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# The effect of footcore stability exercise therapy on increasing range of motion and functional walking ability in cerebral palsy children

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**ABSTRACT**

Cerebral Palsy (CP) is a permanent disorder in the development of movement and posture in children. One of the movement problems in children with CP is stiffness of the soleus muscle which results in a tiptoe position. This position will make it difficult for the child to stand and walk, thereby reducing the child's functional and movement abilities. This research was conducted to determine the effect of providing foot core stability training therapy on increasing the range of motion of the ankle dorsi flexion joint and increasing the functional ability to walk in children with CP. This research is a field experimental one group pre and post test design. The sample was 15 children with CP at the AzZaki inclusion foundation in Surabaya, who were given foot core stability exercise therapy intervention 10 times in a row for 10 days. The ankle dorsiflexion range of motion was measured with a gonometer and functional walking ability with GMFM (gross motor function measurement). Research Results is there was a mean increase in ankle LGS towards dorsi flexion of 3.2° (p=0.001) and a mean increase in walking ability with GMFM measurements of 11.2% (p=0.00).



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# INTRODUCTION

Cerebral Palsy (CP) is a brain development disorder characterized by impaired movement and posture during the growth and development of children that is non-progressive and permanent. (Vitrikas K, 2020). CP children will experience several movement disorders such as muscle stiffness, impaired coordination of movement, which will result in daily functional disorders such as sitting, standing and walking (Beyaert, 2019). One area or part of the limbs of CP children who often experience stiffness and difficulty in moving is the ankle area (Chughani, 2021). In CP children, it will appear that the ankle area experiences stiffness in the direction of plantar flexion and flexion of the toes, or in layman's language, toe-toeing (Davids, 2018). This condition will make it difficult for CP children to plant their feet when standing and walking (Furtado, 2021). Even more severe if it is chronic, it will result in contracture/shortening of the ankle joint until subluxation and eventually pain in the child (Kilgour et al., 2022; Romeo et al., 2024; Tamboosi et

al., 2021). Pain in the child's leg will aggravate stiffness during movement because CP children will be lazy to move and afraid to move because of pain (Krarup, 2021).

Physiotherapy as a profession that works in the field of movement and function of the human body, plays a very important role in the above conditions (Furtado, 2021). Physiotherapy can help prevent stiffness in the legs of CP children and improve functional standing and walking abilities (Chughani, 2021). One of the physiotherapy modalities that can be applied to the condition of the tiptoe feet of CP children is exercise therapy (Gbonjubola, 2021). The purpose of exercise therapy is to reduce spasticity in the muscles, relax rigid tissues, and stimulate antagonist muscles to work against their stunted pattern so far (Davids, 2018). *Foot core stability* model exercise therapy is one type of exercise therapy that has been applied and responded well by leg muscles in athletes, musculoskeletal patients and post-stroke patients (Fourchet F, 2019), (HASMAR, 2021), (McKeon, 2015). Some existing research such as research by (Fourchet F, 2019) and (McKeon, 2015) which states that foot core stability training can improve movement in the ankle joint and balance in athletes.

Until now, there has been no research adapting foot core stability exercises to be applied to CP children, considering that the concept and technology of intervention are the same. Conceptually and theoretically, foot core stability exercises will increase awareness of position and motion on the soles of the patient's feet, increase the elasticity of the dorsal flexor ankle muscles which are components of functional standing and walking abilities in CP children.

AzZaki Inclusion Foundation Surabaya is a foundation consisting of parents of CP children in Surabaya and surrounding areas. The foundation has 50 CP children with various types and variations of movement problems. The preliminary survey obtained data, namely 15 children experiencing movement disorders in the form of toe feet. These children find it difficult to move in a standing and walking position because the shape of their feet is always on tiptoe and stiff. From the description above, it is necessary to conduct research for these children by giving the modality of foot core stability exercise therapy to help increase the scope of motion of the ankle flexion dorsal joint and the functional ability to stand and walk in CP children at the foundation.

# RESEARCH METHOD

This study used a field experimental method, with 15 subjects of CP patients who experienced tiptoe. The research design is one group pre and post test design. The population was all CP children at the AzZaki Inclusion Surabaya foundation, while the sample was all CP children at the foundation who experienced tiptoe feet totaling 15 children. The independent variable is foot core stability exercise therapy, the dependent variable is the scope of motion of the ankle flexion dorsal joint and the functional ability to stand and walk. The research will be conducted at the AzZaki Inclusion Surabaya foundation which is located at Jl Sawahan Baru Surabaya. All samples were present according to a predetermined schedule. The treatment was carried out for 10 days, with a daily dose of 20 minutes for each child.

