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Posture and quality of life in children with hemiparesis: Preliminary study

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***Abstract*---**Aim of the study: Evaluate posture and quality of life in children with hemiparesis and assess the relation between them. Study Design: the observational-cross-sectional study was conducted in the National Institute of Neuromotor System in Giza Governorate. Subjects & Methods: Sixty children with hemiparesis cerebral palsy, 28 girls and 32 boys whose ages ranged from 6 to 10 years old, participated in this study. The Postural assessment software (PAS/SAPO) was used to assess their body posture from digitalized pictures (anterior, posterior, right, and left lateral views). The quality of life of participating children was evaluated through the Pediatric Quality of Life Inventory Version 4.0 (PedsQL 4.0). All statistical measures were carried out using the statistical SPSS package program. Results: Postural deviations of children with hemiparesis were characterized by the asymmetry of acromions, anterior superior iliac spine (ASIS), and scapula alignments from the anterior and posterior view. It also adopted head, trunk, and knee flexion and reduced ankle angle from lateral views. There was a decrease in PedsQL 4.0 scores (all domains and the total score). There were positive correlations between posture variables (horizontal alignment of head, vertical alignment of the head from the right side and left ankle angle) and school domain of PedsQL 4.0 parent proxy form ($p < 0.05$), r=(0.39, 0.35, 0.35) respectively. However, for the child report form, the correlation was between the horizontal alignment of the head and school domain ($p < 0.05$), r=(0.43). Other body angles showed no correlation with physical, emotional, social, and even the total score of PedsQL 4.0 scale forms (parent proxy and child report) ($p > 0.05$). Conclusion: Children with hemiparesis have postural

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deviations that affect their quality of life scores in all domains and the total scores. There was a correlation between posture alignment and the school domain of the PedsQL 4.0 scale.

***Keywords*---**cerebral palsy, hemiparesis, posture, quality of life.

Introduction

Cerebral palsy (CP) is primarily a neuromotor disorder that affects the development of movement and posture. The prevalence of CP for all live births ranges from 1.5 to 3 per 1,000 live births (1). The types of children who have CP are spastic, dyskinetic, hypotonic, and ataxic (2). Twenty-five percent of children with CP have spastic hemiplegia (3). Children with hemiparesis CP experience a reduced range of motion (ROM) in joints and muscle contractures (4). The postural disturbance of the symmetry causes spinal deviation from the midline. Due to their central location in the body's linked chain of segments, the trunk and pelvis are more mechanically restricted than the extremities and the head. Despite this constraint, the trunk and pelvis movement can be altered through training (5).

Posture is the position of all the body segments observed at a specific moment. Ideal posture occurs when the body is balanced with the least expenditure of energy (6). The neutral postural alignment from a standing position is achieved when viewed from the front or the back; the vertical line passes through the body's center of gravity and bisects the body into halves, with the bodyweight distributed between the two feet (7).

Inadequate posture is poor interrelations between parts of the body. That causes muscle tension and shortening; Incorrect movements lead to injuries to the musculoskeletal system and limitations in daily activities (6). Postures that represent an attempt to improve function or normalize appearance are called compensatory posture. Posture evaluators need to identify the deviations and determine their causes (8). Postural assessment software (PAS/SAPO) has been developed to assess posture from digitalized pictures of 32 anatomic points (including 14 bilateral points (9). This software is available free online. The PAS allows the measurement of distances and angles. (10).

Quality of life (QOL) is a person's sense of well-being that stems from fulfillment or disappointment with the zones of life that are critical to him (11). There was a lack of tools to assess health-related quality of life in children under 11 years until the Pediatric Quality of Life Inventory 4.0 (PedsQL TM 4.0) was designed, including a Generic Core and a scale specific to certain diseases (12). The PedsQL TM Generic Core scale (PedsQLTM 4.0 GCS) has been translated and validated for many languages and used in research. The PedsQLTM4.0 GCS had good feasibility, validity, and reliability (13). It was created to assess core health in both healthy and sick children. It is a multidimensional quality-of-life measure that has 23 items distributed on four sub-Scales (Physical, Emotional, Social, and School functioning). It was reported to both child and parent. (14). No previous studies have assessed the correlation between posture and quality of life in

children with hemiparesis. Therefore, this study was conducted with a specific goal to assess the posture, quality of life, and the relation between them.

