Validity and reliability of a microcontroller-based instrument for measuring karate punch speed and power

Validez y fiabilidad de un instrumento basado en microcontroladores para medir la velocidad y la potencia del golpe en karate

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Abstract

Introduction: Objective, field-ready instruments are needed in karate because punch performance depends on both speed and power. In practice, punch evaluation relies on coach observation, which supports technical feedback but is limited in producing repeatable measurement data. Few studies have examined devices designed for karate punching.
Objective: This study examined the validity and reliability of a microcontroller-based instrument for measuring karate punch speed and power.
Results: The study used a research and development approach involving expert validation, a small-group trial with 10 karate athletes, and a large-group trial with 20 athletes from FORKI Palembang, Indonesia. Expert judgment showed feasibility, with scores of 93% from the karate coaching expert, 92% from the karate refereeing expert, and 90% from the mechatronics and sensor expert, producing an average score of 91%. Normality was examined using the Kolmogorov-Smirnov test, with significance values of .498 for speed and .800 for power. Pearson analysis showed a strong inverse association between speed and power outputs (r = -.972, p < .001), interpreted as preliminary empirical coherence rather than standalone validity evidence. Test-retest results indicated stable scores, with corrected item-total correlation values ranging from .994 to .999 and Cronbach's alpha if item deleted values ranging from .997 to .999.
Discussion: These findings indicate that the instrument can provide stable measurements of karate punch performance in applied settings, although future criterion-related validation against biomechanical systems is needed.
Conclusions: The instrument appears feasible, reliable, and promising for training evaluation and athlete monitoring, provided future studies strengthen criterion-related validation and sensor refinement.

Keywords

Validity, reliability, punch speed, punch power, karate, microcontroller.

Resumen

Introducción: En karate se necesitan instrumentos objetivos y aplicables en el campo, ya que el rendimiento del golpe depende tanto de la velocidad como de la potencia. En la práctica, la evaluación del golpe suele basarse en la observación del entrenador, la cual apoya la retroalimentación técnica, pero es limitada para producir datos de medición repetibles. Pocos estudios han examinado dispositivos diseñados específicamente para medir el golpe en karate.
Objetivo: Este estudio examinó la validez y la fiabilidad de un instrumento basado en microcontroladores para medir la velocidad y la potencia del golpe en karate.
Resultados: El estudio utilizó un enfoque de investigación y desarrollo que incluyó validación por expertos, una prueba en grupo pequeño con 10 atletas de karate y una prueba en grupo grande con 20 atletas de FORKI Palembang, Indonesia. El juicio de expertos mostró factibilidad, con puntuaciones de 93% del experto en entrenamiento de karate, 92% del experto en arbitraje de karate y 90% del experto en mecatrónica y sensores, con una puntuación media de 91%. La normalidad se examinó mediante la prueba de Kolmogorov-Smirnov, con valores de significación de .498 para la velocidad y .800 para la potencia. El análisis de Pearson mostró una fuerte asociación inversa entre las salidas de velocidad y potencia (r = -.972, p < .001), interpretada como evidencia preliminar de coherencia empírica y no como evidencia independiente de validez. Los resultados test-retest indicaron puntuaciones estables, con valores de correlación ítem-total corregida entre .994 y .999 y valores de alfa de Cronbach si se elimina el ítem entre .997 y .999.
Discusión: Estos hallazgos indican que el instrumento puede proporcionar mediciones estables del rendimiento del golpe en karate en contextos aplicados, aunque aún se requiere una validación relacionada con criterios frente a sistemas biomecánicos establecidos.
Conclusiones: El instrumento parece factible, fiable y prometedor para la evaluación del entrenamiento y el monitoreo de atletas, siempre que futuros estudios fortalezcan la validación relacionada con criterios y el refinamiento de los sensores.

Palabras clave

Validez, fiabilidad, velocidad del golpe, potencia del golpe, karate, microcontrolador.

