during which fundamental biomotor capacities should be developed systematically to maximize future athletic potential (Lloyd et al., 2016). Consequently, regular assessment of physical condition becomes essential for monitoring athlete development and designing evidence-based training programs. Despite the importance of physical fitness in karate performance, many athlete development programs still lack comprehensive evaluations of athletes' physical condition. In Indonesia, physical fitness assessments are frequently conducted descriptively and rarely used as a basis for comparing different coaching systems. This limitation hinders the identification of effective training models capable of producing athletes with superior physical capacities (Gati & Suyoko, 2025). Recent studies have emphasized the significant role of physical fitness in determining karate performance. Research by Chaabène et al. (2018) reported that elite karate athletes demonstrate high levels of lower-body power, agility, and anaerobic capacity, which contribute significantly to competitive success. Similarly, Tabben et al. (2022) highlighted that physical conditioning is closely associated with technical effectiveness and tactical decision-making during kumite matches.

Several studies conducted in Indonesia have revealed varying levels of physical fitness among karate athletes. Hardiansyah et al. (2022) found that karate athletes from the Riau Student Sports Education and Training Center (PPLP) generally exhibited moderate physical fitness levels. Research by Julianty and Sagitarius (2023) reported that West Java karate athletes were predominantly categorized within the moderate fitness category. Likewise, Telew et al. (2023) identified moderate physical fitness profiles among athletes from the INKAI Ponompian Dojo in North Sulawesi. Conversely, Mustofa and Sahri (2022) reported that most athletes from the INKANAS Yonda Dojo were classified in the low physical fitness category, indicating potential deficiencies in training effectiveness. In contrast, Berliana and Putra (2022) observed that male youth karate athletes aged 13–16 years in Jambi City generally demonstrated good physical

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fitness levels. Similar findings were reported in international studies, where differences in physical performance were associated with training intensity, coaching quality, and athlete development systems (Chaabène et al., 2018; Franchini et al., 2019).

Previous investigations have also demonstrated that structured training environments positively influence athletes' physical development. Sports education and training centers such as PPLOP employ systematic periodization, regular monitoring, and scientific training approaches that contribute to athlete development (Bompa & Buzzichelli, 2019). Meanwhile, club-based and dojo-based systems often emphasize individualized coaching and practical competitive experience, which may produce different physiological adaptations (Lloyd et al., 2016). These findings collectively suggest that athlete physical fitness is influenced not only by individual characteristics but also by the nature of the training system employed. Therefore, understanding differences in physical condition across coaching environments is crucial for optimizing athlete development strategies.

Although numerous studies have examined the physical fitness profiles of karate athletes, most investigations have focused on descriptive analyses within a single group of athletes (Hardiansyah et al., 2022; Telew et al., 2023; Mustofa & Sahri, 2022). Existing research primarily reports fitness levels without directly comparing athletes from different coaching systems under similar demographic conditions. Furthermore, previous studies have generally evaluated athletes from different regions, age groups, and organizational backgrounds, making it difficult to determine whether observed differences result from training systems or contextual factors. Limited empirical evidence is available regarding the comparative effectiveness of government-supported athlete development programs such as PPLOP and club-based dojo training systems. Another important limitation concerns the lack of comprehensive biomotor assessments. Many studies focus only on selected fitness components, such as endurance or strength, rather than examining multiple dimensions simultaneously, including speed, agility, flexibility, muscular endurance, and power. Consequently, a comprehensive understanding of athletes' physical condition remains incomplete.

This gap becomes increasingly important because adolescence represents a critical developmental stage in athletic preparation. Without objective comparisons based on scientific measurements, coaches may encounter difficulties in identifying strengths, weaknesses, and priorities for training intervention. Therefore, empirical studies comparing athletes from different training environments are necessary to provide evidence-based recommendations for athlete development programs. Based on the identified research gaps, this study aims to analyze and compare the physical condition profiles of Central Java PPLOP karate athletes and Superior Dojo karate athletes in Semarang Regency. Specifically, the study seeks to evaluate differences in key biomotor components, including strength, speed, agility, endurance, power, and flexibility, between athletes participating in two distinct training systems.

