Journal of Physical Sport Therapy and Rehabilitation
ISSN(E): XXXX-0000 ‖ Volume 1 Issue 3, 2026 ‖ P.010-018
https://cakra-edus.id/index.php/JPSTR
cakra.journal@gmail.com ‖ 082348954778

The Effect of Hand Band Resistance Training And Dumbbell On The Speed Ability of Chudan Tsuki Punches In Karate Athletes Inkanas

Nurul Magfira Rusli[1A-E*], Nukhrawi Nawir[2B-D], Dahlan[3B-D]

[1,2,3] Universitas Negeri Makassar, Sulawesi Selatan, Indonesia

magfiranurul17@gmail.com[1*], nukhrawi.nawir@unm.ac.id[2], dahlan@unm.ac.id[3]

ABSTRACT

Punching speed is one of the most important determinants of performance in karate, particularly in kumite competitions, where athletes are required to execute fast and accurate attacks to obtain points. However, observations at the INKANAS Tribun Timur Branch in Makassar City indicated that athletes exhibited suboptimal chudan tsuki punch speed, which affected their competitive performance. Therefore, this study aimed to examine the effects of hand resistance band training and dumbbell training on the speed ability of chudan tsuki punches among karate athletes. This study employed a quasi-experimental design using a two-group pretest–posttest approach. Twenty karate athletes were selected through random sampling and divided equally into a hand resistance band training group and a dumbbell training group. The intervention was conducted for 16 training sessions. Data were collected using the Chudan Tsuki Punch Speed Test and analyzed using descriptive statistics, normality and homogeneity tests, as well as paired and independent sample t-tests with SPSS version 22. The results showed that the hand resistance band group improved significantly from a mean score of 25.70 ± 0.823 to 29.30 ± 0.823 ($t = 22.045$; $p = 0.000$). The dumbbell group also improved significantly from 25.50 ± 0.707 to 26.70 ± 0.675 ($t = 9.000$; $p = 0.000$). Furthermore, a significant difference was found between the two training methods ($t = 7.723$; $p = 0.000$), indicating that hand resistance band training was more effective than dumbbell training. In conclusion, both training methods positively affect chudan tsuki punch speed, with hand resistance band training providing superior outcomes.

ARTICLE HISTORY

Revised: 2026/05/29

Accepted: 2026/06/12

Published: 2026/07/21

KEYWORDS

Karate;

Resistance Band;

Dumbbell;

Chudan Tsuki;

Punch Speed.

AUTHORS' CONTRIBUTION

A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

Cites this Article : Rusli, N.M.; Nawir, N.; Dahlan, D. (2026). The Effect of Hand Band Resistance Training And Dumbbell On The Speed Ability of Chudan Tsuki Punches In Karate Athletes Inkanas. **Journal of Physical Sport Therapy and Rehabilitation**. 1(3), P.010-018

INTRODUCTION

Karate is one of the most popular martial arts sports originating from Japan and has developed rapidly in Indonesia since the 1970s. As a competitive sport, karate consists of two main events, namely kata and kumite, each requiring different technical and physical demands. Kata emphasizes the demonstration of technical precision, aesthetics, and power, whereas kumite focuses on the application of offensive and defensive techniques in actual combat situations (Indrajaya, 2017). Regardless of the event category, karate athletes are required to master fundamental techniques (kihon), including stances (dachi), blocking (uke), punching (tsuki), and kicking (geri), which serve as the foundation for advanced performance.

Among these techniques, punching speed is one of the most decisive determinants of success in kumite competition. The chudan tsuki, a middle-level straight punch targeting the abdomen or solar plexus area, requires not only technical mastery but also rapid neuromuscular coordination, explosive upper-body strength, trunk rotation, and lower-limb support. Fast and accurate punches increase the probability of scoring points and improve competitive performance (Chaabène et al., 2017). Therefore, developing punch speed has become an important focus in karate training programs.

Speed in karate is a complex biomotor component involving the interaction of muscle strength, coordination, reaction time, flexibility, balance, and power (Fenanlampir & Faruq, 2015). The execution of chudan tsuki does not solely depend on arm movement; instead, it involves coordinated actions of the hips, trunk, shoulders, and lower limbs. Efficient transfer of force from the legs through the hips to the upper extremities is essential for producing rapid and powerful punches (Koropanovski et al., 2019). Consequently, training methods aimed at improving punching speed should incorporate exercises that enhance both upper-body strength and neuromuscular efficiency.

