

# The benefit of a four-week range of motion exercise on hand muscle strength in children with Down Syndrome

Slamet Raharjo<sup>1ABDE</sup>, Mahmud Yunus<sup>1ABD</sup>, Ramdan Pelana<sup>2BCD</sup>,  
Raja Mohammed Firhad Raja Azidin<sup>3BCD</sup>

<sup>1</sup> Department of Sports Science, Faculty of Sports Science, State University of Malang, Indonesia

<sup>2</sup> Department of Sport Science, Faculty of Sport Science, State University of Jakarta, Indonesia

<sup>3</sup> Faculty of Sports Science and Recreation, Universiti Teknologi MARA, Malaysia

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## Abstract

**Background and Study Aim** Down syndrome is linked to motor disorders, leading to reduced physical activity and fitness, including diminished aerobic endurance and muscle strength. Study Aim - to investigate the efficacy of range of motion exercises in enhancing hand muscle strength in children with Down syndrome.

**Material and Methods** This research employed a true experimental approach with a pre-test and post-test control group design. The study sample consisted of 18 children with Down syndrome, aged between 10 to 12 years. The selected participants underwent range of motion exercises, which were systematically conducted 3 times a week over a span of 4 weeks. To assess the efficacy of the exercises, hand muscle strength was gauged both before and after the intervention. The measurement tool utilized was a Handgrip Strength (HGS) test, executed with the aid of a Takei dynamometer, ensuring accuracy and consistency in the results. For the statistical analysis of the collected data, a paired sample t-test was employed. The threshold for statistical significance was set at a p-value of less than 0.05 or 5%.

**Results** The range of motion exercise, when carried out for 4 weeks, has been shown to increase hand muscle strength in children with Down syndrome. Based on the results of statistical analysis of hand muscle strength pretest and posttest in the control group (CtrG) ( $6.06 \pm 2.11$  vs.  $6.13 \pm 2.23$  kg,  $p \geq 0.05$ ), and the experimental group (ExpG) ( $6.10 \pm 2.68$  vs.  $8.95 \pm 2.69$  kg,  $p \leq 0.001$ ).

**Conclusions** These exercises play a pivotal role in boosting muscle strength in children with Down syndrome. Emphasizing their physical health, especially muscle strength, is vital for their current educational pursuits and future well-being.

**Keywords:** muscle strength, children, down syndrome, range, motion exercise

## Introduction

Trisomy 21 (Ts21) is the most prevalent congenital chromosomal anomaly and a hereditary cause of Down syndrome [1]. The etiology of the Down syndrome genotype-phenotype, or Ts21, affects 1 in 800 live births [2, 3]. Down syndrome is distinguished by anatomical abnormalities as well as intellectual difficulties [4]. Short height, muscular hypotonia, atlantoaxial instability, reduced neuron density, cerebellar hypoplasia, intellectual impairment, and congenital heart abnormalities are common in people with Down syndrome [5]. Down syndrome was first recognized in 1866 by an English physician named John Langdon Down, but its relation to chromosome 21 was found over 100 years later by Dr. Jerome Lejeune in Paris [6]. Children with special needs are at higher risk of being physically inactive and associated health risks later in life [7]. Down syndrome cannot be cured because Down syndrome is not a disease. Primary changeable outcomes are short- and long-term

goals for Down syndrome children and their parents including increased independence and quality of life [8]. According to the findings of Fernández Scotto and Eymann [9], Down syndrome children between the ages of 2 and 4 have a worse health-related quality of life., which may influence social and academic performance. Therefore, Down syndrome is a problem that still requires a solution.

Children with Down syndrome have neuromuscular disorders that cause developmental delays, poor movement quality, and poor balance [10]. Movement difficulties linked with Down syndrome can lead to a more sedentary lifestyle and decreased physical fitness, with adults having poorer aerobic capacity than healthy people [11, 12]. In addition, children with Down syndrome consistently show decreased upper and lower body muscle strength compared to children with normal conditions [13]. Overall motor performance parameters can be known from muscle strength [14]. Reduced muscle fitness in children is associated with negative health outcomes [15]. Meanwhile, a school-based exercise program that involves strength training can help

youngsters increase their muscle conditioning, preparing them for the demands of sports and physical activities [16].