Introduction

Karate, particularly in kumite, is a striking-based combat sport in which successful performance depends on the ability to execute technically precise actions under severe temporal constraints. Among the offensive techniques used in competition, the punch, especially gyaku tsuki, is one of the most decisive actions because it must be delivered rapidly, accurately, and with sufficient mechanical effectiveness to score. Existing karate research shows that punching performance is closely linked to physical capacities such as lower-limb power, while biomechanical evidence indicates that higher-level karate athletes tend to produce greater punch velocity and kinetic energy during striking actions (Quinzi, Rosellini, and Sbriccoli 2022; Robalino et al. 2025). Therefore, punch speed and punch power can be understood as central performance indicators in karate rather than merely supplementary training variables.

An effective karate punch is not merely an isolated upper-limb action, but the result of coordinated force transmission along the kinetic chain. The ability to generate punching speed and power depends on the interaction between lower-limb drive, trunk rotation, upper-limb acceleration, timing, and technical control. For this reason, coaches require assessment tools that can capture how fast and how powerfully a punch is executed. However, in many training contexts, punch evaluation is still largely based on direct observation by coaches, which may be useful for technical feedback but limited in providing objective and repeatable measurement data. Visual observation alone may not adequately detect small differences in strike quality, technical refinement, or athlete performance progression over time (Quinzi et al. 2022; Robalino et al. 2025).

At the same time, athlete monitoring is being reshaped by advances in sensor technology, embedded systems, and field-based digital measurement. Recent developments in combat-sport measurement have shown that inertial measurement units, pressure sensors, force-related sensors, and other wearable or embedded technologies can be used to quantify punches, kicks, fatigue, and technique execution in practical training environments (Xue, Han, and Zhu 2025). These technologies offer opportunities to support more objective performance evaluation, but their use in sport should be accompanied by evidence of validity, reliability, usability, and applied relevance. In line with this concern, the sports technology quality framework proposed by Robertson et al. (2023) emphasizes that new sport technologies should not be evaluated only based on innovation, but also based on the quality and usefulness of the data they produce.

This concern is especially relevant in striking sports because the evidence on punch-measurement devices remains developing and uneven. Budijono et al. (2024) reported positive validity and reliability evidence for a digital punch-measuring tool in young combat athletes, while Mamani-Ramos et al. (2025; Pezenka and Wirth 2025) examined the reliability of a low-cost inertial measurement unit for estimating punch and kick velocity. Other studies have compared sensor-based punch trackers with laboratory-based or criterion systems, reflecting increasing interest in objective punch monitoring across combat sports (Budijono et al. 2024; Omcirk et al. 2023; Pezenka and Wirth 2025; Qi et al. 2026). Nevertheless, the available evidence also shows that measurement quality may differ across devices, testing protocols, sensor positions, and performance outputs. Therefore, the adoption of sport technology in training should be guided by empirical and technical evidence rather than by technological novelty alone.

Despite this progress, an important gap remains in karate-specific performance assessment. Much of the recent validation work has focused on boxing or general combat-sport contexts, and many systems emphasize acceleration or velocity rather than the integrated assessment of both punch speed and punch power (Mestre Moron et al. 2026). For karate training, this gap is important because coaches need a practical instrument that can provide direct information about two essential dimensions of punching performance in one system: how fast the punch is delivered and how much force-related output it produces. In addition, the lack of standardization in sensor placement, testing procedures, and validation strategies makes comparison across devices difficult and limits confidence in their application across sports and settings (Pezenka and Wirth 2025; Qi et al. 2026; Xue et al. 2025). Taken together, these conditions indicate the need for a portable, sport-specific, and field-ready instrument designed explicitly for karate punching assessment.

From a measurement perspective, this need is not only practical but also methodological. Contemporary validation guidance emphasizes that newly developed instruments should be supported by a clear construct rationale, content evaluation by relevant experts, and empirical evidence of validity and reliability before they are used for research, training evaluation, or performance decisions (López-Pina and Veas 2024; Robertson et al. 2023). In sport settings, inaccurate or unstable measurement tools may lead to misleading interpretations of athlete performance and may reduce the usefulness of technology-based monitoring. Therefore, the development of a new measurement system for karate punching should be accompanied by systematic evaluation from the outset, including expert judgment, field testing, and reliability analysis.

