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Impact of Comorbidities on Physical Activity in Children with Cerebral Palsy

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ABSTRACT

Introduction: Cerebral palsy (CP) is commonly associated with various comorbidities that may affect children's engagement in physical activity. This study aimed to investigate the individual and cumulative effects of common comorbid conditions on physical activity participation in children with CP.
Objective: To examine how different comorbidities influence physical activity levels in children with CP.
Methods: A cross-sectional study was conducted with 67 children diagnosed with CP (aged 5–18 years). Data on comorbidities, including visual and hearing impairments, learning disabilities, scoliosis, hip dislocation, epilepsy, and hydrocephalus, were collected via parent-reported questionnaires. Physical activity participation was assessed using the Physical Activity Questionnaire for Children (PAQ-C).
Results: Children with learning disabilities, scoliosis, and hip dislocation had significantly lower PAQ-C scores compared to those without these conditions ($p < 0.001$ for each). No statistically significant differences were observed between children with and without visual or hearing impairments. A significant negative correlation was found between the total number of comorbidities and physical activity levels ($r = -0.438$, $p < 0.001$).
Conclusion: Not all comorbidities equally affect physical activity in children with CP. Learning difficulties, orthopedic problems, and multiple coexisting conditions are particularly associated with decreased activity. These findings underscore the importance of individualized and multidisciplinary strategies to address these barriers and enhance physical activity participation among children with CP.

Keyswords: Cerebral Palsy, Comorbidities, Pediatric Rehabilitation, Physical Activity.

INTRODUCTION

Cerebral palsy (CP) is defined as a group of permanent disorders affecting posture and movement resulting from non-progressive brain injuries that occur during brain development (1). It is the most common physical disability in childhood, with an overall prevalence of 2.0-3.5 per 1,000 live births (2). In addition to motor impairment in children with CP, comorbidities such as learning disabilities, epilepsy, hearing and visual impairments, scoliosis, and hip dislocation are frequently present (3). The severity and combination of these comorbidities can vary significantly from individual to individual (4). Cognitive impairment is observed in approximately 50% of children with CP (5), and epileptic seizures in 35-40% (4). In addition, visual impairment is also common -reported in one-third to three-quarters of cases- (6), and significant hearing loss is reported in 4-13% of these children (7). These comorbidities can lead to additional difficulties in the child's functioning and may affect the child's ability to participate in daily activities and exercise (4).

Regular physical activity is essential for the health and well-being of all children, including children with disabilities. The World Health Organization recommends at least 60 minutes of moderate-to-vigorous physical activity per day for school-age children. In contrast, it is known that children and adolescents with CP are generally less active and more sedentary than their typically developing peers (3). Decreased participation in physical games and exercise increases the risk of poor cardiometabolic health, reduced bone and muscle strength, and increased secondary complications in children with CP (8). Therefore, increasing participation in physical activity is a key goal of CP management (9). Participation is a complex construct that is influenced not only by a child's motor capacity but also by personal and environmental factors (10). In particular, comorbidities may further limit a child's

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participation in activities of daily living, exercise, and recreation (11). For example, intellectual disabilities can limit a child's understanding of the rules of game, reducing social participation in game, visual or hearing impairments can create communication and safety barriers during activities, while orthopedic problems such as scoliosis or hip displacement can prevent active movement by causing pain and biomechanical problems (12,13).

One of the most important determinants of participation in physical activity is the severity of motor impairment. The severity of motor impairment is classified by the Gross Motor Function Classification System (GMFCS) (14). Children with lower levels of motor limitations (GMFCS Levels I and II) are more active than children with higher levels (15). The motor impairment, communication ability, cognitive level, and manual dexterity have been shown to significantly influence participation in leisure and daily living activities (16). Children with no or few comorbidities have higher levels of physical activity, while children with multiple or severe comorbidities tend to have lower levels of physical activity (17). However, there is limited quantitative research examining the effects of specific comorbidities on physical activity levels in children with CP in isolation. The extent to which conditions such as epilepsy, hydrocephalus, or sensory impairments independently affect participation in physical activity remains unclear (18).

Considering all this information, this cross-sectional study conducted with children with CP aimed to examine the isolated and cumulative effects of seven common comorbidities—epilepsy, hydrocephalus, visual and hearing impairments, learning disability, hip dislocation, and scoliosis—on participation in physical activity.

