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Effect of Postural Management with Proper Wheelchair Use on Children with Spastic Cerebral Palsy in Saudi Arabia

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Abstract

Postural management is an essential part of treating cerebral palsy (CP), but research in this area, particularly in the Middle East, is limited. This study aimed to assess how selecting the right wheelchair can affect spasticity, quality of life, and motor function in children with CP. The study included 35 children, aged 4 to 12 years, all with moderate to severe motor impairments (GMFCS levels 3 to 5). After four weeks of postural management using properly selected wheelchairs, there was a significant reduction in spasticity, as seen in improvements across key joints like the shoulders, elbows, wrists, and hips ($p < 0.001$). There were also notable improvements in motor function, with GMFCS scores improving significantly ($p < 0.001$). Additionally, the children's quality of life scores saw a marked increase, from 3083.9 ± 206.6 to 3538.6 ± 186.9 ($p < 0.001$). These findings stress the importance of choosing the correct wheelchair for children with CP, as it can make a significant difference in both physical function and overall well-being. The results also highlight how important postural management and occupational therapy are in improving the lives of children with CP.

Keywords: Cerebral Palsy; Children with Disabilities; Spasticity; Wheelchairs; Postural Management; Rehabilitation; Quality of Life.

INTRODUCTION

Cerebral Palsy (CP) is the most common amongst children globally. CP can also be mentioned early, with Hippocrates being one of the first to mention it in his writings (Panteliadis and Vassilyadi, 2018). Nevertheless, a nominal definition of CP did not develop until the 18th century because of its polyfaceted nature. The first person to give a formal description of CP as a neuro-developmental disorder was William Little. Nevertheless, the complete etiology and clinical course of CP were only formed during the 20th century (Korzeniewski *et al.,* 2018; Michael-Asalu *et al.,* 2019). In 2005 an international conference has identified CP as a collection of enduring disorders in the development of posture and movement resulting in limitations in activities brought about by non-progressive disorders in the growing fetal or infant brain. The cognitive, perceptual, sensory, behavioral, and communication disorders, along with secondary musculoskeletal issues and epilepsy are usually associated with motor impairments in CP (Graham *et al.,* 2016; Michael-Asalu *et al.,* 2019).

The classification of Cerebral Palsy can usually be carried out in respect to the spasticity of the muscles and the disorder has two major subcategories spastic and non-spastic CP. A spastic CP is one of them, and approximately 75 percent of individuals have CP (Schmidt *et al.,* 2020, p. 1). The global rates of CP were estimated as 2.1 per 1,000 live births (Oskoui *et al.,* 2013), and the prevalence of CP was estimated by Al Salloui *et al.,* to 2.3 per 1,000 live births in Saudi Arabia (Al Salloui *et al.,* 2011). The specified relatively high levels in Saudi Arabia can be attributed to the tendencies in other Middle East countries and can be partly attributed to the high rates of consanguinity marriage, hereditary diseases, and preterm mother age (Al Salloum *et al.,* 2011; el Rifai *et al.,* 1984).

CP management requires a multidisciplinary approach, and its focus should be on the particular needs and demands of families (Schmidt *et al.,* 2020). Physiotherapists are in the origin of the treatment of CP, and the use of physical therapy usually begins immediately after the suspicion of the diagnosis of CP, the goal of which is to retain or enhance motor activity

(Graham *et al.,* 2016). The role of occupational therapists has also been incorporated in CP management recently and provide personalized interventions to suit the needs of the patients (Chikwanha *et al.,* 2015).

It has been shown that even the improvements motivated by motor functioning and muscle strength do not correspond to the overall functional improvement, which makes the role of occupational therapy closer to help bridge the gap between motor functioning and practical functional abilities (Chikwanha *et al.,* 2015; Kruijsen-Terpstra *et al.,* 2014). The use of postural management, specifically, has been demonstrated to offer important outcomes in the motor functioning as well as respiratory well-being in CP patients. Some of the studies have proved the statement that postural management may significantly decrease complications especially in people with severe motor dysfunction (Gmelig Meyling *et al.,* 2018; Ravi *et al.,* 2017).

A postural management plan is a broad-based individualized intervention that includes all activities that affect the posture and functionality of a person. Each child has these programs tailor built and they could involve special seating, exercise routines, standing aids, surgery, and one-on-one sessions (Gericke, 2006).

In Saudi Arabia, especially rural settings, there is a high shortage of available rehabilitation to disabled people (Mohamed Madi *et al.,* 2019). The past studies have noted that CP is highly stigmatized, and most families of children with CP experience social problems, and malnutrition is also common in Saudi children with CP (Almuneef *et al.,* 2019; Soliman *et al.,* 2019). A 2012 study also suggested that a significant proportion of mothers with children with CP were characterized by high levels of denial in terms of the fact that their children were diagnosed with CP, which may adversely affect the quality of care offered and the quality of life of a child in question (Madi *et al.,* 2012).

Most children with CP lack the proper wheelchairs and where they are available, proper training on how to utilize them is unavailable. This results in a great deal of wheelchair abandonment among severely disabled children (Toro *et al.,* 2015). The results of a study held in the past showed that 80 percent of CP children were not using wheelchairs that could fit their disabilities (Ekiz *et al.,* 2017).

