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Research article

Physical Performance Profiles of Junior Hapkido Athletes in West Sumatra: Comparative Insights with National-Level Standards

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Abstract: This study aims to present a comprehensive analysis of the physical abilities of junior athletes who are being prepared for the elite level in West Sumatra Province, Indonesia. Using a quantitative descriptive design with a survey approach, this study involved 36 athletes selected purposively (18 boys aged 9–17 years and 18 girls aged 9–16 years). Five national standard measurement instruments were used to evaluate the main components of physical fitness: agility (T-test), flexibility (flexiometer), leg muscle strength (leg dynamometer), abdominal muscle endurance (Sit-Up Test), and cardiorespiratory endurance (Bleep Test). The Shapiro–Wilk normality test ($p = 0.821 > 0.05$) confirmed the normal distribution of the data. The results of the analysis showed contrasting profiles between male and female athletes male athletes excellent in leg muscle strength (100%) but were weak in agility (83% low), while female athletes showed better flexibility (44% good) but low cardiorespiratory endurance (61% poor). Overall, 39% of athletes were classified as good and 61% as adequate, indicating a moderate level of fitness with significant potential for improvement. These findings emphasize the urgency of implementing targeted, evidence-based training programs to optimize agility, flexibility, and aerobic capacity as the foundation for elite-level performance.

Keywords: Athletes' Physical Condition, Hapkido, Martial Arts, Junior Athletes

1. Introduction

The development of martial arts in Indonesia shows a positive trend, marked by increased participation of young athletes in national and international competitions as part of ongoing performance development [1]–[5]. One martial art that requires multi-component readiness is Hapkido, a martial art that emphasizes a combination of attack and defense techniques (punches, kicks, locks, throws). A Hapkido athlete is required to have specific physical conditions consisting of neuromuscular capacity (speed, explosive power, core strength), metabolic endurance, and anthropometric characteristics that support range and movement efficiency [6]–[8]. Studies on combat sports consistently show that differences between sports and competition levels are closely related to the anthropometric profile and fitness of athletes, which form the basis for the selection process and the design of evidence-based training programs [9], [10]

In the junior athlete development stage, biological growth and maturation strongly influence physical indicators such as height, body composition, strength, explosive power, speed, and agility, with research consistently showing a significant correlation between maturity levels, anthropometric parameters, and overall physical performance [11]–[14]. This highlights the need for an analytical approach that accounts for maturity variables to ensure valid comparisons between junior and elite athletes, while also considering weight management strategies, which are crucial for optimal martial arts performance. Research by [15], indicate that rapid weight loss (RWL) of ≤5% within seven days is a common practice in martial arts and does not always impair strength or endurance, yet research [16], highlights the physiological and psychological risks, particularly for young athletes, underscoring the importance of safe weight management strategies along with proper nutrition and hydration education in performance coaching. BMI provides a general overview of weight relative to height, but in athletes it should be interpreted carefully since it cannot distinguish muscle from fat; nonetheless, comparisons between levels (e.g., junior vs. national athletes) can serve as a screening tool if supplemented with fitness or body composition data."

Mechanical and tactical factors are closely related to martial arts such as Hapkido, with studies on teenage Taekwondo athletes highlighting spinal muscle strength as a foundation of fitness [17], while other research emphasizes the importance of specific functional fitness beyond general measures [18]. Fitness profiles of elite athletes can serve as external benchmarks, providing data to identify performance gaps and guide exercise interventions [19], and the availability of national fitness data enables coaches to systematically assess athletes across competition levels relative to elite standards [20]–[23].

In Indonesia, particularly in West Sumatra, the martial arts training ecosystem receives programmatic support through multi-branch events, opening up opportunities for the integration of data-based talent identification and development at the regional level, aligned with national standards [24]. The availability of organized data on the physical condition and body proportions of local junior athletes will accelerate coaches' decision-making in advancing junior athletes to the national training center (elite category) in a measured manner [25], [26]. Therefore, national athlete preparation policies and cycles need to be intensively geared toward multi-event agendas, so that they can become up-to-date national benchmarks [24], [27]. This data is important for calibrating or adjusting athlete development targets at the regional/local level, so that they are in line with national standards.