Against this background, the present study aimed to examine the validity and reliability of a microcontroller-based instrument for measuring karate punch speed and power. The instrument was designed as an integrated field device capable of combining speed-related and force-related sensing with real-time output. Specifically, this study evaluated the instrument through expert judgment, staged athlete trials, empirical association analysis, and test-retest reliability analysis. By doing so, this study seeks to contribute to karate-specific performance assessment and to the broader development of sport-specific measurement technology in combat sports.

Method

Participants

The participants in this study were 30 karate athletes recruited from karate dojos in Palembang City and surrounding areas using purposive sampling. This sampling technique was chosen because the participants had to meet specific criteria, namely being active karate athletes and being able to perform the punching protocol required to test the instrument. The field-testing stage was conducted in two phases, consisting of a small-group trial with 10 athletes and a large-group trial with 20 athletes. Such staged participant involvement is consistent with contemporary instrument-development studies, which recommend limited pilot testing before broader field validation to examine feasibility and measurement performance (Ranganathan, Caduff, and Frampton 2024; Rhayha and Alaoui Ismaili 2024).

Study Design

This study employed a research and development (R&D) design to develop and evaluate a microcontroller-based instrument for measuring karate punch speed and power (Nurfauzan et al. 2025). In line with recent recommendations in measurement development and sports technology research, the study did not focus solely on prototype construction, but also on evaluating the quality, feasibility, validity, and reliability of the device before recommending it for practical use in training and athlete evaluation settings (López-Pina and Veas 2024; Robertson et al. 2023).

Procedure

The study was carried out in several sequential stages. First, a needs analysis was conducted to identify the lack of an objective instrument for measuring karate punch speed and power in local training practice. Second, the prototype was designed by integrating a microcontroller, an infrared-based proximity sensor to detect movement speed, a load-cell sensor to detect force, a controller box, an LCD display, and a punch pad into a single measurement system. Third, the initial prototype underwent expert judgment, involving a karate coaching expert, a karate refereeing expert, and a mechatronics and sensor expert, because expert review is an essential early step for establishing content relevance, clarity, technical adequacy, and practical suitability of a newly developed instrument (Almanasreh, Moles, and Chen 2019; Ranganathan et al. 2024).

After expert validation, the instrument was revised and tested in a small-group trial involving 10 karate athletes to assess its initial performance, reading stability, and practicality of use. Findings from this stage, including field notes on sensor sensitivity, were used to improve the prototype before broader testing. The revised instrument was then examined in a large-group trial involving 20 karate athletes to evaluate its performance under more varied conditions. To assess temporal stability, a test-retest procedure with a three-day interval was applied, which is in line with recent reliability studies emphasizing repeated measurement to determine the stability of instrument scores across time (Alonso-Hernán and Gomez-Suarez 2026; López-Pina and Veas 2024; Ríder-Vázquez et al. 2025).

Data Analysis

Data analysis was conducted in four stages. First, descriptive statistics were used to summarize the results of the small-group and large-group trials. Second, content-related evidence was summarized using the percentage of feasibility scores obtained from expert judgments. This approach was used to determine whether the instrument was considered relevant, technically adequate, and appropriate for the intended karate assessment context by subject-matter experts (Almanasreh et al. 2019; Rhayha and Alaoui Ismaili 2024).

