

## The Effect of Combination of Core Stability Training and Lower Extremity Strength Training on Static Standing Balance Ability in a Child with Down Syndrome

Adelia Rahmayanti, Farid Rahman\*, Intan Herlinawati

Physiotherapy Department, Faculty of Health Science, Universitas Muhammadiyah Surakarta, Indonesia

\*Corresponding Author

Email: [farid.rahman@ums.ac.id](mailto:farid.rahman@ums.ac.id)

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### Abstract

*Balance is the ability to stay in one position with good control. Children with a diagnosis of Down syndrome usually have decreased muscle tone (hypotonia) or muscle weakness, so that their balance is disturbed and they are more prone to falling when standing. Core stability and lower extremity strength exercise are expected to improve the ability of static standing balance in children with a diagnosis of Down syndrome. The aim of the study is to determine the effect of giving a combination of core stability and lower extremity strength exercises on the static standing balance ability in children with Down syndrome. This study uses a single subject research on a child with a diagnosis of Down syndrome who is given core stability and lower extremity strength exercise for 4 weeks to improve the ability of static standing balance. The ability of static standing balance in this study was measured using Gross Motor Function Measure (GMFM). Measurements were taken before exercise was given (A1), follow-up (B) and final evaluation (A2). After being given exercise twice for four weeks, there was no increase in the GMFM score, so it was concluded that there was no increase in the ability of static standing balance in children with Down syndrome in this study. In conclusions, giving core stability exercise and lower extremity strength exercise twice for four weeks is considered not to be able to improve the ability of static standing balance in children with Down syndrome.*

**Keywords:** Down Syndrome; Balance; Static Standing Balance; Core Stability Exercise; Lower Extremity Strength Exercise

### INTRODUCTION

Balance is the ability to stay in one position with good control. Balance can occur because of the ability of a capable postural control (Ludwig et al., 2020; Pollock et al., 2000). Impaired balance and postural control in a person can occur due to problems with the muscles so that the ability to activate posture properly is hampered (Villarroya et al., 2012). According to Villarroya et al., (2012), children with a diagnosis of Down syndrome generally experience a decrease in postural control abilities so they tend to experience growth and development problems.

Children with a diagnosis of Down syndrome usually experience decreased muscle tone (hypotonia) or muscle weakness due to incomplete brain development processes (Agarwal Gupta & Kabra, 2014; Wang et al., 2012). Hypotonus experienced by children with Down syndrome disrupts their balance ability, making them more prone to falling while standing (Aly & Abonour, 2016). According to Chen et al., (2015), children born with normal conditions

generally begin to stand up with good postural control at the age of 10-12 months, while children with a diagnosis of Down syndrome can only stand at the age of 24 months.

Static standing balance is the ability to maintain and control the posture at one point well without falling (Villarroya et al., 2012). This ability is important in the growth process of children before they enter the walking phase (Wu et al., 2015). Static standing balance involves proprioceptive abilities, motor coordination, sensory-motor integration, and anticipatory changes in posture. Thus, missing the static standing balance phase can lead to impaired growth and development in children (Villarroya et al., 2012).

Children with a diagnosis of Down syndrome tend to lead a sedentary life because of general hypotonia or muscle weakness in all their extremities (Hussein, 2017). Due to this general hypotonus condition, children with Down syndrome are more prone to have poor posture such as scoliosis and kyphosis (Arumugam et al., 2016). Core stability exercises are given to strengthen weak muscles and correct the incorrect posture due to trunk and abdominal muscle weakness. The core stability exercise provided involves lumbar-pelvic proprioception, spinal stabilization, and abdominal exercise (Saeed et al., 2019).

Based on research conducted by Aly & Abonour (2016), it is proven that providing core stability exercises can improve balance in children with Down syndrome within eight weeks, performed for three times per week. The provision of core stability exercises can strengthen the core stabilization area of the muscles in children with Down syndrome so that the physical abilities of children with Down syndrome can work optimally and postures that can really be maintained properly during daily activities (Saeed et al., 2019).