The misuse of wheelchair in CP cases is associated with various problems, such as the development of pressure ulcers, hip pain, and the increased fall risk (Hodgkinson *et al.,* 2001; Newman *et al.,* 2010). Indicatively, Newman et al. reported a large percentage of skin injuries in patients with wheelchair dependence on CP (Newman *et al.,* 2010). Likewise, Alkhateeb *et al.,* discovered that long-term sitting in the wheelchair without any proper positioning may also be a contributor to considerable pain (Alkhateeb *et al.,* 2019).

The World Health Organization (WHO) came up with a holistic guide on wheelchair evaluation and training, which was intended to aid in the selection of the right wheelchair to be used by a person with CP, particularly in resource-constrained environments (Khasnabis *et al.,* 2013). The correct postural management with the help of correctly chosen wheelchairs gives a significant support to the vertebral column, trunk, and neck and helps children with CP to move (Alkhateeb *et al.,* 2019; Rodby-Bousquet and Hägglund, 2010).Cerebral palsy significantly impacts the quality of life of both children and their caregivers, with various factors such as the severity of disability, the presence of complications, and socioeconomic circumstances affecting overall well-being (Mohammed *et al.,* 2016).

The primary goal of this research is to examine the impact of selecting an appropriate wheelchair on spasticity, quality of life, and gross motor skills in children diagnosed with spastic cerebral palsy. This study seeks to explore how different wheelchair choices affect spasticity levels, overall quality of life, and motor function in these children.

PATIENTS AND METHODS

To achieve the study's objectives, a quantitative interventional research approach was utilized. The research was carried out at the Seating and Positioning Clinic within the Rehabilitation Services and Program at Sultan Bin Abdulaziz Humanitarian City (SBAHC). The medical services SBAHC provides are the overall rehabilitation and treatment of children with cerebral palsy (CP) (Al-Owesie *et al.,* 2012; Ibrahim, 2018; SBAHC, 2020). SBAHC is a strategic site in Riyadh, the capital city of Saudi Arabia with an estimated population of the city of 8 million people (Alanazi *et al.,* 2020).

Data were gathered using self-administered electronic questionnaires that were completed on a tablet with the help of the primary researcher. The children aged in between 4 to 12 years of inpatients in SBAHC and had spastic CP were suitable to take part in the study.

The inclusion criteria were that the subjects needed to have a Gross Motor Function Measure (GMFM) of 3-5 with stable medical conditions during admission. The study did not include children whose parents failed to fill or had not agreed to fill the questionnaire.

The eligibility of all the qualified children was explained thoroughly to the parents in face-to-face consultation before enrolling. The recruitment was conducted in a nonrandom consecutive tools and the participants were measured in three time points namely on day one and after two weeks since the initial intervention and four weeks using postural management. Their ratings were anchored to the protocol of the

wheelchair by the World Health Organization (WHO) (Khasnabis *et al.,* 2013).

The physiotherapy assessment of each respondent was conducted through a comprehensive examination of the respondents to ascertain the suitable wheelchair based on the WHO standards. After the evaluation, the parents or the caregivers were trained on how to position the patient correctly, how to keep him or her safe during transfers, how to avoid pressure ulcers, and how to adjust the wheelchair. Caregivers took 30 minutes educational classes, five days a week. These sessions were separated into three sections, which included 10 minutes of theoretical training and demonstration, 10 minutes of sitting exercises, and 10 minutes of transfer training.

Each of the participants was assessed three times at baseline, two- and four-weeks post-intervention: the Modified Ashworth Scale (MAS) to measure spasticity, the Cerebral Palsy Quality of Life (CPQOL) Questionnaire to determine quality of life, and the Gross Motor Function Classification System (GMFCS) to determine the classification of motor functioning.

CPQOL Questionnaire is a multidisciplinary, standardized instrument that is used to determine the quality of life of children with cerebral palsy aged 4-12. It is a publicly accessible tool that is available to researchers all around the world (Waters *et al.,* 2013). It is made up of 65 questions that are categorized in seven domains. The ratings are on 1 (very unhappy) to 9 (very happy). Domains evaluated entail feelings regarding functioning, participation and physical health, emotional wellbeing, social wellbeing, pain and the effect of disability, access to services, and family health. The CPQOL was administered in Arabic version and a brief explanation of the reason and way that specific questionnaire was given. The scores of the CPQOL were converted to a 100 points scale with 0 (very unhappy) and 100 (very happy) being the scores (Waters *et al.,* 2013). All the participants were computed on mean CPQOL score.

The Muscular Spasticity Scale (also known as the Modified Ashworth Scale or MAS) is a highly popular tool of measuring muscular spasticity and is regarded as the best evaluation tool of spasticity in the case of CP (Ghotbi *et al.,* 2009). The MAS is an ordinal reference scale which involves assessing muscle resistance in a passive movement, the measure starts at 0 (normal muscle tone) and goes through 4 (rigidity in flexion or extension). An increase in muscle tone is slightly manifested, and a catch is observed with slight resistance resulting in a score of +1 (Germanotta *et al.,* 2020).