One training method increasingly applied in combat sports is resistance band training. Resistance bands provide elastic resistance that stimulates muscle activation throughout the range of motion while improving movement velocity and coordination (Lopes et al., 2019). Another commonly used method is dumbbell training, which effectively increases muscular strength and explosive power through external loading (Suchomel et al., 2018). Both methods have shown positive effects on athletic performance; however, their comparative effectiveness in enhancing chudan tsuki punch speed remains insufficiently explored. Preliminary observations conducted at the Inkanas Tribun Timur Branch, Makassar City, on July 8, 2024, revealed that athletes exhibited suboptimal chudan tsuki performance. Their punches were characterized by inadequate speed, poor technical execution, and limited success in scoring during simulated matches. Furthermore, athletes rarely achieved podium finishes in recent competitions, indicating a need for evidence-based training interventions to improve punching performance. This practical problem forms the basis of the present study.

Recent studies have emphasized the importance of physical conditioning and strength training in improving karate performance. Research by Chaabène et al. (2017) demonstrated that explosive strength, reaction speed, and neuromuscular coordination are among the primary determinants of competitive karate achievement. Similarly, Koropanovski et al. (2019) reported that punching effectiveness is strongly associated with upper-limb power and lower-limb force production, suggesting that whole-body training approaches are essential. Resistance training has gained increasing attention in combat sports because it improves muscle strength, movement velocity, and sport-specific performance. Elastic resistance training using bands has been shown to enhance muscle activation, dynamic stability, and movement speed while minimizing injury risk (Lopes et al., 2019). In martial arts athletes, resistance bands facilitate sport-specific movements because resistance can be applied in directions that mimic actual competitive actions (Andersen et al., 2022). Moreover, elastic resistance training has been associated with improvements in upper-body power and punching velocity in boxing and taekwondo athletes (Turner et al., 2020).

Dumbbell training also plays a significant role in developing muscular strength and explosive movements. Suchomel et al. (2018) found that free-weight resistance exercises effectively improve force production and power output in athletes. Studies in combat sports indicate that upper-body strength training using dumbbells can enhance punching force and movement speed through increased neuromuscular recruitment (Loturco et al., 2020). Additionally, strength and conditioning programs integrating dumbbell exercises have been reported to improve athletic performance in karate, boxing, and taekwondo athletes (Chaabène et al., 2021).

Biomechanical investigations further reveal that punching speed is not solely determined by arm strength but also by kinetic chain efficiency. The contribution of hip rotation, trunk stabilization, and lower-limb propulsion significantly affects punch velocity and impact force (Marques et al., 2020). Therefore, training interventions that integrate upper-body resistance exercises with coordinated movement patterns may provide superior adaptations for karate athletes. Although previous studies have extensively investigated resistance training and strength development in combat sports, several limitations remain. First, most studies have focused on general performance indicators such as muscular strength, power, or aerobic capacity rather than sport-specific techniques such as chudan

tsuki punch speed (Chaabène et al., 2021). Second, research comparing different resistance modalities—particularly hand resistance bands and dumbbells—in karate athletes is still limited.

Furthermore, most existing studies have been conducted on athletes from boxing, taekwondo, or mixed martial arts, while empirical evidence involving Indonesian karate athletes remains scarce. Differences in technical characteristics, training culture, and athlete profiles necessitate context-specific investigations. To date, no study has specifically examined the comparative effects of hand resistance band training and dumbbell exercises on the speed ability of chudan tsuki punches among athletes of the Inkanas Tribun Timur Branch in Makassar City. This gap highlights the necessity of conducting research that evaluates scientifically validated training interventions tailored to karate athletes. Such investigations are expected to provide empirical evidence regarding effective methods for enhancing punching speed and competitive performance. Based on the aforementioned problems and gaps, this study aims to examine the effect of hand resistance band training and dumbbell training on the speed ability of chudan tsuki punches among karate athletes of the Inkanas Tribun Timur Branch in Makassar City. The novelty of this study lies in three aspects. First, it focuses specifically on the chudan tsuki technique as a sport-specific performance indicator, which has received limited attention in previous research. Second, it compares two popular resistance training modalities elastic resistance bands and dumbbells to determine their effectiveness in improving punch speed. Third, this study is conducted within the context of Indonesian karate athletes, thereby contributing local empirical evidence to the broader literature on combat sports training.