Ethical considerations

The ethical committee of Cairo University's Faculty of Physical Therapy has authorized the current research (NO: P.T.REC/012/002059). The participants' parents have signed a legal consent form to initiate the study process.

Study design

Observational, cross-sectional study.

Sample size

The sample size for this study was calculated using the G*power program 3.1.9 (G power program version 3.1, Heinrich-Heine-University, Düsseldorf, Germany). Sample size calculation based on Exact-Correlation: Bivariate normal model, Type I error (α) = 0.05, power (1-β error probability) = 0.90, Correlation ρH_1 = 0.3674235. The appropriate minimum sample size for this study is 60 patients.

Participants

seventy children with hemiparesis were recruited from the National Institute of Neuromotor System in Giza Governorate. However, four children refused to participate in the study, and six were excluded for not meeting the inclusion criteria. So, the total number of students who continued the study was 60, as illustrated in the Flow chart figure (1). They were (28 girls and 32 boys). The sample was chosen using inclusion and exclusion criteria. Children were diagnosed with hemiparesis CP based on a physician's report or review of medical records. Their age ranged from 6 to 10 years of both sexes; According to the Center of Disease Control and Prevention (CDC) growth charts, They had an average Body Mass Index (BMI) (15). Moreover, they had mild spasticity according to the modified Ashworth scale (grade 1 and 1+). According to the Gross Motor Function Classification System (GMFCS), they were distributed in levels I and II, were cooperative with normal vision and hearing, and followed verbal instructions. The children were excluded if they had fixed deformities of the musculoskeletal system or seizures. Alternatively, who had orthopedic surgery or been injected Botulinum toxin for extremities in the preceding 4 to 6 months.