This study addresses the limited quantitative research on Hapkido for athletes aged 12–18 in Indonesia [28], [29]; unlike martial arts such as Taekwondo, Judo, and Karate, which have explored the relationships between anthropometry, fitness, and performance, Hapkido studies remain scarce [30]–[36]. While insights from other martial arts can provide a starting point, their application requires caution due to differences in techniques, attack intensity, and scoring [37]. Evidence-based coaching that links basic physical data (height, weight, BMI) with key fitness components sprint speed (≤10 m), jumping ability, change of direction, and core strength is crucial [38]. Coaches must also consider athletes' developmental stage and implement safe, age-appropriate weight management strategies. This approach aims to establish a scientific foundation for training young Hapkido athletes in Indonesia more effectively and sustainably.

Based on this background, this study focuses on mapping and comparing body profiles such as anthropometric indicators, body mass and BMI, as well as the physical condition of junior Hapkido athletes in West Sumatra with data on national-level athletes. Practically, this analysis has three main objectives: (1) to provide an initial overview of the body and fitness indicators of junior athletes at the regional level, (2) to see the extent of differences or gaps with national standards, as an important foundation for preparing athletes for the elite level, (3) to develop more specific and targeted training recommendations as a way to maximize athlete performance. The results of this study are expected to enrich sports development data in the region, assist in the selection process and planning of safer and more effective training, and contribute scientific evidence from the Indonesian context to expand the international literature in the field of martial arts.

1. Materials and methods

Research Design

This study uses a quantitative descriptive method with a survey approach [39]. This method is used to objectively describe the physical abilities of athletes based on the results of a series of performance tests that have been conducted. The descriptive approach was chosen because this study does not aim to find a cause-and-effect relationship, but rather to provide a realistic picture of the physical condition of junior athletes who are being prepared to become elite athletes in West Sumatra.

Subjects of study

The population of this study consisted of all junior Hapkido athletes participating in the sports coaching program in West Sumatra. A purposive sampling method [40], was used to select 36 athletes based on age criteria and active participation in regular performance training, including 18 male athletes aged 9–17 years and 18 female athletes aged 9–16 years. The age range difference between male (9–17 years) and female athletes (9–16 years) reflects the actual composition of participants, with fewer older female athletes actively training; this difference is not expected to substantially affect comparability, as analyses focus on performance profiles within each gender.

All participants were physically fit to perform the tests. It should be noted that, due to the limited sample size and the focus on a single region, the findings may not be generalizable to all junior Hapkido athletes in Indonesia. Therefore, the results should be interpreted as providing preliminary insights into the physical performance profiles of junior athletes in this specific context.

Research Instruments

The instruments used in this study consisted of several tools and tests to measure physical condition, namely:

a. *Agility Test*
   Using the T-Test to assess the ability to move quickly forward, sideways, and backward. Scores were recorded in units of time (seconds) and classified into five categories (Excellent to very poor).
b. *Flexibility Test*
   Using a Flexiometer to measure joint range of motion. The use of this tool is based on its high validity and reliability in measuring flexibility [41].
c. *Leg Strength Test*
   Performed using a Leg Dynamometer on athletes over 15 years of age. This test assesses maximum leg muscle strength and the results are categorized based on international standards [42].
d. *Sit-Up Test*
   Used to measure abdominal muscle strength and endurance. Test results are expressed in repetitions per minute and categorized from Excellent to very poor [43].
e. *Bleep Test (Multi-Stage Fitness Test)*
   Used to assess cardiorespiratory endurance (VO_2max). Athletes run back and forth 20 meters following the tempo of the “bleep” sound, which gets faster and faster. The final level and stage reached becomes the final score.

Research Procedure

The research was conducted in several stages. First, preparation was carried out, including coordinating with coaches and club officials and determining the test schedule according to the athletes’ regular training times. Before testing, all procedures were explained to the athletes to ensure understanding, safety, and proper technique. The tests were conducted at the Faculty of Sports Science UNP field, which served as a laboratory for physical measurements. A team of trained testers, who received prior instruction on standardized testing procedures, administered all tests. All measuring instruments, including the Leg Dynamometer and flexibility devices, were calibrated before and during the testing period to ensure accuracy. Athletes were provided with **rest intervals of 3–5 minutes between different tests** to minimize fatigue and avoid its impact on performance results. Environmental conditions such as temperature, humidity, and surface stability were monitored and kept consistent throughout testing sessions. Data from each test were recorded on individual observation sheets and subsequently entered into a statistical program for further analysis. These detailed procedures were implemented to ensure the reliability, validity, and replicability of the testing protocol

Analyzes Data
The data obtained was analyzed using the following steps:

a. *Data Normality Test*
The Shapiro-Wilk test was used because the sample size was less than 50. The results showed that the data was normally distributed ($p = 0.821 > 0.05$), so descriptive analysis could be performed.

b. *Descriptive Analysis*
Each test result was categorized based on standard assessment norms. The analysis was conducted to obtain: the average score and percentage of each component category (agility, flexibility, strength, sit-ups, bleep test). Distribution of results by gender (male and female). Classification of the athletes' total ability based on their overall score (Excellent, Good, Fair, Poor, Very Poor).