The novelty of this study lies in its direct comparative approach involving athletes from a government-supported elite athlete development center (PPLOP Central Java)

and a club-based dojo training environment (Superior Dojo Semarang). Unlike previous studies that merely describe fitness profiles, this research statistically examines differences in physical condition between two coaching models operating within the same regional context and age category. Additionally, this study employs a comprehensive physical condition assessment framework covering multiple biomotor components relevant to karate performance. The findings are expected to provide empirical evidence regarding the effectiveness of different athlete development systems and contribute to the formulation of more effective training programs for karate athletes aged 11–16 years.

In conclusion, physical condition represents a critical determinant of karate performance and athlete development. Previous studies have demonstrated substantial variation in physical fitness levels among karate athletes across different regions and coaching environments. However, empirical evidence comparing athletes from different training systems remains limited. This study addresses this gap by comparing the physical condition profiles of Central Java PPLOP karate athletes and Superior Dojo Semarang athletes through comprehensive biomotor assessments. The findings are expected to enrich the scientific literature on karate athlete development and provide practical recommendations for coaches, sports organizations, and policymakers in optimizing athlete training programs.

METHODS

This study employed a quantitative research approach using a descriptive-comparative design. Quantitative methods are widely used in sports science research to objectively measure physical performance variables and statistically compare differences between groups (Thomas et al., 2022). The descriptive-comparative design was selected because it enables researchers to provide a comprehensive profile of athletes' physical condition while simultaneously identifying significant differences between groups based on the same physical fitness variables (Fida & Candra, 2020). Such an approach is particularly appropriate in karate research because physical performance characteristics often vary according to training systems, coaching methods, and athlete development environments (Chaabène et al., 2018; Tabben et al., 2022). The study was conducted in 2026 involving karate athletes from two different athlete development systems in Central Java, namely the Central Java Student Sports Education and Training Center (PPLOP) and the Superior Dojo of Semarang Regency. The population consisted of 30 karate athletes, including 15 athletes from the Central Java PPLOP and 15 athletes from the Superior Dojo. The total sampling technique was employed because the population size was relatively small and all eligible athletes met the inclusion criteria (Etikan & Bala, 2017). Participants were active karate athletes aged 11–16 years, had participated in structured training programs for at least one year, and were free from injury during the data collection period. This age range was selected because it corresponds to the "Train to Train" stage within the Long-Term Athlete Development

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framework, a critical phase for the development of biomotor abilities and sport-specific performance capacities (Lloyd et al., 2016).

Data collection was conducted over two consecutive days to minimize fatigue effects and ensure optimal athlete performance during testing. Prior to testing, all participants completed a standardized warm-up lasting approximately 15 minutes under the supervision of certified coaches and researchers. Standardized testing procedures were implemented throughout the study to ensure consistency, reliability, and objectivity of the measurements (Bompa & Buzzichelli, 2019). Previous studies have emphasized that standardized physical testing protocols are essential for obtaining valid assessments of athlete performance and minimizing measurement bias (Franchini et al., 2019; Gawel et al., 2025). The instruments used in this study consisted of standardized physical condition tests recommended by the Indonesian Ministry of Youth and Sports Regulation (Permenpora No. 15 of 2024). Eight physical fitness components relevant to karate performance were assessed. Anaerobic endurance was measured using the 300-meter run test, while aerobic endurance (VO_2max) was assessed through the beep test. Abdominal muscle strength was evaluated using the two-minute sit-up test, and upper-body strength was measured through the one-minute push-up test. Flexibility was assessed using the sit-and-reach test, agility through the shuttle run test, lower-body explosive power through the vertical jump test, and speed through the 20-meter sprint test. These physical fitness components have been identified as key determinants of successful karate performance in both kata and kumite competitions (Koropanovski et al., 2020; Chaabène et al., 2018).