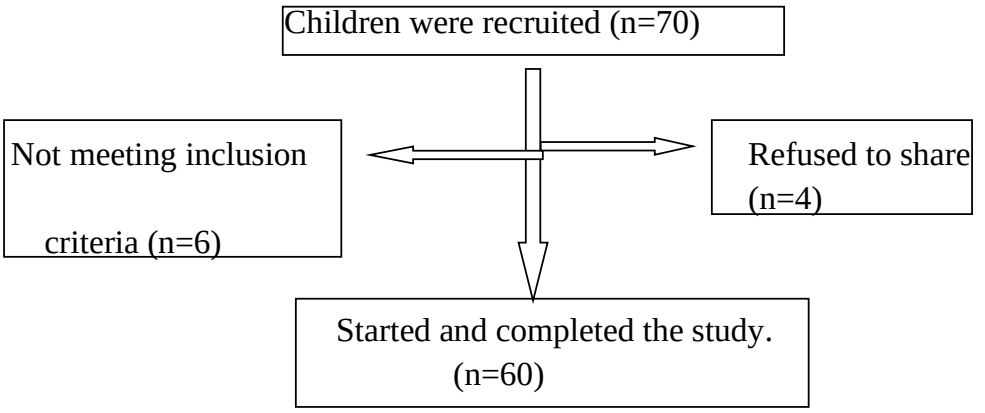

Fig. 1): Flow chart

Procedures

Assessment of body posture

The Postural assessment software (PAS/SAPO) was used to assess body posture for all participating children from digitalized pictures (anterior, posterior, right, and left lateral views). Those were captured by a digital camera (Sony Cybershot DSCW55 7.2MP, 7.2-megapixel, 2.5-inch LCD; 3x optical zoom, Tokyo, Japan) placed on a tripod at 1 m height, at a distance of 2.5 m from the child. Self-adhesive labels of 13 mm and 9 mm Styrofoam balls were used to mark anatomical points on each child's trunk and upper and lower limbs. A plumb line marked with two Styrofoam at a distance of 100 cm balls was used for vertical calibration. Pictures were calibrated according to distance and the vertical guiding line. To take pictures of the children, the plumb line was put on the wall in the appropriate space; the child was positioned in front of the plumb line in such a way that the line and the child were in the same plane perpendicular to the axis of the camera; the camera was positioned at least 2.5 meters away from the child and at the height of 1 meter. Each camera's zoom was adjusted to allow about 0.5 meters of free space below and above the subject to minimize any image distortion. The child was given a verbal command to stand in a familiar and comfortable position. The photos were taken in anterior, posterior, right, and left lateral views then they were transferred to the laptop to be analyzed by SAPO software**(16)**, which measured the following angles:

A) From the anterior view, as illustrated in fig. (2):
   1- Horizontal head alignment (HHA)
      (Angle between the two ear lobes and the horizontal line.)
   2- Horizontal alignment of the acromions (HAA)
      (Angle between the two acromions and the horizontal line)
   3- Horizontal alignment of the ASISs (HAASIS)
      (Angle between the two ASISs and the horizontal line)
   4- The angle between the two acromions and the two ASISs (AAASIS)
      (Angle between the two acromions and the ASISs)

5- Frontal alignment of the right lower limb (FARLL)
(Angle between the greater trochanter of the right femur, the articular line of the right knee, and the right lateral malleolus.)
6- Frontal alignment of the left lower limb (FALLL)
(Angle between the greater trochanter of the left femur, the articular line of the left knee, and the left lateral malleolus.)

B) From lateral views (right & left) as illustrated in fig. (3) & (4):
1-Vertical head alignment (VHA)
(Angle between right tragus, right acromion, and the vertical line)
2- Vertical trunk alignment (VTA)
(Angle between the acromion, the greater trochanter of the femur, and the vertical line)
3-Pelvic horizontal alignment (PHA)
(Angle between right ASIS, right PSIS, and the horizontal line).
4-Knee angle (KA)
(Angle between the greater trochanter of the femur, the articular line of the knee, and the lateral malleolus)
5-Ankle angle (AA)
(Angle between the lateral malleolus, the articular line of the knee, and the horizontal line)

C)From the posterior view, as illustrated in fig. (5):
1-Horizontal asymmetry of the scapula with T3 (HAST3)
(Difference in the distances of the scapulas to the T3 vertebrae).

Figure 2. Postural analysis from the anterior view

Figure 3. Postural analysis from the Right lateral view

Figure 4. Postural analysis from the left lateral view

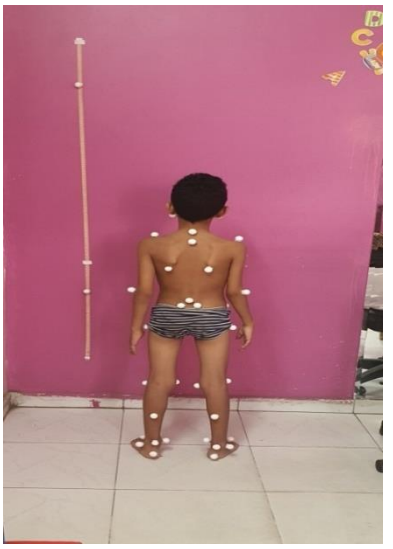

Figure 5. Postural analysis from the posterior view

Assessment of quality of life

- The PedsQL 4.0 generic scoring scale assessed the quality of life, which was valid, consisting of parent proxy and child self-reports. Each was 23 items in 4 dimensions (physical, emotional, social, and school functioning). The scale was explained to the parents and children, and any question asked was clarified for them. They filled out a hard copy of the reports after translating them into Arabic.
- The instructions stated that the parent first completed the parent proxy report separately from their child. They read the instructions and items aloud to a child aged 6–7 years, but children aged 7–10 independently completed their self-report items after reading them.
- Each item was scored on a 5-point scale from 0 (Never) to 4 (Almost always). Scores were transformed from 0 to 100, A 0-100 scale as follows: 0=100, 1=75, 2=50, 3=25, 4=0. If more than 50% of the items on the scale are missing, the Scale Scores should not be computed. Total Score: Sum of all the items over the number of items been answered. The Standard Version asked how much problem each item had been during the past month. For our study, each child had two reports (parent proxy and self one), and all were computed for the total score(14).