Footcore stability exercises consist of several exercise protocols and interventions, namely sitting upright on a chair, relaxation of the extensor back muscles, relaxation of the hamstring-soleus-plantaris muscles, stimulation of the dorsal flexor ankle muscles by stepping on the calcaneus bone, sitting standing exercises. Data collection techniques using the goneometer measuring instrument for range of motion (ROM), and the ability to stand and walk with GMFM (gross motor function measurement), both numerical scales. Data analysis uses descriptive data of age, gender, mean ROM and GMFM. To prove the hypothesis using normality test and paired data difference test.

# RESULTS AND DISCUSSIONS

The respondents in this study were CP children with primary impairment of toe-toeing and difficulty standing and walking. The mean age of the respondents was 4.6 years, with 10 male (67%) and 5 female (33%) respondents.

In table 1 and figure 1, it can be seen that the average change in the ROM of the joints of dorsal flexion of the right and left ankle is from 2.6 ± 1.7 degrees, to 6.2 ± 1.5 degrees. The difference test uses the Wilcoxon test because the data distribution is not normal, with a value of p = 0.001 so that foot core stability exercise therapy increases the ROM of dorsal flexion of the ankle in respondents.

**Table 1**. Mean changes in ankle dorsal flexion ROM and Wilcoxon test

| Variables | Pre-test average (in degrees) | Post test mean (in degrees) | Wilcoxon test |
|---|---|---|---|
| Right and left ankle dorsal flexion joint range of motion (ROM) | 2,6±1,7* | 6,2±1,5 | 0,001** |

*Normal data distribution
**p<0,05

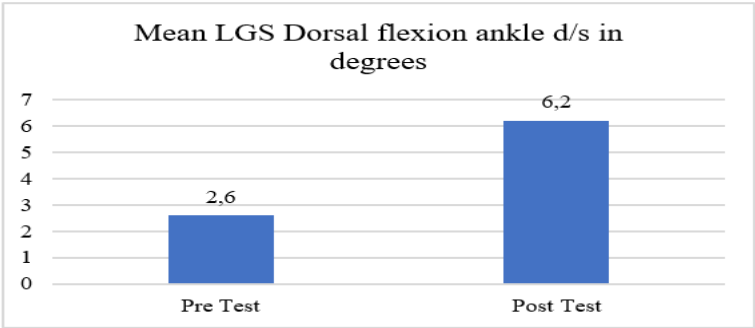


**Figure 1.** Mean difference of pre and post test ankle dorsal flexion ROM

Table 2 and Figure 2 show changes in the average ability to stand and walk with GMFM from 5.4 ± 1% to 16.6 ± 2.2%. The difference test uses a paired t test because the data distribution is normal, with a value of p = 0.000 so that foot core stability exercise therapy improves functional walking ability in respondents.

**Table 2**. Changes in mean GMFM and paired t test.

| Variables | Pre-test average (in percent) | Post test mean (in percent) | Paired t test |
|---|---|---|---|
| Functional walking ability | 5,4±1* | 16,6±2,2* | 0,000** |

*Normal data distribution
**p<0,05

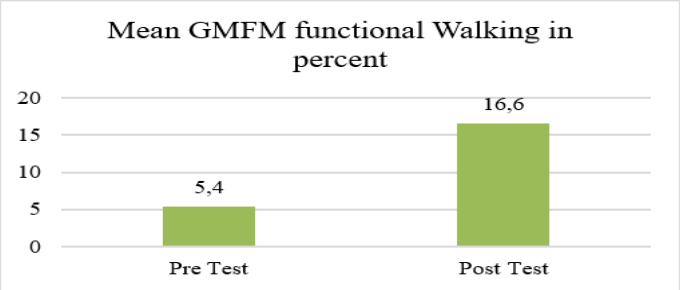


**Figure 2.** Mean difference of functional walking pre and post test

Cerebral palsy is a condition of impaired control of movement and body function in children during development that is non-progressive in nature. (LIANG, 2021). Although it is not progressively worsening, it needs further and intense treatment, including by physiotherapy. (LIANG, 2021). One of the problems in CP children is toe-toeing which results in difficulty in standing and walking (Mukhopadhyay, 2018). (Mukhopadhyay, 2018).