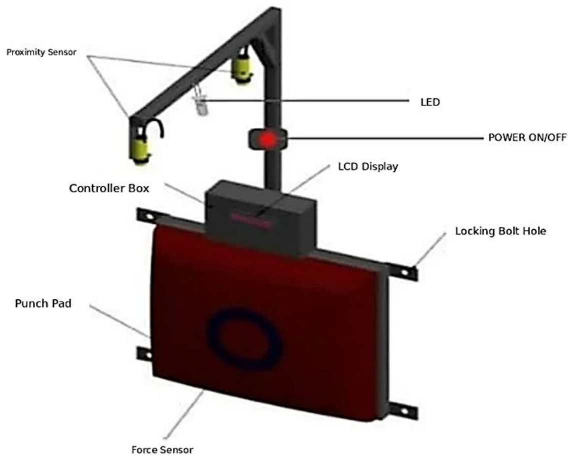
Third, before inferential analysis, the distribution of the large-group data was examined using the Kolmogorov-Smirnov normality test. This test was used as a preliminary screening procedure to determine whether the speed and power data significantly deviated from a normal distribution. A significance value greater than .05 was interpreted as indicating no significant deviation from normality, thereby supporting the use of parametric analysis within the analytical context of this study. Because the sample size was modest, the normality results were interpreted cautiously and not as absolute evidence of distributional adequacy (Gosselin 2024).

Fourth, the empirical relationship between speed and power outputs was examined using the Pearson product-moment correlation. In response to methodological concerns regarding validation, this coefficient was interpreted as preliminary evidence of empirical coherence between instrument outputs rather than as the sole basis for establishing instrument validity. Reliability was assessed using a test-retest procedure, while corrected item-total correlation and Cronbach's alpha if item deleted were used as descriptive indices of internal consistency within the Classical Test Theory framework (López-Pina and Veas 2024; Ranganathan et al. 2024).

Results

Conceptually, the instrument was designed to measure the two main components of punching, namely movement speed and power. Figure 1 shows the system design, which integrates a proximity sensor, a force sensor, a controller box, an LCD display, and a punch pad into a single integrated measurement system.

Figure 1. Design of the microcontroller-based instrument for measuring karate punch speed and power

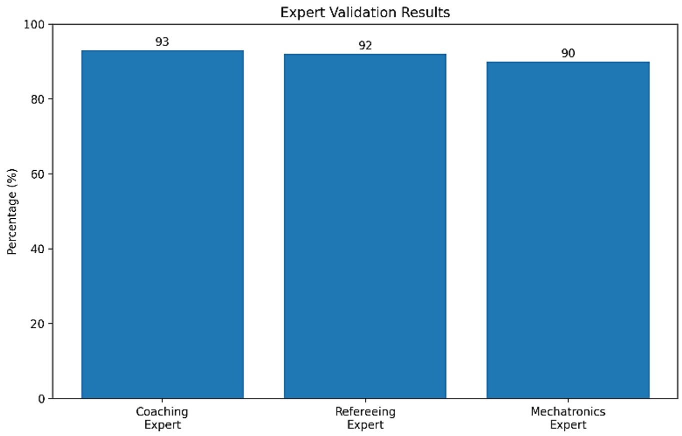


The content-related validity evidence of the instrument was examined through expert judgment. The experts' assessments showed that the device was considered highly feasible in terms of sport-specific relevance, technical adequacy, and practicality for field use. A summary of the expert validation results is presented in Table 1.

Table 1. Expert validation results

No.	Validator	Percentage	Category
1	Karate coaching expert	93%	Highly feasible
2	Karate refereeing expert	92%	Highly feasible
3	Mechatronics and sensor expert	90%	Highly feasible
	Average	91%	Highly feasible

Figure 2. Visualization of expert validation results



The average expert validation score reached 91%, indicating that the instrument met the feasibility criteria from the perspectives of karate coaching, refereeing, and sensor systems. The relatively consistent scores across the three validators suggest that the device was considered suitable not only as a technical prototype, but also as a sport-specific assessment tool for karate punching performance. This result provides content-related support for the relevance and practical adequacy of the instrument before field testing.

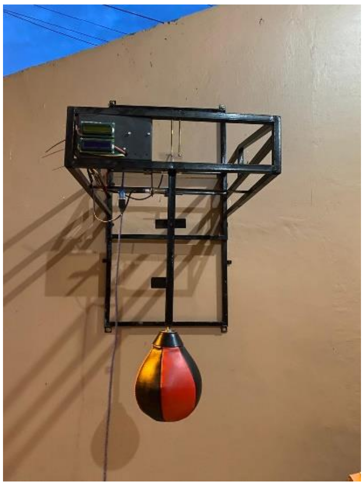
The small-group trial was conducted with 10 athletes to evaluate the initial performance of the instrument, the stability of its readings, and its practicality of use. The main results at this stage are presented in Table 2.