Data analysis

The key features of the current study's children were summed up using descriptive statistics. Quantitative variables were recapped through the mean and standard deviation, whereas categorical variables were totalized using frequencies and percentages. The significance level for all statistical examinations was set at p 0.05. All statistical tests were performed using the statistical SPSS package program version 25 for windows (SPSS, Inc., Chicago, IL).

Results

Sixty children with hemiparesis included 28 girls and 32 boys. The demographic characteristics of the children with hemiparesis are described in the following (Table 1).

Table (1). Demographic characteristics of the participants

Variables	Study group (n=60)
Children age, year (mean ±SD)	8.11 ±1.20
Children's weight, kg (mean ±SD)	25.82 ±5.20
Children's height, cm (mean ±SD)	124.26 ±9.41
Children BMI, kg/m^2 (mean ±SD)	16.72 ±1.06
Children's gender (Boys: Girls)	32 (53.33%) : 28 (26.67%)
Children affected side (Right: Left)	35 (58.33%) : 25 (41.67%)

Data are expressed as mean ±standard deviation for age, weight, height, and BMI of the child
Data are expressed as number (percentage) for gender and affected side of the child

Table (2) describes the posture and quality of life variables. The standing posture of children was characterized from the anterior and posterior view by an asymmetry of (Head, Acromions, ASIS, and Scapula) alignment with values (0.43 ±0.48, -3.75 ±4.71, 16.03 ±3.44), respectively. Moreover, the sagittal plane showed an anteriorized position with values greater than zero from both sides (right and left). Also(trunk, hip, knee) flexion and a reduced ankle angle with values from the right and left sides (80.35 ±1.25, 83.36 ±0.84), respectively.

In PedsQL 4.0 parent proxy and child reports, children demonstrated a lower quality of life scores in all domains (physical, emotional, social, and school) and the total score compared to the reference scores of the scale. Also, there were differences in the scores between parent proxy and child reports (Table 2).

Table (2). Mean values of SAPO and QOL variables in the participants.

(SAPO)Variables	Mean ±SD (n=60)	(QOL) Variables	Mean ±SD (n=60)
Anterior view		Parent proxy report	455.26±10.93
HHA	0.43 ±0.48	Physical score	364.47±60.30
HAA	-3.75 ±4.71	Emotional score	313.82±60.31
HAASIS	0.47 ±0.57		

		Social score	
AAASIS	4.27 ±4.79		281.58±74.81
FARLL	-4.31 ±0.98	School score	61.54 ±10.53
FALLL	-1.75 ±1.19		
		Total score	
Right lateral view			
	2.54 ±1.81		466.45±92.68
VHA	-0.75±0.89	Child report	
	-17.23 ±1.48		344.74±77.14
VTA		Physical score	
	10.11 ±1.95		
PHA			303.95±69.63
	80.35 ±1.25	Emotional score	
KA			
			267.11±72.15
AA	5.72 ±1.93	Social score	
			60.11 ±11.66
Left lateral view	3.88 ±0.66		
		School score	
VHA			
	-19.29 ±1.31	Total score	
VTA			
	-1.69 ±1.73		
PHA	83.36 ±0.84		
KA			
AA	16.03 ±3.44		
Posterior view			
HAST3			

Data are expressed as mean ±standard deviation.