In this study, there were 15 respondents with diplegiate CP who experienced toe-toeing with difficulty standing and walking. Respondents in this study were dominated by male CP children who were in accordance with research (Hägglund, 2013) which states that boys have a higher risk factor for CP than girls. The results of this study were able to increase the ROM of dorsal flexion of the ankle joint and improve the functional ability of walking in respondents. Although it needs to be further investigated how long the increase in these results can be maintained by respondents.

Exercise therapy is carried out every day for 10 days with a dose of 20 minutes per meeting. Intense exercise therapy every day is carried out to improve the ability to move in CP children. If you want optimal results, the exercise therapy given to CP children must be carried out regularly every day. (Størvold, 2020).

Foot core stability exercise therapy consists of several protocols and types of exercises, namely relaxation of the trunk extensors, relaxation of the hamstring, relaxation of the plantaris and the introduction of a tread position on the calcaneus or heel to increase antagonistic plantar flexion. After that, sitting and standing exercises are given on a bench to increase motion in the antagonist pattern. (Hong, 2017), (McKeon, 2015) (Fourchet F, 2019).

CP children with tiptoe on the soles of their feet and ankles will experience a series of movement stiffness in the extensor trunk, hamstring, soleus and plantaris. (Hong, 2017). This series of muscles needs to be relaxed in general to reduce spastic / stiffness (Siddique, 2023). Stiff muscles will make it difficult for children to move (Siddique, 2023). (Siddique, 2023).

Relaxation of the extensor muscle group will increase muscle elasticity, so that when given exercises against the pattern / antagonist, it will increase ROM in the respondent's legs. (Howard JJ, 2021). Although the addition of ROM is not significant and has not reached normal limits, at least there has been an increase in ROM of dorsal flexion ankle.

After the muscle group is relaxed, it must be immediately activated to its antagonistic movement so that the balance of tonus and elasticity occurs. (Khurana, 2021). The next exercise protocol is to position the child to counteract the stance pattern, namely activating the antagonist muscles, namely the quadriceps, core muscles and extensor digitorum with sitting upright exercises, resting on the calcaneus and sitting standing exercises. (Hong, 2017). A series of movements will activate the antagonist pattern, namely the muscles to fight gravity, so that the respondents increase ROM and functional walking ability. (Khurana, 2021), (Hong, 2017).

Functional standing and walking improves, because the increase in ROM is followed by an understanding of new ankle positions and movements. (Youn, 2020). The child understands a good footing position, even though it is not perfect, but helps in mobilizing standing and walking.

(Youn, 2020). GMFM scores improved in the static standing with grip, and walking with grip segments.

Exercise therapy, which is practiced daily on a constant basis, will increase sensory information to the brain, enhance movement memory, and improve short memory related to movement (Plautz, 2000). (Plautz, 2000). Constant training and motor learning will increase memory information to the brain regarding movement (Plautz, 2000). (Plautz, 2000). That is the reason why this study uses a repetition dose every day, and it is possible that in this study *short term potentiation* has occurred so that the child's movement pattern changes according to the stimulation provided (Loprinzi, 2019). (Loprinzi, 2019).

Due to time constraints, the exercise therapy in this study was only carried out for 10 days, with the duration of the meeting every day for 20 minutes. To improve movement memory, exercise therapy in CP children should be done regularly every day for 3 hours and repeated for 3 months, to get permanent results. This is part of the suggestions and considerations for exercise therapy in future studies.

# CONCLUSION

Foot core stability exercise therapy is able to increase ankle dorsal flexion ROM and improve functional walking ability in respondents. The contribution of the study is that it is the first study to adapt exercise therapy for adult athletes, which was adapted to children with cerebral palsy. The results showed that there were changes towards improving the range of motion of CP children's ankles, and improving walking ability. So that it adds an alternative to the provision of exercise therapy for children with cerebral palsy who experience obstacles in walking. The limitation of the study is that there is no control group, so it has not been able to assess the effectiveness of foot core exercise therapy in depth. So that in the future it is hoped that there will be a control group to prove a more optimal method. The implications of the study indicate that footcore stability exercise therapy is one concept in improving movement in the ankle and foot in children with cerebral palsy. For the future, research is needed on the length of time to maintain the effects that have been obtained, in order to find the right dose and formula, and a control group is needed to ensure the effectiveness of the exercise therapy method used.

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