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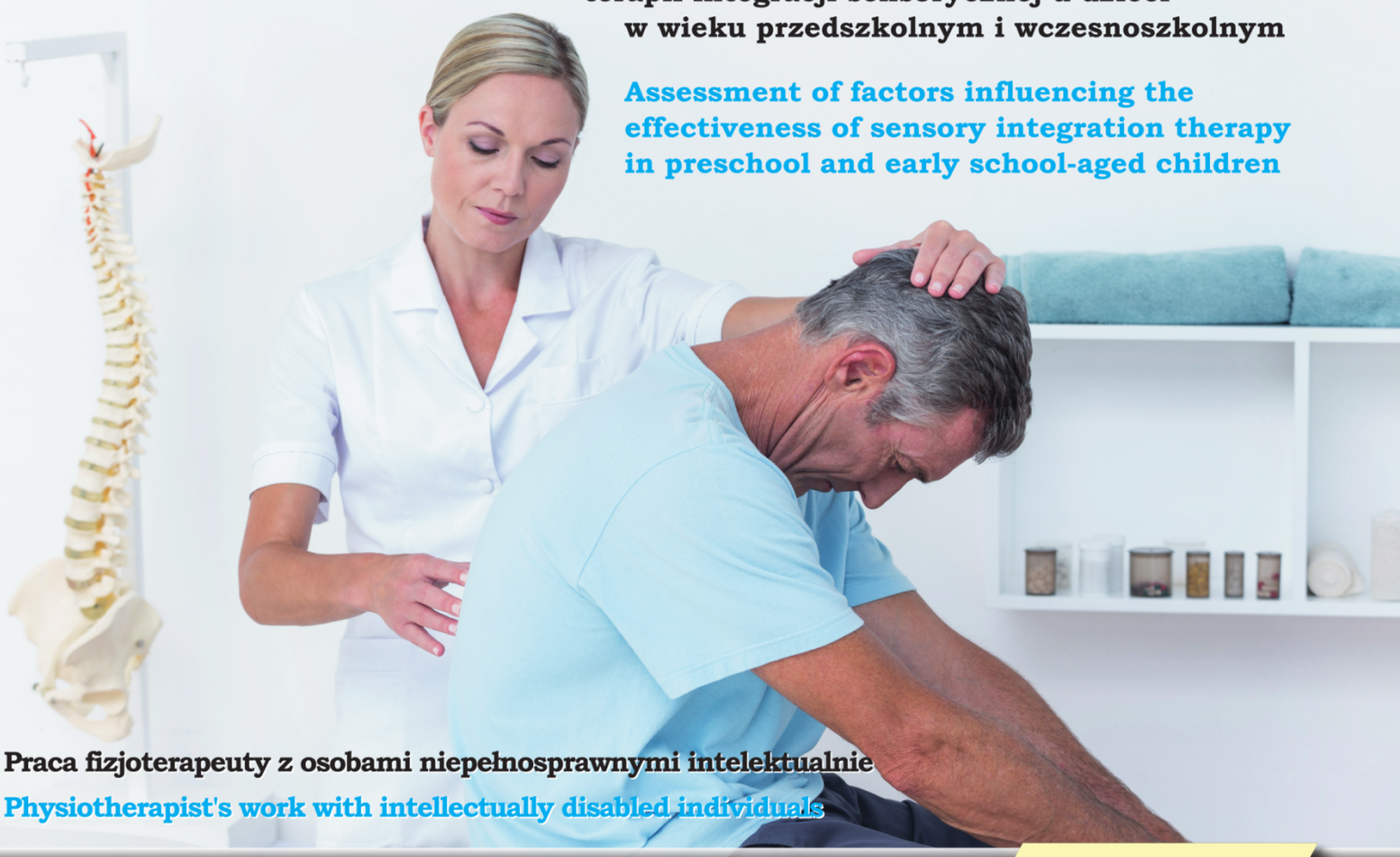
## Ocena czynników wpływających na skuteczność terapii integracji sensorycznej u dzieci w wieku przedszkolnym i wczesnoszkolnym

## Assessment of factors influencing the effectiveness of sensory integration therapy in preschool and early school-aged children



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# The effect of contrast training in increasing taekwondo athlete's strength and power

