Toothbrushing Behavior and Handgrip Strength among Children with Intellectual Disabilities: a Cross-Sectional Study

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Abstract

Children with intellectual disabilities have cognitive limitations, fine motor impairments and low conceptual understanding, which hinder their ability to perform self-care activities independently, including brushing their teeth. Limited fine motor skills can affect their ability to grip and control a toothbrush, making hand grip strength a relevant variable in efforts to enhance the independence of children with intellectual disabilities in brushing their teeth. The aim of this study is to analyze the relationship between toothbrushing behavior and hand grip strength in children with intellectual disabilities. This study employs an observational analytic design with a cross-sectional approach. The sample selection was conducted using purposive sampling, resulting in 38 respondents. Toothbrushing behavior has a significant relationship with hand grip strength in children with intellectual disabilities. Variables such as frequency, duration and brushing time (morning and night) consistently influence grip type, strength control, independence, grip duration, stability and grip precision. Repeated toothbrushing with a specific pattern can improve fine motor strength and support children's independence and quality of life.

Anak disabilitas intelektual memiliki keterbatasan kognitif, ketidakmampuan motorik halus dan rendahnya pemahaman konseptual sehingga menghambat melaksanakan kegiatan kebersihan diri secara mandiri, termasuk menyikat gigi. Kemampuan motorik halus yang terbatas, dapat mempengaruhi kemampuan anak menggenggam dan mengontrol sikat gigi maka kekuatan genggaman tangan menjadi variabel yang relevan dalam upaya meningkatkan kemandirian anak disabilitas intelektual menyikat gigi. Tujuan penelitian ini adalah untuk menganalisis hubungan perilaku menyikat gigi dengan kekuatan genggaman tangan pada anak disabilitas intelektual. Desain penelitian ini menggunakan pendekatan observasional analitik dengan metode cross-sectional. Pemilihan sampel dilakukan dengan metode purposive sampling dan didapatkan 38 responden. Perilaku menyikat gigi memiliki hubungan signifikan dengan kekuatan genggaman tangan anak disabilitas intelektual. Variabel frekuensi, durasi dan waktu menyikat gigi (pagi dan malam) secara konsisten mempengaruhi jenis genggaman, kontrol kekuatan, kemampuan mandiri, durasi genggaman, stabilitas dan presisi genggaman. Pengulangan menyikat gigi

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dengan pola tertentu akan meningkatkan kekuatan motorik halus anak dan mendukung kemandirian dan kualitas hidup.

A. Introduction

Toothbrushing behavior is an essential aspect of maintaining oral health (Raison et al., 2020). Brushing teeth regularly and using the correct technique can prevent various oral health issues, such as dental caries, gingivitis and periodontal disease (Al-Nasser & Lamster, 2020). However, children with intellectual disabilities often face challenges in adopting this behavior (Sabilillah & Daniati, 2025). Factors such as cognitive limitations, fine motor impairments and low conceptual understanding hinder their ability to perform self-care activities independently, including brushing their teeth (Gaunkar et al., 2021).

Intellectual disability is a developmental condition that affects intellectual functioning and adaptive behavior, covering conceptual, social and practical skills (Sabilillah et al., 2025). Children with intellectual disabilities tend to require additional support in carrying out daily activities, including personal hygiene care (Pesau et al., 2020). One of the main obstacles is limited fine motor skills, which directly affect their ability to grip and control a toothbrush (Tangnuntachai et al., 2021). Therefore, hand grip strength becomes a relevant variable in efforts to enhance the independence of children with intellectual disabilities in brushing their teeth (Sam, 2020).

Hand grip strength plays a significant role in daily functional activities, including toothbrushing (Tuuliainen et al., 2020). Previous research indicates that adequate hand grip strength is necessary to hold a toothbrush stably and apply sufficient pressure during brushing. For children with intellectual disabilities, low hand grip strength can lead to difficulties in controlling toothbrush movements, ultimately impacting the quality of tooth cleaning (Palanisamy et al., 2023). Therefore, measuring hand grip strength is essential to understand the relationship between grip strength and the effectiveness of toothbrushing (Droubi et al., 2021).

