





Innovation in physical testing equipment for karate junior kumite category

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ABSTRACT

Background Problems: The lack of instruments suited to the unique needs of karate athletes in the junior Kumite category poses a significant challenge. **Research Objectives:** This study aims to develop a physical testing tool specifically designed to measure the physical abilities of junior athletes in the Kumite category. **Methods:** The research method used developmental research to test the effectiveness of the product in the form of a karate physical test instrument. The data analysis was obtained from the results of interviews, observations, field notes, and describes the percentage of success of the trial product both in terms of process and research results starting from the planning, implementation, reflection, evaluation stages in the form of psychomotor, affective, cognitive data, and physical test results. Furthermore, the data from the physical test results were analysed using SPSS version 23 statistical techniques to identify the relationship between physical test results and performance in Kumite. **Findings and Results:** The results of this study indicated that the newly developed physical test instrument can provide a more specific measurement of the physical abilities of junior karate athletes in the Kumite category. In addition, the results also provided greater insight into the physical factors that influence performance in Kumite matches. By providing a more effective tool and increasing the understanding of the relationship between physical attributes and competitive performance. **Conclusion:** The implication of this study is that a scientific approach using physical measures provides a valuable contribution to the development of a selection system and the coaching of junior karate athletes. Thus, this study makes an important contribution to the development of the performance of junior karate athletes and improves the efficiency of their selection and coaching processes.

Keywords: Innovation; physical testing; junior karate; kumite category



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INTRODUCTION

Good physical condition, technique, tactics, and mental strength are required to achieve performance in sport (Gröpel et al., 2016; Van Yperen, 2022; Yukhymenko-Lescroart, 2023). Optimal physical condition is

very important for athletes to master techniques well. Physical condition is an absolute prerequisite for an athlete to achieve and improve maximum sport performance (Foo et al., 2023; Schütz et al., 2023; Sprong et al., 2023). Therefore, all aspects of physical condition must be developed and improved according to the characteristics and needs of each sport. Physical condition is a unity consisting of different components that cannot be separated from each other and must be properly improved and maintained (Cuesta-Gómez et al., 2022; Kızılay & Cengiz, 2023). Optimal physical condition is very important because it plays a crucial role, especially in a match that requires a lot of energy (García-Rico et al., 2021; Jackman et al., 2021). A karate athlete must be in excellent physical condition in order to perform satisfactorily during the match.

Specific components of physical condition in karate include reaction speed, arm strength, abdominal muscle strength, leg muscle explosiveness, and flexibility (Vuković et al., 2021; Zhang et al., 2018). Physical testing in competitive sports is rare, so it is necessary to evaluate physical testing tools for the athlete selection process. Physical condition is the most important capital in any game besides technical ability (Fares et al., 2022; Pezoa-Fuentes et al., 2023; Zhang, 2021). The physical component is used as a systematic and planned evaluation to make decisions based on measurements and assessments (Chen & Zhu, 2022; Robinson, 2023). Coaches tend to focus on evaluating technique and physical condition, while the selection of testing instruments is based on experience or even ignored. Therefore, the knowledge of the physical condition in the sport is very important and the existence of measuring instruments is absolutely necessary. Measurement tools for conducting assessments can be in the form of physical test instruments performed by athletes (Sofiyana et al., 2022).

When developing physical tests for junior karate, several fundamental aspects need to be considered (Zhu et al., 2017). Physical testing focuses on measuring the basic technical skills of junior athletes before they progress to the next level. Physical aspects such as strength, flexibility, endurance, and coordination must also be assessed to ensure that athletes have a strong physical foundation (Avers, 2020; Warreman et al., 2023). The physical test should also include an assessment of mental factors such as concentration, focus and self-control, which are essential skills in karate (Harris & Bray, 2023; Vella et al., 2023). A progressive approach allows athletes sufficient time to master each level before moving on to the next. Inclusivity and the specific needs of each athlete must be considered to provide constructive feedback in the development of personalisation. Physical tests should be adaptable to the physical and emotional changes that pupils experience as they grow and develop. Regular assessments are needed to monitor the athlete's progress and provide additional guidance to energise and motivate them during training (Satria et al., 2023). As a holistic approach that includes various physical, mental and ethical aspects, the Junior Karate Physical Test can be an effective tool to measure the progress and level of physical condition of athletes. This research is important because it contributes to the development of physical tests specifically for the Kumite category among junior karateka. A good physical test will help coaches and athletes to measure and improve their physical performance, which is an important factor in sports performance.