Giving core stability exercises will strengthen the deep muscles and trunk muscles so that they can support the movement of the lower extremities. Core stability exercises can improve the neuromuscular system which can optimize lumbo-pelvic-hip chain mobility, muscle balance, proximal stability and improve lower extremity function. These points can increase the strength of the lower extremity muscles so that they can support the body optimally (Aly & Abonour, 2016).

Hip and knee muscle strength in children with Down syndrome tend to be weaker than normal children (Eid, 2015). This makes children with Down syndrome more susceptible to flat foot which is a plantar ankle condition that does not have an arch. The arch of the plantar ankle works to help support body weight and reduce the load on the plantar ankle (Endo et al., 2020). If the flat foot condition is left unattended, it can cause postural disorders in children when standing or walking (Arumugam et al., 2016). Therefore, it is necessary to offer strengthening exercises for the lower extremities to strengthen the muscles in the lower limbs and avoid posture disturbances (Lin & Wuang, 2012).

Strengthening exercises in the form of core stability and lower extremity strength exercises are expected to increase trunk, abdominal and lower extremity muscle strength in children with Down syndrome (Lin & Wuang, 2012; Mercer & Lewis, 2001; Saeed et al., 2019). Strength of trunk muscles, abdomen and lower extremities is the main component for fluent standing ability in children. Thus, this study was conducted with the aim of knowing the effect of core stability and lower extremity strength training on static standing balance in children with a diagnosis of Down syndrome.

## **METHOD**

### **Research design**

This study was conducted using single-subject research with an ABA design approach. This design was used to determine the effect of combination of core stability and lower extremity strength exercise on the ability of static standing balance in children with Down syndrome diagnosis: Case Report. The ABA research design can be seen in Figure 1 as the following:

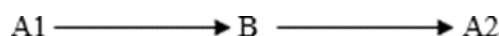


Figure 1: ABA Research Design

Information:

- A1: baseline, to examine the children's motor skills using the GMFM (Gross Motor Function Measure) instrument
- B: intervention (core stability and lower extremity strength exercise) for 4 weeks (8 times) then evaluated after treatment ended.
- A2: re-examination or evaluation after being given treatment 8 times.

### **The subject of the study**

The subject in this study was a child with a diagnosis of Down syndrome who was 2 years 2 months old with a height of 85 cm and a weight of 11 kg. This patient was born normally at 37 weeks through spontaneous delivery. At birth, the patient had neonatal hyperbilirubinemia. At the age of 6 months, the patient had a delay in sitting. It was found that the patient had microcephaly and non-communicating hydrocephalus, which was considered to be one of the factors why the patient experienced a growth delay (Marano et al., 2020).

This research was conducted at Intan Fisioterapi Anak (IFA), Ngemplak, Boyolali, Central Java, from November 3, 2021 to November 27, 2021. The baseline stage in this study was conducted twice, on November 5, 2021 and November 8, 2021 to measure children's gross motor skills. The intervention given in this study was in the combination of core stability exercise and lower extremity strength exercise.

### **Instruments of the study**

The ability of static standing balance in children with Down syndrome in this study was measured using the Gross Motor Function Measure (GMFM) instrument. Gross Motor Function Measure (GMFM) is a measurement used to see gross motor skills in children who have growth and development problems such as cerebral palsy and Down syndrome. There are 88 examination items which are divided into:

- a. Lying down and rolling over, which consists of 17 activities while lying down and rolling over
- b. Sitting, which consists of 20 activities while sitting
- c. Crawling and kneeling, consisting of 14 activities while crawling and kneeling
- d. Standing, which consists of 13 activities while standing
- e. Walk, run and jump; which consists of 24 activities while walking, running and jumping.

Patients in this study complained of not being able to stand fluently. The patient is only being able to do 9 of the 13 items at point D, which is standing.

Assessment of static standing balance ability was measured using a gross motor functional measure (GMFM) and was carried out at the beginning, middle and end of the study. The

development of the patient's static standing balance ability can be assessed from what movements the patient has been able to do in each item in the GMFM.