Previous studies have explored the relationship between fine motor strength and independence in daily activities for children with intellectual disabilities (Williams et al., 2021). However, limited research has examined how daily routines such as toothbrushing contribute to fine motor development and independence. Most studies have treated oral hygiene behavior and fine motor skills as separate domains, without integrating them as mutually reinforcing aspects of child development. Therefore, this study aims to analyze the relationship between toothbrushing behavior and handgrip strength to provide new insights into oral health as a potential medium for motor skill enhancement (Nazar, 2020).

Although toothbrushing behavior in children can generally be taught through visual and verbal learning methods, children with intellectual disabilities require a more structured and individualized approach (Gaunkar et al., 2021). Occupational therapy and play-based interventions have been used to enhance children's ability to perform personal hygiene activities (O'Connor et al., 2021). Environmental factors, parental support and therapist involvement also play essential roles in the learning process of toothbrushing behavior (Byrd, 2022). These approaches emphasize that oral hygiene education can simultaneously serve as a treatment medium, particularly for improving fine motor function.

Previous research has shown that the ability to control toothbrush movements plays an important role in improving oral hygiene among children with intellectual disabilities (Asiri et al., 2024). Although assistive tools such as modified toothbrush handles can support brushing performance, this study focuses on examining natural variations in toothbrushing behavior and handgrip strength without the use of additional devices (Mahajan et al., 2023). This provides a more ecological understanding of children's actual capabilities in daily life settings.

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From a public health perspective, efforts to improve toothbrushing behavior in children with intellectual disabilities have a significant impact (Son & Ahn, 2023). Children with intellectual disabilities are at a higher risk of dental and oral diseases than children without disabilities, which can worsen their quality of life and increase the caregiving burden on families (Nunes et al., 2021). In Indonesia, this issue remains a challenge, as access to oral health services for children with special needs is still limited, particularly in inclusive schools and community health centers. Although school-based dental programs such as *Usaha Kesehatan Gigi Sekolah (UKGS)* aim to promote oral hygiene, their implementation rarely addresses the specific needs of children with disabilities. Therefore, evidence-based interventions are needed to improve toothbrushing habits and optimize handgrip strength in this population (Shukla et al., 2022), while aligning with national oral health policies and inclusive health service initiatives.

Understanding the relationship between toothbrushing behavior and hand grip strength in children with intellectual disabilities is essential to identify problems and needs. This can be done by evaluating the relationship between the two variables within a specific period. This approach aims to identify factors that influence the quality of toothbrushing behavior and provide a basis for developing more effective intervention programs.

Data collection from a large number of subjects can provide a clear picture of the relationship patterns between toothbrushing behavior and hand grip strength in children with intellectual disabilities. The data obtained can be used as a basis for developing more appropriate interventions, such as creating fine motor training programs or introducing grip assistive devices tailored to individual needs.

This study contributes to the development of policies and intervention programs that support the oral health of children with intellectual disabilities. Support from special education institutions, medical professionals and parents is needed to ensure that children can adopt effective toothbrushing habits. The results of this study can also serve as a foundation for further research to improve the quality of life of children with intellectual disabilities through better oral health care. The aim of this study is to analyze the relationship between toothbrushing behavior and hand grip strength in children with intellectual disabilities, providing evidence for oral health interventions that simultaneously promote motor development and support inclusive health policies in Indonesia.

B. Research Methods

Research Design

This study employed an observational analytic design with a cross-sectional approach to examine the relationship between toothbrushing behavior and handgrip strength in children with intellectual disabilities. The cross-sectional method was selected because it allows data collection from a specific population within a limited timeframe, which is suitable for assessing behavioral and physical variables simultaneously. This design also enables identification of associations between the two variables as a basis for developing targeted health education interventions.