Instrument Validity and Reliability

The instruments used refer to standards for measuring athletes' physical condition that have been validated by previous studies, including: Leg Dynamometer Test [42], Sit-Up and Bleep Test [43]. The reliability test results from previous studies showed a Cronbach's Alpha value > 0.8, so all instruments were declared reliable for measuring the variables in this study.

Research Ethics

Before the test, the researchers explained the purpose and procedure of the study to all participants. Participating athletes gave their informed consent and were assured that their data would remain confidential.

2. Results

The results of the research obtained are presented in the following description:

Normality Test

Table 1. Normality Test

	Shapiro-Wilk		
	Stand	**Df**	**Sig.**
Athlete Ability	0.968	36	0.379

Based on the results of the assumption test, the researcher used the Shapiro Wilk test to see whether the data was normally distributed or not. The Shapiro Wilk test was used because the number of subjects in this study was 36 people < 50. In this study, the data was normally distributed with a significance value of 0.379 > 0.05. When the assumption test was accepted, further testing could be carried out. The following is a graph showing the data distribution

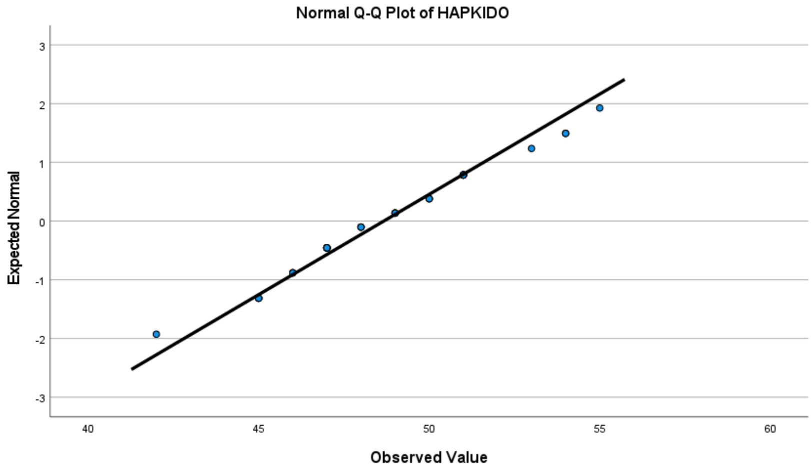

Figure 1. Grafik Persebaran Data

Subject Description

Based on the results of tests conducted to measure the physical performance of junior athletes who are being prepared to become elite athletes in West Sumatra, the characteristics of the research subjects are as follows:

Tabel 2. Deskripsi Subjek

Gender	Ages	Sum
Male	9 - 17 years old	18
Female	9 – 16 years old	18
Total		**36**

Based on the results of tests conducted to measure the physical performance of junior athletes who are being prepared to become elite athletes in West Sumatra, the following characteristics of the research subjects were obtained:

Agility Test

From the descriptive test above, after determining the gender, age, and gender of the athletes, an agility test was conducted. For the first test, a T-Test was used to measure agility, which aims to see a person's ability to move quickly forward, sideways, and backward to form a "T" shaped path. In this test, the subjects were divided into two categories, namely male and female. The agility level of both male and female athletes was determined using a category classification based on the time scores obtained.