Recent research has emphasised the development of more precise and accurate physical assessment methods specifically for junior karate athletes. It is important to ensure that physical testing can provide an accurate picture of the physical capabilities of these young athletes so that training programmes can be designed in a more targeted and effective manner. In addition, recent research has investigated specific physical factors that have a significant impact on performance in Kumite fights, and this study aims to determine the physical and physiological characteristics of international karate athletes (Arazi & Izadi, 2017). The results show that karate athletes have tall bodies, long arm spans, low body fat, mesomorphic bodies, good aerobic capacity, excellent muscular strength and high flexibility. This may include aspects such as speed, strength, agility and endurance, all of which are important elements in karate (Fares et al., 2022; Smith et al., 2021; Wilcock et al., 2021). By understanding more about these factors, coaches can develop more targeted and adaptive training strategies to improve junior athletes' performance in Kumite competition. As such, this research has great potential to make a positive contribution to coaching and improving the performance of young karate athletes at a competitive level.

Karate, as a sport, demands a thorough understanding of the athlete's physical abilities, especially in the Kumite category, where quick reflexes, agility, and strength play an important role. Although physical testing instruments already exist, there is still a gap in the development of tools specifically designed for junior karate athletes involved in Kumite. Previous studies (Setiawan et al., 2022; Hardiansyah, 2018; Yoda et al., 2021; Rajagukguk & Putra 2022) have shown that current tools aren't perfect and can't accurately predict how well someone will do in Kumite matches. While some studies offer insights into the physical elements important for Kumite (Yoda et al., 2021), a comprehensive evaluation of physical testing instruments and the identification of critical areas for improvement are still needed. Furthermore, the lack of instruments tailored to the unique needs of junior athletes in Kumite poses a significant challenge. Thus, the urgent need for new physical testing equipment designed specifically for this demographic becomes apparent.

Existing research mainly focuses on general physical testing instruments for karate athletes and is less specific to the junior Kumite category. The absence of customised tools results in an inadequate assessment of important physical attributes pertinent to junior Kumite competitors. Therefore, there is an urgent need to bridge this gap by developing innovative physical testing equipment aimed specifically at junior karate athletes involved in Kumite. This research introduces a novel approach by designing and validating a physical testing instrument specifically designed for junior athletes participating in the Kumite category. By addressing the shortcomings of existing instruments and incorporating insights from previous research (Yoda et al., 2021; Rajagukguk & Putra 2022), this study pioneered the development of a more accurate and relevant tool. Through rigorous validation procedures, including validity and reliability analyses, this research ensures the effectiveness and credibility of the proposed instrument.

In conclusion, this study sought to fill the existing gap in physical testing equipment for junior karate athletes in the Kumite category. By introducing specific instruments, this study aimed to develop a physical testing tool specifically designed to measure the physical abilities of junior athletes in the Kumite category to improve the accuracy of physical fitness assessment, deepen the understanding of performance factors in Kumite, and facilitate targeted training programmes. Ultimately, the results of this study hold significant promise for improving the performance and competitiveness of junior karate athletes in Kumite matches.

METHOD

This is a physical test instrument specifically developed to measure various aspects of the physical abilities of athletes in the Kumite category. The instrument was designed with validity, reliability, availability of tools, and ease of administration in mind. It has been created to measure the physical abilities of junior karate athletes in the Kumite category effectively and accurately, in accordance with research needs. This study used the research and development (R&D) method (Arifin, 2018). The research design was prepared to develop a special physical test instrument to be used in evaluating the physical abilities of junior karate athletes in the Kumite category. The population consisted of karate athletes in Palembang City in the junior karateka category (aged 16-17 years), a total of 85 athletes. The research sample used purposive sampling consisting of a small sample of 30 male athletes and 15 female athletes, and a large sample of 60 male athletes and 25 female athletes. Data measurement involved the use of physical test instruments specifically designed and developed to measure various aspects of the physical abilities of athletes in the Kumite category (Donie et al., 2022). Data analysis was obtained from the results of interviews, observations, field notes, and described the percentage of success of the trial products both in terms of process and research outcomes from the planning, implementation, reflection, and evaluation stages in the form of psychomotor, affective, cognitive data, and physical test results. Furthermore, the data from the physical test results were analysed using SPSS version 23 statistical techniques to identify the relationship between physical test results and performance in Kumite.