The postural variables that correlated with school domain of PedsQL 4.0 were the HHA (parent proxy &child)reports (r=0.39,p=0.016) (r=0.43,p=0.006) respectively. Also the right VHA (r=0.35,p=0.033) and the left AA (r=0.35,p=0.033) of parent proxy report. There were no significance (p > 0.05) and no correlation between the other domains of PedsQL 4.0 (physical, emotional, social), the total score, and the rest of the variables in SAPO software (Table 3 and 4).

Table (3). Correlation between SAPO and PedsQL 4.0 score (parent proxy report)

SAPO	score (parent proxy report)PedsQL 4.0				
	Physical score	Emotional score	Social score	School score	Total score

					Anterior view
HHA	r=0.03	r=0.32	r=0.23	r=0.39	r=0.27
P-value	0.862	0.051	0.173	0.016	0.104
HAA	r=0.03	r=-0.03	r=-0.23	r=-0.15	r=-0.05
P-value	0.853	0.869	0.892	0.356	0.784
HAASIS	r=0.08	r=-0.22	r=-0.03	r=-0.16	r=-0.08
P-value	0.642	0.194	0.879	0.334	0.648
AAASIS	r=-0.02	r=0.01	r=0.02	r=0.13	r=0.04
P-value	0.921	0.974	0.924	0.429	0.819
FARLL	r=0.14	r=-0.15	r=0.15	r=0.03	r=0.07
P-value	0.398	0.357	0.361	0.869	0.674
FALLL	r=0.23	r=-0.16	r=-0.03	r=-0.30	r=-0.04
P-value	0.162	0.328	0.852	0.065	0.808
					Right lateral view
VHA	r=-0.24	r=0.14	r=0.05	r=0.35	r=0.05
P-value	0.144	0.417	0.776	0.033	0.777
VTA	r=0.04	r=-0.08	r=-0.13	r=-0.15	r=-0.08
P-value	0.816	0.642	0.439	0.380	0.638
PHA	r=-0.08	r=0.16	r=0.21	r=0.16	r=0.11
P-value	0.652	0.336	0.214	0.345	0.525
KA	r=-0.06	r=0.10	r=-0.133	r=0.121	r=0.01
P-value	0.731	0.538	0.426	0.470	0.981
AA	r=-0.15	r=-0.15	r=-0.04	r=-0.26	r=-0.20
P-value	0.361	0.359	0.806	0.116	0.241
					Left lateral view
VHA	r=-0.14	r=0.02	r=-0.03	r=0.30	r=0.03
P-value	0.392	0.902	0.880	0.069	0.866
VTA	r=-0.13	r=0.05	r=-0.10	r=-0.18	r=-0.13
P-value	0.440	0.783	0.543	0.268	0.447
PHA	r=-0.07	r=-0.01	r=-0.01	r=-0.12	r=-0.07
P-value	0.699	0.990	0.982	0.492	0.697
KA	r=0.08	r=0.05	r=0.05	r=0.26	r=0.14
P-value	0.639	0.748	0.766	0.114	0.403
AA	r=-0.16	r=-0.08	r=-0.13	r=-0.35	r=-0.23
P-value	0.343	0.624	0.404	0.033	0.164
					Posterior view
HAST3	r=-0.05	r=-0.02	r=-0.03	r=-0.19	r=-0.09
P-value	0.783	0.910	0.871	0.245	0.581

r: Pearson correlation coefficient P-value: probability value *Significant: (P<0.05)

Table (4) .Correlation between SAPO and PedsQL 4.0 score(child report)

	PedsQL 4.0 score (child report)				
SAPO	Physical score	Emotional score	Social score	School score	Total score
					Anterior view
HHA	r=0.01	r=0.29	r=0.22	r=0.43	r=0.26