METHODS

Study Design and Participants

A total of 67 children aged between 5 and 18 years with different subtype of CP were recruited for this cross-sectional study. Inclusion criteria were a confirmed diagnosis of CP and being between 5 and 18 years of age, while exclusion criteria included acute illnesses that could significantly affect physical activity levels during the study period or a recent history of orthopedic surgery. Written and verbal informed consent was obtained from the parents of all participants. The study was approved by the Marmara University Institute of Health Sciences Non-Clinical Research Ethics Committee (Ethics Number: 110) and was conducted following the ethical principles of the Declaration of Helsinki.

Sample size estimation was performed using G*Power version 3.1.9.7 (19). A one-tailed test was assumed to detect a correlation coefficient of $r = 0.30$ (medium effect size), with a significance level of $\alpha = 0.05$ and a statistical power of 80% ($1–\beta = 0.80$). The analysis indicated that a minimum of 67 participants would be required to detect a medium effect size. In the present study, the actual observed correlation between the number of comorbidities and physical activity (PAQ-C score) was $r = –0.438$, suggesting that the sample size was adequately powered to detect the observed association (19). A study flow chart is shown in Figure 1.

Data Collection Instruments

This study used a questionnaire designed by the researcher to assess sociodemographic characteristics and comorbidities, and The Physical Activity Questionnaire for Older Children (PAQ-C) scale to evaluate children’s participation in physical activity.

1. Demographic Data Form Designed by Researcher

This form was used to collect information about the child's clinical and demographic characteristics. Parents reported the presence or absence of accompanying diseases and health conditions such as epilepsy, hydrocephalus, visual impairment, hearing impairment, learning disability, hip dislocation, and scoliosis. In addition, the children's GMFCS levels were recorded using the same questionnaire.