Written ethical approval was requested and given by the UniSZA Human Research Ethics Committee (UHREC) and the SBAHC Ethics Committee. A hard copy of a written and informed consent was obtained from all caregivers of the included subjects in this study. It was indicated in the consent form that there would be no negative impact on the management plan in case of voluntary participation in the study or refusal of the people. The data collected in this study was anonymous and the filled out electronic questionnaires were stored securely and only the primary investigator had access to the data.

The anonymized data were assigned numerical codes and organized in an Excel spreadsheet (Microsoft Corp., Redmond, WA, USA). Data analysis was conducted using version 25 of the Statistical Package for the Social Sciences (SPSS, Chicago, IL, USA). The normality of the dataset was assessed using the Kolmogorov-Smirnov test. Statistical significance was determined with a p-value of less than 0.05. To compare the scores before and after the postural management intervention, a paired sample t-test was performed.

RESULTS

A total of 35 children participated in this study. The mean age of the participants was 8.0 ± 2.7 years, with ages ranging from 4 to 12 years, and the sample was nearly evenly distributed between genders, with 51.4% males and 48.6% females. Approximately half of the participants were assigned a WHO standard wheelchair after an assessment of their postural management needs. Additionally, 34.3% received a WHO active wheelchair, and 20.0% were provided with WHO pushchairs. The sociodemographic characteristics of the participants and the types of wheelchairs assigned to them are summarized in Table 1.

Table 1: Socio-Demographic Characteristics of Study Subjects and type of provided wheelchair (n=35).

Category	Details	Number (n)	Percent (%)
Age (Mean ± SD = 8.0 ± 2.7 years)	4–6 years	12	34.3
	7–9 years	12	34.3
	10+ years	11	31.4
Gender	Male	18	51.4
	Female	17	48.6
Type of Wheelchair Provided	Standard Wheelchair	16	45.7
	Active Wheelchair	12	34.3
	Push Wheelchair	7	20.0

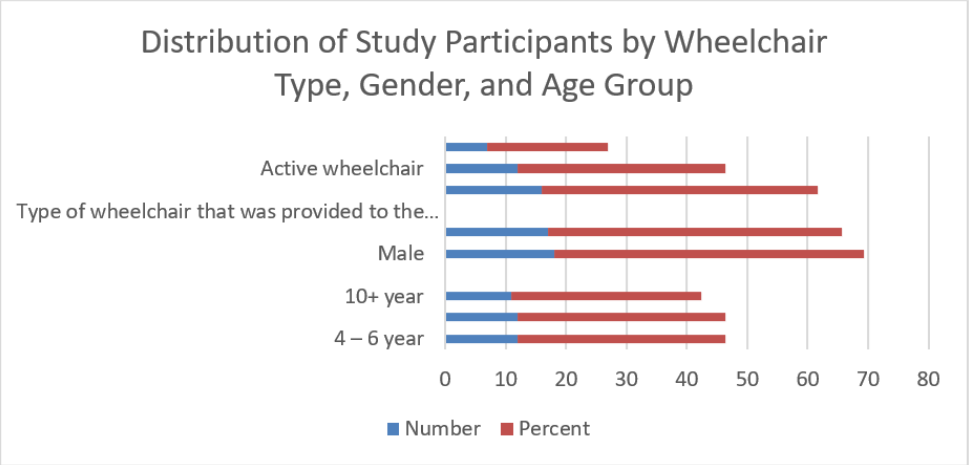

Figure 1: Distribution of Study Participants by Wheelchair Type, Gender, and Age Group

Postural management with the adequate wheelchair in cerebral palsy children was related to a statistically significant bilateral decrease in MAS score between the baseline and follow-up after 4 weeks (p-value <0.001) for the shoulder, elbow, wrist and hip joints. Meanwhile, there were no significant changes of the MAS score in the knee and ankle joints. Changes in the MAS scores of the study subjects are presented in Table 2.

Table 2: The Modified Ashworth Scale (MAS) Score of Study Subjects pre, during, and post postural management using a proper wheelchair (n=35)

Joint	Baseline MAS (Mean ± SD)	MAS after 2 Weeks (Mean ± SD)	MAS after 4 Weeks (Mean ± SD)	p-value
Right Shoulder	2.7 ± 0.82	2.7 ± 0.82	2.1 ± 1.07	<0.001**
Left Shoulder	2.7 ± 0.82	2.7 ± 0.82	2.1 ± 1.05	<0.001**
Right Elbow	2.7 ± 0.82	2.7 ± 0.82	2.1 ± 1.07	<0.001**
Left Elbow	2.7 ± 0.82	2.7 ± 0.82	2.1 ± 1.05	<0.001**
Right Wrist	2.7 ± 0.82	2.7 ± 0.82	2.1 ± 1.07	<0.001**
Left Wrist	2.7 ± 0.82	2.7 ± 0.82	2.1 ± 1.05	<0.001**
Right Hip	2.7 ± 0.82	2.7 ± 0.82	1.9 ± 0.83	<0.001**
Left Hip	2.7 ± 0.82	2.7 ± 0.82	2.0 ± 0.84	<0.001**
Right Knee	2.7 ± 0.82	2.7 ± 0.82	2.7 ± 0.86	0.324
Left Knee	2.7 ± 0.82	2.7 ± 0.82	2.7 ± 0.82	-
Right Ankle	2.7 ± 0.82	2.7 ± 0.82	2.7 ± 0.86	0.324
Left Ankle	2.7 ± 0.83	2.7 ± 0.83	2.7 ± 0.83	-