The collected data were analyzed using descriptive and inferential statistical techniques. Descriptive statistics included the calculation of the mean and standard deviation to summarize the physical condition profiles of both groups (Arizal, 2020). The mean was used to determine the average performance score for each physical fitness component, whereas the standard deviation was utilized to assess score variability among participants. To determine whether significant differences existed between PPLOP athletes and Superior Dojo athletes, an independent samples t-test was conducted. This statistical test is commonly used to compare the means of two independent groups and identify whether observed differences are statistically significant (Field, 2022). All analyses were performed using a significance level of $\alpha = 0.05$. The results of the statistical analysis were subsequently interpreted to evaluate the effectiveness of the respective training systems in developing the physical condition of karate athletes aged 11–16 years.

RESULTS AND DISCUSSION

Result

The purpose of this study was to compare the physical condition profiles of karate athletes from the Central Java Student Sports Education and Training Center (PPLOP) and the Superior Dojo of Semarang Regency. The comparison was conducted across eight physical fitness components that are essential for karate performance, namely flexibility, abdominal muscle endurance, upper-body strength, speed, lower-body

explosive power, agility, anaerobic endurance, and aerobic endurance. Descriptive and inferential statistical analyses were performed to determine the differences between the two athlete development systems. The complete results are presented below.

Descriptive Statistics of Physical Condition Variables

Table 1 presents the descriptive statistics of all physical fitness variables measured in both groups.

Table 1.
Descriptive Statistics of Physical Condition Variables

Variable	PPLOP Mean	PPLOP SD	Dojo Mean	Dojo SD
Sit and Reach (cm)	42.03	6.48	39.37	6.66
Sit Up (repetitions)	85.13	12.39	61.47	13.96
Push Up (repetitions)	46.67	16.43	48.47	8.19
20 Meter Run (s)	3.33	0.19	4.04	0.34
Vertical Jump (cm)	53.33	6.32	39.00	9.26
Shuttle Run (s)	6.06	0.57	11.11	1.02
300 Meter Run (s)	48.40	6.43	58.30	7.13
Beep Test (level)	49.02	4.52	38.54	6.03

The descriptive analysis demonstrates that PPLOP athletes achieved superior performance in most physical fitness components. Higher scores were observed in flexibility, abdominal muscle endurance, lower-body explosive power, and aerobic capacity. Furthermore, lower completion times in the 20-meter sprint, shuttle run, and 300-meter run indicate better speed, agility, and anaerobic endurance among PPLOP athletes. Conversely, the Superior Dojo athletes recorded a slightly higher average score in the push-up test, suggesting relatively greater upper-body muscular strength. Overall, the findings indicate that PPLOP athletes possess a more comprehensive physical fitness profile than their counterparts from the Superior Dojo.

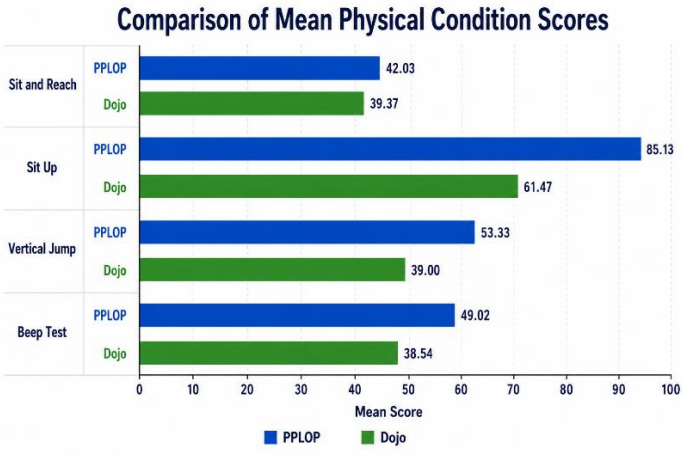

Figure 1.
Comparison of Mean Physical Condition Scores

The graphical representation clearly illustrates the dominance of PPLOP athletes in variables associated with competitive karate performance, particularly muscular endurance, explosive power, and cardiorespiratory fitness.

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Normality Test Results

Prior to conducting the comparative analysis, a normality test was performed to determine whether the data met the assumptions required for parametric statistical procedures.