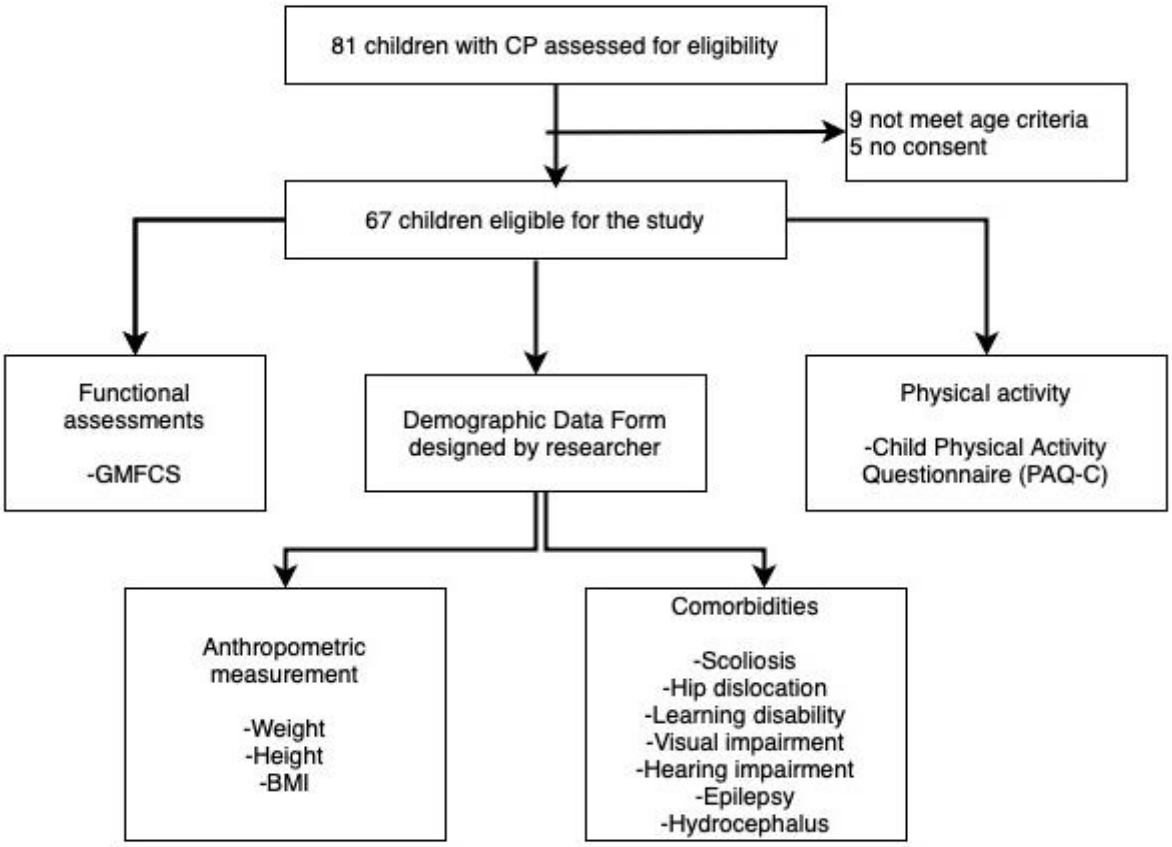


Figure 1. Flowchart of Participant Recruitment and Data Collection Procedures
This diagram summarizes the inclusion process of children with cerebral palsy (CP), the exclusion criteria, and the assessments used in the study, including GMFCS for motor function, PAQ-C for physical activity, anthropometric measurements, and comorbidities evaluation.

2. Child Physical Activity Questionnaire (PAQ-C)

The Physical Activity Questionnaire for Older Children (PAQ-C) which evaluates physical activity status over the past seven days, consists of 10 questions. Validity and reliability analyses were conducted by Erdim et al. The form is completed by the children's parents. The ten-item questionnaire is evaluated on a 5-point scale for each item except for the tenth question, which questions disease status. The Cronbach Alpha coefficient is 0.86, and was found to be 0.88 in this study (20,21).

3. Gross Motor Function Classification System (GMFCS)

The GMFCS ranks the level of motor impairment and was designed for children with CP. GMFCS levels I and II typically indicate that a child can walk or run without assistance, although difficulties with speed, coordination, and balance may be present. Level III suggests that mobility is achieved with the help of walking aids, while Levels IV and V are associated with a primary reliance on wheelchairs for mobility. The classification primarily evaluates a person's voluntary movement capabilities, with particular emphasis on sitting, walking, and mobility through assistive means such as wheelchairs (22).

Statistical Analysis

All data obtained from the study were analyzed using the SPSS 30 (Statistical Package for Social Sciences) package program. The normality of data distribution was determined using the Kolmogrov-Smirnov test. Among the variables, age, height, weight, and BMI were found to be normally distributed. The Mann Whitney U test was used to compare the physical activity levels of children with and without selected comorbidities. The number of participants, minimum, maximum, mean and standard deviation values were used as descriptive statistics; and for continuous variables, median and interquartile range (25th–75th percentile) values were used. Results were considered statistically significant at $p < 0.05$.

Boxplots were also generated to visually present the distribution of physical activity scores across groups.

RESULTS

Sixty-seven children with cerebral palsy (36 girls, 31 boys) participated in the study. Their mean age was 11.9 years. The average height was 142.1 cm, weight 39.0 kg, and BMI 18.7 kg/m² (Table 1). According to the GMFCS, 58.2% of the children were able to walk independently (Levels I–II), while 41.8% needed assistance (Levels III–V) (Table 2).

Table 1. Descriptive Statistics of Participants (n=67)

Variable	Min	Max	Mean±SD
Age	5	17	11.9 ± 3.6
Height (cm)	108	167	142.1 ± 15.3
Weight (kg)	15	56	39.0 ± 9.6
BMI (kg/m2)	15.3	28.1	18.7 ± 2.5

Min: Minimum; Max: Maximum; BMI: Body Mass Index.

Table 2. Distribution of Participants According to Gross Motor Function Classification System (GMFCS) Levels

GMFCS Level	Frequency (n)	Percent (%)	Cumulative Percent (%)
Level I	17	25.4	25.4
Level II	22	32.8	58.2
Level III	14	20.9	79.1
Level IV	10	14.9	94.0
Level V	4	6.0	100.0
Total	67	100	

GMFCS: Gross Motor Function Classification System.