* Paired sample t-test (baseline and after 4 weeks), ** Significant p-value

Similar to the MAS score, the GMFCS scores decreased significantly between the baseline and after four weeks of postural management using proper wheelchairs (p-value <0.001). The mean GMFCS score of study subjects was 4.5 ±0.89 at baseline, which decreased to 3.5 ±0.82 after two weeks, and further decreased to 3.4 ±0.81 after four weeks of postural management and follow-up. The changes in GMFCS scores before and after postural management are shown in Table 3. This table demonstrates the improvement in motor function classification as a result of the postural management intervention.

Table 3: The Gross Motor Function Classification System (GMFCS) Score of Study Subjects pre, during, and post postural management using a proper wheelchair (n=35)

	Mean score		p-value*
Baseline GMFCS	GMFCS after 2 wks	GMFCS after 4 wks	
4.5 ±0.89	3.5 ±0.82	3.4 ±0.81	<0.001**

* Paired sample t-test (baseline and after 4 weeks), ** Significant p-value

In contrast, CPQOL scores followed a similar improvement trend after postural management, with statistically significant enhancements observed in five out of the seven quality of life domains. The Social Wellbeing and Acceptance domain saw a mean increase from 556.4 ± 91.9 at baseline to 642.8 ± 99.5 after four weeks of postural management, which was statistically significant (p-value < 0.001). Similarly, the mean score

for the 'Feelings About Functioning' domain rose from 597.8 ± 92.3 to 670.7 ± 97.3, with this increase also reaching statistical significance (p-value 0.003). In the 'Participation and Physical Health' domain, the mean score improved significantly (p-value 0.001), with scores increasing from 508.2 ± 120.2 at baseline to 611.4 ± 128.1 after four weeks of postural management. Likewise, the mean score of the 'Emotional Wellbeing and Self-Esteem' domain increased from 276.7 ± 69.6 at baseline to 310.3 ± 70.9 after two weeks of postural management, and continued to rise to 319.2 ± 90.6 after four weeks. The 'Access to Services' domain also showed significant improvement, with mean scores rising from 563.9 ± 119.9 before treatment to 672.5 ± 121.3 after one month of postural management (p-value 0.001). However, the 'Pain and Impact of Disability' and 'Family Health' domains did not demonstrate significant changes, with p-values of 0.184 and 0.301, respectively. A detailed summary of the postural management effects on CPQOL scores is provided in Table 4.

Table 4: The Cerebral Palsy Quality of Life (CPQOL) Score of Study Subjects pre, during, and post postural management using a proper wheelchair (n=35)

Domain	Baseline CPQOL (Mean ± SD)	CPQOL after 2 Weeks (Mean ± SD)	CPQOL after 4 Weeks (Mean ± SD)	p-value
Social Wellbeing and Acceptance	556.4 ± 91.9	615 ± 101	642.8 ± 99.5	<0.001**
Feelings About Functioning	597.8 ± 92.3	616 ± 113.7	670.7 ± 97.3	0.003**
Participation and Physical Health	508.2 ± 120.2	595 ± 116.6	611.4 ± 128.1	<0.001**
Emotional Wellbeing and Self-Esteem	276.7 ± 69.6	310.3 ± 70.9	319.2 ± 90.6	0.033**
Access to Services	563.9 ± 119.9	619.6 ± 114.5	672.5 ± 121.3	0.001**
Pain and Impact of Disability	386.4 ± 82.8	403.5 ± 93.7	411.7 ± 81.2	0.184
Family Health	194.2 ± 47.6	195.7 ± 58.7	210 ± 68.8	0.301
Total Score	3083.9 ± 206.6	3355.4 ± 98.3	3538.6 ± 186.9	<0.001**