In conclusion, improving chudan tsuki punch speed requires training programs that enhance muscular strength, neuromuscular coordination, and kinetic chain efficiency simultaneously. By investigating the effectiveness of hand resistance band and dumbbell training, this study is expected to provide practical recommendations for coaches and athletes in designing evidence-based conditioning programs and contribute to the advancement of karate training science, particularly in Indonesia.

METHODS

This study employed a quasi-experimental design using a two-group pretest–posttest design to investigate the effect of hand resistance band training and dumbbell training on the speed ability of chudan tsuki punches in karate athletes. This design is widely recommended in sports science research because it allows researchers to compare changes before and after treatment while controlling for baseline differences between groups (Chaabène et al., 2021; Thomas et al., 2022). Experimental approaches with pretest–posttest measurements have been frequently used to evaluate the effectiveness of resistance training interventions in combat sports, particularly in improving speed, strength, and sport-specific skills (Loturco et al., 2020). The population of this study consisted of all athletes of the Inkanas Tribun Timur Branch in Makassar City. A random sampling technique was employed to minimize selection bias and ensure that each athlete had an equal opportunity to participate in the study (Fraenkel et al., 2019). From the population, 20 karate athletes who met the inclusion criteria were selected as research participants and randomly assigned into two groups: the hand resistance band training group and the dumbbell training group.

The instrument used to collect data was the Chudan Tsuki Punch Speed Test, which measures the number and speed of valid punches performed within a predetermined time interval. Sport-specific performance tests have been recognized as reliable tools for assessing technical performance in karate because they reflect actual competitive movements and neuromuscular demands (Koropanovski et al., 2019; Chaabène et al., 2017). Previous studies have demonstrated that punch speed is a critical performance indicator associated with success in kumite competitions (Marques et al., 2020). The research procedure consisted of four stages. First, participants performed a pretest to assess their initial chudan tsuki punch speed. Second, participants were randomly divided into two treatment groups. Third, the experimental groups received either hand resistance band training or dumbbell training for 16 training sessions, conducted according to progressive overload principles. Resistance band exercises have been shown to improve movement velocity, muscle activation, and sport-specific power through elastic loading (Lopes et al., 2019; Andersen et al., 2022). Similarly,

dumbbell training effectively enhances upper-body strength, neuromuscular recruitment, and explosive performance in combat athletes (Suchomel et al., 2018; Turner et al., 2020). Finally, a posttest was administered to determine changes in chudan tsuki punch speed after the intervention.

Data were analyzed using SPSS version 22. Descriptive statistics were first calculated to summarize participants' characteristics and performance outcomes. Prior to hypothesis testing, assumption tests including the normality test and homogeneity test were conducted to ensure that the data met the requirements for parametric analysis (Field, 2022). Subsequently, a paired-sample t-test was used to compare pretest and posttest scores within each group, while an independent-sample t-test was employed to compare the effectiveness of hand resistance band and dumbbell training. The level of statistical significance was set at $p < .05$, which is commonly adopted in sports and exercise science research (Thomas et al., 2022). Through these procedures, the study aimed to provide robust empirical evidence regarding the effectiveness of resistance-based training methods in improving the speed ability of chudan tsuki punches among karate athletes.

RESULTS AND DISCUSSION

Result

Descriptive Statistics of Chudan Tsuki Punch Speed

The descriptive analysis was conducted to provide an overview of the pretest and posttest scores of chudan tsuki punch speed in both experimental groups, namely the hand resistance band training group and the dumbbell training group. The results are presented in Table 1.

Table 1.
Descriptive Statistics of Chudan Tsuki Punch Speed in INKANAS Tribun Timur Makassar Karate Athletes

Variable	N	Range	Min	Max	Sum	Mean	SD
Pretest Resistance Band Group	10	2.00	25	27	257	25.70	0.823
Posttest Resistance Band Group	10	2.00	28	30	293	29.30	0.823
Pretest Dumbbell Group	10	2.00	25	27	255	25.50	0.707
Posttest Dumbbell Group	10	2.00	26	28	267	26.70	0.675

Table 1 shows that the resistance band group experienced a considerable increase in chudan tsuki punch speed after the intervention. The pretest mean score was 25.70 (SD = 0.823), increasing to 29.30 (SD = 0.823) at the posttest, with an improvement of 3.60 points. The minimum and maximum scores also increased from 25–27 during the pretest to 28–30 during the posttest.

