



Original Article

An investigation of the factors affecting handwriting articulation of school aged children with cerebral palsy based on the international classification of functioning, disability and health

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Abstract. [Purpose] This study was designed to identify factors influencing handwriting articulation based on the international classification of functioning, disability and health (ICF) and to recommend effective evaluation and intervention strategies to improve the handwriting of children with cerebral palsy. [Subjects] The subjects were 96 elementary school children with cerebral palsy and the study was conducted from 04/07/2011 to 29/08/2011. [Methods] Factors related to handwriting articulation were investigated based on the ICF model. [Results] Wrist lateral deviation, upper-extremity speed of body function and education of personal factor were significantly associated with handwriting articulation. [Conclusion] Efforts to manage and improve the handwriting articulation of children with cerebral palsy should focus on wrist lateral deviation, upper-extremity speed, and education.

Key words: Cerebral palsy, Handwriting articulation, ICF

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INTRODUCTION

Children with cerebral palsy experience restrictions on handwriting due to difficulties of motor coordination and balance due to damage to the central nervous system and involuntary movements. One study found that 81.3% of children with cerebral palsy were found to write incorrect, uneven and unrecognizable letters¹⁾. Previous studies¹⁻⁵⁾ of handwriting related factors of children with cerebral palsy have been carried out, but these studies had limitations regarding the identification of comprehensive relevant factors and the selection of efficient priorities. In the last ten years, perspectives on outcome assessments of cerebral palsy have been influenced and shaped by the World Health Organization's International Classification of Functioning, Disability, and Health (ICF)⁶⁾, as a guiding principle. ICF provides descriptions of three major domains of body function, body structure, and activities and participation (execution of tasks and activities and involvement in a life situation). These domains are further clarified with contextual factors, either personal or environmental, and by applying the ICF's conceptual framework, vocational evaluators can systematically gather, organize, synthesize and interpret health related assessment information⁷⁾. Also, ICF domains have been used to understand and describe the many impacts of CP on individuals and allow the categorization of various CP outcome measures by the domain that is being assessed⁸⁾. We investigated factors affecting handwriting articulation of children with cerebral palsy based on the ICF model to provide comprehensive data for the assessment and design of interventions for effective handwriting of children with cerebral palsy.

SUBJECTS AND METHODS

Among the subjects who participated in the research, there were 54 male (56.3%) and 42 female subjects (43.8%). Their average age was 11.16 (± 2.06), average education year was 3.75 (± 1.97). There were 78 right-handers (81.3%) and 18 left

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handers (18.8%). There were 54 subjects with diplegia (56.2%), 30 with hemiplegia (31.3%) and 12 with quadriplegia (12.6%) (Table 1). The subjects did not have any diseases related to the hands, fractures, or past histories of diseases. Before the study, the principal investigator explained all procedures to the subjects in detail. All subjects signed an informed consent form, which was approved by the Cheonnam University College of Human Health Science Studies Committee. Based on the ICF, factors related to handwriting were classified as personal factors (gender, age, education, hand dominance, type of cerebral palsy), environmental factors (writing aids, sitting aids, type of desk), body structure(affected side), body functions (cognitive function: orientation, visual perception, spatial perception, motor praxis, visuomotor organization, thinking operation; sensory function: proprioception, tactile; strength function: upper extremity, grasp, prehension; motor function: bilateral coordination, upper extremity speed), and activity and participation (sitting balance, pencil grasp posture). To identify the factors related to handwriting articulation, assessment tools were classified and used based on the ICF model (Table 2). Data analyses were performed using SPSS version 17.0.

RESULTS

Some personal factors (age, education) and body functions (cognitive function: visual perception, visuomotor organization; strength function: upper extremity elbow flexion and extension, wrist extension, lateral deviation and medial deviation, grasp; and motor function: bilateral coordination, upper-extremity speed, factors were related to handwriting articulation. According to the backward regression analysis, wrist lateral deviation, upper-extremity speed and education were significantly associated with handwriting articulation (Table 3).

DISCUSSION

Cerebral palsy may involve problems in the neuromuscular system such as spasticity, contracture, muscle weakness, and loss of selective movement⁹). This decreased functioning limits the ability of children with CP to participate in various activities. In particular school aged children with CP have academic difficulties¹⁰). So, the identification of factors that lead to