* Paired sample t-test (baseline and after 4 weeks), ** Significant p-value

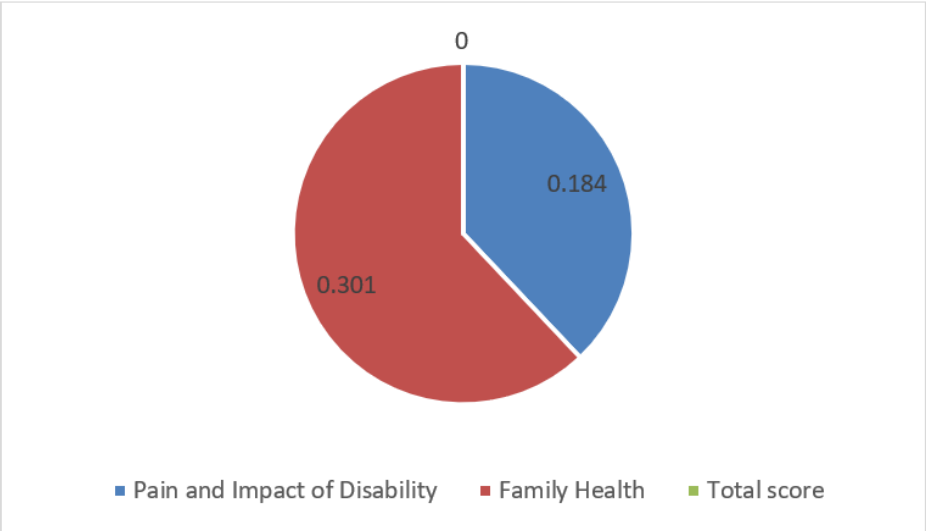

Figure 2: Statistical Significance of CPQOL Score Improvements Across Key Domains

DISCUSSION

There is a significant need for proper wheelchair selection, especially in developing countries where rehabilitation services may not cover all children with cerebral palsy (CP) in need of these essential services (Toro *et al.,* 2015). A recent cross-sectional study from Turkey revealed that 8 out of 10 CP children did not use an appropriate wheelchair that met their clinical and functional needs (Ekiz *et al.,* 2017). Similarly, a Japanese study indicated that approximately half of CP cases did not receive appropriate postural support while using wheelchairs, which could negatively affect their health and functional status (Hatta *et al.,* 2007). Rodby-Bousquet and Hägglund emphasized that early intervention during childhood, with proper wheelchair selection, would improve mobility outcomes for CP cases and potentially increase their independence (Rodby-Bousquet & Hägglund, 2010).

Most previous studies on wheelchair selection for CP children were observational or cross-sectional in nature, and there is a noticeable scarcity of interventional postural management studies. One of the few interventional studies was conducted by Alkhateeb *et al.,* on nine CP cases in Jeddah, Saudi Arabia. This study concluded that adjusting head and neck support in wheelchairs resulted in better body positioning and subsequent patient benefits (Alkhateeb *et al.,* 2019). The

findings from Alkhateeb *et al.,* align with the current study, where postural management using proper wheelchair selection led to better MAS scores and improved gross motor function. However, the scope of the present study focused on wheelchair selection rather than adjustment, which sets it apart from earlier research.

One of the largest interventional studies on wheelchair selection for CP cases was conducted in Indonesia, involving over 300 adult and child CP patients. This large-scale study found that proper wheelchair selection according to WHO criteria improved quality of life, particularly among female participants (Toro *et al.,* 2015). This finding mirrors the current study, where significant improvement in total CPQOL scores was observed after four weeks of postural management and proper wheelchair selection.

In a retrospective study conducted in the United Kingdom, proper wheelchair selection for over 100 CP patients significantly improved their function and reduced spasticity (Frank & De Souza, 2017). The results from the current study show a similar trend, with improvement in spasticity and functional scores after postural management in Saudi CP children.

Meanwhile, another small-scale interventional study in Japan, involving only three patients, demonstrated promising results for CP cases when postural and feet support were applied in their wheelchairs (Shirogane *et al.,* 2017). Similarly, a study in Taiwan with 20 CP cases showed that using wheelchair technology providing proper support improved body alignment and benefited CP patients (Liu *et al.,* 2014). However, McDonald and Surtees conducted an interventional study involving 23 British CP cases who were treated with postural intervention at the knee level. Their study did not result in significant improvements in CP cases (McDonald & Surtees, 2007). The findings of our study contradict those of McDonald and Surtees, which can be explained by differences in postural management interventions and study methodology.

Additionally, Vekerdy conducted a postural interventional study on 47 CP children in Hungary, which also reported measurable improvements in posture among the participants (Vekerdy, 2007). While objective measurement of posture was outside the scope of the present study, the observed improvements in joint spasticity and functional scores mirror those seen in other studies focused on postural management interventions for CP children.

A series of four interventional and observational studies in Sweden showed significant improvements in quality of life for CP cases through the use of standing devices (Nordström, 2014). This finding aligns with the results of the present study, though it is important to note that the postural intervention in these Swedish studies involved standing devices, while the current study focused on wheelchair postural management.

Although the present study demonstrates positive outcomes, the determination of the causality between the intervention and the outcomes is still restricted (Waddington *et al.,* 2017). Besides, the research sample is quite small and not randomly chosen, which limits the extrapolation of findings. The case was carried out in Sultan Bin Abdulaziz Humanitarian City (SBAHC), which boasts of the best rehabilitation services throughout Saudi Arabia. This fact might have raised up the expectations of the participants and it might have enhanced compliance to postural management. Thus such results could not be readily applied to other centers where the services are not as standard. Nevertheless, the main researcher attempted to incorporate CP children not only in the main city of Riyadh but the suburbs as well.