Similarly, the dumbbell training group demonstrated an improvement in punch speed performance. The average score increased from 25.50 (SD = 0.707) at the pretest to 26.70 (SD = 0.675) at the posttest, representing an improvement of 1.20 points. The score range changed from 25–27 in the pretest to 26–28 in the posttest.

These descriptive findings indicate that both training methods contributed positively to the enhancement of chudan tsuki punch speed. However, the resistance band training group exhibited a greater increase compared to the dumbbell training group. Descriptive statistics alone, however, are insufficient to determine whether these improvements are statistically significant. Therefore, inferential statistical analyses were conducted.

Normality Test

Prior to hypothesis testing, the data were examined for normality using the Kolmogorov–Smirnov test. The results are shown in Table 2.

Table 2.
Results of the Normality Test

Variable	K-S Statistic	Sig.	α	Interpretation
Resistance Band Training	0.302	0.260	0.05	Normal
Dumbbell Training	0.360	0.110	0.05	Normal

As shown in Table 2, the resistance band training group obtained a significance value of 0.260, while the dumbbell training group obtained a significance value of 0.110. Since both significance values are greater than α = 0.05, the data are considered normally distributed. Therefore, parametric statistical analyses could be applied.

Homogeneity Test

The homogeneity of variance was assessed using Levene's Test. The results are summarized in Table 3.

Table 3.
Results of the Homogeneity Test

Variables	Levene Statistic	Sig.	α	Interpretation
Resistance Band vs Dumbbell	0.815	0.379	0.05	Homogeneous

The Levene's Test produced a significance value of 0.379, which is greater than α = 0.05. Therefore, the variances of the two groups were homogeneous, fulfilling another assumption for parametric hypothesis testing.

Hypothesis 1

There is a significant effect of hand resistance band training on the speed ability of chudan tsuki punches in INKANAS Tribun Timur Makassar karate athletes.

Table 4.
Results of Hypothesis 1 Testing

t-observed	t-table	Sig. (p)	Interpretation
22.045	2.262	0.000	Significant

The results revealed that the calculated t-value (22.045) was substantially higher than the critical t-value (2.262), with a significance level of p = 0.000 (< 0.05). Therefore, the null hypothesis (H_0) was rejected and the alternative hypothesis (H_1) was accepted. This finding indicates that hand resistance band training significantly improved the speed ability of chudan tsuki punches among INKANAS Tribun Timur Makassar karate athletes.

Hypothesis 2

There is a significant effect of dumbbell training on the speed ability of chudan tsuki punches in INKANAS Tribun Timur Makassar karate athletes.

Table 5.
Results of Hypothesis 2 Testing

t-observed	t-table	Sig. (p)	Interpretation
9.000	2.262	0.000	Significant

The t-test analysis showed that the calculated t-value (9.000) exceeded the critical t-value (2.262), with a significance level of p = 0.000 (< 0.05). Thus, H_0 was rejected and H_1 was accepted. These results confirm that dumbbell training also had a statistically significant effect on improving chudan tsuki punch speed.

Hypothesis 3

There is a significant difference between hand resistance band training and dumbbell training in improving the speed ability of chudan tsuki punches in INKANAS Tribun Timur Makassar karate athletes.

Table 6.
Results of Hypothesis 3 Testing

t-observed	t-table	Sig. (p)	Interpretation
7.723	2.101	0.000	Significant

Table 6 demonstrates that the calculated t-value (7.723) was greater than the critical t-value (2.101), with a significance value of p = 0.000, which is lower than α = 0.05. Therefore, H_0 was rejected and H_1 was accepted. These findings indicate a significant difference between the two training methods. Furthermore, the posttest mean score of the resistance band group (29.30) was higher than

that of the dumbbell group (26.70). This result suggests that hand resistance band training produced greater improvements in chudan tsuki punch speed compared with dumbbell training.

Overall, the findings demonstrate that both training methods are effective for enhancing punching speed; however, hand resistance band training appears to be the more effective intervention for improving the speed ability of chudan tsuki punches in karate athletes of INKANAS Tribun Timur Makassar.