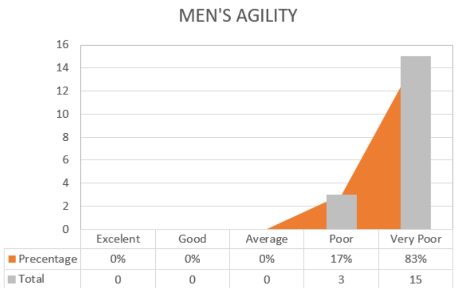

Figure 2. Male Agility Test Categorization Chart

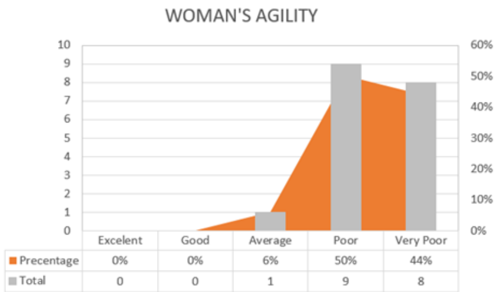

Figure 3. Female Agility Test Categorization Chart

The agility test results for 18 male athletes showed that 3 athletes were categorized as having low agility, while the remaining 15 athletes (83%) were in the very poor category (Figure 2). For the 18 female athletes, one athlete was in the average category, 9 athletes (50%) were in the poor category, and 8 athletes (44%) were in the very poor category (Figure 3). Overall, these results indicate that the majority of both male and female participants exhibited low levels of agility, highlighting the need for targeted training interventions to improve this key physical component.

Flexibility Test

To test athletes' flexibility, researchers used a flexiometer as a measuring tool. The flexiometer was chosen because it provides more objective and standardized results in assessing the range of motion of athletes' joints [41]. This flexibility test aims to determine how good the elasticity of the muscles and range of motion of the joints are in athletes, as these aspects are very important in supporting athletic performance, especially in sports that require high flexibility.

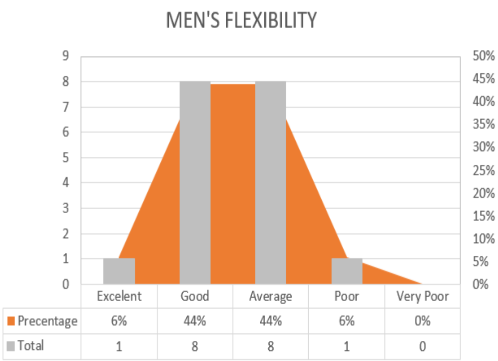

Figure 4. Male Flexibility Test Categorization Chart

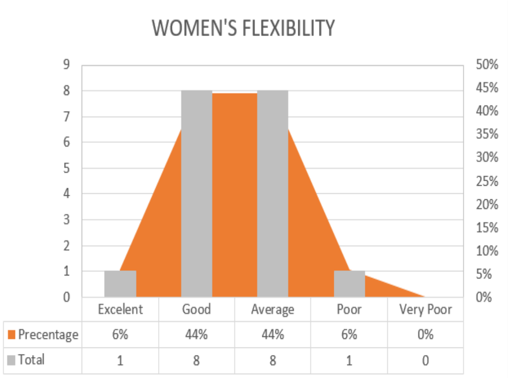

Figure 5. Female Flexibility Test Categorization Chart

The results of the flexibility tests indicate differences between male and female participants. Among male athletes, none scored in the excellent category (0%), one athlete (6%) was in the good category, six athletes (33%) were in the average category, five athletes (28%) were in the poor category, and six athletes (33%) were in the very poor category (Figure 4). Overall, the majority of male participants fell into the moderate and very poor categories, indicating that flexibility levels among males in the study group were generally low. In contrast, female athletes showed better flexibility, with one athlete (6%) in the excellent category, eight athletes (44%) each in the good and average categories, and one athlete (6%) in the poor category, while none were in the very poor category (Figure 5). These results suggest that most female participants had adequate flexibility, predominantly in the good and moderate categories, although a small number still required improvement to reach higher levels of flexibility.

Strength Test

Strength tests were conducted only on junior athletes over the age of 15 using a Leg Dynamometer, which measures maximum leg muscle strength [42]. This test is important because leg strength supports key performance aspects such as thrust, jumping, and body stability [44], [45]. Athletes performed the test by pulling the Leg Dynamometer handle using the correct and stable body position, and results were recorded in kilograms and classified according to established assessment norms.