It is the first interventional research on postural management of CP children in Riyadh. It used several evaluation instruments to study the outcomes of postural management using correct wheelchair choice. The overall measure of quality of life, as well as the analysis of functional and spasticity issues, can bring much value to the evidence base of this intervention. The specific impact of these aspects on CP outcomes can be used as a distinct contribution to the physiotherapy research. Despite the small sample size, it was bigger than some other interventional studies of the postural management of CP children, and it offered valuable initial evidence in the future larger-scale studies.

CONCLUSION

Finally, postural management with a well-chosen wheelchair resulted in statistically significant changes in the spasticity scores and gross motor functioning of children with spastic cerebral palsy. Also, this intervention made a significant contribution to the overall quality of life, and the greatest changes have been noticed in the social wellbeing, feelings about functioning, physical health, emotional wellbeing, and access to services domains.

The findings of this interventional investigation refer to the usefulness of adequate wheelchair choice in this susceptible group of people and deliver the evidence that can raise awareness regarding the significance of postural control in pediatric rehabilitation. The findings highlight the importance of physiotherapy and occupational therapy as an intervention in enhancing the functional performance of children with spastic CP.

According to the recent findings, it is advised to conduct large-scale studies in future to determine the subjective and objective outcomes of postural management in accordance with the selection of the wheelchair. In order to increase the external validity of

future research, blinded randomized techniques are important. Moreover, in this study, the follow-up period only covered four weeks, and therefore, no long-term and longitudinal studies have been conducted on the sustainability of postural management effects on cases of spastic CP, in the future. Since this was a single-center study, multi-center and even multi-country researches are suggested to further support these conclusions and be able to make more generalizations.

Postural management interventions should receive sufficient resources and funds that can be allocated by the health authorities to prevent, as well as postpone, negative health and psychological consequences in children with spastic CP. A screening initiative of children in less fortunate or isolated localities would help in early detection and prevention since those that would be beneficiaries of postural management in the use of a proper wheelchair will be identified and aided.

REFERENCES

- Abolhasani, H., Ansari, N. N., Naghdi, S., Mansouri, K., Ghotbi, N., & Hasson, S. (2012). Comparing the validity of the Modified Modified Ashworth Scale (MMAS) and the Modified Tardieu Scale (MTS) in the assessment of wrist flexor spasticity in patients with stroke: Protocol for a neurophysiological study. *BMJ Open*, *2*(6). https://doi.org/10.1136/bmjopen-2012-001394
- Al Salloum, A. A., El Mouzan, M. I., Al Omar, A. A., Al Herbish, A. S., & Qurashi, M. M. (2011). The prevalence of neurological disorders in Saudi children: A community-based study. *Journal of Child Neurology*, *26*(1), 21–24. https://doi.org/10.1177/0883073810371510
- Alanazi, F., Alotaibi, K., Almutlaq, F., Aldahash, A., & Alsenani, A. (2020). Awareness of adult population toward palpitation and its risk factors in Riyadh region, Saudi Arabia. *International Journal of Medicine in Developing Countries*, 383–388. https://doi.org/10.24911/IJMDC.51-1575930917
- Alkhateeb, A. M., Daher, N. S., Forrester, B. J., Martin, B. D., & Jaber, H. M. (2019). Effects of adjustments to wheelchair seat to back support angle on head, neck, and shoulder postures in subjects with cerebral palsy. *Assistive Technology*, 1–7. https://doi.org/10.1080/10400435.2019.1641167
- Almuneef, A. R., Almajwal, A., Alam, I., Abulmeaty, M., Bader, B. A., Badr, M. F., Almuammar, M., & Razak, S. (2019). Malnutrition is common in children with cerebral palsy in Saudi Arabia – a cross-sectional clinical observational study. *BMC Neurology*, *19*(1), 317. https://doi.org/10.1186/s12883-019-1553-6
- Al-Owesie, R. M., Moussa, N. M., & Robert, A. A. (2012). Anxiety and depression among traumatic spinal cord injured patients. *Neurosciences*, *17*(2), 145–150.
- Birth Injury Guide. (2015). *Gross Motor Function Classification System for Cerebral Palsy*. Birth Injury Guide. https://www.birthinjuryguide.org/cerebral-palsy/gross-motor-function-classification-system-cerebral-palsy/
- Chikwanha, T. M., Chidhakwa, S., & Dangarembizi, N. (2015). Occupational therapy needs of adolescents and young adults with cerebral palsy in Zimbabwe: Caregivers' perspectives. *The Central African Journal of Medicine*, *61*(5–8), 38–44.
- Ekiz, T., Özbudak Demir, S., Sümer, H. G., & Özgirgin, N. (2017). Wheelchair appropriateness in children with cerebral palsy: A single center experience. *Journal of Back and Musculoskeletal Rehabilitation*, *30*(4), 825–828. https://doi.org/10.3233/BMR-150522
- el Rifai, M. R., Ramia, S., & Moore, V. (1984). Cerebral palsy in Riyadh, Saudi Arabia: II. Associations between gestational age, birthweight and cerebral palsy. *Annals of Tropical Paediatrics*, *4*(1), 13–17. https://doi.org/10.1080/02724936.1984.11748299
- Frank, A. O., & De Souza, L. H. (2017). Problematic clinical features of children and adults with cerebral palsy who use electric powered indoor/outdoor wheelchairs: A cross-sectional study. *Assistive Technology*, *29*(2), 68–75. https://doi.org/10.1080/10400435.2016.1201873
- Gericke, T. (2006). Postural management for children with cerebral palsy: Consensus statement. *Developmental Medicine and Child Neurology*, *48*(4), 244–244.
- Germanotta, M., Gower, V., Papadopoulou, D., Cruciani, A., Pecchioli, C., Mosca, R., Speranza, G., Falsini, C., Cecchi, F., Vannetti, F., Montesano, A., Galeri, S., Gramatica, F., Aprile, I., & FDG Robotic Rehabilitation Group. (2020). Reliability, validity and discriminant ability of a robotic device for finger training in patients with subacute stroke. *Journal of Neuroengineering and Rehabilitation*, *17*(1), 1. https://doi.org/10.1186/s12984-019-0634-5
- Ghotbi, N., Ansari, N. N., Naghdi, S., Hasson, S., Jamshidpour, B., & Amiri, S. (2009). Inter-rater reliability of the Modified Modified Ashworth Scale in assessing lower limb muscle spasticity. *Brain Injury*, *23*(10), 815–819. https://doi.org/10.1080/02699050903200548
- Gmelig Meyling, C., Ketelaar, M., Kuijper, M.-A., Voorman, J., & Buizer, A. I. (2018). Effects of Postural Management on Hip Migration in Children With Cerebral Palsy: A Systematic Review. *Pediatric Physical Therapy: The Official Publication of the Section on Pediatrics of the American Physical Therapy Association*, *30*(2), 82–91. https://doi.org/10.1097/PEP.0000000000000488