Table 2. Summary of small-group trial results

Aspect	Result	Interpretation
Number of subjects	10 karate athletes	Initial trial
Mean	3.100	Fairly high
Median	3.100	Stable
Standard deviation	0.1286	Small data spread
Normality sig.	0.971	Normally distributed
Reliability coefficient	0.994	Very high
Mean practicality	4.73	Very practical
Field notes	2 athletes were not optimally detected	Sensor revision needed

At this stage, the instrument showed high initial consistency and practicality, but the field notes indicated that two athletes were not optimally detected by the sensor. This finding was important for product revision because it identified a technical sensitivity issue before the instrument was tested in a larger group. Therefore, the small-group trial functioned not only as a preliminary performance test, but also as a basis for improving sensor responsiveness and field usability.

Figure 3. Prototype of the developed instrument



After revision, the instrument was tested again in a large group consisting of 20 karate athletes. This test aimed to examine instrument performance under broader and more varied usage conditions. A summary of the descriptive statistics is presented in Table 3, while the results of the Kolmogorov-Smirnov normality test are presented in Table 4.

Table 3. Descriptive statistics of the large-group trial

Aspect	Value	Description
Number of subjects	20 karate athletes	Large-group trial
Mean	3.375	Average measurement result
Median	3.400	Close to the mean
Standard deviation	0.3275	Moderate data spread

Table 4. Results of the Kolmogorov-Smirnov normality test for large-group data

Variable	Kolmogorov-Smirnov statistic	Sig.	Description
Speed	0.178	0.498	No significant deviation from normality
Power	0.137	0.800	No significant deviation from normality

The Kolmogorov-Smirnov normality test showed significance values greater than .05 for both variables, namely .498 for speed and .800 for power. These results indicate that the large-group data did not significantly deviate from normality. Therefore, the use of parametric analysis was considered acceptable in this study, although the interpretation remained cautious because of the modest sample size.

Table 5. Pearson association between speed and power outputs

Variable pair	Pearson coefficient	Sig. (2-tailed)	Interpretation
Speed and power	-0.972	$p < .001$	Very strong inverse association; preliminary empirical coherence evidence

The Pearson analysis showed a coefficient of -.972 with a significance value of $p < .001$. This result indicates a very strong inverse association between speed and power outputs. The negative direction is understandable because speed was represented by time-based values, where lower values indicate faster punches, whereas power values reflect force-related output. Therefore, this result was interpreted as preliminary evidence that the instrument produced coherent empirical outputs. However, it was not treated as the sole or strongest evidence of validity, because criterion-related validity would require comparison with an external reference system.

Table 6. Descriptive statistics of the test-retest procedure

Variable	Test	Retest	Meaning
Speed	0.6975	0.6970	Mean highly stable
Power	0.6950	0.7055	Very small change

Figure 4. Comparison of mean test and retest scores

Table 7. Results of the test-retest reliability test

Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Interpretation
Speed (test)	0.994	0.999	Very reliable
Speed (retest)	0.994	0.999	Very reliable
Power (test)	0.999	0.997	Very reliable
Power (retest)	0.999	0.997	Very reliable

The test-retest results showed only very small differences between the first and second measurements. Corrected item-total correlations ranging from .994 to .999 and Cronbach's alpha if item deleted values ranging from .997 to .999 indicate a very high level of measurement consistency. These results support the temporal stability of the instrument and suggest that it can be used repeatedly to monitor karate punch performance, while future studies should continue to examine its reliability in larger and more diverse samples.