Comparisons of PAQ-C total scores according to the presence of selected comorbidities are presented in Table 3. Children with scoliosis had significantly lower PAQ-C scores than those without scoliosis ($U = 248.50$, $Z = -3.89$, $p < 0.001$). Similarly, participants with hip dislocation ($U = 192.50$, $Z = -4.14$, $p < 0.001$) and those with learning disabilities ($U = 222.50$, $Z = -3.39$, $p < 0.001$) exhibited significantly lower levels of physical activity compared to their peers without these conditions. In contrast, there was no statistically significant difference in PAQ-C scores between children with and without visual impairment ($U = 199.00$, $Z = -1.51$, $p = 0.130$) or hearing impairment ($U = 70.50$, $Z = -1.46$, $p = 0.147$), although median scores were lower in the groups with these comorbidities.

Table 3. Comparison of PAQ-C Scores According to the Presence of Selected Comorbidities in Children with Cerebral Palsy

	n	PAQ-C Median (IQR)	p
Scoliosis			
Yes	16	1.41 (1.18-2.07)	<0.001*
No	51	2.58 (1.77-3.43)	
Visual impairment			
Yes	10	1.89 (1.41-2.92)	0.130
No	57	2.71 (1.68-3.53)	
Hearing impairment			
Yes	5	1.91 (1.41-2.85)	0.147
No	62	3.51 (1.92-3.62)	
Learning disability			
Yes	20	1.33 (1.13-1.87)	<0.001*
No	47	2.10 (1.62-3.41)	
Hip dislocation			
Yes	23	1.41 (1.17-1.89)	<0.001*
No	44	2.58 (1.66-3.47)	

IQR: Interquartile range (25th–75th percentile). PAQ-C: Physical Activity Questionnaire for Children. *$p < 0.05$, statistically significant.

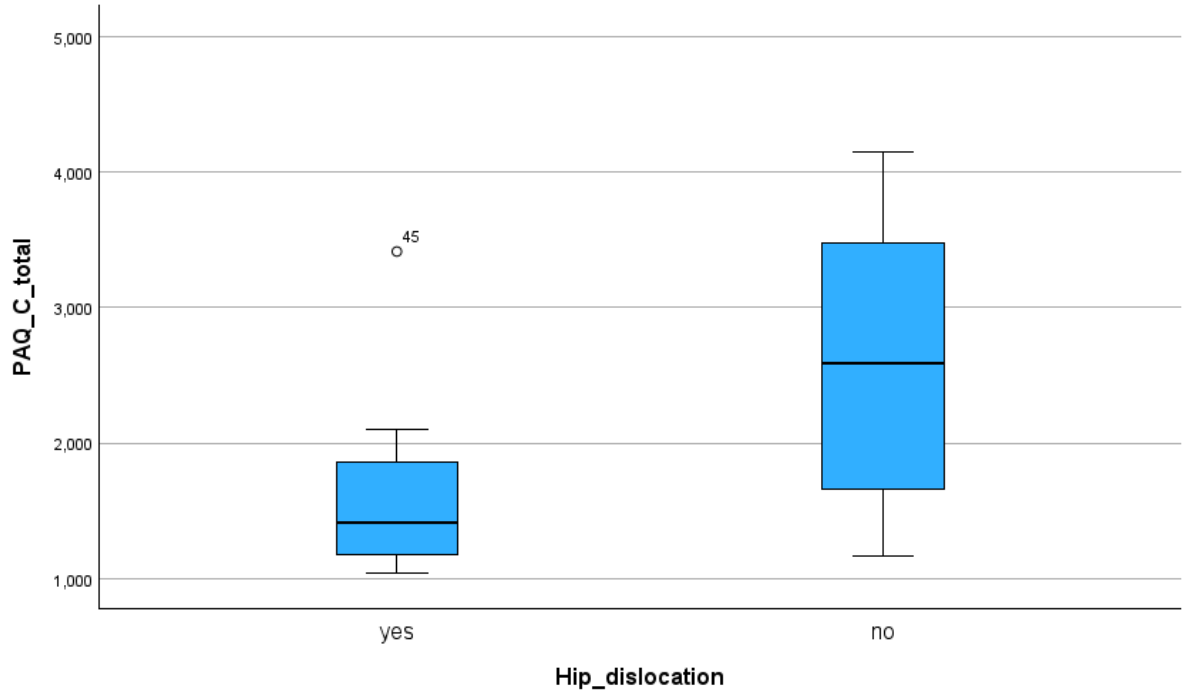
A Spearman's correlation was conducted to explore the relationship between the number of comorbidities and physical activity participation (PAQ-C total scores). The analysis showed a significant negative correlation between the two variables, with a correlation coefficient of -0.438 ($p < 0.001$), suggesting that as the number of comorbidities increases, physical activity participation tends to