P-value	0.933	0.082	0.188	0.006	0.114
HAA	r=0.05	r=-0.05	r=-0.04	r=-0.18	r=-0.06
P-value	0.788	0.753	0.799	0.272	0.723
HA ASIS	r=0.099	r=-.041	r=0.135	r=-0.110	r=0.027
P-value	0.553	0.805	0.419	0.511	0.872
AAASIS	r=-0.03	r=0.05	r=0.06	r=0.17	r=0.06
P-value	0.873	0.767	0.744	0.318	0.705
FARLL	r=0.20	r=-0.15	r=0.12	r=-0.03	r=0.05
P-value	0.241	0.370	0.481	0.870	0.775
FALLL	r=0.23	r=-0.06	r=0.02	r=-0.28	r=-0.01
P-value	0.157	0.721	0.910	0.095	0.972
					Right lateral view
VHA	r=-0.21	r=-0.02	r=-0.02	r=0.25	r=-0.02
P-value	0.204	0.925	0.904	0.133	0.928
VTA	r=0.08	r=-0.13	r=-0.05	r=-0.14	r=-0.06
P-value	0.642	0.428	0.753	0.399	0.711
PHA	r=-0.09	r=0.17	r=0.20	r=0.16	r=0.12
P-value	0.611	0.302	0.228	0.330	0.492
KA	r=-0.07	r=0.10	r=-0.04	r=0.18	r=0.04
P-value	0.675	0.550	0.804	0.281	0.806
AA	r=-0.18	r=-0.13	r=-0.07	r=-0.26	r=-0.18
P-value	0.287	0.455	0.683	0.115	0.268
					Left lateral view
VHA	r=-0.01	r=-0.17	r=-0.05	r=0.12	r=-0.03
P-value	0.994	0.322	0.779	0.458	0.873
VTA	r=-0.14	r=-0.01	r=-0.15	r=-0.22	r=-0.15
P-value	0.407	0.950	0.379	0.178	0.373
PHA	r=-0.08	r=0.03	r=0.08	r=-0.07	r=-0.02
P-value	0.618	0.842	0.643	0.682	0.916
KA	r=0.15	r=-0.04	r=-0.02	r=0.19	r=0.08
P-value	0.385	0.800	0.917	0.261	0.623
AA	r=-0.19	r=-0.03	r=-0.02	r=-0.28	r=-0.15
P-value	0.254	0.856	0.907	0.087	0.355
HAST3	r=-0.05	r=0.04	r=-0.04	r=-0.22	r=-0.08
P-value	0.747	0.798	0.810	0.190	0.650

r: Pearson correlation coefficient P-value: probability value *Significant: (P<0.05)

Discussion

This study aimed to evaluate the postural misalignments and quality of life in children with hemiparesis and assess the relation between them. The comfortable standing position was used in this study to evaluate 17 postural variables. Araujo et al., (17) also used the habitual standing position for photographing and SAPO to analyze photos of the patients. Regarding the results of the present study, none of the children with hemiparetic CP met the postural symmetry criteria in the coronal or the sagittal plane about the base of support (BOS) during quiet stance. Asymmetries were seen primarily on the affected body side. This study showed that there were acromions and ASIS asymmetries with means (0.43, -3.75),

respectively, as the expected value suggested by SAPO is equal to zero for those variables. A study by Domagalska et al., (5) reported that hemiplegic children had high scapular and pelvic lines (up to 20° of inclination of the scapular line and up to 40° of inclination of the pelvis line). They added that Other hemiplegic children's shoulder was slightly above (0–5°) and the pelvis below the contra-lateral segments (up to 34°).

The Asymmetrical muscle pull that results from imbalances in muscles around the vertebrae is the possible cause of scoliosis (18). Our study reported a high angle between 2 acromions and 2 ASIS (4.27), indicating developing scoliosis. Furthermore, another study estimated the angle between the acromion and ASIS (0.92) for healthy children aged seven to ten (19). Children with hemiparesis have chronic changes in the mechanical load onto the paretic side (trunk, pelvic and lower limb) under static and dynamic conditions. The excessive overloading of the paretic body toward the concavity of lateral spinal curvature poses an additional risk for the progression of scoliosis (5).