Discussion

The present study examined the effects of hand resistance band training and dumbbell training on the speed ability of chudan tsuki punches among karate athletes of INKANAS Tribun Timur Makassar. The findings revealed that both training methods significantly improved punch speed; however, hand resistance band training produced greater improvements than dumbbell training. These findings support contemporary theories in sports training, which emphasize that sport-specific resistance exercises can enhance neuromuscular performance, movement velocity, and technical efficiency in combat sports (Chaabène et al., 2021; Suchomel et al., 2018).

The first hypothesis was accepted, indicating that hand resistance band training had a significant effect on chudan tsuki punch speed. The statistical analysis showed a substantial increase in the mean score from 25.70 during the pretest to 29.30 in the posttest, with a t-value of 22.045 ($p < .05$). This finding suggests that elastic resistance training effectively stimulates muscular adaptations related to speed and explosive movement. Resistance bands provide variable resistance throughout the range of motion, allowing athletes to perform movements that closely resemble actual sport techniques while maintaining high movement velocity (Lopes et al., 2019; Andersen et al., 2022).

From a physiological perspective, resistance band training enhances neuromuscular activation by increasing motor unit recruitment and synchronization during dynamic movements (Cormie et al., 2016). During chudan tsuki execution, several muscles are actively involved, including the biceps brachii, triceps brachii, deltoid, brachioradialis, flexor carpi radialis, and flexor carpi ulnaris, in addition to the trunk and lower-limb muscles that contribute to force transmission (Marques et al., 2020). The elastic properties of the resistance band require these muscles to undergo repeated concentric and eccentric contractions, resulting in improved rate of force development and movement speed (Loturco et al., 2020). Consequently, when the elastic resistance is removed, athletes are able to execute punches more rapidly and efficiently.

The results of this study are consistent with previous research. Lopes et al. (2019) reported that elastic resistance training significantly improved upper-body power and movement velocity in athletes. Similarly, Andersen et al. (2022) demonstrated that resistance band exercises increased muscle activation and sport-specific performance across various athletic populations. In combat sports, Turner et al. (2020) found that elastic resistance training enhanced punching speed and coordination due to its ability to replicate sport-specific movement patterns. Therefore, the present findings provide further evidence that hand resistance band training is an effective intervention for improving karate punching performance.

The second hypothesis was also accepted, demonstrating that dumbbell training significantly improved chudan tsuki punch speed. The mean score increased from 25.50 in the pretest to 26.70 in the posttest, and the t-test yielded a value of 9.000 ($p < .05$). Although the improvement was smaller than that observed in the resistance band group, the results confirm that dumbbell exercises remain an effective training modality for enhancing muscular strength and speed-related performance.

Dumbbell training is widely recognized as an effective method for developing muscular strength, power, and neuromuscular coordination because it imposes external loads that stimulate muscle hypertrophy and motor unit recruitment (Suchomel et al., 2018). According to Stone et al. (2021), progressive resistance training using free weights improves force production and movement efficiency, which are essential for explosive actions in sports. In karate, stronger upper-extremity muscles enable athletes to generate greater acceleration during punching movements, thereby improving punch speed and impact (Chaabène et al., 2021).

Furthermore, the principle of progressive overload explains the positive effects observed in this study. Training adaptations occur when athletes are exposed to gradually increasing workloads that

challenge their physiological capacity (Bompa & Buzzichelli, 2019). Repeated dumbbell exercises increase muscle fiber recruitment, enhance intermuscular coordination, and improve motor control, all of which contribute to faster and more powerful punches (Grgic et al., 2020). Previous studies have also shown that dumbbell-based resistance programs improve upper-body power and striking performance in boxing, taekwondo, and karate athletes (Loturco et al., 2020; Chaabène et al., 2021).

The third hypothesis revealed a significant difference between hand resistance band training and dumbbell training. The posttest comparison showed that the resistance band group achieved a higher mean score (29.30) than the dumbbell group (26.70), and the independent t-test indicated a significant difference ($t = 7.723$, $p < .05$). This finding suggests that although both methods are beneficial, resistance band training is more effective in improving chudan tsuki punch speed.

Several factors may explain the superiority of resistance band training. First, the elastic resistance provided by the band closely mimics the biomechanics of karate punching. Unlike dumbbells, which mainly produce vertical gravitational resistance, resistance bands generate multidirectional resistance that follows the movement trajectory of the punch (Andersen et al., 2022). This characteristic enables athletes to train the entire kinetic chain involved in chudan tsuki, including the legs, hips, trunk, shoulders, and arms (Koropanovski et al., 2019).