Table 1. General characteristics of the subjects

Components of ICF		N (%)
Gender	Male	54 (56.3)
	Female	42 (43.8)
Age	8 years	14 (14.6)
	9 years	13 (13.5)
	10 years	13 (13.5)
	11 years	7 (7.3)
	12 years	14 (14.6)
	13 years	23 (24.0)
	14 years	12 (12.5)
	(M±SD)	11.16±2.06
Hand dominance	Right	78 (81.3)
	Left	18 (18.8)
Education (elementary school)	First grade	19 (19.8)
	Second grade	13 (13.5)
	Third grade	11 (11.5)
	Fourth grade	8 (8.3)
	Fifth grade	18 (18.8)
	Sixth grade	27 (28.1)
	(M±SD)	3.75±1.97
Type of cerebral palsy	Spastic	74 (77.1)
	Athetoid	5 (5.2)
	Athetoid with spasticity	4 (4.2)
	Ataxic	11 (11.5)
	Flaccid	2 (2.1)
Affected side	Diplegia	54 (56.2)
	Hemiplegia	30 (31.3)
	Quadriplegia	12 (12.5)

functional impairment is of fundamental importance in clinical decision making and the evaluation of the effect of therapeutic strategies¹¹).

This study investigated handwriting articulation among school-aged child with cerebral palsy and factors related to it. Handwriting articulation is related to body functions and personal factors. Lower body function cognitive function: visual perception, visuomotor organization; strength function: upper extremity (elbow flexion and extension, wrist extension, lateral deviation, and medial deviation, grasp; and motor function: bilateral coordination, upper-extremity speed) contributed towards poor handwriting articulation, and also occurred in individuals with lower ages and education. Several studies have described the influence of visual perception, visual motor organization¹), strength function of the upper extremity¹²), and motor function⁴). Visual perception is the ability to recognize forms, notice likenesses and differences, infer the movements necessary for the production of the form. Visuomotor organization is the ability to copy or transpose from printing material to cursive or manuscript writing¹). Upper extremity strength is important for developing pencil control and handwriting¹²). Bilateral coordination impairment negatively affects handwriting skills⁴). Crossing the midline is an integral skill related to bilateral coordination. A child who avoid midline crossing may have difficulty coordinating both sides of the body, has

Table 2. Assessment based on the ICF

Components of ICF	Handwriting factors	Assessment	
Personal factors	Gender	Interview	
	Age		
	Education		
	Hand dominance		
	Type of cerebral palsy		
Environmental factors	Writing aids	Interview	
	Sitting aids		
	Type of desk		
Body structure	Affected side	Interview	
Body functions	Cognitive function	Orientation	DOTCA
		Visual perception	
		Spatial perception	
		Praxis	
	Sensory function	Visuomotor construction	Proprioception test
		Thinking operation	Tactile test
		Proprioception	Manual Muscle Test
	Strength function	Tactile	Dynamometer
		Upper extremity	Pinch meter
		Grasp	B-O test (subtest 3)
Motor function	Prehension	B-O test (subtest 8)	
	Bilateral coordination		
	Upper extremity speed		
Activity & Participation	Sitting balance	Sitting balance test	
	Pencil grasp posture	Survey	
Health	Writing articulation	Korean alphabet writing assessment	

Table 3. Factors related to handwriting articulation

Component of ICF	Handwriting factors		Unstandardized coefficients		Standardized coefficients	VIF
			B	Standard error	Beta	
Body function	Strength function	Upper extremity-Wrist lateral deviation	1.046	0.299	0.307	1.001*
	Motor function	Upper extremity speed	0.079	0.018	0.393	1.024**
Personal factor	Education		0.364	0.176	0.183	1.023*

*p<0.05, **p<0.001

difficulty establishing hand dominance and tends to use alternate hands when writing.

Backward regression analyses shows that wrist lateral deviation of muscle strength, upper-extremity speed and education were important predictors of handwriting articulation. Wrist lateral deviation showed great impact on handwriting articulation. A previous study reported that the muscles of the wrist stabilize and prevent unwanted wrist movements, which allow the finger muscles to maintain an adequate length that is favorable for producing tension and prehension¹³). Upper extremity mobility is a coordinated effort of the upper extremity structure and function, and poor upper extremity speed can lead to functional limitation. A previous study reported upper extremity speed is significantly related to handwriting skills¹⁴). Education is a more important factor than age affecting handwriting articulation. Coordinated handwriting movements improve with schooling¹⁵). This study had several limitations, and one of them was the small sample size, therefore these results cannot necessarily be generalized to all children with cerebral palsy. It also exclusively investigated physical body function and structure and personal factors but not environmental factors.

In conclusion, this study comprehensively handled overall health-related factors on the basis of the ICF health model for intervention approaches for children with cerebral palsy, therefore, it can be used as basic data in setting systematic intervention goals and plans for articulation of handwriting. Comprehensive personal function and body function assessments that involve cognitive function (visual perception, visuomotor organization), strength function (upper extremity: elbow flexion, extension, wrist extension, lateral deviation, medial deviation, grasp) and motor function (bilateral coordination, upper-extremity speed) must be performed. Efforts to manage and improve the handwriting articulation of children with cerebral palsy should focus on wrist lateral deviation and upper-extremity speed.

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