The data was analysed comprehensively to gain a deeper understanding of the factors that influenced the performance of junior karate athletes in the Kumite category. The research process began with field observations (Endrawan & Aliriad, 2023; Satria et al., 2023), which included direct observation of karateka training and interviews with coaches, to identify the needs in developing a physical test instrument for junior karate. The physical test instrument was then developed with attention to validity, reliability, tool availability, and ease of administration (Yulianto, 2018). The research trial was tested on a small scale, and then progressed

to a large scale trial. The small scale trial was conducted to identify the strengths and weaknesses of the instrument, while the large scale trial involved more karate athletes aged 16-17 years nationwide to test reliability. In addition, the final stage involved the production of standardised scores based on the physical test results, which allowed the skills of junior karate athletes to be categorised into five broad groups. With this procedure, the junior karate physical test instrument can be used effectively and in accordance with the characteristics of karate.

Table 1. Instrument Grid

Sub Variable	Indicator	Test Instrument
Reaction speed	The ability to react with the movement of catching the dropped object/ruler.	Hand reaction test
Explosive power	The farthest distance of three jumps in centimeters. The furthest push of 3 repetitions.	Standing broad jump Medicine ball
Muscle endurance	The ability to perform convergent motion straighten your arms and Head, Shoulders, and Back to feet. The ability to perform seated lying movements to the maximum.	Push-Up (1 minute) Sit-Up (1 minute)
Malleability	Flexion and torso test and measurement (toggle). To measure the thickness of the took.	Sit and reach Flexion of Trunk
Agility	Speed performs the movement of compacting back and forth in six directions (hexagon) in three turns. Speed to run back and forth by covering a distance of 5 meters.	Hexagon obstacle test Shuttle run
Balance	The athlete's timing results in maintaining body balance in dynamic conditions.	Modified Bass Test
Coordination	The number of Points Earned when the ball hits the target.	Hand and foot-eye coordination test
Speed	The result of the running time of 30 meters.	Run 30 meters
Cardiorespiratory endurance	The number of levels and shuttle.	Running MTF / Beep test

RESULTS AND DISCUSSION

The initial design of junior karate physical test instrument model in Kumite category, namely (i) standing broad jump, (ii) medicine board, (iii) push-up, (iv) sit-up, (v) hand reaction test, (vi) hexagonal obstacle, (vii) shuttle run, (viii) sit & reach, (ix) flexion of trunk, (x) modified bass test, (xi) eye-hand and foot coordination, (xii) 30-metre running speed, (xiii) multi-stage running. After receiving expert judgement, it is recommended as an initial product, namely 13 test instrument items. The effectiveness of the product development of the physical test instrument for junior karate in the Kumite category was evaluated through small and large scale trials, including the effectiveness of its use. The physical test instrument model is considered effective because there is a significant increase between the pre-test score before treatment and the post-test score after treatment. Calculating the reliability coefficient as a measure of internal validity was the first empirical validity analysis. Based on Table 2, the elements of the test instrument have good and very good internal validity categories, which are presented in Table 3.

Table 2. Guidelines for Giving the Interpretation of Correlation Coefficients

Category	Correlation Coefficient
0.00 – 0.199	Very low
0.20 – 0.399	Low
0.40 – 0.599	Medium
0.60 – 0.799	Good
0.80 – 1.000	Very good

Table 3. Reliability Coefficient of Small-Scale Instruments

Variable	Man		Woman	
	<i>r_{x1x2}</i>	Category	<i>r_{x1x2}</i>	Category
Standing Broad Jump	0.984	Very good validity	0.945	Very good validity
Medicine Board	0.998	Very good validity	0.999	Very good validity
Push Up	0.910	Very good validity	0.927	Very good validity
Sit Up	0.636	Validity is quite good	0.676	Validity is quite good
Hand Reaction Test	0.912	Very good validity	0.906	Very good validity
Hexagon Obstacle	0.907	Very good validity	0.954	Very good validity
Shuttle Run	0.241	Very low validity	0.684	Validity is quite good
Sit & Reach	0.920	Very good validity	0.917	Very good validity
Flexion of Trunk	0.686	Validity is Quite Good	0.645	Validity is Quite Good
Modified Bass Test	0.904	Very good validity	0.903	Very good validity
Hand And Foot-Eye Coordination Test	0.971	Very good validity	0.910	Very good validity
Run 30 Meters	0.905	Very good validity	0.928	Very good validity
Running MTF/Beep test	0.907	Very good validity	0.932	Very good validity

The final stage of the empirical validity analysis is to calculate the reliability coefficient as an indicator of internal validity and the discrimination index as an indicator of external validity;