Figure 5. Implementation of instrument use on the research subjects

Discussion

The present study examined whether a microcontroller-based instrument could provide preliminary evidence of feasibility, empirical coherence, and reliability for measuring karate punch speed and power. The findings suggest that the device has practical potential for field-based athlete evaluation, particularly because it integrates speed-related and force-related outputs in one system. This contribution is relevant to current sports technology literature, which emphasizes that field devices should be evaluated not only for innovation, but also for the quality, interpretability, and practical usefulness of the data they produce (Robinson 2023; Xue et al. 2025)

The expert judgment process provided the first source of evidence for the instrument's content-related feasibility. Involving experts in karate coaching, karate refereeing, and mechatronics/sensor systems was important because the device had to meet both sport-specific and technical requirements. From this perspective, the expert review strengthened the development process by ensuring that the instrument was relevant to karate performance assessment and technically appropriate for field use. This is consistent with measurement-development guidance stating that new instruments should first be examined for content relevance, clarity, and contextual suitability before broader empirical testing is conducted (Almanasreh et al. 2019; Irianto et al. 2025; Ranganathan et al. 2024).

The small-group trial also played an important methodological role. Rather than functioning only as a preliminary data collection stage, it helped identify a sensor sensitivity issue in a small number of athletes. This finding was useful because it informed revision before the larger-group trial. In development research, such iterative refinement is important because technical weaknesses found during early testing can affect measurement consistency if they are not corrected before broader application. Thus, the small-group phase strengthened the credibility of the development process by showing that the prototype was improved based on field performance.

The large-group trial indicated that the revised instrument generated data that were suitable for subsequent analysis. The clarified Kolmogorov-Smirnov normality testing showed that the speed and power data did not significantly deviate from normality, supporting the use of parametric procedures within the limits of the study design. However, these findings should not be overinterpreted because the sample size was modest. Normality testing in small samples should be treated as one element of analytical justification rather than as definitive proof of distributional adequacy (Gosselin 2024).

The Pearson correlation finding requires careful interpretation. Although the coefficient indicated a very strong inverse association between speed and power outputs, this result should not be considered the strongest or sole evidence of validity. In this study, Pearson analysis is better understood as preliminary evidence that the instrument produced coherent measurement outputs. Stronger validity evidence would require criterion-related testing against an external standard such as motion capture, radar-based velocity measurement, force-platform data, or other established biomechanical systems. This distinction is important because contemporary validation guidance separates content-related evidence, internal empirical evidence, reliability evidence, and criterion-related evidence (López-Pina and Veas 2024).

The reliability findings are important for applied karate training because an instrument used for athlete monitoring must produce stable results across repeated administrations. The test-retest pattern in this study suggests that the instrument can generate consistent outputs when used under similar testing conditions. This supports its potential use for monitoring training progress, comparing repeated performances, and providing more objective feedback to coaches and athletes. Similar concerns have been emphasized in combat-sport technology studies, where practical adoption depends on whether sensor-based tools can produce reliable and interpretable data in real training contexts (Budijono et al. 2024; Pezenka and Wirth 2025; Qi et al. 2026).

From a sport-specific perspective, the integrated measurement of speed and power is useful because karate punching performance is shaped by both rapid execution and force-related effectiveness. Prior biomechanical studies have shown that punching performance is associated with lower-limb power, kinetic-chain coordination, velocity, and energy transfer (Quinzi et al. 2022; Robalino et al. 2025). Therefore, a device that captures both speed-related and force-related outputs may provide more meaningful feedback than an assessment approach focused on only one performance dimension. This supports the relevance of developing sport-specific technology for karate rather than relying only on tools designed for boxing or general striking sports.

Several limitations should be acknowledged. The sample size was still relatively modest, the participants came from a limited regional context, and the validation design did not yet include criterion comparison with a gold-standard biomechanical system. In addition, the sensor-detection issue observed during the small-group trial suggests that environmental conditions, striking variability, or hardware sensitivity may influence measurement performance in some cases. Future research should involve larger and more diverse samples, different punch types, repeated testing across varied training settings, automated digital data storage, and criterion-related validation against established biomechanical systems. These steps would strengthen the validity argument and improve the readiness of the instrument for broader use in sports science and karate coaching practice (Omcirk et al. 2023; Qi et al. 2026; Robertson et al. 2023).

