ORIGINAL ARTICLE

The Relationship between Achievement Age of Fine Motor and Language Skills in Children with Down Syndrome

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ABSTRACT

Introduction: Fine motor and language skills in children with Down Syndrome (DS) play an important role in independence and social participation in daily life. The objective of this study is to know whether there is a relationship between the achievement age of fine motor skills and language skills in children with DS.

Methods: This study was an analytic observational study with a cross sectional design. The subjects of this study were forty-six children with DS, ranging in age from 15 to 199 months. The examination was done after informed consent were obtained from the parents. Milestones development, weight-age%, length-age%, and head circumference-age% charts for DS were used to examine subjects.

Results: There was a significant relationship between the achievement age of fine motor skills and language skills in children with DS ($p< 0.05$). There was no significant relationship between weight-age%, length-age%, and head circumference-age% with the achievement age of fine motor skills and language skills in children with DS ($p>0.05$).

Conclusion: Fine motor skills stimulation was expected to improve language skills, and vice versa in children with DS.

Keywords: Down syndrome, fine motor skills, language skills

ABSTRAK

Pendahuluan: Ketrampilan motorik halus dan bahasa pada anak-anak sindrom Down (SD) memiliki peran penting dalam kemandirian dan partisipasi sosial dalam kehidupan sehari-hari. Penelitian ini bertujuan untuk mengetahui apakah terdapat hubungan antara usia pencapaian ketrampilan motorik halus dan bahasa pada anak-anak dengan SD

Metode: Penelitian ini merupakan penelitian observasional analitik dengan desain penelitian *cross sectional.* Setelah mendapatkan informed consent dari orang tua, dilakukan pemeriksaan terhadap 46 anak SD usia 15-199 bulan. Subyek diperiksa menggunakan tabel *milestones* motorik halus dan bahasa khusus untuk anak SD; dan tabel *weight-age%, length-age%, head circumference-age%* untuk anak SD.

Hasil: Terdapat hubungan yang bermakna antara usia pencapaian ketrampilan motorik halus dan bahasa pada anak-anak dengan SD ($p<0,05$). Diketahui pula tidak terdapat hubungan bermakna antara *weight-age%, length-age%, head circumference-age%* dengan usia pencapaian motorik halus dan bahasa pada anak-anak SD ($p>0,05$).

Kesimpulan: Stimulasi perkembangan ketrampilan motorik halus diharapkan dapat meningkatkan perkembangan bahasa pada anak SD, dan sebaliknya.

Kata kunci: Sindrom Down, motorik halus, Bahasa

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INTRODUCTION

Down Syndrome (DS) is the most prevalent autosomal condition worldwide, affecting roughly 1 in every 1000 live births.[1] World Health Organization (WHO) predicted a global prevalence of eight million cases of DS. Riset Kesehatan Dasar (RISKESDAS) report indicated a consistent rise in the prevalence of DS from 2013 to 2018.[2] In the last decade, the incidence of DS has increased by about 30%.[3]

DS was named in honor of John Langdon Down, an English physician who first documented the characteristics of this disorder in 1866.[4] DS is the result of a condition called trisomy 21, when there is an extra copy of chromosome 21. DS has distinct clinical characteristics and is linked to an elevated susceptibility to other medical problem. The clinical characteristics of individual with DS were categorized into general, facial, ocular, cardiac, abdominal, and hematological features[1] DS is also linked to cognitive impairment. The severity of mental retardation typically ranges from mild (Intelligence Quotient (IQ): 50-70) to moderate (IQ: 35-49), with severe mental retardation

(IQ: 20-34) being less common.[4]

Involvement in community life has grown in importance as person with DS live longer lives and attain greater independence.[5] Children with DS require specialized care that must be provided for a longer length of time and at great expense. DS is considered to have one of the greatest economic consequences among intellectual disabilities.[3] A mild to severe burden was experienced by less than half of the primary caregivers in DS families. The chance of caregiver burden was raised by female caregiving, single parent status and DS children of young age, female sex and having congenital heart disease increased the likelihood of caregiver burden. Physicians should be encouraged to assist caregivers of children with DS by providing appropriate counseling regarding the nature and complication of DS, managing and referring complex cases from the outset, correcting misconceptions through educational programs, and providing information about social and medical resources.[6]