### Procedures

The intervention given in this study was in the form of core stability exercise and lower extremity strength exercise. The core stability exercises (consists of neck flexion, pelvic-tilting exercise and standing) was carried out for 10 minutes each. Lower extremity exercise (consists of kneeling and sitting squat) for kneeling is done for 30 minutes, while sitting squat is done for 15 minutes. The following is a detailed explanation of the interventions provided:

a. Core stability exercise

- Neck flexion

This exercise is given with the aim of stimulating the patient's abdominal muscles to contract by passively doing neck flexion to the patient. Position of the patient was supine lying and the therapist handles the patient's occipital joint towards neck flexion. By doing this movement, the patient will be stimulated to lift both legs so that the abdominal muscles will contract.

- Pelvic tilting

This exercise is given with the aim of strengthening the abdominal and trunk muscles. The exercise is given when the patient is standing with a support stool whose height reaches the patient's neck and is placed in front of the patient when standing. In this position, the therapist mobilizes the patient's pelvis anteriorly and posteriorly while keeping the trunk and lower extremities straight.

- Standing

This exercise is given with the aim of correcting the patient's position which tends to be incorrect when standing. Before performing this exercise, the patient is required to wear socks and AFO shoes. After that the therapist will loop the rope around the patient's axilla, hip and knee. Standing is done for 30 minutes.

Table 1. Dose of core stability exercise

Week	Frequency	Intensity	Time	Type
1	Twice a week	1 set	10 minutes	<i>Neck flexion</i>
		1 set	10 minutes	<i>Pelvic-tilting exercise</i>
		1 set	30 minutes	<i>Standing</i>
2	Twice a week	1 set	10 minutes	<i>Neck flexion</i>
		1 set	10 minutes	<i>Pelvic-tilting exercise</i>
		1 set	30 minutes	<i>Standing</i>
3	Twice a week	1 set	10 minutes	<i>Neck flexion</i>
		1 set	10 minutes	<i>Pelvic-tilting exercise</i>
		1 set	30 minutes	<i>Standing</i>
4	Twice a week	1 set	10 minutes	<i>Neck flexion</i>
		1 set	10 minutes	<i>Pelvic-tilting exercise</i>
		1 set	30 minutes	<i>Standing</i>

b. Lower extremity strength exercise

- Sitting squat

This exercise is given with the aim of increasing the strength of the lower extremity muscles. The exercise is given when the patient is in a squatting position, then the therapist sits behind the patient while keeping the patient in a squatting position.

- Kneeling

This exercise is given with the aim of increasing the strength of the hip muscles. The exercise is given when the patient is kneeling with a support stool whose height reaches the patient's neck. The support stool is placed in front of the patient. The therapist sits behind the patient while keeping the patient in a kneeling position with the trunk in a stable position. The following is the dose of giving lower extremity exercise.

Table 2. Dose of lower extremity strength exercise

Week	Frequency	Intensity	Time	Type
1	Twice a week	1 set	10 minutes	<i>Sitting squat</i>
		1 set	10 minutes	<i>Kneeling</i>
2	Twice a week	1 set	10 minutes	<i>Sitting squat</i>
		1 set	10 minutes	<i>Kneeling</i>
3	Twice a week	1 set	10 minutes	<i>Sitting squat</i>
		1 set	10 minutes	<i>Kneeling</i>
4	Twice a week	1 set	10 minutes	<i>Sitting squat</i>
		1 set	10 minutes	<i>Kneeling</i>

### Data analysis

Data analysis and processing in this study used a descriptive statistical approach, by looking at the progress experienced by patients after being given both types of interventions. The outcome in this study was the patient's static standing balance, which was assessed by gross motor function measure (GMFM).

In the process of analyzing the data, the baseline or A1 measurements were carried out twice to obtain the appropriate data, which can be seen from what abilities the patient has achieved. The second phase in this study is the intervention process given to the patient for 4 weeks. The next phase is evaluation or A2 to determine the success of the intervention on the patient's functional development as measured using a gross motor function measure (GMFM).

## RESULTS AND DISCUSSION

### Results

After being given core stability exercise and lower extremity exercise for 4 weeks with training sessions 5 times and intensity 2 times a week to the patient, there were no results and significant changes in the ability of the static standing balance as measured using the gross motor function measure (GMFM).