Table 2.
Results of the Normality Test

Variable	PPLOP Sig.	Dojo Sig.	Description
Sit and Reach	0.860	0.546	Normal
Vertical Jump	0.121	0.526	Normal
Shuttle Run	0.792	0.036	Not Normal
300 Meter Run	0.003	0.361	Not Normal
Beep Test	0.499	0.288	Normal

The normality analysis showed that most variables were normally distributed, as indicated by significance values greater than 0.05. However, the shuttle run and 300-meter run variables exhibited non-normal distributions in one of the groups. Despite this condition, the Independent Samples t-test remained applicable because both groups consisted of equal sample sizes (n = 15), and the majority of variables satisfied the assumptions of normality. Therefore, the data were considered sufficiently robust for parametric comparison.

Homogeneity and Independent Samples t-Test Results

To determine whether significant differences existed between PPLOP and Superior Dojo athletes, homogeneity testing and Independent Samples t-tests were performed.

Table 3.
Homogeneity Test and Independent Samples t-Test Results

Variable	Homogeneity Sig.	t-Test Sig.	Interpretation
Sit and Reach	0.772	0.276	Not Significant
Sit Up	0.593	0.001	Significant
Push Up	0.341	0.707	Not Significant
20 Meter Run	0.129	0.001	Significant
Vertical Jump	0.300	0.001	Significant
Shuttle Run	0.038	0.001	Significant
300 Meter Run	0.264	0.001	Significant
Beep Test	0.129	0.001	Significant

The Independent Samples t-test revealed statistically significant differences between the two groups in six of the eight physical fitness variables assessed. Significant differences were found in abdominal muscle endurance (sit-up), sprint speed (20-meter run), lower-body explosive power (vertical jump), agility (shuttle run), anaerobic endurance (300-meter run), and aerobic endurance (beep test), all with significance values below 0.05.

These findings indicate that PPLOP athletes possess significantly better biomotor capacities than Superior Dojo athletes in several performance-related components. The largest differences were observed in agility, explosive power, and cardiovascular endurance, suggesting that the PPLOP training system may provide a more comprehensive physical conditioning program. In contrast, no statistically significant

differences were identified in flexibility (sit-and-reach) and upper-body muscular strength (push-up), indicating that both groups demonstrated relatively comparable levels in these fitness components.

Overall, the results demonstrate that Central Java PPLOP karate athletes exhibit superior physical condition profiles compared to Superior Dojo athletes in Semarang Regency. Significant advantages were identified in muscular endurance, speed, explosive power, agility, anaerobic endurance, and aerobic endurance. Only flexibility and upper-body strength showed no significant differences between groups. These findings suggest that the structured and performance-oriented training environment implemented within the PPLOP system contributes positively to the development of sport-specific physical capacities required for competitive karate performance.

Discussion

The present study aimed to compare the physical condition profiles of karate athletes from the Central Java Student Sports Education and Training Center (PPLOP) and the Superior Dojo of Semarang Regency. The findings revealed that PPLOP athletes demonstrated significantly superior performance in several biomotor components, including abdominal muscle endurance, speed, lower-body explosive power, agility, anaerobic endurance, and aerobic endurance. Meanwhile, no significant differences were found in flexibility and upper-body muscular strength. These findings confirm that differences in training systems, training supervision, and program periodization contribute substantially to the development of physical fitness among adolescent karate athletes.

The superiority of PPLOP athletes observed in this study is consistent with contemporary sports science literature emphasizing that structured athlete development programs produce more optimal physiological adaptations than conventional club-based training systems (Bompa & Buzzichelli, 2019; Cid-Calfucura et al., 2023; Xu & Wang, 2025). PPLOP athletes generally train within a highly regulated environment characterized by systematic periodization, continuous monitoring, sports science support, and performance-based evaluation systems. Such conditions enable coaches to manipulate training intensity, volume, and recovery more effectively, thereby promoting long-term athlete development (Lloyd et al., 2016; Winarni & Yogaswara, 2021).