Conclusions

This study concludes that the microcontroller-based instrument for measuring karate punch speed and power demonstrates strong preliminary evidence of feasibility and reliability for use in athlete evaluation. Expert validation showed that the instrument was highly feasible from the perspectives of karate coaching, refereeing, and sensor technology. The small-group and large-group trials further indicated that the device functioned consistently in applied settings and was capable of producing stable measurement outputs. In particular, the test-retest findings showed a very high level of reliability, suggesting that the instrument can be used repeatedly to monitor athlete performance under similar testing conditions.

These findings suggest that the instrument has practical potential as an objective tool for measuring two important components of karate punching performance, namely speed and power, within a single integrated system. However, the study should be viewed as an initial validation stage rather than definitive evidence of full measurement validity. Future research is needed to strengthen criterion-related validity through comparison with gold-standard biomechanical systems, involve larger and more diverse samples, and further refine sensor sensitivity and digital data management. Overall, the instrument represents a promising step toward sport-specific technology for karate performance assessment.

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References

Almanasreh, Enas, Rebekah Moles, and Timothy F. Chen. 2019. “Evaluation of Methods Used for Estimating Content Validity.” *Research in Social and Administrative Pharmacy* 15(2):214–21. doi:10.1016/j.sapharm.2018.03.066.

Alonso-Hernán, Daniel, and Monica Gomez-Suarez. 2026. “Escala de Expresividad Identitaria En Aficionados de Fútbol: Validación y Aplicaciones Para La Gestión Deportiva.” *Retos* 80:193–205. doi:10.47197/retos.v80.118559.

Budijono, Agung Prijo, Pradini Puspitaningayu, Wahyu Dwi Kurniawan, Awang Firmansyah, Novadri Ayubi, Kritchapol Arsapakdee, and Andika Bayu Putro. 2024. “Considering the Validity and Reliability Testing of a Digital Punch Measuring Tool in Young Combat Athletes.” *Physical Education Theory and Methodology* 24(5):683–88. doi:10.17309/tmfv.2024.5.01.

Gosselin, Romain-Daniel. 2024. “Testing for Normality: A User’s (Cautionary) Guide.” *Laboratory Animals* 58(5):433–37. doi:10.1177/00236772241276808.

Irianto, Subagyo, Tomoliyus Tomoliyus, Awan Hariono, Yulvia Miftachurochmah, and Hary Widodo. 2025. "Development of Junior Football Skills Test Based on Validity and Reliability through Expert Judgment." *Retos* 70:493–504. doi:10.47197/retos.v70.111188.

López-Pina, Jose-Antonio, and Alejandro Veas. 2024. "Validation of Psychometric Instrumentswith Classical Test Theory in Social and Health Sciences: A Practical Guide." *Anales de Psicología* 40(1):163–70. doi:10.6018/analesps.583991.

Mamani-Ramos, Angel Anibal, Edgar Froilan Damian-Nuñez, Edgar Eloy Carpio-Vargas, Jorge Alber Quisocala-Ramos, Carlos Wyly Dextre-Mendoza, Xavier Fuentes-Avila, Kandy Faviola Tuero-Chirinos, Naysha Sharon Villanueva-Alvaro, Carlos Vidal Cutimbo-Quispe, and Jhony Ruben Rodriguez-Mamani. 2025. "Cuestionario Sobre Apoyo Familiar En La Actividad Física Para Adolescentes (CAFAFA): Validez y Fiabilidad de Una Nueva Propuesta." *Retos* 70:317–30. doi:10.47197/retos.v70.115153.

Mestre Moron, Beatriz Elena, Everardo Manuel Sanchez Puche, Gabriel Fernando Franco Maya, Edelberto R. Redondo Reynoso, and José Mauricio Rivero Olmos. 2026. "Cinética y Perfil Del Lactato En Karatecas Universitarios: Comparación Entre Protocolos Incremental y Mínimo." *Retos* 76:544–53. doi:10.47197/retos.v76.117680.