Table 4. Reliability Coefficient of Large-Scale Instruments

Variable	Man		Woman	
	<i>r_{x1x2}</i>	Category	<i>r_{x1x2}</i>	Category
Standing Board Jump	0.905	Very good validity	0.965	Very good validity
Medicine Ball	0.999	Very good validity	0.999	Very good validity
Push Up	0.930	Very good validity	0.903	Very good validity
Hand Reaction Test	0.900	Very good validity	0.930	Very good validity
Hexagon Obstacle	0.833	Good validity	0.900	Very good validity
Sit & Reach	0.921	Very good validity	0.927	Very good validity
Modified Bass Test	0.902	Very good validity	0.934	Very good validity
Hand and Foot-Eye Coordination Test	0.904	Very good validity	0.914	Very good validity
Run 30 Meters	0.918	Very good validity	0.928	Very good validity
Running MTF/Beep Test	0.906	Very good validity	0.907	Very good validity

The effectiveness of the model can be measured by the difference between the pre-test before treatment and the post-test after treatment. The results of the calculation show that the average score of the post-test is higher than the average score of the pre-test. In order to measure the effectiveness of this training model, an effectiveness test was carried out using the Sample Paired t Test through SPSS 25 software. Assessment norms are the result of the development of physical research that is used as a guideline to measure the extent to which an athlete achieves performance or results in various physical tests conducted in the context of junior karate in the Kumite category (Ihsan et al., 2017; Mustafa & Masgumelar, 2022). These norms provide a classification of values and scores based on a predetermined range of values.

Table 5. Norms of Assessment of Man and Woman Athletes

Variable Test	Category Value	Assessment Man		Assessment Woman	
		Conversion	Score	Conversion	Score
Standing Board Jump	Very good	5	≥ 234	5	≥ 236.26
	Good	4	221,68 - 233	4	227.08 – 236.25
	Medium	3	210,34 - 221,67	3	217,93 - 227,07
	Less	2	199 - 210,33	2	208.75 - 217,92
	Very less	1	≤ 198	1	≤ 208.74
Medicine Ball	Very good	5	≥ 475.76	5	≥ 465
	Good	4	437.59 - 475.75	4	429.34 – 4.64
	Medium	3	399.43 - 437.58	3	394.68 – 429.33
	Less	2	361.25 - 399.42	2	360 - 394.67
	Very less	1	≤ 361.24	1	≤ 359

Variable Test	Category Value	Assessment Man		Assessment Woman	
		Conversion	Score	Conversion	Score
Push Up	Very good	5	≥ 57.6	5	≥ 55.26
	Good	4	50.51 - 57.5	4	48.76 - 55.25
	Medium	3	43.51 - 50.50	3	42.25 - 48.75
	Less	2	36.51 - 43.50	2	35.76 - 42.25
	Very less	1	≤ 36.50	1	≤ 35.75
Hand Reaction Test	Very good	5	≤ 12.38	5	≤ 12.89
	Good	4	12.39 - 15.29	4	12.90 - 14.70
	Medium	3	15.10 - 18.21	3	14.71 - 16.50
	Less	2	18.22 - 21.25	2	16.51 - 18.3
	Very less	1	≥ 21.26	1	≥ 18.2
Hexagon Obstacle	Very good	5	≤ 5.47	5	≤ 5.51
	Good	4	5.48 - 6.43	4	5.52 - 6.45
	Medium	3	6.42 - 7.37	3	6.46 - 7.38
	Less	2	7.36 - 8.36	2	7.39 - 8.32
	Very less	1	≥ 8.37	1	≥ 8.33
Sit & Reach	Very good	5	≥ 41.66	5	≥ 41.51
	Good	4	37.05 - 41.65	4	37.98 - 41.50
	Medium	3	32.47 - 37.04	3	34.35 - 37.97
	Less	2	27.89 - 32.46	2	30.90 - 34.34
	Very less	1	≤ 27.88	1	≤ 30.89
Modified Bass Test	Very good	5	≥ 78.6	5	≥ 79.26
	Good	4	73.51 - 78.5	4	75.43 - 79.25
	Medium	3	68.51 - 73.50	3	71.58 - 75.42
	Less	2	63.51 - 68.50	2	67.75 - 71.57
	Very less	1	≤ 63.50	1	≤ 67.74
Hand and Foot-Eye Coordination Test	Very good	5	≤ 25.49	5	≤ 26.24
	Good	4	25.50 - 29.17	4	26.25 - 29.75
	Medium	3	29.18 - 32.83	3	29.76 - 33.26
	Less	2	32.84 - 36.5	2	33.27 - 36.77
	Very less	1	≥ 36.7	1	≥ 36.78
Run 30 Meters	Very good	5	≥ 4.99	5	≥ 5.03
	Good	4	5.00 - 5.58	4	5.04 - 5.60
	Medium	3	5.59 - 6.16	3	5.61 - 6.15
	Less	2	6.17 - 6.76	2	6.16 - 6.71
	Very less	1	≤ 6.77	1	≤ 6.72
Running MTF/Beep test	Very good	5	≥ 38.28	5	≥ 38.28
	Good	4	35.20 - 38.27	4	35.19 - 38.27
	Medium	3	32.12 - 35.19	3	32.11 - 35.19
	Less	2	29.03 - 32.11	2	29.03 - 32.11
	Very less	1	≤ 29.02	1	≤ 29.02