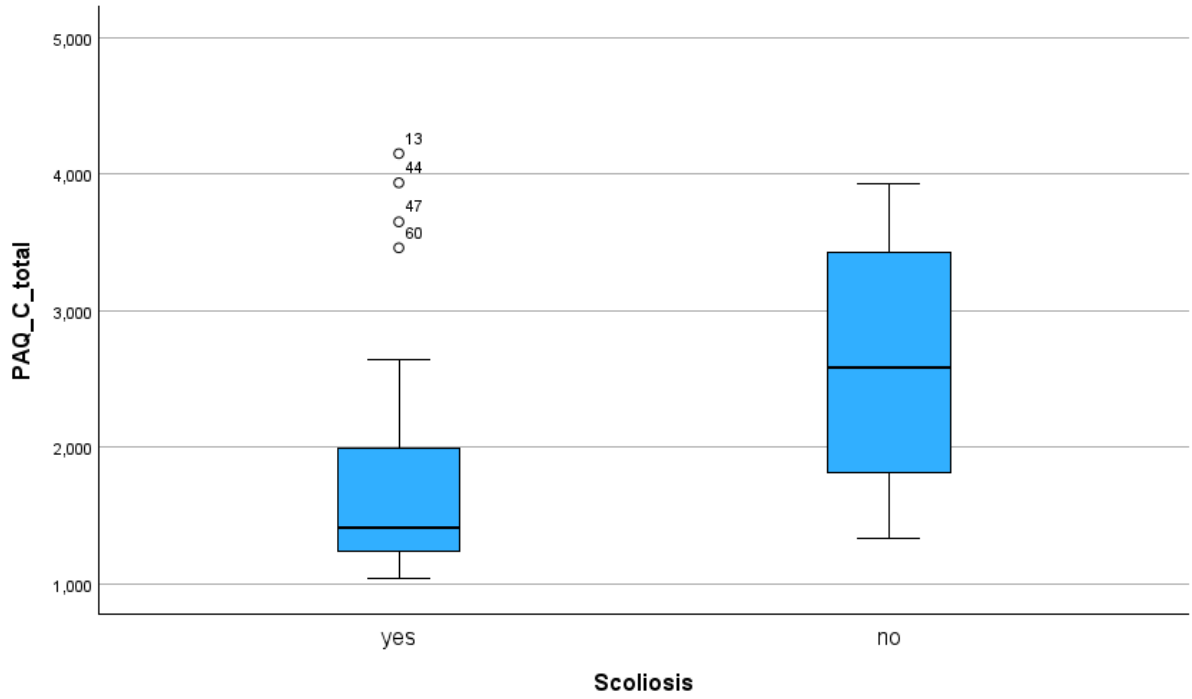
decrease (Table 4). Additioanlly, Boxplots show PAQ-C total scores in children with cerebral palsy, stratified by the presence or absence of selected comorbidities, including learning disability, visual impairment, hearing impairment, hip dislocation, and scoliosis. Higher scores indicate greater participation in physical activity (Figure 2).

Table 4. Spearman's Correlation between Number of Comorbidities and PAQ-C Total Scores

Variable		PAQ-C
Number of comorbidities	r	-0.438*
	p value	< 0.001

PAQ-C: Physical Activity Questionnaire for Children; r: Spearman's correlation coefficient; *p < 0.05, statistically significant. Note: The comorbidities considered in this analysis include learning disability, hip dislocation, scoliosis, visual impairment, hearing impairment.