Exercise is known to help improve strength, balance, and physical function in people with Down syndrome [17]. Hand grip strength has been utilized as a proxy for entire body strength [18-19]. Handgrip strength is a potential marker in assessing muscle metabolism [20]. Skeletal muscle plays a key role in metabolic function, facilitates glucose uptake and storage, and is related to physical performance [21]. Skeletal muscle is the human body's biggest organ, 20–40% of total body weight in women and 30–50% in men, and serves as the body's principal protein storage organ [22]. Therefore, it is necessary to have an exercise program to support the manipulative skills of Down syndrome children. Down syndrome children are expected to do sports with low or moderate intensity, as revealed by Shin & Park [23] that sports programs with a short duration with an intensity of 30–60 minutes per week are more effective than long durations. Selection of the right exercise program with the appropriate dosage intervention is a promising activity for the development of children's gross motor skills [24]. Range of motion exercises are performed to maintain or increase the ability to move joints correctly and completely in order to create muscle development and tone. Range of motion is the movement normally carried out by the joint in question. The provision of range-of-motion exercise therapy in the form of passive movements is very useful in maintaining the physiological properties of muscle and joint tissues [25]. Range of motion for someone with intellectual impairment can also provide light exercise for them and it is also simple to do various warm-ups or in a light sport. The objective of this research is to show how a range of motion exercises can improve the hand muscle strength of children with Down syndrome.

## Material and Methods

### Participants

The study involved 18 children with Down syndrome, aged between 10 to 12 years. All participants willingly joined the research, as evidenced by the informed consent forms signed on their behalf by their parents or guardians. All procedures in this study adhered to the Helsinki Declaration standards concerning ethical conduct with human participants.

### Research Design

This was a true-experimental study using a pre-test and post-test control group design. All participants received the same dosage of the range of motion exercise intervention. The exercise involved holding a rubber ball with the dominant hand for 10 minutes, performing 3 repetitions

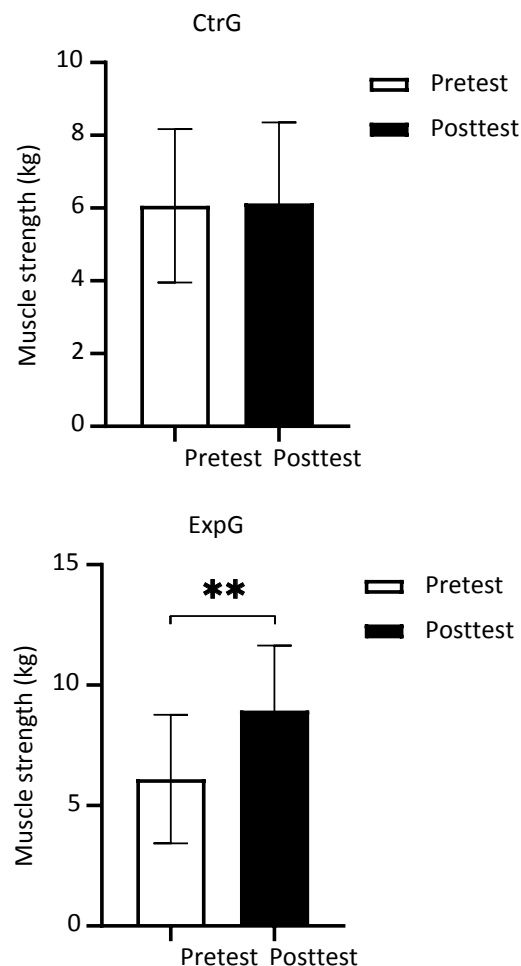
for each exercise with a 2.5-minute rest interval between repetitions. This regimen was followed 3 times a week for a duration of 4 weeks. Hand muscle strength was measured using the Handgrip Strength (HGS) test with a Takei dynamometer (TKK 5401; Takei Scientific Instruments, Tokyo, Japan) both before and after the intervention.

### Statistical Analysis

Data were first subjected to a normality test using the Shapiro-Wilk method. Differences were then assessed using both paired sample t-tests and independent sample t-tests. All statistical analyses were conducted with a significance level set at 5%.