Sample Selection

The sample for this study consisted of 38 children with intellectual disabilities enrolled in two special schools (Sekolah Luar Biasa, SLB) in Bontang City. Participants were selected using a purposive sampling technique based on inclusion and exclusion criteria (Campbell et al., 2020). The sample size of 38 was determined based on the total number of eligible students available during the data collection period (October 23–28, 2023) who met the study criteria. This approach ensured that the selected participants were appropriate for examining the relationship between toothbrushing behavior and handgrip strength in this specific group.

Inclusion and Exclusion Criteria

Table 1
Inclusion and Exclusion Criteria

Category	Criteria
Inclusion Criteria	1. Children diagnosed with mild to moderate intellectual disabilities. 2. Aged 6–24 years ensures that participants are (1) developmentally capable of performing toothbrushing with or without assistance, (2) within the scope of educational programs provided by SLB and (3) representative of the population for which interventions in oral health and fine motor development are most relevant). 3. Actively enrolled in a special school (*Sekolah Luar Biasa*, SLB). 4. Provided written informed consent signed by parents or guardians. 5. Cooperative and able to follow simple instructions.
Exclusion Criteria	1. Children with physical or motor impairments affecting handgrip strength (e.g., cerebral palsy, limb deformities). 2. Children with severe behavioral disorders that prevent participation. 3. Lack of parental or guardian permission. 4. Children who were ill or absent during the study period due to systemic illness.

Note. Based on the author's analysis, 2024.

Data Collection

Data collection was conducted through direct observation and measurement of hand grip strength.

1. Toothbrushing behavior was measured using an observation sheet that recorded the child's brushing routine, frequency, duration, timing and technique. Observations were conducted directly by researchers or trained personnel both at school and at home to ensure ecological validity and consistency. The assessment captured how regularly the child brushed their teeth, how long each session lasted and whether the brushing technique followed recommended patterns.

2. Hand grip strength was measured using a digital electronic hand dynamometer (CAMRY EH101) and an accompanying observation sheet. Each child was instructed to grip the dynamometer using their dominant (stronger) hand while in a sitting position with the elbow flexed at approximately 90 degrees and the forearm in a neutral position. Measurements were conducted at school under the supervision of the researcher to ensure safety and standardization.

Each measurement was repeated twice (two trials) and the average score was recorded as the final value. The measurement focused on six components: grip type, strength control, independence, grip duration, grip stability and grip precision, with the following classifications:

Grip Type includes:

- Palmar grip, where the child holds the toothbrush with the entire palm, similar to gripping a bottle.

- Digital grip, where the child holds the toothbrush with four fingers and the palm, but the thumb is not used optimally.

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- Pincer grip, where the child holds the toothbrush using only the thumb and index finger.
- Cylindrical grip, where the child grips the toothbrush or a glass with their hand wrapped around the handle.

Strength Control includes:

- Weak, where the child cannot hold an object firmly, causing it to slip easily, with a score of < 7 kg.
- Moderate, where the child can hold an object stably but needs to adjust hand position occasionally, with a score of 7-12 kg.
- Strong, where the child can grip an object firmly and stably without needing adjustments, with a score of > 12 kg.

Independence includes:

- Independent, where the child can hold an object without assistance and adjust the grip position when feeling uncomfortable.
- Needs minimal assistance, where the child can hold an object but requires minimal guidance, such as verbal cues or visual instructions.
- Needs full assistance, where the child needs an adult's help to hold an object correctly or guide their hand to perform specific movements.

Grip Duration and Stability involve the child having a strong and stable grip while holding an object for an extended time. The grip duration is categorized as < 5 seconds, 5-10 seconds and > 10 seconds.

Grip Precision includes:

- Low, where the child is unable to hold small objects properly.
- Medium, where the child can hold medium-sized objects well.
- High, where the child can hold small objects well.

Research Variables

The variables in this study are toothbrushing behavior, which is measured through the child's routine, frequency, duration, timing and method of brushing teeth and hand grip strength, which is measured through grip type, strength control, independence, grip duration and stability and grip precision.