Language skills are essential for children with DS and are associated with communicative, social, and behavioral functions. Language is the most affected development domain in children with DS. Language and communication abilities in children with DS were constant. In children with DS, receptive language skills outperformed expressive language skills. Less expressive language skills, as well as decreased oral motor skills in children with DS, are linked to the specific anatomical characteristics of the oral cavity. Oral motor skills abnormalities can affect speech clarity, articulation, and fluency. These disorders are caused by hypotonia and variations in the structure of the oral cavity. Future expressive vocabulary in children with DS was found to be accurately predicted by the home literacy environment, receptive vocabulary, auditory memory, phonological awareness, and oral motor skills. Therefore, the goal of language intervention for children with DS is to enhance their social, intellectual, communication, and vocational skills. [7–10]

Activities involving the small muscles in the hands and fingers are referred to as fine motor skills. Achieving independence in everyday life, self-care, and academics in linked to the development of fine motor skills. One factor that affects how slowly fine motor skills develop in children with DS is low intellect.[11] Aside from that, hypotonia and/ or hypermobility in the hands, wrist, and/ or elbows of children with DS affect their inability to perform fine motor skills.[12] Problems with motor, functional, and balancing functions results from neuromuscular anomalies, such as hypotonia, retained primary reflexes, and sluggish performance of volitional reaction.[8,13]

Given the significance of fine motor skills and language skills in day-to-day living, we are intrigued to find out if there is a correlation between the age at which children with DS develop these abilities. Aside from that, the majority of the research on children with DS concentrated on comorbidities, developmental milestones, and the impact of interventions. The connection between fine motor skills and language skills was the focus of fewer studies. [14] Moreover, to our knowledge, no previous study has undertaken this point of focus in the DS population, especially in Central Java.

METHODS

This study was analytic observational with a cross sectional design and used prospective primer data from examination and direct screening of subjects. We are affiliated with Central Java Branch Perkumpulan Orang Tua Anak Down Syndrome (POTADS) community that was gathered at Dr. Soeharso Orthopedic Hospital on November 5, 2023. This study was approved by the Dr. Soeharso Orthopedic Hospital Ethics Committee.

The inclusion criteria of this study were children with DS clinical features, which were permitted by their parents. The exclusion criteria were aged less than twelve months. Total sampling was used for the sampling method in this study, and data was collected from the entire population based on the inclusion and exclusion criteria.

Before the examination, a classical explanation was done by researchers, and then the parents of subjects was signed informed consent. The examination was done by Physical Medicine and Rehabilitation physiatrists. Data that was collected were identity; chronological age in moths; body height, body weight, and head circumferences that were assessed with Growth Charts for Children with Down Syndrome[15] ; developmental history; and developmental achievement examination that were then assessed with Milestone for Down Syndrome Charts.[16–18]

The fine motor skills and language skills achievement age variables were categorized as nominal data. And then these variables were analyzed using univariate descriptive analysis. Then, non-parametric comparative bivariate analysis was done for two variables of nominal data. Chi square test with alternative Fischer's exact test, and the significant value was calculated with Statistical Product and Service Solutions (SPSS) 15.

Table 1. Fine Motor Skills Milestones for Children with Down Syndrome.[16,17]

FINE MOTOR SKILLS		
1,5-6 months	:	follows object with eyes
4-11 months	:	grasps dangling ring
5-13 months	:	removes towel from eyes (during play)
5-13 months	:	looks for an object which disappear out from the view
5-11 months	:	lets go of one objects in order to pick up another
6-12 months	:	passes object from hand to hand
8-17 months	:	imitates movements
8-17 months	:	shakes rattle to make a sound
7-17 months	:	pulls a string to attain toy
9-17 months	:	picks up object from a box
9-21 months	:	finds objects hidden under cloth

Table 1. Fine Motor Skills Milestones for Children with Down Syndrome.[16,17]

FINE MOTOR SKILLS		
8-22 months	:	uses index finger to explore object
9-18 months	:	claps hands
11-17 months	:	open box to find a toy
10-19 months	:	rolls/ catches ball
10-21 months	:	attempts to imitate a scribble
10-24 months	:	puts cube in cup
12-34 months	:	puts three or more objects into cup or box
12-36 months	:	picks up an object size of a currant using thumb and forefinger only
14-32 months	:	builds a tower of two 1” cubes
16-27 months	:	hold bottle
20-22 months	:	self-feed with fingers
17-36 months	:	puts a peg in peg-board two or more times
22-36 months	:	intentional drop/ release, hold crayon and scribble
42-72 months	:	feed with spoon
36-60 months	:	drink from straw cup
66-90 months	:	drink from open cup, feed with fork
84-144 months	:	cut 4” straight line
120-216 months	:	cut 11” straight line
60-120 months	:	traces pre-writing shapes
72-144 months	:	string beads
90-168 months	:	toilet trained
108-144 months	:	traces letters in name
120-144 months	:	copies a sequence of letters
120-216 months	:	writes name
168-216 months	:	copies numbers
168-192 months	:	dress/ undress no fasteners
180-216 months	:	cut curved line
216 months	:	independent zipper, button on pants and shirt, tie shoes