*Wpływ treningu kontrastowego na zwiększenie siły i mocy u zawodników taekwondo*

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## Abstract

Purpose. This study aimed to examine the effects of contrast training on taekwondo athletes' strength and power. Contrast training, which combines heavy and low loads in the same training session, was investigated to see if it could improve the taekwondo athletes' performance. Material and methods. In an experimental study with a pre-test-post-test control group design, 10 taekwondo athletes underwent contrast training for seven weeks. This training served as the independent variable, whereas strength and power were the dependent variables. Following that, the data were evaluated using multiple statistical tests, including Levene's test for variance homogeneity and the Kolmogorov-Smirnov test for data normality. The independent samples t-test or ANOVA was also performed to compare the means of the contrast training group and the control group. Results. Athletes were placed into two groups in this experimental study: the treatment group and the control group. According to the findings of this study, contrast training has a substantial influence on boosting taekwondo athletes' strength and power. When compared to the control group, the contrast training group had higher average strength and power ($p < 0.05$). The contrast training group had an average post-test strength of 6.868 while the control group had an average post-test strength of 6.766. Conclusions. This study has found that contrast training has a significant positive effect on developing taekwondo athletes' strength. Taekwondo athletes who received contrast training had higher average strength and power than the control group ($p < 0.05$). Thus, it can be concluded that contrast training is an effective strategy for enhancing taekwondo athletes' strength and power.

## Keywords

contrast training, taekwondo athlete, strength, plyometrics, weight training

## Streszczenie

Cel. Celem badania było zbadanie efektów treningu kontrastowego na siłę i moc zawodników taekwondo. Trening kontrastowy, łączący obciążenia ciężkie i lekkie w jednej sesji treningowej, był badany pod kątem możliwości poprawy wyników sportowych zawodników taekwondo. Materiał i metody. W badaniu eksperymentalnym z grupą kontrolną i pomiarami przed i po treningu, 10 zawodników taekwondo przeszło przez siedem tygodni treningu kontrastowego. Trening ten służył jako zmienna niezależna, podczas gdy siła i moc były zmiennymi zależnymi. Następnie dane były oceniane przy użyciu wielu testów statystycznych, w tym testu Levene'a na jednorodność wariancji oraz testu Kolmogorova-Smirnova na normalność danych. Wykonano również test t Studenta dla prób niezależnych lub ANOVĘ, aby porównać średnie grupy treningu kontrastowego i grupy kontrolnej. Wyniki: Zawodnicy zostali podzieleni na dwie grupy w tym badaniu eksperymentalnym: grupę otrzymującą terapię i grupę kontrolną. Zgodnie z wynikami tego badania, trening kontrastowy ma znaczący wpływ na zwiększenie siły i mocy zawodników taekwondo. W porównaniu z grupą kontrolną, grupa trenująca kontrastowo miała wyższą średnią siłę i moc ($p < 0.05$). Grupa trenująca kontrastowo osiągnęła średnią siłę na koniec badania wynoszącą 6.868, podczas gdy grupa kontrolna osiągnęła średnią siłę na koniec badania równą 6.766. Wnioski. Badanie to wykazało, że trening kontrastowy ma znaczący pozytywny wpływ na rozwój siły u zawodników taekwondo. Zawodnicy, którzy otrzymali trening kontrastowy, mieli wyższą średnią siłę i moc niż grupa kontrolna ($p < 0.05$). Można zatem wnioskować, że trening kontrastowy jest skuteczną strategią na zwiększenie siły i mocy zawodników taekwondo.

## Słowa kluczowe

trening kontrastowy, zawodnik taekwondo, siła, plyometria, trening siłowy


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## Introduction

For centuries, martial arts have been practiced for self-defense. Currently, martial arts of many kinds and features are frequently employed for sports, self-defense, and recreation [1]. Aikido, judo, jiu-jitsu, karate, kung fu, and taekwondo are examples of martial arts that use a variety of hand and foot techniques for striking, kicking, and parrying [2, 3]. When compared to other martial arts, taekwondo emphasizes the power of the lower limbs. Taekwondo tournament competitors' success is determined by adjusting the speed of kicks and raising the strength of the hips and lower extremities, which results in an increase in the speed and force of strikes. Taekwondo athletes must build core and lower extremity strength in order to increase kicking speed and attack frequency in the permissible area, which might impact win or defeat [4-7]. After acquiring basic technical and tactical training in combat sports, punches and kicks become effective weapons through repetition. In taekwondo battles, the two most significant fast-movement skills are punching and kicking. However, kicks play a more vital function than punches. In fact, at the 2002 Sydney Olympics, the 98% kicking style came into use [8]. Building fundamentals for athlete growth has been suggested to produce great strength and power, which have a significant impact on athlete performance [9]. This demonstrates the importance of strength and explosive leg force in winning events. As a result, the coaches' attention is drawn to organizing and implementing effective training to generate explosive leg strength [10].