Regarding flexibility, measured through the sit-and-reach test, no statistically significant difference was found between the two groups. Both PPLOP and Dojo athletes were classified within the "good" category. This finding suggests that flexibility training has been adequately incorporated into both training systems. Flexibility is widely recognized as a fundamental physical component in karate because effective execution of kicking techniques requires adequate range of motion in the hip, hamstring, and lower extremity musculature (Gaweł et al., 2025; Janiak et al., 2021). Previous studies reported that elite karate athletes generally possess high levels of flexibility, although flexibility alone is not always a distinguishing factor between athletes of different competitive levels (Marchenko et al., 2023). Consequently, when both groups routinely perform stretching and mobility exercises, differences in flexibility may become less pronounced.

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A significant difference was observed in the sit-up test, where PPLOP athletes demonstrated considerably higher scores than Superior Dojo athletes. This result indicates superior abdominal muscle strength and endurance among PPLOP athletes. Core muscle endurance plays a critical role in karate performance because the trunk serves as the kinetic link between the lower and upper extremities during punching and kicking actions (Luo et al., 2022). Efficient force transmission requires strong abdominal and lumbar musculature capable of stabilizing the body during explosive movements. Studies by Cid-Calfucura et al. (2023) and Bouguezzi et al. (2024) demonstrated that structured core training significantly improves balance, stability, agility, and striking performance in combat sports athletes. Therefore, the superior sit-up performance observed among PPLOP athletes likely reflects the implementation of more systematic core conditioning programs integrated into their training periodization.

Conversely, the push-up test revealed no significant difference between groups. Both groups achieved scores categorized as "good," indicating comparable levels of upper-body muscular strength. This finding supports previous investigations suggesting that general upper-body strength may not differ substantially among young combat sport athletes when similar training stimuli are provided (Cid-Calfucura et al., 2023; Morris et al., 2022). Although Dojo athletes demonstrated a slightly higher mean score, the difference was insufficient to reach statistical significance. This result suggests that both training systems emphasize upper-body conditioning to a relatively similar extent.

One of the most notable findings concerns sprint speed, assessed through the 20-meter run test. PPLOP athletes recorded significantly faster sprint times than Superior Dojo athletes. Speed is a crucial determinant of success in modern karate because competitive actions occur within extremely short time intervals and require rapid offensive and defensive responses (Tabben et al., 2022; Rezaei et al., 2024). Faster athletes possess a greater ability to initiate attacks, evade opponents, and exploit tactical opportunities. Research conducted by Xu and Wang (2025) demonstrated that sprint interval training combined with resistance exercises significantly improves short-distance speed among adolescent karate athletes. The superior speed performance of PPLOP athletes therefore suggests more effective implementation of speed-oriented training methods.

The vertical jump results further demonstrated significant differences favoring PPLOP athletes. Lower-body explosive power is one of the most important physical attributes in karate because explosive kicking techniques require rapid force production from the lower extremities (Chaabène et al., 2018; Koropanovski et al., 2020). Explosive power also contributes to acceleration, rapid directional changes, and dynamic movement transitions during competition. Previous studies reported strong associations between lower-limb power and competitive success among elite karate athletes (Marchenko & Fedotov, 2024; Xu & Wang, 2025). Consequently, the superior vertical jump performance exhibited by PPLOP athletes indicates more effective neuromuscular adaptations resulting from structured power development programs.

Agility, measured through the shuttle run test, also showed a highly significant advantage for PPLOP athletes. Agility is essential in karate because athletes must

constantly change direction, adjust body position, and respond rapidly to opponents' actions (Bouguezzi et al., 2024; Rezaei et al., 2024). Research has consistently shown that elite karate athletes outperform lower-level competitors in agility-related assessments (Gaweł et al., 2025; Marchenko et al., 2023). The excellent shuttle-run performance observed among PPLOP athletes likely reflects training programs that incorporate multidirectional movement drills, reaction exercises, and sport-specific agility development.