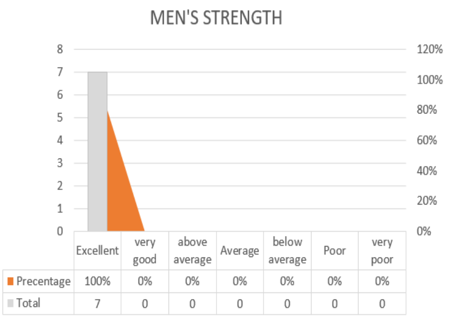

Figure 6. Male Strength Test Categorization Chart

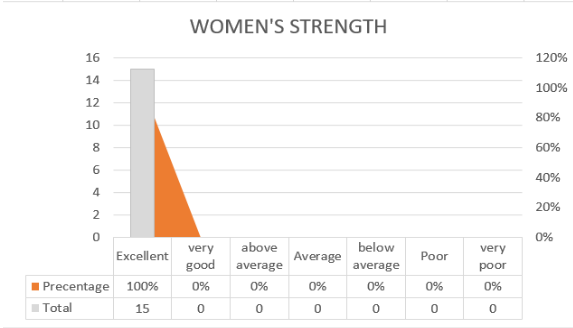

Figure 7. Female Strength Test Categorization Chart

The results showed that all male athletes over 15 (7 athletes, 100%) and all female athletes over 15 (15 athletes, 100%) fell into the excellent category. This uniformity likely reflects a combination of factors: first, the tested subgroup represents the most advanced athletes who had been actively training for several years, resulting in high strength levels; second, the Leg Dynamometer may have a ceiling effect for this age group, meaning it cannot differentiate above a certain threshold; and third, the assessment norms used may be relatively low compared to the actual strength levels of these athletes. Therefore, while the results confirm that the athletes demonstrate very strong leg muscle strength, caution is advised when interpreting these findings, and future assessments may require more sensitive instruments or additional tests to better capture variations in high-level strength.

Sit Up Test

The sit-up test is used to measure the strength and endurance of athletes' abdominal muscles. This test is important because the abdominal muscles play a major role in maintaining body stability, supporting explosive movements, and improving athletes' performance in various sports [43].

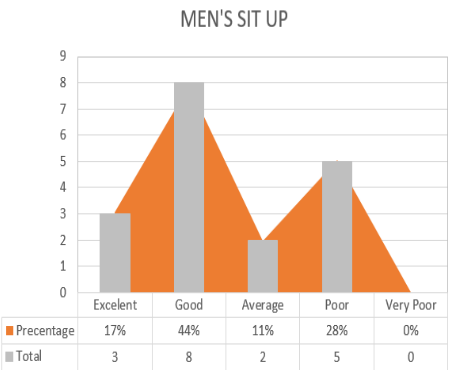

Figure 7. Male Chart Category Sit Up

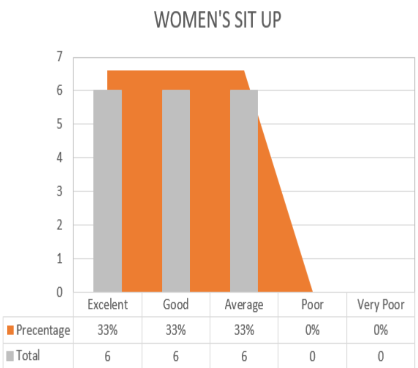

Figure 8. Female Chart Category Sit Up

Based on the results of the sit-up test for male athletes, it appears that most athletes are in the good category, namely 8 people (44%). Furthermore, there are 3 athletes (17%) who are in the excellents category, indicating excellent endurance and abdominal muscle strength. Two athletes (11%) were in the average category, while 5 athletes (28%) were in the poor category. No athletes were in the very poor category. Based on the bar and line diagrams of the male sit-up test results, it can be seen that most athletes were in the good category, namely 8 people (44%). This shows that the majority of male athletes have good abdominal muscle strength and endurance.

Based on the results of the sit-up test for female athletes, the distribution of test results shows a balanced distribution across the three main categories. A total of 6 athletes (33%) were in the excellent category, 6 athletes (33%) in the good category, and 6 athletes (33%) in the average category. No athletes fell into the poor or very poor categories, with a percentage of 0% each. The bar and line diagrams show a fairly even distribution between the very good, good, and average categories, indicating that the majority of female athletes have abdominal muscle strength at a good to excellent category, with the rest at a average category.

Bleep Test

The bleep test is used to measure an athlete's cardiorespiratory fitness or aerobic endurance. This test is conducted by running back and forth to the sound of increasingly rapid bleeps over a certain distance (usually 20 meters). Each time a bleep sounds, the participant must reach the line before the next bleep sounds. If the participant fails twice in a row, the test is stopped and the last level reached is recorded as the result.