Table 2. Language and Communication Skills Milestones for Children with Down Syndrome.[16,18]

LANGUAGE AND COMMUNICATION SKILLS		
0,5-1,5 months	:	reacts to sounds
1,5-8,5 months :	:	vocalizes to smile and talk
5-9 months	:	shows satisfaction in social interaction
5-12 months	:	gains attention by making sounds variation (not crying)
3-8 months	:	turns to sound of voice
6-13 months	:	reacts appropriately to signal gestures (come up, look)
7-18 months	:	babbling, say "da-da, ma-ma", imitates sounds
10-18 months	:	responds to familiar words by gestures
11-24 months	:	responds to 'no'
12-24 months	:	responds to simple verbal instructions, joint attention, conveying an increasing number of meanings in gestures and some words, first 10 words
12-30 months	:	jabbers expressively
13-36 months	:	says first word(s)
24-36 months	:	initiating conversations (pointing, requesting), first 30 words, comprehension ahead of production
18-60 months	:	says two words
36-60 months	:	repairing conversations when not understood – by trying again, first 100 words, at 60 months about 300 words
60-84 months	:	learning to continue narratives, taking part in conversations, telling stories, requesting clarification (what, where. Average vocabulary of about 2000 words at 60 months. More difficult preposition (above, below), conjunctions (because), comparatives (longer than). Speech intelligible.
85-192 months	:	give longer explanations or instructions, telling jokes. From 85 months, 3000 new words learned each year, 50.000 words or more at 192 months.

RESULTS

The total subjects were 46 children with DS clinical features. The baseline characteristics of the subjects are presented in Table 3. Participants consist of twenty-four (52.2%) boys and twenty-two (47.8%) girls. The range of chronological age of the subjects was 15-199 months, with a mean age of 77.57 ± 46.01. For weight for age (%), most of the participants were in the <5% percentile (twelve subjects); for length for age (%), the most participants were in the 10-25% and 25-50% percentile (eight subjects); and for head circumference for age (%), most of the participants were in the 25-50% percentile (sixteen subjects). There were thirty subjects (65.2%) and twelve subjects (26.1%) from total participants that achieved fine motor skills and language skills in consecutively appropriated reference charts.

Table 3. Baseline Characteristics of Subjects

Variable	Freq.	%	Mean ± SD	Median (min – max)
Gender				
Boys	24	52.2		
Girls	22	47.8		
Chronological Age			77.57 ± 46.01	64.5 (15 – 199)
Weight-Age%				
<5%	12	26.1		
5%	1	2.2		
5-10%	7	15.2		
10%	4	8.7		
10-25%	6	13.0		
25-50%	6	13.0		
50%	2	4.3		
50-75%	4	8.7		
75-90%	2	4.3		
90%	1	2.2		
90-95%	1	2.2		
Length-Age%				
<5%	5	10.9		
5-10%	2	4.3		
10%	2	4.3		
10-25%	8	17.4		
25%	3	6.5		
25-50%	8	17.4		
50%	2	4.3		
50-75%	7	15.2		
75%	1	2.2		
75-90%	4	8.7		
90%	1	2.2		
90-95%	1	2.2		
95%	1	2.2		
>95%	1	2.2		
Head Circumference-Age%				
<5%	9	19.6		
5%	1	2.2		
5-10%	3	6.5		

Table 3. Baseline Characteristics of Subjects

Variable	Freq.	%	Mean ± SD	Median (min – max)
10-25%	5	10.9		
25-50%	16	34.8		
50%	1	2.2		
50-75%	9	19.6		
75-90%	1	2.2		
90-95%	1	2.2		
Fine Motor				
Appropriate	30	65.2		
Not Appropriate	16	34.8		
Language				
Appropriate	12	26.1		
Not Appropriate	34	73.9		

Table 4 showed there was no significant relationship between weight for age (%) and achievement age of fine motor skills, with p value 0.824 (p>0.05).

Table 4. The Relationship between Weight for Age (%) and Achievement Age of Fine Motor.