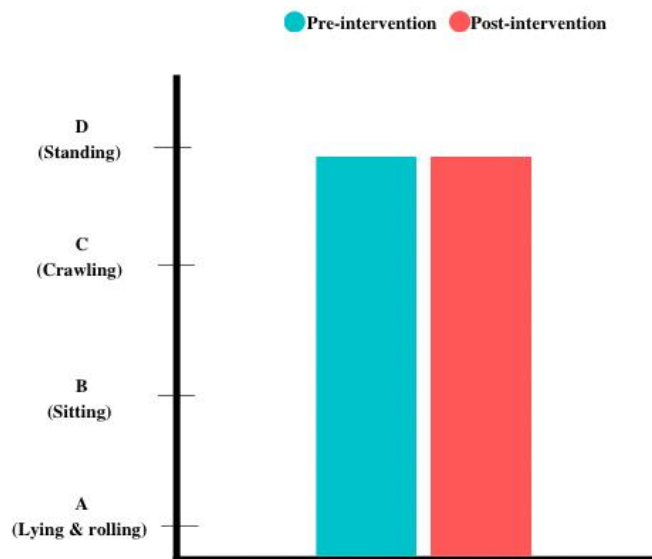


Figure 2. Development of patient's ability

The first follow-up measurement GMFM began on November 3, 2021 and the results showed that the patient had not been able to stand fluently, which the patient had not mastered the 13 activities in point D (standing). The second follow-up measurement was carried out on November 19, 2021, it was found that the patient was still unable to stand up fluently. The third follow-up measurement was carried out on November 27, 2021 and there was still no significant improvement, the same as the previous follow-up.

### Discussions

Giving core stability and strengthening exercises has a very good impact on the development of core muscle strength and muscles that experience weakness (Saeed et al., 2019). The core stability exercises given in this study were neck flexion, pelvic-tilting exercise and standing. Neck flexion is given with the aim of stimulating contraction of the patient's abdominal muscles by providing passive-flexion neck movements in the patient in the supine lying position. Pelvic-tilting exercise is given with the aim of strengthening the abdominal and trunk muscles. The exercise is given when the patient is standing with a support stool whose height reaches the patient's neck and is placed in front of the patient when standing. In this position, the therapist mobilizes the patient's pelvis anteriorly and posteriorly while keeping the trunk and lower extremities straight. Standing is given with the aim of correcting the patient's posture and increasing the strength of the postural muscles and lower extremity muscles. The same study was conducted by Zulfiqar et al. (2022) in children with a diagnosis of Down syndrome. In this

study, the given of core stability exercise was able to increase the ability of static standing balance and postural control in children with Down syndrome within 6 weeks.

In the lower extremity, strengthening exercises are given in the form of sitting squats and kneeling. Sitting squats are given with the aim of strengthening the lower extremity muscles such as the quadriceps, hamstring, and calf muscles. Kneeling is given with the aim of strengthening the quadriceps muscle. Research conducted by Saeed et al., (2019) also proves that giving lower extremity strength can improve the ability of children with Down syndrome to control movement and balance.

Giving core stability exercise and strengthening exercise to lower extremity muscles in children with Down syndrome is very necessary for the continuity of their daily activities. Core stability is an ability that must be possessed so that posture during activities can be coordinated properly and correctly (Aly & Abonour, 2016). The strength of the muscles in the lower extremity is something that children with Down syndrome need to understand who tend to experience hypotonia so that they can support the body properly during activities (Lin & Wuang, 2012). When the muscles in the lower extremity and core stability can work well, then a person can stand in a balanced manner with the correct posture (Aly & Abonour, 2016).

## **CONCLUSION**

Based on the measurement results and the discussion that has been described, it can be concluded that giving core stability and lower extremity strength exercise twice for four weeks has not been able to improve the ability of static standing balance in children with Down syndrome. For further research, researchers hope that the exercise can be given more than four weeks to see whether there is a significant change in the ability of static standing balance in children with Down syndrome or not.

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