Despite many different combat sports, only a few of them are included in the Olympic program, such as wrestling, judo, karate, fencing, taekwondo, and boxing. Therefore, combat sports competitors strive to achieve their best performance during each Olympic cycle in order to achieve the highest level of successful sporting performance [11]. Combat sports contain numerous complicated physical components that play a role during training and competition, such as maximal strength, strength endurance, muscle strength, speed, flexibility, aerobic, and anaerobic [12, 13]. Taekwondo relies on muscle strength and speed, which are features of the quick attacks of taekwondo. Muscle power has a large influence on attack tactics in combat sports such as punches, kicks, elbows, knees, throwing techniques, transitions to the ground, and other foundation techniques [14]. Muscle strength can be obtained if the athlete has first gained maximum strength. In other words, maximal strength and muscle strength have a linear and positive relationship [15]. A good training approach shapes good athlete performance. The athlete's abilities are the most significant factor in determining an athlete's success in competition. Taekwondo athletes must be physically active for a short period of time and have explosive strength [7]. Therefore, strength training is needed as a foundation to support other physical abilities such as endurance, speed, power, and agility.

There are various methods for increasing an athlete's strength and power. Weight training has been shown to improve athletes' strength with relatively heavy loads (80-90% of 1 RM) in a few repetitions [16, 17]. It has also been related to greater increases in strength than light weights. Unlike traditional weight training methods, plyometric training has been proposed as a means to increase muscle strength and the rate of strength development, which increases performance in dynamic sports like running and jumping [18]. Another training, plyometrics, is believed to help bridge the gap between strength and power training methods by using the athlete's own mass as a stimulus rather than external loads as is typically used in resistance training and having 100 to 250 milliseconds of contact with the ground to increase linear speed, strength, ability to change direction, and running efficiency [19].

Contrast training (CST) approaches have already been shown in the literature to be an effective strategy for developing muscle strength and power levels [20]. CST is described as a strength training program that incorporates both heavy and light weights within the same training session [21]. Some studies using CST for two weeks found that it could improve athletic performance [22, 21]. Another research found that the contrast strength group had their strength improved, although the plyometric group demonstrated significantly better improvement [23]. Several research findings indicate that CST can have an effect on athletic performance. However, due to the ineffective placement of the training methods, weight training and plyometric training can result in injuries, lowering the athlete's performance in competition. Aside from that, no studies have been conducted on the effect of contrast strength training on martial arts athletes' strength, particularly taekwondo, which places the greatest emphasis on strength and power. Therefore, as a novelty, this study was designed to examine the impact of employing contrast strength training to see if it could enhance taekwondo athletes' strength and power.

## Material and methods

### Participants

This research was carried out on ten senior taekwondo athletes while undergoing a 2022 Sleman Regency Regional Sports Week training camp for seven weeks. The Sleman Regency Taekwondo Team was ranked second in the accumulated medals from the Yogyakarta Special Region Regional Sports Week.

### Procedures

Contrast training is a set of exercises in which heavy and light weights are alternated. Lifting heavy weights during the first training session and smaller weights during the second training session is an example of contrast training [9]. In this training, heavy and light weights are alternated to improve muscle strength. The greatest approach for performing contrast training is to exhaust all weight training subjects. Athletes can do a series of squats, leg presses, barbell lunges, chest presses, and bench presses beginning at 60% of maximal repetitions and ending with a recovery time. Finally, lightweight training (plyometrics) such as hops, jump to box, single-leg push-offs, and depth pushups can be done.

Muscle strength refers to a physical set of muscles' ability to exert pressure against an obstruction or object [24]. This research aims to measure the strength capability required to lift 100% of the load assessed using the 1RM test.

Power is the ability of a collection of muscles to move fast over barriers [25]. This research assessed the athletes' power using the triple jump test.