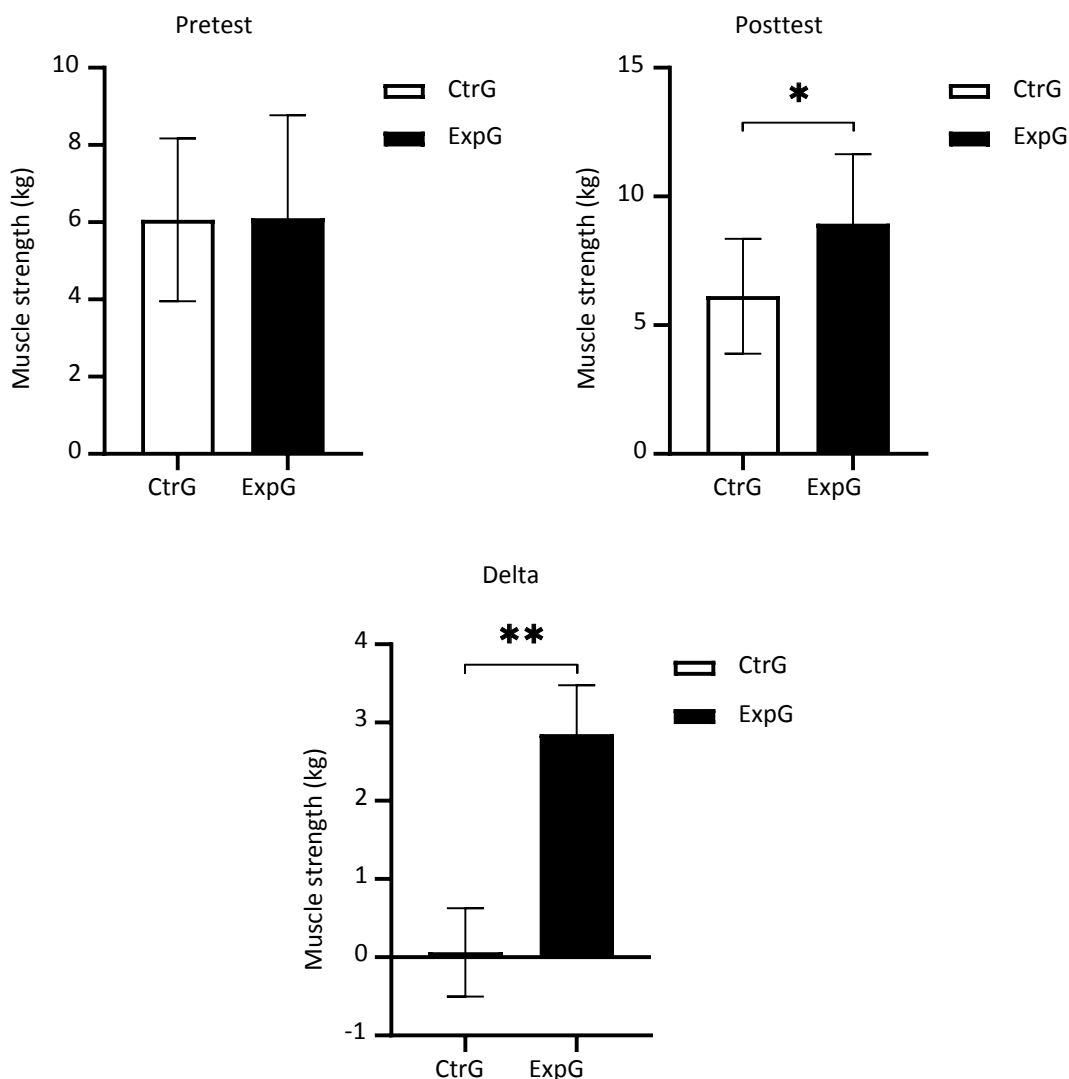
## Results

The results of hand muscle strength analysis between the pretest and posttest in each group are presented in Figure 1, while the results of hand muscle strength analysis between the control group (CtrG) and the experimental group (ExpG) are presented in Figure 2.



**Figure 1.** Hand muscle strength (kg) between pretest and posttest. (\*\*) Significant to pretest ( $p \leq 0.001$ ).

Figure 1 demonstrates the change in hand muscle strength (in kg) between two time points:



**Figure 2.** Hand muscle strength (kg) between the control group (CtrG) and the experimental group (ExpG). (\*) Significant to CtrG ( $p \leq 0.05$ ). (\*\*) Significant to CtrG ( $p \leq 0.001$ ).

the pre-test and the post-test period. Based on statistical analysis, a significant increase in hand muscle strength was observed in the post-test period compared to the pre-test ( $p \leq 0.001$ ). This indicates the effectiveness of the applied training method in improving hand muscle strength.