Weight-Age%	Fine Motor				P
	Appropriate		Not Appropriate		
	n	%	n	%	
<5%	7	23.3	5	31.3	0.824
5%	1	3.3	0	0	
5-10%	5	16.7	2	12.5	
10%	2	6.7	2	12.5	
10-25%	5	16.7	1	6.3	
25-50%	3	10	3	18,8	
50%	2	6.7	0	0	
50-75%	2	6.7	2	12.5	
75-90%	2	6.7	0	0	
90%	1	3.3	0	0	
90-95%	0	0	1	6.3	

Table 5 shows there was no significant relationship between length for age (%) and achievement age of fine motor skills, with p value 0.780 (p>0.05).

Table 5. The Relationship between Length for Age (%) and Achievement Age of Fine Motor.

Length-Age%	Fine Motor				p
	Appropriate		Not Appropriate		
	N	%	N	%	
<5%	3	10	2	12.5	0,780
5-10%	1	3.3	1	6.3	
10%	1	3.3	1	6.3	
10-25%	6	20	2	12.5	
25%	2	6.7	1	6.3	
25-50%	6	20	2	12.5	
50%	2	6.7	0	0	
50-75%	4	13.3	3	18.8	
75%	1	3.3	0	0	
75-90%	2	6.7	2	12.5	
90%	0	0	1	6.3	
90-95%	1	3.3	0	0	
95%	1	3.3	0	0	
>95%	0	0	1	6.3	

Table 6 shows there was no significant relationship between head circumference for age (%) and achievement age of fine motor skill, with p value 0.461 (p>0.05).

Table 6. The Relationship between Head Circumference for Age (%) and Achievement Age of Fine Motor.

Head Circumference-Age%	Fine Motor				p
	Appropriate		Not Appropriate		
	N	%	n	%	
<5%	5	16.7	4	25	0.461
5%	1	3.3	0	0	
5-10%	1	3.3	2	12.5	
10-25%	4	13.3	1	6.3	
25-50%	10	33.3	6	37.5	
50%	1	3.3	0	0	
50-75%	7	23.3	2	12.5	
75-90%	1	3.3	0	0	
90-95%	0	0	1	6.3	

Table 7 shows there was no significant relationship between weight for age (%) and achievement age of language skills, with p value 0.929 (p>0.05).

Table 7. The Relationship between Weight for Age (%) and Achievement Age of Language Skill.

Weight-Age%	Language				P
	Appropriate		Not Appropriate		
	n	%	n	%	
<5%	3	25	9	26.5	0.929
5%	1	8.3	0	0	
5-10%	2	16.7	5	14.7	
10%	1	8.3	3	8.8	
10-25%	1	8.3	5	14.7	
25-50%	0	0	6	17.6	
50%	2	16.7	0	0	
50-75%	0	0	4	11.8	
75-90%	2	16.7	0	0	
90%	0	0	1	2.9	
90-95%	0	0	1	2.9	

Table 8 shows there was no significant relationship between length for age (%) and achievement age of language skills, with p value 0.910 (p>0.05).

Table 8. The Relationship between Length for Age (%) and Achievement Age of Language Skill.

Length-Age%	Language				P
	Appropriate		Not Appropriate		
	n	%	N	%	
<5%	2	16.7	3	8.8	0.910
5-10%	0	0	2	5.9	
10%	1	8.3	1	2.9	
10-25%	1	8.3	7	20.6	
25%	1	8.3	2	5.9	
25-50%	2	16.7	6	17.6	
50%	0	0	2	5.9	
50-75%	2	16.7	5	14.7	
75%	1	8.3	0	0	
75-90%	1	8.3	3	8.8	
90%	0	0	1	2.9	
90-95%	1	8.3	0	0	
95%	0	0	1	2.9	
>95%	0	0	1	2.9	

Table 9 shows there was no significant relationship between head circumference for age (%) and achievement age of language skills, with p value 0.949 (p>0.05).

Table 9. The Relationship between Head Circumference for Age (%) and Achievement Age of Language Skill.

Head Circumference-Age%	Language				p
	Appropriate		Tidak Sesuai		
	n	%	N	%	
<5%	3	25	6	17.6	0.949
5%	1	8.3	0	0	
5-10%	1	8.3	2	5.9	
10-25%	1	8.3	4	11.8	
25-50%	1	8.3	15	44.1	
50%	1	8.3	0	0	
50-75%	3	25	6	17.6	
75-90%	1	8.3	0	0	
90-95%	0	0	1	2.9	

Table 10 shows there was significant relationship between the achievement age of fine motor skills and language skills in children with DS, p value 0.004 (p<0.05).