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**Statistical analysis**

The data were then analyzed using two-way ANOVA with the help of SPSS 20 at a significance level of 0.05. Tukey's test was performed to compare means. The normality test was carried out to determine whether the data distribution was normal using the Kolmogorov-Smirnov test. The Homogeneity of Variance Test was conducted to find out if the two groups came from a population that had homogeneous variance using the Levene Test.

## Results

Both experimental and control groups completed the research stages in accordance with the method and design. All training sessions were attended by all athletes without complaints of injuries that interfered with training or testing activities.

Based on the strength and power pretest results, the experimental group obtained a mean of 5.1220, a median of 5. 1450, a mode of 2.94, with a standard deviation of 1.00246, a minimum score of 2.94, and a maximum score of 6.51 (Table 1).

Meanwhile, the strength and power posttest results revealed that the experimental group had a mean of 6.868, a median of 6,6, a mode of 5.59, with a standard deviation of 1,02776, a minimum score of 5,39, and a maximum score of 8,52 (Table 1).

**Table 1. Pretest and posttest – experimental group**

| Analysis Results | Pretest | Posttest |
|---|---|---|
| Mean | 5.1220 | 6.868 |
| Median | 5.1450 | 6.6 |
| Mode | 2.94 | 6.59 |
| Standard Deviation | 1.00246 | 1.02776 |
| Minimum Score | 2.94 | 5.39 |
| Maximum Score | 6.51 | 8.52 |

On the other hand, in the pretest, the control group had a mean of 5.7330, a median of 5.6650, a mode of 4.81, with a standard deviation of 0.62861, a minimum score of 4.81, and a maximum score of 6.61 (Table 2).

In the posttest, the control group obtained a mean of 6,7660, a median of 6.86, a mode of 6.86, with a standard deviation of 0.41647, a minimum score of 5.92, and a maximum score of 7.50 (Table 2).

**Table 2. Pretest and posttest – control group**

| Analysis Results | Pretest | Posttest |
|---|---|---|
| Mean | 5.7330 | 6.7660 |
| Median | 5.6650 | 6.8600 |
| Mode | 4.81 | 6.86 |
| Standard Deviation | 0. 62861 | 0.41647 |
| Minimum Score | 4.81 | 5.92 |
| Maximum Score | 6.61 | 7.50 |

Next, to ensure that each variable came from a normally distributed population, a normality test was carried out on each variable. The test was done to measure the pretest and posttest data on the athlete's strength and power. If the Asymp. Sig was higher than the alpha value (0,05), the population could be considered normal. On the contrary, if the Asymp. Sig was lower than the alpha value (0,05), the data were not normally distributed. With the help of SPSS 16.0 for Windows, the normality test was performed using Kolmogorov-Smirnov formula. If the population had a normal distribution and the p-value was greater than 0.05 significance, then the population was not significant. Table 3. shows the results of normality calculations using the SPSS 16.0 for Windows.

**Table 3. Data normality test (Kolmogorov-Smirnov)**

| Variable | Z | Asymptotic significance | Conclusion |
|---|---|---|---|
| Pretest Contrast | 0.659 | 0.779 | Normal |
| Posttest Contrast | 0.630 | 0.823 | Normal |
| Pretest Control | 0.557 | 0.915 | Normal |
| Posttest Control | 0.599 | 0.866 | Normal |


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The F-test or Levene test was used to calculate homogeneity. In this study, the Levene test was carried out using SPSS 25.0 for Windows. The significance value of the Levene test in both experimental and control groups was greater than 0.05 as can be seen in Table 4. This indicates that the variances of the two groups were homogeneous.

**Table 4. Homogenity test**

| Category | Levene Statistic | Asymptotic significance | Conclusion |
|---|---|---|---|
| Pretest of athlete's strength and power | 0.954 | 0.342 | Homogen |
| Posttest of athlete's strength and power | 1.975 | 0.177 | Homogen |

Hypothesis testing was carried out with a significance level of 0.05. If the probability of error was less than or equal to 0.05, the null hypothesis (Ho) was rejected. If it was more than or equal to 0.05, the null hypothesis (Ho) was accepted. After performing the two-way ANOVA test, an F value of 4.981 and a P value of 0.039 were obtained. Because the P value was less than 0.05, H0 could be rejected and Ha was accepted. Therefore, it can be concluded that there was a difference between regular training and contrast training on improving taekwondo athletes' strength and power (Table 5).