Figure 2 compares the hand muscle strength (in kg) between the control group (CtrG) and the experimental group (ExpG). It was found that the experimental group showed significant improvement compared to the control group at significance levels of  $p \leq 0.05$  and  $p \leq 0.001$ . This suggests that the experimental group employed a method that proved effective in enhancing hand muscle strength.

Based on the provided analysis of the charts, it can be concluded that the research demonstrates positive results concerning the improvement of hand muscle strength.

## Discussion

The objective of this research is to show how a range of motion exercises can improve the hand muscle strength of children with Down syndrome. Our results show that range of motion exercises significantly increase muscle strength in children with Down syndrome. According to Ballenger et al. [28], aerobic and strength training improves physical fitness parameters such as maximum oxygen uptake, maximum heart rate, upper and lower body strength, body weight, and body fat percentage. This study involved children with Down syndrome aged 10-12 years. Range of motion exercise is done by holding a rubber ball for 10 minutes and doing 3 repetitions for each exercise with 2.5 minutes of rest between repetitions. The range of motion exercise is carried out 3x/week for 4 weeks. Measurement of hand muscle strength using the Handgrip strength (HGS) was carried out before and after the intervention [26,

27]. Differences (in body structure and function) in children with Down syndrome have been proven to affect activity and involvement during treatments [29-30]. This is one of the limitations of researchers in determining the type of aerobic or resistance training. However, we have endeavored to monitor and supervise the application of exercise doses to comply with the exercise program that we have made for its application.

The potential mechanism for increasing muscle strength in Down syndrome may be due to the occurrence of regular and programmed muscle contractions that lead to adaptation of the body which is characterized by an increase in muscle strength. Increased physical exercise has been linked to improved muscular strength in people with Down syndrome [31, 32]. Due to their restricted cognitive capacities, people with Down syndrome have special requirements and problems that make them exposed to risk factors in the obesogenic environment [33]. According to the WHO, physical activity is any skeletal muscle movement that requires energy expenditure and can be performed at varying intensities, whereas physical fitness is a set of attributes achieved or possessed regarding the ability to perform physical activity or exercise with certain skills that affect sports achievements, such as the ability to carry out daily activities and the learning process at school [34, 35, 36, 37, 38]. Down syndrome people have been linked to a lack of physical exercise [39], and this can have an impact on poor health conditions [40]. Inadequate physical activity is defined as failing to reach recommended levels of physical activity in children and adolescents aged 5 to 17 years (60 minutes of moderate to high-intensity physical exercise daily

[41]. However, independence and quality of life are goals expected by parents and people close to children with Down syndrome [8]. It is important for parents and people who influence children with Down syndrome to pay more attention, especially in terms of muscle strength for children with Down syndrome. Muscular strength was a predictor and indicator of current and future health regardless of age and gender [42]. Predictors of future disability and death in middle-aged and older people may be due to low hand grip strength [42, 43]. On the other hand, health conditions are a basic requirement for children in pursuing learning, especially at school [44]. It can be concluded that a significant range of motion exercises can increase muscle strength in children with Down syndrome. So, it becomes important for children with Down syndrome to pay attention to their physical condition, especially the level of muscle strength. Because this will have an impact on health conditions about the life expectancy of children with Down syndrome in dealing with the current learning process and for life at a later age.

## Conclusion

Range of motion exercise carried out for four weeks has been shown to increase muscle strength in children with Down syndrome. As a result, a range of motion exercises can be used as an alternative therapy to help children with Down syndrome improve their motor abilities.

## Conflicts of Interest

The authors declare no conflict of interest in this study.

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#### Information about the authors:

**Slamet Raharjo;** (Corresponding Author); <https://orcid.org/0000-0002-0708-867X>; slamet.raharjo.fik@um.ac.id; Department of Sports Science, Faculty of Sports Science, State University of Malang; Malang, Indonesia.

**Mahmud Yunus;** <https://orcid.org/0000-0002-9611-8921>; mahmud.yunus.fik@um.ac.id; Department of Sports Science, Faculty of Sports Science, State University of Malang; Malang, Indonesia.

**Ramdan Pelana;** <https://orcid.org/0000-0003-2540-4020>; ramdanpelana@unj.ac.id; Department of Sport Science, Faculty of Sport Science, State University of Jakarta; Jakarta, Indonesia.

**Raja M.F.R. Azidin;** <https://orcid.org/0000-0003-4770-2870>; firhad@uitm.edu.my; Faculty of Sports Science and Recreation, Universiti Teknologi MARA; Shah Alam, Malaysia.

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