Table 10. The Relationship between Achievement Age of Fine Motor and Language Skills in Children with DS.

Fine Motor	Language				P
	Appropriate		Not Appropriate		
	n	%	n	%	
Appropriate	12	100	18	52.9	0.004
Not Appropriate	0	0	16	47.1	

DISCUSSION

In DS children, the least developed aspects are speech coordination and fine motor skills. [19] The hypothesis of this study was that there was a significant relationship between the achievement age of fine motor skills and language skills in children with DS. The result of this study is in line with the hypothesis (Table 8). This study was in line with the previous studies in children with DS;[8,19] in children with mental retardation;[20] and in typical developing children that stated there was a relationship between motor and language skills.[21] This claim was supported by neuroimaging techniques that have shown that regions important to motor performance cognition, such as the cerebellum, dorsolateral prefrontal cortex, and the connecting structures (including the basal ganglia), are co-activated

in certain motor and cognitive tasks. This confirms the mutual association between these two domains. Furthermore, areas of the brain implicated in language functions (e.g., Broca's area) are also activated during motor tasks (i.e., action planning, action observation, action understanding, and imitation), and the activation of motor areas has been observed during language tasks.[22] The idea that there is a relationship between motor and cognitive development, and consequently between motor and language development, stems in part from the embodied cognition perspective, in which cognition, and language as a subdomain of cognition are considered to occur in the context of the individual's bodily interaction with the physical and social environment, which enhances language comprehension.[21,22]

Participants of this study were children with DS aged 15 to 199 months. This study did not categorize the achievement age of fine motor skills and language skills. Wang et al showed there was a relationship between fine motor and language skills in typical developing children before and after 3 years. Neurological maturity, neurological abnormalities, and environmental factors such as environmental characteristics and parenting influence motor and cognitive development.[22] There were over-expression genes localized in chromosome 21 that are responsible for such dysfunction in the Central Nervous System (CNS) as smaller volume, shaped, and amount of neuron; delayed neuron myelination in the CNS; and pathophysiological process such as degeneration, dysfunction of regulation neural apoptosis, over-expression beta amyloid precursor protein, and lower capacity of neurotransmitters in children with DS.[8,23] This was associated with more pronounced difficulties in executive function, especially in working memory tasks that need cognitive control. Working memory has a role in the basic comprehension of writing and speaking language in children with DS.[12,24] Previous studies showed approximately 80% of children with DS experience moderate intellectual disability, some of them had severe intellectual disability and average. [10] This study did not categorized the age of participants, so this study represented all of participants.

Delayed of language development in children with DS was influenced by auditory, oral motor, cognitive, social, and nonverbal communication skill in early and prelingustic stage. Two-third of children with DS had conductive or sensory neural hearing loss. Otitis media occurs because of narrow auditory canal and craniofacial structure differences and can be cause of conductive hearing loss.[10] Prematurity, hypothyroidism, autism spectrum disorder (ASD), and history of congenital heart disease can influence the age of development in children with DS.[13] The stunted growth phenotype of DS could be associated with an increased risk of several co-occurring conditions, most prominently ASD, autoimmune diagnoses, and chronic lung disease.[25] This study did not exclude the co-morbid factors that can influence developmental delays in children with DS, so this study can represent all of the condition of participants.

Results of this study showed there was no significant relationship between weight for age, length for age, and head circumference to the achievement age of fine motor skills and language skills (Table 7). Growth is a well-

known indicator of health during childhood. The average final height of males and females with DS falls below the third percentile on the growth charts for height of the general population. The results of study by Klosowska, et al indicate that the height percentile of children with DS correlates with their Intelligence Quotient (IQ), which can be observed in terms of general, verbal, and nonverbal IQ. They did not find any correlation between the IQ and the BMI.[26] This implied that, despite the fact that language is part of cognitive, language skill did not correlate with height.

This study did not categorize gender of the participants. Previous study stated that the severity of motor performance precision in children with DS was associated with gender differences, [12] however other study stated that they did not find any gender-related differences in verbal and non-verbal communication and motor skill among the DS subjects[27] we examined age and gender-specific variability revolving around major challenges related to ophthalmologic and auditory health, social integration, daily life, and behavioral problems in 468 age: 2–84 years. Based on that, it is interesting to study the relationship between the achievement age of fine motor skills and language skills and gender.

CONCLUSION

This study showed a relationship between the achievement age of fine motor skills and language skills in children with DS. This implies that therapy intervention that stimulate fine motor skills can influence language skills, and vice versa.

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