Unilateral spastic CP children often experience a reduced ROM in joints and contractures of the hip, knee, and ankle muscles, contributing to the atypical posture in standing. That leads to Asymmetric alignment in standing. (5). In this study, there were pelvic, knee, and ankle postural deviations. The horizontal alignment of the pelvis showed anterior pelvic tilting. The right knee joint showed a positive angle, which means flexion deformity (crouch). The knee's bending angles are (positive values), and the extension angles are (negative values) (20). Miller and Clark (21) cited that the most common problems encountered in the lower limbs of hemiparetic children are evident in the region of the knees, ankles, and feet, where the motor control may be unsatisfactory. The hip is partially flexed and adducted; knee flexion is due to increased tone of the hamstrings. Moreover, the ankle joint angle in this study showed dorsiflexion associated with knee flexion. Another study found an association between knee flexion and ankle dorsiflexion in SAPO postural assessment of Tropical Spastic Paraparesis patients (22).

Scapular abduction corresponds to the horizontal distance in millimeters from the centroid point of the scapula to the spinal column. A greater distance between markers indicated greater scapular abduction (23). In this study, HAST3 was (16.03 ±3.44), which indicated right scapular abduction that agreed with 58.33% of the study population are right side hemiparetic children. Between 7 and 12 years of age, a child's posture changes to adapt to new body proportions (24). In a study of children aged 7 to 10, there was a high frequency of postural alterations (protrusion of the shoulders, abduction, and upward rotation of the scapulas). According to the authors, the range of motion at this age can cause transitory deviations in postural alignment (25).

The study results of the PedsQL 4.0 scale showed a decrease in quality of life scores in all domains (physical, emotional, social, and school) and the total score of parent proxy and child reports compared to the reference scores of the scale. Several studies assessed the quality of life in hemiparetic cp children, measured by different scales and questionnaires. One study evaluated the child's quality of life, mother's burden, and the correlation between these parameters in children

with spastic CP. Children's QOL was significantly lower, and the mother's burden was higher in the quadriplegia group than in the hemiplegia and diplegia groups (26). Another one studied the extent to which sensory processing disorders in unilateral CP can affect the QOL in children aged 6 to 15 years. Kidscreen was used to evaluate QOL. It ended in difficulty in proprioceptive processing (auditory, visual, and tactile) associated with participation in the school environment. Behavioral and social-emotional responses are associated with psychological well-being (27).

This study showed a difference in the results between child and parent proxy reports in PedsQL 4.0. That matched another study that assessed the agreement between child and parent proxy reports in child PedsQL. Children ages were 5.5 – 8.5 years. The agreement between child and parent proxy reports of child QOL could be affected by the domains investigated, the age of children (higher agreement for younger age on physical health, compared to a higher agreement for older age on psychosocial aspects of health) (28). The parent-child agreement can differ across domains investigated (higher agreement for physical aspects of health vs. emotional aspects) (29).

This study showed a correlation between (HHA, right VHA, and left AA) and the school domain of parent proxy report of the PedsQL 4.0 scale. However, only HHA correlated with the school domain of child self-report of the PedsQL 4.0 scale. Other posture variables showed no correlation neither with the total score of the PedsQL 4.0 scale nor (physical, emotional, and social) domains. Kothari et al., (30) correlated the foot arch with quality of life. Children ages were (8 – 15) years. They were assessed by 3D gait analysis and the Oxford Ankle Foot Questionnaire for Children (OxAFQ_C). Reduced OxAFQ_C physical domain scores in the flat feet children were associated with slower walking speed and reduced stride length. Increased eversion correlated strongly with lower QOL scores in flat feet children.

Limitations

The main limitation of this study is the small sample number due to the spread of corona virus (COVID-19) and obligatory quarantine. A lack of literature studied the relation between posture and QOL in children with hemiparesis. The findings of our study may be used to guide further research.

Conclusion

Children with hemiparesis have postural deviations that affect their quality of life scores in all domains and the total scores. There was a correlation between posture alignment and the school domain of the PedsQL 4.0 scale.

Conflict of interest

No conflict of interest is found or stated.

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