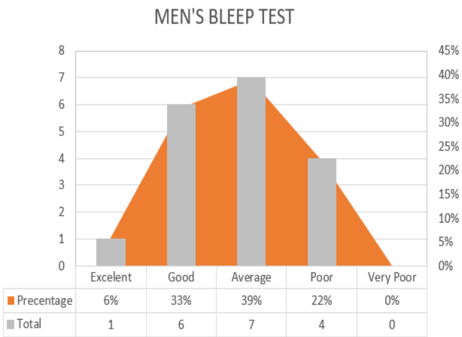

Figure 9. Male Bleep Test Categorization Chart

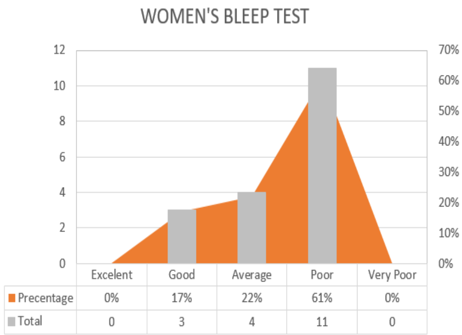

Figure 10. Female Bleep Test Categorization Chart

Based on the results of the Bleep Test administered to 18 male athletes, the following results were obtained: 1 person (6%) was in the excellent category, 6 people (33%) were in the good category, 7 people (39%) were in the average category, and 4 people (22%) were in the poor category, while no athletes were in the very poor category. These results indicate that the majority of male athletes are in the moderate and good categories, suggesting that their cardiorespiratory fitness is quite good but still needs improvement to reach the excellent category.

Based on the results of the Bleep Test on 18 female athletes, the following results were obtained: no athletes (0%) were in the excelent category, 3 athletes (17%) were in the good category, 4 athletes (22%) were in the Moderate category, and the majority, namely 11 athletes (61%), were in the poor category. while none of the athletes (0%) were in the very poor category. These results indicate that most of the female athletes were in the poor category (61%), indicating that their cardiorespiratory fitness was relatively low compared to the standard, while only a few were able to be in the good category (17%). This categorization is used as a reference to assess the physical abilities and skills of athletes. With this classification, the quality of an athlete's performance can be determined, which then becomes the basis for deciding on an appropriate training program to improve their abilities. From the table, it can be concluded that:

Table 3. Summary of All Test Data

Category	Score	Percentage
Excelent	0	0%
Good	14	39%
Average	22	61%
Poor	0	0%
Very Poor	0	0%
Total	**36**	**100%**

Based on the results of five performance tests conducted on 36 athletes, the overall ability levels were classified. According to the categorization table, no athletes fell into the excellent, poor, or very poor categories. Fourteen athletes (39%) were classified as good, while 22 athletes (61%) were in the average category. These results indicate that most athletes possess sufficient ability to perform their duties and activities; however, there is still potential for improvement to increase the number of athletes reaching the good or excellent categories, highlighting areas for targeted training and development. To strengthen the descriptive comparison, effect sizes (Cohen's d) were calculated to quantify gender differences for each physical test. These values provide a clearer interpretation of the magnitude of differences between male and female athletes [46].

3. Discussions

The results of this study indicate that most junior athletes have adequate physical abilities (61%), while the rest are in the good category (39%). No athletes reached the excellent category, indicating that their physical fitness levels still need to be improved to achieve optimal performance standards. These findings illustrate that athletes have adequate basic fitness levels for youth-level competition, but still require significant improvement, particularly in several aspects of physical performance. This aligns with findings by [47] and [48], which indicate that adolescents generally show moderate levels of agility, flexibility, and endurance due to ongoing biological maturation and limited exposure to high-intensity training. According to the LTAD framework [49], this developmental stage should prioritize fundamental motor and multilateral skills before specialization. Therefore, the results of this study provide a useful basis for coaches to design structured, age-appropriate training programs that follow principles of long-term development, physiological adaptation, and progressive loading.

The results of this study show that young Hapkido athletes exhibit strong leg muscle strength and good core endurance, yet display weaknesses in agility, flexibility, and aerobic capacity. Most male athletes (83%) were in the "very poor" agility category, while 94% of female athletes fell below "moderate," indicating limited neuromuscular coordination. These findings align with studies showing that SAQ and reactive agility training can effectively improve change-of-direction ability in youth athletes [50], [51]. Flexibility results also showed a clear gender difference, with females demonstrating higher joint mobility, consistent with anatomical and hormonal explanations described in previous studies [52], [53]. Meanwhile, all athletes over age 15 reached the "excellent" category in leg strength, likely due to repeated exposure to explosive Hapkido movements such as jumping, running, and kicking, which is consistent with evidence on the benefits of plyometric and resistance training for neuromuscular strength [54]. However, the imbalance between high strength and poor agility supports the argument that maximum strength must be converted into functional coordination through targeted motor-transfer training [55]. Core endurance was generally good, in line with findings that training frequency and physiological factors contribute to better abdominal muscle endurance in young athletes [56]–[58].