Second, resistance bands facilitate high-velocity training. Research has shown that movement velocity is a critical determinant of sport-specific power and punching performance (Cormie et al., 2016; Pareja-Blanco et al., 2020). Because resistance bands provide accommodating resistance that increases as the band stretches, athletes can maintain maximal acceleration throughout the movement (Lopes et al., 2019). In contrast, dumbbells tend to limit movement speed due to the constant effect of gravity and inertia.

Third, resistance band exercises improve coordination and neuromuscular efficiency more effectively because they require stabilization and control during movement (Behm et al., 2021). This finding is particularly relevant in karate, where punching performance depends not only on muscular strength but also on timing, coordination, and the efficient transfer of force through the kinetic chain (Marques et al., 2020; Chaabène et al., 2021). Nevertheless, it should be emphasized that both resistance band and dumbbell training contributed positively to improving chudan tsuki punch speed. Systematic and continuous training induces physiological adaptations, including increased muscle strength, enhanced neural activation, improved coordination, and greater movement efficiency (Bompa & Buzzichelli, 2019; Grgic et al., 2020). Therefore, coaches may consider integrating both training modalities into karate conditioning programs according to athletes' needs and training objectives.

Overall, the findings of this study contribute to the growing body of literature on strength and conditioning in combat sports. The results demonstrate that sport-specific resistance training, particularly hand resistance band exercises, represents an effective strategy for improving punch speed in karate athletes. Consequently, coaches and practitioners are encouraged to incorporate elastic resistance training into regular karate practice to optimize athletes' technical performance and competitive achievement.

CONCLUSION

This study concludes that both hand resistance band training and dumbbell training significantly improve the speed ability of chudan tsuki punches among karate athletes of INKANAS Tribun Timur Makassar. The findings demonstrated that the hand resistance band group showed a significant increase in mean punch speed scores from 25.70 ± 0.823 in the pretest to 29.30 ± 0.823 in the posttest, with a t-value of 22.045 ($p = 0.000$). Similarly, the dumbbell training group improved from 25.50 ± 0.707 to 26.70 ± 0.675, yielding a t-value of 9.000 ($p = 0.000$). These results indicate that both training methods effectively enhance neuromuscular function, muscular strength, and movement velocity associated with karate punching performance.

Furthermore, the comparative analysis revealed a significant difference between the two interventions ($t = 7.723$, $p = 0.000$), indicating that hand resistance band training is more effective than dumbbell training in improving chudan tsuki punch speed. Conceptually, resistance bands provide

elastic and sport-specific resistance that closely resembles the punching movement pattern, thereby optimizing muscle contraction, coordination, and kinetic chain efficiency.

Therefore, hand resistance band training is recommended as an effective and practical conditioning method for karate athletes. Nevertheless, both training modalities can be incorporated systematically into karate training programs to enhance technical skills, physical performance, and competitive achievement.

REFERENCES

Andersen, V., Fimland, M. S., Mo, D. A., Iversen, V. M., & Saeterbakken, A. H. (2022). Elastic resistance training in athletes: Effects on muscular strength and power performance. Sports Medicine, 52(4), 851–867. https://doi.org/10.1007/s40279-021-01579-2

Behm, D. G., Alizadeh, S., Anvar, S. H., Drury, B., Granacher, U., & Moran, J. (2021). Neuromuscular adaptations associated with elastic resistance training: A systematic review. Frontiers in Physiology, 12, 719603. https://doi.org/10.3389/fphys.2021.719603

Bompa, T. O., & Buzzichelli, C. (2019). Periodization: Theory and Methodology of Training (6th ed.). Human Kinetics.

Chaabène, H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and physiological profile of elite karate athletes. Sports Medicine, 42(10), 829–843. https://doi.org/10.1007/BF03262297

Chaabène, H., Negra, Y., Capranica, L., Bouguezzi, R., Hachana, Y., Rouahi, M. A., & Mkaouer, B. (2018). Validity and reliability of a new test of planned agility in elite taekwondo athletes. Journal of Strength and Conditioning Research, 32(9), 2542–2547. https://doi.org/10.1519/JSC.0000000000002325

Chaabène, H., Franchini, E., Sterkowicz, S., Tabben, M., Hachana, Y., & Chamari, K. (2015). Criterion related validity of karate specific aerobic test (KSAT). Asian Journal of Sports Medicine, 6(3), e23807. https://doi.org/10.5812/asjsm.23807

Chaabène, H., Negra, Y., Capranica, L., Prieske, O., & Granacher, U. (2021). Strength and conditioning in combat sports: Current evidence and practical applications. Frontiers in Physiology, 12, 719. https://doi.org/10.3389/fphys.2021.719

Cormie, P., McGuigan, M. R., & Newton, R. U. (2016). Developing maximal neuromuscular power: Part 1—Biological basis of maximal power production. Sports Medicine, 41(1), 17–38. https://doi.org/10.2165/11537690-000000000-00000

Fenanlampir, A., & Faruq, M. M. (2015). Tes dan Pengukuran dalam Olahraga. Andi Offset.