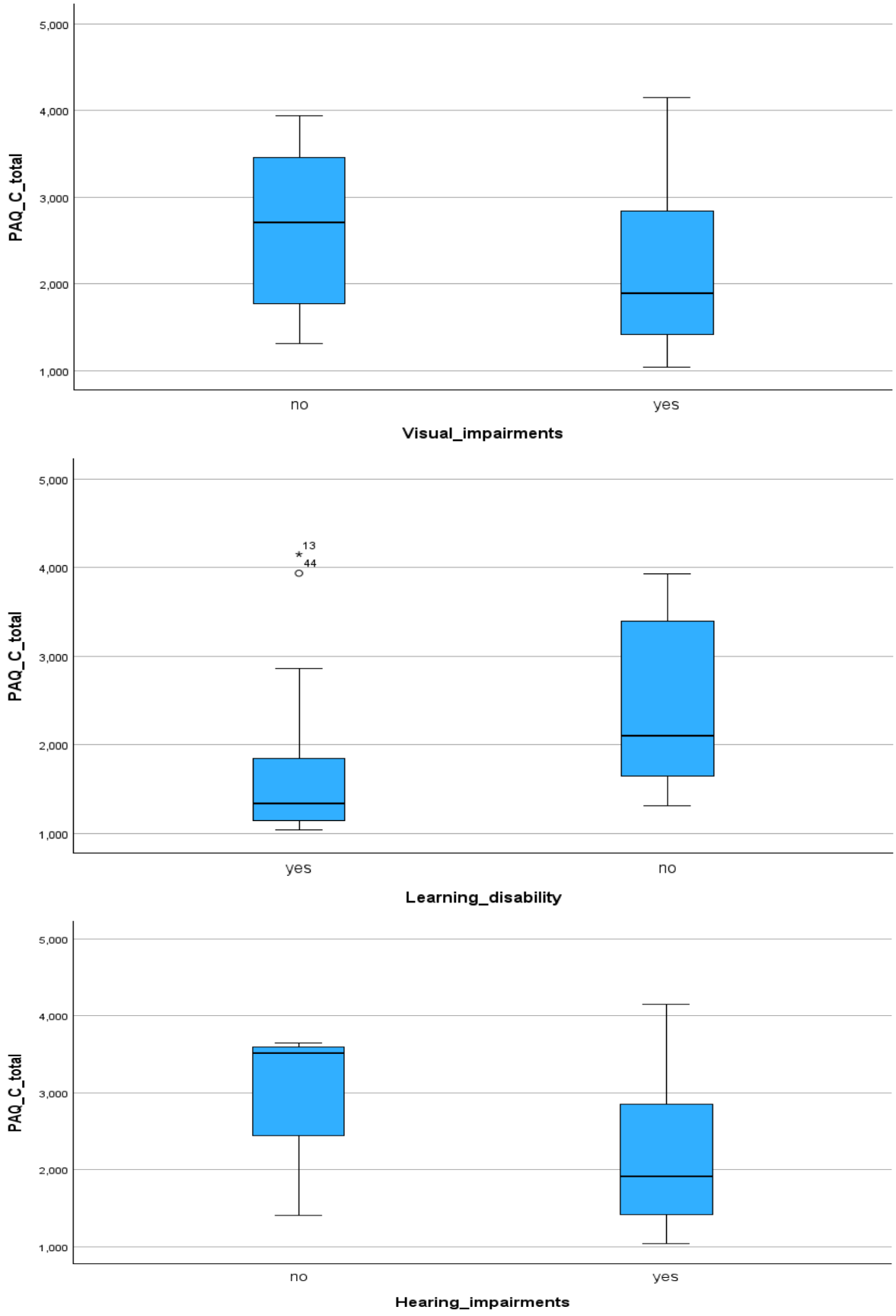


Figure 2. Comparison of Physical Activity Levels (PAQ-C Scores) According to the Presence of Comorbidities in Children with Cerebral Palsy

DISCUSSION

This cross-sectional study involving 67 children with cerebral palsy examined the relationship between various comorbid conditions (visual impairment, scoliosis, hip dislocation, learning disabilities, hearing impairment) and physical activity participation. Our findings suggest that not all comorbidities affect activity levels equally. We found no significant difference in physical activity participation between children with and without sensory (visual/hearing) impairments. In contrast, children with learning (intellectual) disabilities, hip dislocation, or scoliosis exhibited significantly lower levels of physical activity compared to their peers without these comorbidities. Furthermore, the cumulative number of comorbidities was inversely related to physical activity: children with multiple comorbidities tended to be the least active. However, since only one child had epilepsy and one had hydrocephalus, these comorbidities were excluded from the statistical analysis.