As can be seen in the table above athletes with contrast training had a mean of 1.9090, while the control group had a mean of 0.9770. This indicates that athletes with contrast training had greater strength and power than the control group (without treatment).

**Table 5. ANOVA test result**

| Method | Mean | F calculation | p-value |
|---|---|---|---|
| Contrast | 1.9090 | 4.981 | 0.039 |
| Control | 0.9770 | | |

## Discussions

The study's findings showed that the contrast training method carried out for seven weeks on 10 taekwondo athletes contributed to strengthening and increasing their strength and power. The contrast training method is a training strategy that mixes heavy and light weights in contrast, essentially doing training activities with heavier weights lifted during the first exercise and lighter weights lifted during the second activity [9]. Contrast training is a type of resistance training that involves alternating between workouts that use heavy and light weights to build muscles. To apply this training strategy, the training movement must be able to flip between two different forms of training. The first exercise involves lifting weights, whereas the second involves a similar movement pattern but stronger muscles. Contrast training strategies seek to develop strength while also increasing the rate at which a muscle or group of muscles is activated [26]. Contrast training is completing a strength training program before starting plyometric training [27].

The analysis in this study shows that contrast training has an effect on increasing the muscle strength of taekwondo athletes. One example of contrast training is a set of back squats performed at 85% of one repetition maximum followed by a set of hop jumps performed at 30% of 1 RM [28]. This is because contrast training involves heavy and light loads with relatively similar biomechanical movements and is carried out at maximum movement speed [20]. Plyometric training is a part of contrast training with a concept that aims to increase muscle strength and power. Using different weights during the same exercise, contrast training is claimed to be very effective for increasing strength. Some types of strength training usually use a combination of high and low-intensity loads. The use of various heavy and light loads in contrast training methods as a strength training technique is supported by Post Activation Potentiation (PAP) activity in the neuromuscular system. Contrast training has been shown to produce substantial neuromuscular modifications that are more likely to transfer to multiple performance domains.

Post Activation Potentiation has lately been employed to boost muscle performance and power generation dramatically. PAP is generated by high-resistance training conducted prior to biomechanically equivalent ballistic actions [29]. PAP is triggered by contractions at maximum intensity or near maximum intensity occurring repeatedly aimed at increasing peak strength and strength development. During contractions, mechanical strength (strength and speed) can increase, which affects sports performance [30]. The process of increasing PAP is in line with the onset of muscle fatigue which affects the condition of energy expenditure and subsequent performance. Activities that can increase PAP performance will cause a higher increase in fatigue, and if recovery from fatigue is greater, a decrease in PAP can occur due to a longer recovery threshold between the end of training and the beginning of training [31]. Therefore, the process of increasing PAP with greater fatigue recovery can be further investigated. Post-activation potentiation (PAP) has been shown to improve performance during movement when adapted to specific sporting activities.

The primary goal of training is to increase an athlete's performance in competition. The applicability and accuracy of training methods determine an athlete's success in competition. As a result, the position of a trainer is critical and should meet academic and experience requirements. Taekwondo athletes


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must be physically active for a short period of time and have explosive strength [7]. This highlights the essential role of strength and explosive leg force in winning events. Therefore, the trainers should focus on organizing and implementing effective training to enhance explosive leg strength through the use of the appropriate treatment [10].

Strength training is required to support other physical abilities such as endurance, speed, power, and agility. It has been proposed that developing principles for athlete growth will result in increased strength and power, which will have a substantial impact on athlete performance [9]. However, this study was hampered by a lack of particular sample size information. Aside from that, the usefulness of various training strategies in improving physical strength was not widely discussed. This study also did not address the potential flaws and detrimental impacts of various training approaches, such as failure training. Additionally, this study did not consider the needs and characteristics of athletes, both of which are critical considerations in establishing an effective strength training program. Future research is expected to analyze the side effects of training methods as well as investigate the optimal placement of training including training volume, rest interval between sets, and load to produce more optimal results. Is also suggested to explore the effects of post-potentiation activation on strength performance particularly when performing plyometric exercises.

## Conclusions

This study has found a significant effect of contrast training on increasing taekwondo athletes' strength and power. The contrast training group showed a higher mean of strength and power compared to the control group. Thus, it can be concluded that contrast training is an effective method for strengthening and increasing taekwondo athletes' strength.

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