- Graham, H. K., Rosenbaum, P., Paneth, N., Dan, B., Lin, J.-P., Damiano, D. L., Becher, J. G., Gaebler-Spira, D., Colver, A., Reddihough, D. S., Crompton, K. E., & Lieber, R. L. (2016). Cerebral palsy. *Nature Reviews Disease Primers*, *2*(1), 15082. https://doi.org/10.1038/nrdp.2015.82
- Hatta, T., Nishimura, S., Inoue, K., Yamanaka, M., Maki, M., Kobayashi, N., Kishigami, H., & Sato, M. (2007). Evaluating the relationships between the postural adaptation of patients with profound cerebral palsy and the configuration of the Seating Buggy's seating support surface. *Journal of Physiological Anthropology*, *26*(2), 217–224. https://doi.org/10.2114/jpa2.26.217
- Hodgkinson, I., Jindrich, M. L., Duhaut, P., Vadot, J. P., Metton, G., & Bérard, C. (2001). Hip pain in 234 non-ambulatory adolescents and young adults with cerebral palsy: A cross-sectional multicentre study. *Developmental Medicine and Child Neurology*, *43*(12), 806–808. https://doi.org/10.1017/s0012162201001463
- Ibrahim, F. M. (2018). *The Effect of Self-Management Telecare Educational Program on Knowledge, Attitude and Practice among Saudi Type-2 Diabetic Patients at Sultan Bin Abdulaziz Humanitarian City ‹Kindom of Sudia Arabia (2015-2017)* [PhD Thesis]. University of Gezira.
- Khasnabis, C., Mines, K., & Organization, W. H. (2013). *Wheelchair service training package: Intermediate level*. World Health Organization.
- Korzeniewski, S. J., Slaughter, J., Lenski, M., Haak, P., & Paneth, N. (2018). The complex aetiology of cerebral palsy. *Nature Reviews Neurology*, *14*(9), 528–543. https://doi.org/10.1038/s41582-018-0043-6
- Kruijsen-Terpstra, A. J. A., Ketelaar, M., Boeije, H., Jongmans, M. J., Gorter, J. W., Verheijden, J., Lindeman, E., & Verschuren, O. (2014). Parents' experiences with physical and occupational therapy for their young child with cerebral palsy: A mixed studies review. *Child: Care, Health and Development*, *40*(6), 787–796. https://doi.org/10.1111/cch.12097
- Liu, W., Chen, F., Lin, Y., Kuo, C., Lien, H., & Yu, Y. (2014). Postural alignment in children with bilateral spastic cerebral palsy using a bimanual interface for powered wheelchair control. *Journal of Rehabilitation Medicine*, *46*(1), 39–44. https://doi.org/10.2340/16501977-1233
- Madi, S., Mandy, A., & Pountney, T. (2012). 1753 The Perception of the Term Cerebral Palsy (CP) in Saudi Arabia. *Archives of Disease in Childhood*, *97*(Suppl 2), A495–A496. https://doi.org/10.1136/archdischild-2012-302724.1753
- McDonald, R., & Surtees, R. (2007). Changes in postural alignment when using kneeblocks for children with severe motor disorders. *Disability and Rehabilitation: Assistive Technology*, *2*(5), 287–291. https://doi.org/10.1080/17483100701497057
- Michael-Asalu, A., Taylor, G., Campbell, H., Lelea, L.-L., & Kirby, R. S. (2019). Cerebral Palsy. *Advances in Pediatrics*, *66*, 189–208. https://doi.org/10.1016/j.yapd.2019.04.002
- Mohamed Madi, S., Mandy, A., & Aranda, K. (2019). The Perception of Disability Among Mothers Living With a Child With Cerebral Palsy in Saudi Arabia. *Global Qualitative Nursing Research*, *6*, 233339361984409. https://doi.org/10.1177/2333393619844096
- Mohammed, F. M. S., Ali, S. M., & Mustafa, M. A. A. (2016). Quality of life of cerebral palsy patients and their caregivers: A cross sectional study in a rehabilitation center Khartoum-Sudan (2014 - 2015). *Journal of Neurosciences in Rural Practice*, *7*(3), 355–361. https://doi.org/10.4103/0976-3147.182778
- Newman, C. J., Holenweg-Gross, C., Vuillerot, C., Jeannet, P.-Y., & Roulet-Perez, E. (2010). Recent skin injuries in children with motor disabilities. *Archives of Disease in Childhood*, *95*(5), 387–390. https://doi.org/10.1136/adc.2009.163691
- Nordström, B. (2014). *Experiences of standing in standing devices: Voices from adults, children and their parents* [PhD Thesis, Lule\aa tekniska universitet]. https://www.diva-portal.org/smash/record.jsf?pid=diva2:991300
- Oskoui, M., Coutinho, F., Dykeman, J., Jetté, N., & Pringsheim, T. (2013). An update on the prevalence of cerebral palsy: A systematic review and meta-analysis. *Developmental Medicine & Child Neurology*, *55*(6), 509–519. https://doi.org/10.1111/dmcn.12080
- Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., & Galuppi, B. (1997). Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Developmental Medicine and Child Neurology*, *39*(4), 214–223. https://doi.org/10.1111/j.1469-8749.1997.tb07414.x
- Panteliadis, C. P., & Vassilyadi, P. (2018). Cerebral Palsy: A Historical Review. In C. P. Panteliadis (Ed.), *Cerebral Palsy* (pp. 1–12). Springer International Publishing. https://doi.org/10.1007/978-3-319-67858-0_1
- Ravi, D. K., Kumar, N., & Singhi, P. (2017). Effectiveness of virtual reality rehabilitation for children and adolescents with cerebral palsy: An updated evidence-based systematic review. *Physiotherapy*, *103*(3), 245–258. https://doi.org/10.1016/j.physio.2016.08.004
- Rodby-Bousquet, E., & Hägglund, G. (2010). Use of manual and powered wheelchair in children with cerebral palsy: A cross-sectional study. *BMC Pediatrics*, *10*, 59. https://doi.org/10.1186/1471-2431-10-59