Significant differences were also identified in both anaerobic and aerobic endurance. The 300-meter run test demonstrated superior anaerobic endurance among PPLOP athletes, while the beep test indicated higher aerobic capacity. These findings are particularly important because karate competition relies on both energy systems. Anaerobic metabolism supports explosive high-intensity actions such as punches, kicks, and rapid movement exchanges, whereas aerobic metabolism facilitates recovery between actions and successive bouts (Franchini et al., 2019; Tabben et al., 2022). Studies have reported that athletes with higher aerobic capacity recover more efficiently and maintain technical effectiveness throughout competition (Fulvian et al., 2025; Rezaei et al., 2024). Therefore, the superior endurance profile of PPLOP athletes provides a substantial competitive advantage.

The categorization analysis further strengthens these findings. PPLOP athletes generally achieved "good" to "very good" classifications across most physical fitness components, whereas Superior Dojo athletes were predominantly categorized as "moderate" or "poor," particularly in speed and agility variables. Similar patterns have been reported in studies involving Indonesian athletes from various sports disciplines, where structured athlete development centers consistently demonstrate higher fitness profiles than conventional club-based programs (Aditya et al., 2022; Mahmudi & Irawan, 2023; Wicaksono & Hariyanto, 2021). This evidence suggests that systematic training management remains a critical factor influencing athlete performance development.

The superiority of the PPLOP system can also be explained through the principles of Long-Term Athlete Development (LTAD). Athletes aged 11–16 years are in a highly sensitive developmental period characterized by rapid neuromuscular adaptation and physiological growth (Lloyd et al., 2016). During this phase, scientifically designed training programs can significantly accelerate improvements in biomotor capacities. PPLOP's structured approach, supported by periodic evaluation and performance monitoring, appears better aligned with LTAD principles than traditional dojo-based training models. Furthermore, these findings support the implementation of the Indonesian Ministry of Youth and Sports Regulation Number 15 of 2024, which emphasizes the importance of systematic physical fitness evaluation as a foundation for athlete development. Regular assessment of speed, strength, flexibility, agility, power, and endurance provides objective information for coaches in designing evidence-based training interventions. The present findings demonstrate that athletes participating in training systems characterized by systematic evaluation and structured conditioning tend to achieve higher physical performance standards than athletes training in less regulated environments. Overall, this study provides strong empirical evidence that the Central Java PPLOP training system is more effective

in developing the physical condition of adolescent karate athletes than the Superior Dojo training system. The significant advantages observed in muscular endurance, speed, explosive power, agility, anaerobic endurance, and aerobic endurance highlight the importance of structured training programs, systematic periodization, sports science integration, and continuous performance monitoring. These findings contribute to the growing body of literature emphasizing the critical role of scientifically based athlete development systems in enhancing competitive performance among young karate athletes and may serve as a reference for coaches, sports institutions, and policymakers seeking to optimize karate athlete development programs in Indonesia.

CONCLUSION

on profile of Central Java PPLOP karate athletes is generally superior to that of Superior Dojo Semarang Regency athletes across most biomotor components. Descriptive and inferential analyses revealed significant differences in abdominal muscular endurance, speed, lower-body explosive power, agility, anaerobic endurance, and aerobic endurance. PPLOP athletes achieved higher mean scores in the sit-up test (85.13 vs. 61.47), vertical jump (53.33 cm vs. 39.00 cm), beep test (49.02 vs. 38.54), and demonstrated faster performances in the 20-meter sprint (3.33 s vs. 4.04 s), shuttle run (6.06 s vs. 11.11 s), and 300-meter run (48.40 s vs. 58.30 s). In contrast, flexibility and upper-body muscular strength showed no statistically significant differences between the two groups, indicating relatively similar levels of performance in these components.

These findings provide empirical evidence that a structured, systematic, and performance-oriented athlete development system, such as that implemented by the Central Java PPLOP, contributes positively to the enhancement of physical fitness among youth karate athletes. The study also highlights the importance of periodic physical condition assessments as a scientific basis for designing effective, individualized, and sport-specific training programs. Future research should involve larger sample sizes, separate analyses based on gender and competition level, and incorporate physiological, nutritional, and psychological variables to obtain a more comprehensive understanding of karate athlete development and performance optimization.

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