The purpose of this assessment norm is to facilitate the evaluation of athlete performance in various physical aspects relevant to junior karate in the Kumite category (Putranto et al., 2015; Lesmana et al., 2022). By using these norms, coaches or assessors can easily assess and compare athletes' physical abilities with predetermined standards. This can assist in the development of more effective training programmes and the improvement of athlete performance.

The results of this study illustrate that it is important for karate athletes to have adequate muscular strength, especially in the lower body, in order to be able to perform fast and powerful movements. This strength is key in Karate Kumite matches, which often require sharp reactions and movements in a short period of time. In addition, muscular endurance also plays an important role, as Kumite fights tend to be intensive and last for short periods of time. Reaction speed is a crucial factor in anticipating an opponent's attack and providing a quick response. Flexibility is essential to enable athletes to execute technical movements well and reduce the risk of injury. Aspects of agility, balance, and hand-eye and foot coordination also play a vital role in performing karate techniques well. In addition, factors such as age, gender, training intensity, and genetics

also influence an athlete's physical fitness level. Therefore, a well-planned, systematic, and sustainable physical training programme is crucial to improving the physical condition of karate athletes.

The results of this study indicate that the physical test instrument developed for the junior Kumite karate category has an objective and consistent assessment standard and shows a high level of reliability on various variables for both male and female athletes (Yudhistira & Tomoliyus, 2020; Güler & Ramazanoglu, 2018; Yudhistira, 2023). Effectiveness tests also show that this instrument is effective in improving athlete performance. This finding is in line with physical and sport measurement theory, as well as previous studies that underline the importance of clear assessment standards and reliable instruments in measuring athletes' physical abilities (Edwarsyah et al., 2017; Ramli, 2021). The significant contribution of this research to the development of a physical test instrument specifically for junior karate in the Kumite category can provide a more accurate tool for coaches and assessors to measure athletes' abilities (Camella et al., 2023; Pranata et al., 2017). Furthermore, the relationship between an athlete's body mass index and his physical fitness is a factor that helps the athlete achieve maximum results in every match (Aliriad et al., 2023).

Nonetheless, some limitations need to be noted. The limited focus of the study on junior karate in the Kumite category may affect the generalisability of the findings to this population. In addition, additional factors such as psychological aspects or environmental conditions that were not considered in this study may also affect the results of the physical test. Therefore, future research is expected to expand the sample coverage and consider these additional factors to produce a more holistic and reliable physical test instrument for measuring the physical abilities of karate athletes. As a suggestion for future research, it is important to consider developing physical test instruments that include psychological and environmental aspects, as well as involving a wider population. In addition, future research could focus on a deeper understanding of the interaction between physical factors and other factors that influence the performance of junior karate athletes in Kumite matches, so as to make a greater contribution to the development of more holistic and relevant physical tests.

CONCLUSION

This study developed a physical testing model suitable for 16–17-year-old junior karate (Kumite) athletes for both boys and girls. The results showed that this model is effective in assessing various physical aspects required in karate, such as explosive power, muscular endurance, reaction speed, flexibility, agility, balance, and hand-eye and foot coordination. In addition, this study also developed physical test norms that can be used as guidelines in the selection and training of karate athletes. The implication of this study is that a scientific approach using physical measures provides a valuable contribution to the development of a selection system and the coaching of junior karate athletes. Thus, this study makes an important contribution to the development of the performance of junior karate athletes and improves the efficiency of their selection and coaching processes.

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CONFLICT OF INTEREST

The authors declare that they have no competition.

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