- SBAHC. (2020). *Sultan Bin Abdulaziz Humanitarian City*. http://humanitariancity.org.sa:80/en-us/AboutUs/Pages/About-us.aspx
- Schmidt, S. M., Hägglund, G., & Alriksson-Schmidt, A. I. (2020). Bone and joint complications and reduced mobility are associated with pain in children with cerebral palsy. *Acta Paediatrica*, *109*(3), 541–549. https://doi.org/10.1111/apa.15006
- Shirogane, S., Handa, T., Kozai, Y., & Maeda, Y. (2017). A preliminary study of the measurement of overload applied to the foot support of a wheelchair and a seated postural support device. *Journal of Physical Therapy Science*, *29*(1), 8–11. https://doi.org/10.1589/jpts.29.8
- Soliman, R., Altwairqi, R., Alshamrani, N., Al-Zahrani, A., Al-Towairqi, R., & Al-Habashi, A. (2019). Relationship between quality of life of children with cerebral palsy and their mothers' depression and anxiety. *Saudi Journal for Health Sciences*, *8*(1), 1. https://doi.org/10.4103/sjhs.sjhs_130_18
- Toro, M. L., Eke, C., & Pearlman, J. (2015). The impact of the World Health Organization 8-steps in wheelchair service provision in wheelchair users in a less resourced setting: A cohort study in Indonesia. *BMC Health Services Research*, *16*(1), 26. https://doi.org/10.1186/s12913-016-1268-y
- Vekerdy, Z. (2007). Management of seating posture of children with cerebral palsy by using thoracic-lumbar-sacral orthosis with non-rigid SIDO® frame. *Disability and Rehabilitation*, *29*(18), 1434–1441. https://doi.org/10.1080/09638280601055691
- Waddington, H., Aloe, A. M., Becker, B. J., Djimeu, E. W., Hombrados, J. G., Tugwell, P., Wells, G., & Reeves, B. (2017). Quasi-experimental study designs series-paper 6: Risk of bias assessment. *Journal of Clinical Epidemiology*, *89*, 43–52. https://doi.org/10.1016/j.jclinepi.2017.02.015
- Waters, E., Davis, E., Boyd, R., Reddihough, D., Mackinnon, A., & Graham, H. K. (2013). *Cerebral Palsy Quality of Life Questionnaire for Children (CP QoL-Child) Manual. Melbourne: University of Melbourne.* (2nd ed.).