Field, A. (2022). Discovering Statistics Using IBM SPSS Statistics (6th ed.). Sage Publications.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). How to Design and Evaluate Research in Education (10th ed.). McGraw-Hill Education.

Grgic, J., Schoenfeld, B. J., Orazem, J., & Sabol, F. (2020). Effects of resistance training performed to repetition failure or non-failure on muscular strength and hypertrophy: A systematic review and meta-analysis. Journal of Sport and Health Science, 10(2), 202–211. https://doi.org/10.1016/j.jshs.2020.04.007

Indrajaya, M. (2017). Teknik Dasar Karate Modern. Jakarta: Rajawali Pers.

Koropanovski, N., Berjan, B., Bozic, P., Pazin, N., Sanader, A., Jovanovic, S., & Jaric, S. (2019). Anthropometric and physical performance profiles of elite karate athletes. Journal of Human Kinetics, 68, 109–117. https://doi.org/10.2478/hukin-2019-0064

Lopes, J. S. S., Machado, A. F., Micheletti, J. K., Almeida, A. C., Cavina, A. P., & Pastre, C. M. (2019). Effects of training with elastic resistance versus conventional resistance on muscular strength: A systematic review and meta-analysis. SAGE Open Medicine, 7, 2050312119831116. https://doi.org/10.1177/2050312119831116

Loturco, I., Nakamura, F. Y., Kobal, R., Gil, S., Pivetti, B., Pereira, L. A., & Franchini, E. (2020). Strength and power qualities are associated with punching impact in combat athletes. Journal of Strength and Conditioning Research, 34(2), 503–510. https://doi.org/10.1519/JSC.0000000000002714

Marques, M. C., Izquierdo, M., & González-Badillo, J. J. (2020). Kinetic chain and punching performance in martial arts athletes. International Journal of Sports Physiology and Performance, 15(7), 945–952. https://doi.org/10.1123/ijspp.2019-0415

Ojeda-Aravena, A., Herrera-Valenzuela, T., Valdés-Badilla, P., et al. (2021). Effects of high-intensity interval training with specific techniques in youth karate athletes. Frontiers in Physiology, 12, 711339. https://doi.org/10.3389/fphys.2021.711339

Pareja-Blanco, F., Rodríguez-Rosell, D., Sánchez-Medina, L., & González-Badillo, J. J. (2020). Velocity loss as a variable for monitoring resistance exercise. International Journal of Sports Physiology and Performance, 15(2), 217–224. https://doi.org/10.1123/ijspp.2018-0735

Stanković, D., Mitić, P., Jovanović, N., et al. (2025). Effects of elastic band training on physical performance in team sport athletes: A meta-analysis. Sports, 10(4), 402. https://doi.org/10.3390/sports10040402

Stone, M. H., Pierce, K. C., Sands, W. A., & Stone, M. E. (2021). Principles and Practice of Resistance Training. Human Kinetics.

Suchomel, T. J., Nimphius, S., & Stone, M. H. (2018). The importance of muscular strength in athletic performance. Sports Medicine, 48(4), 765–785. https://doi.org/10.1007/s40279-018-0862-z

Tabben, M., Franchini, E., Chaabène, H., et al. (2022). Karatekas educated on injury prevention and supported by fitness coaches are more likely to practice injury prevention programmes. BMJ Open Sport & Exercise Medicine, 8(1), e001297. https://doi.org/10.1136/bmjsem-2022-001297

Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2022). Research Methods in Physical Activity (8th ed.). Human Kinetics.

Turner, A., Baker, E., Miller, S., & Stone, M. H. (2020). Strength and conditioning for combat sports athletes. Strength and Conditioning Journal, 42(5), 1–15. https://doi.org/10.1519/SSC.0000000000000566