In our study, although the physical activity level of children with cerebral palsy was lower in those with vision or hearing impairments compared to those without impairments, this difference was not statistically significant. The lack of statistical significance may be due to the fact that sensory impairments were mostly mild or were corrected with appropriate devices such as glasses, hearing aids. Additionally, considering that many parents use various stimuli and guidance to ensure that their children remain active, supportive family attitudes may have also contributed to reducing this difference. Furthermore, since only 15% of our participants had vision problems and 7.5% had hearing impairments, we believe that statistical power may have been insufficient to detect significant differences in these subgroups. It is frequently emphasized in the literature that small sample sizes limit subgroup analyses (23,24).

The literature indicates that environmental arrangements and appropriate equipment positively affect participation in physical activity among visually impaired children (3). Scally and Lord (2019) highlighted that the primary obstacle to physical activity participation in visually impaired children is environmental factors, rather than physical or sensory limitations. It has been reported that these children can achieve similar activity levels as their peers when adequate adaptations are provided (23,24). Similar results have been observed in children with hearing impairments. Lauruschkus and colleagues (2017) found that children who were provided with communication support and appropriate hearing aids did not experience significant limitations in physical activity participation (3). Overall, it has been stated that support provided for sensory disabilities increases participation in physical activity (25). In our study, it was observed that the participation of children with visual and hearing impairments, who were appropriately supported, was not significantly restricted in physical activity. These findings underscore the importance of individualized support and assistive technologies for children with sensory disabilities in enhancing participation in physical activity.

In contrast, in our study, we found that children with CP who have learning disabilities exhibited significantly reduced physical activity participation. This is consistent with other studies in the literature that emphasize cognition as a key factor in physical activity participation (26,27). It has been reported that children with cognitive limitations start physical activities later, have difficulty following rules, and require more supervision and support to remain active, which leads to decreased motivation and reduced participation (26). A well-aligned, pain-free hip joint is crucial for comfortable sitting, standing, and walking. In cerebral palsy (CP), spastic muscles can lead to hip dislocation, particularly in children who cannot walk. This condition causes chronic pain, pelvic tilt, and difficulty with mobility (28). Our findings showed that children with a history of hip dislocation were less active, and parents reported that these children were reluctant to move due to pain. It has been reported that hip stability supports activity participation by improving sitting balance and movement comfort, whereas untreated hip dislocations severely limit exercise and supported movement tolerance (29).

Scoliosis is particularly common in children with severe CP and restricts activity by impairing sitting balance, making breathing difficult, and causing back pain (30). Our findings showed that children with moderate to severe scoliosis were less active, and many were unable to walk without an assistive device. Management of orthopedic problems reduces pain and improves posture, allowing children to participate more in activities. Children at GMFCS IV-V levels are particularly affected by these problems, but these painful musculoskeletal issues reduce activity regardless of GMFCS (16,31).

It has been reported in the literature that the number of comorbidities is inversely proportional to the level of physical activity. It has also been reported that children with multiple comorbidities (e.g., intellectual disability, epilepsy, vision loss) face cognitive, physical, and sensory disabilities, which severely restrict their participation in active physical play (16,32). Our findings are consistent with studies showing that multiple impairments reduce participation in physical activity. This suggests that a holistic approach is necessary to increase physical activity in children with CP, and that all problems should be managed concurrently to enhance participation in physical activity (33).

There are several limitations to this study. First, the cross-sectional design prevents causal inferences. Longitudinal studies are needed to assess changes in physical activity participation over time. Second, small sample sizes in certain subgroups such as children with hearing impairments and visual impairments may have reduced the statistical power to detect significant differences. Third, relying solely on parent reports to assess physical activity levels may introduce reporting bias, as parents may overestimate or underestimate their children's activity levels. Finally, the study was conducted with children with CP from only one region, which may limit the generalizability of the findings to other populations.

CONCLUSION

This study examined the effects of various comorbidities on physical activity participation in children with cerebral palsy. Visual and hearing impairments were found to have no significant effect on physical activity levels, whereas children with learning disabilities, hip dislocation, and scoliosis exhibited significantly reduced physical activity participation. These findings highlight the importance of addressing comorbidities in the management of CP and suggest the need for an individualized approach to increasing participation in physical activity. Future research should investigate longitudinal effects and explore the role of specific interventions to enhance physical activity in children with CP.

DESCRIPTIONS

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