Nurfauzan, Prayogi, Guntur Guntur, Aris Fajar Pambudi, Ade Gusti Ningsih, Apriliana Nurulita Nur Fauzi, Andika Triansyah, Fatma Atik Mulyani, St. Nur Almaidah RS., Atina Atina, Maria Magdalena Sri Wahyuni, Arief Kuswidyanarko, Irene Maria Wato, Anna Mariyani, Hidayatul Hikmah, and Amran Amran. 2025. "Development and Validation of a Quantum Learning Model Based on Traditional Games to Improve Physical Literacy in Primary School Students." *Retos* 69:1401–18. doi:10.47197/retos.v69.116823.

Omcirk, Dan, Tomas Vetrovsky, Jan Padecky, Jan Malecek, and James J. Tufano. 2023. "Validity of Commercially Available Punch Trackers." *Journal of Strength & Conditioning Research* 37(11):2273–81. doi:10.1519/JSC.0000000000004535.

Pezenka, Lukas, and Klaus Wirth. 2025. "Reliability of a Low-Cost Inertial Measurement Unit (IMU) to Measure Punch and Kick Velocity." *Sensors* 25(2):307. doi:10.3390/s25020307.

Qi, Ji, Rangxi Jin, Tongling Wang, Zengyi Li, Mitchell James Finlay, and Chao Chen. 2026. "Reliability and Validity of the 'XingXun' System for Measuring Punch Acceleration and Velocity in Elite Boxers." *Frontiers in Physiology* 17. doi:10.3389/fphys.2026.1726442.

Quinzi, Federico, Gioele Rosellini, and Paola Sbriccoli. 2022. "Lower Limb Maximal Power Predicts Punching Speed in Different Static and Dynamic Attacking Techniques in Karate." *Journal of Strength & Conditioning Research* 36(5):1353–59. doi:10.1519/JSC.0000000000003653.

Ranganathan, Priya, Carlo Caduff, and Christopher M. A. Frampton. 2024. "Designing and Validating a Research Questionnaire - Part 2." *Perspectives in Clinical Research* 15(1):42–45. doi:10.4103/picr.picr_318_23.

Rhayha, Radouane, and Abderrahman Alaoui Ismaili. 2024. "Development and Validation of an Instrument to Evaluate the Perspective of Using the Electronic Health Record in a Hospital Setting." *BMC Medical Informatics and Decision Making* 24(1):291. doi:10.1186/s12911-024-02675-0.

Ríder-Vázquez, Antonio, Estanislao Gutiérrez-Sánchez, Clara Martinez-Perez, and María Sánchez-González. 2025. "Test–Retest Reliability of a Computerized Hand–Eye Coordination Task." *Journal of Eye Movement Research* 18(5):54. doi:10.3390/jemr18050054.

Robalino, Johan, João Paulo Vilas-Boas, Emerson Franchini, Antonio Roberto Bendillati, Mauro Gonçalves, and Márcio Fagundes Goethel. 2025. "Kinetic Chain Contribution to Speed and Energy in Karate Techniques." *Applied Sciences* 15(17):9726. doi:10.3390/app15179726.

Robertson, S., J. Zendler, K. De Mey, J. Haycraft, G. I. Ash, C. Brockett, D. Seshadri, C. Woods, L. Kober, R. Aughey, and J. Rogowski. 2023. "Development of a Sports Technology Quality Framework." *Journal of Sports Sciences* 41(22):1983–93. doi:10.1080/02640414.2024.2308435.

Robinson, John. 2023. "Likert Scale." Pp. 3917–18 in *Encyclopedia of Quality of Life and Well-Being Research*. Cham: Springer International Publishing.

Xue, Hongyu, Chaoran Han, and Dinghuang Zhu. 2025. "Limb Biomechanics in Combat Sports: Insights from Wearable Sensor Technology." *Frontiers in Bioengineering and Biotechnology* 13. doi:10.3389/fbioe.2025.1663592.

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