In contrast, aerobic endurance showed considerable limitations, particularly among female athletes, 61% of whom were in the "poor" category. This sex difference is consistent with meta-analysis findings reporting higher VO_2max values among boys compared to girls due to physiological and hormonal factors beyond body size alone [59], [60]. Given that Hapkido performance requires a combination of strength, power, and endurance, the literature emphasizes that plyometric training, strength-endurance development, and core stability are essential to maintain performance under fatigue and support complex kicking and throwing techniques [61]–[65]. Overall, the observed profile high strength but low agility, flexibility, and aerobic fitness reflects a common developmental imbalance in adolescents, where training often prioritizes strength over motor skill development [66]. Therefore, a more holistic long-term training model is needed, integrating reactive neuromuscular training, dynamic mobility, endurance circuits, and progressive load periodization, supported by objective athlete monitoring systems such as wearable tracking technology [67].

The integration of technology into the training process can help coaches adjust training intensity in real time and optimize athletes' recovery cycles. Overall, the results of this study confirm that although athletes have demonstrated adequate physical potential, performance improvements can only be achieved through measurable, continuous, and scientifically-based training programs. Research findings related to the importance of technology integration and predictive approaches in athlete training [68], reported that they had successfully predicted athlete performance by combining physiological, psychological, and training data through machine learning. Meanwhile, the study [69], shows that consumer wearable devices are suitable for longitudinal use in monitoring the biomechanical and physiological variables of junior athletes. Furthermore, a review by [70] and [71], emphasizes that real-time data and continuous monitoring of training load are crucial in coaches' decision-making to adjust training intensity and recovery cycles in order to achieve long-term adaptation.

It should be noted that biological maturation was not measured in this study (e.g., PHV or skeletal age), although it is known to significantly influence strength and endurance. Therefore, some variation in physical performance among athletes of the same chronological age may reflect differences in biological maturity. A major limitation of this study is the lack of officially published national standards for junior Hapkido athletes. Consequently, the findings should be regarded as an initial reference, providing preliminary empirical data that can serve as a foundation for developing standardized and measurable physical performance norms in Indonesia.

4. Conclusions

The results of this study indicate an imbalance in the physical abilities of junior athletes, characterized by high muscle strength but relatively low agility, flexibility, and aerobic endurance. Most athletes fall within the "fair/enough" (61%) and "good" (39%) categories, with none achieving the "excellent" level. In this study, the classification "fair/enough" refers to performance that meets only the minimum functional standards for junior athletes typically equivalent to 40–59% of the expected national readiness level or normative performance benchmarks. This classification reflects basic competency but indicates that athletes are not yet prepared to meet the demands of higher-level competitive performance. Therefore, these results reinforce the need for a more systematic and evidence-based training approach aligned with long-term athlete development principles. The use of performance monitoring technologies such as wearable sensors and force tracking systems is also recommended to help coaches monitor individual progress objectively, prevent overtraining, and adjust training loads in real time. Overall, this study emphasizes the importance of a multi-component and integrative approach in coaching young athletes, where strength development must go hand in hand with improvements in agility, flexibility, and endurance. Only through the synergy between these components can coaches ensure optimal, sustainable physical development that is relevant to the demands of modern sports performance.

Training implications for young Hapkido athletes can be summarized more succinctly by emphasizing a structured and developmentally appropriate approach. Game-based conditioning such as relay sprints, agility-tag activities, simple medicine-ball challenges, and reaction-focused balance games provides an effective way to develop strength, endurance, coordination, and reaction ability without creating psychological overload. These activities may be complemented by age-appropriate

HIIT formats, basic agility and change-of-direction drills, and low-impact plyometric exercises to enhance neuromuscular and cardiorespiratory fitness. All training components should follow progressive overload and individualized monitoring to ensure that intensity aligns with each athlete's maturation level. This structured approach supports functional fitness, enjoyment, and long-term performance readiness in young Hapkido athletes.

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Conflicts of Interest: The authors declare no conflict of interest.

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