Data Analysis

Data analysis was conducted quantitatively using IBM SPSS Statistics version 21. The stages of analysis include:

1. Descriptive analysis to describe the characteristics of the subjects, including gender, limitation criteria, education, age and ability category, as well as the distribution of toothbrushing behavior and hand grip strength variables.

2. Correlation analysis using the Spearman test. The correlation test was used to determine whether there is a relationship between toothbrushing behavior and hand grip strength, as well as the extent to which hand grip strength affects toothbrushing behavior.

Interpretation of Results

The interpretation of results refers to the correlation value and statistical significance. If the correlation value is positive and significant ($p < 0.05$), it can be concluded that toothbrushing behavior has a positive relationship with hand grip strength. Conversely, if the p-value > 0.05, there is no significant relationship between the two variables.

In addition, the descriptive analysis results provide a general overview of the characteristics of children with intellectual disabilities involved in the study. The researcher can also provide intervention recommendations based on these findings, such as the introduction of assistive toothbrushes or motor skill strengthening training programs. This result interpretation is expected to contribute to the management of oral hygiene for children with intellectual disabilities and improve their quality of life.

C. Result & Discussion

The characteristics of children with intellectual disabilities in this study can be seen in Table 2 as follows:

Table 2
Characteristics of Children with Intellectual Disabilities

Variable	n	Percentage
Gender		
Male	26	68.40
Female	12	31.60
Limitation Criteria		
Mild Intellectual Disability	21	55.30
Moderate Intellectual Disability	11	28.90
Mild or Moderate Intellectual Disabilities with Other Limitations	6	15.80
Education		
Exceptional Primary School (SDLB)	18	47.40
Extraordinary Junior High School (SMPLB)	11	28.90
Exceptional Senior High School (SMALB)	9	23.70
Age		
Early Childhood: 6-9 years old	4	10.50
Middle Child: 10-13 years old	17	44.70
Early Adolescence: 14-17 years old	9	23.70
Middle Teens: 18-20 years old	6	15.80
Early Young Adult: 21-24 years old	2	5.30
Capability Categories		
Able to educate	23	60.50
Able to train	15	39.50

Note. Based on the author's analysis, 2024.

Table 2 shows that a total of 38 children with intellectual disabilities participated in this study. Most participants were male (68.40%), had mild intellectual disabilities (55.30%), were enrolled in *Sekolah Dasar Luar Biasa* (47.40%) and were predominantly in the 10–13 age group (44.70%). The

majority (60.50%) were categorized as "able to educate." Furthermore, toothbrushing behavior among children with intellectual disabilities can be seen in Table 3 as follows:

Table 3
Toothbrushing Behavior in Children with Intelectual Disabilities

Variable	Category	n	Percentage
Brushing Routine			
Brushing your teeth every day	Already	8	21.04
	No	30	78.96
How many times to brush your teeth per day	1x	32	84.22
	2x	5	13.15
	3x	1	2.63
	>4x	0	0
Frequency of Brushing			
Do kids brush their teeth after breakfast?	Always	3	7.89
	Sometimes	2	5.26
	Never	33	86.85
Do children brush their teeth before bed?	Always	2	5.26
	Sometimes	5	13.15
	Never	31	81.59
Duration of Brushing			
How long does it take to brush your teeth?	<1 minutes	33	86.85
	1-2 minutes	3	7.89
	>2 minutes	2	5.26
Brushing Time			
Time to brush your teeth in the morning	After waking up	30	78.96
	Before breakfast	4	10.52
	After breakfast	4	10.52
Time to brush your teeth at night	Before bed	6	15.79
	Before dinner	24	63.17
	After dinner	8	21.04
How to Brush Your Teeth			
Does the child use the right way to brush his teeth?	Already	1	2.63
	No	37	97.37

Note. Based on the author's analysis, 2024.

Table 3 shows that regarding toothbrushing behavior, most children (78.96%) did not brush their teeth daily and the majority (84.22%) brushed only once a day. Almost all participants (86.85%) never brushed after breakfast, never brushed before bed (81.59%) and spent less than one minute brushing (86.85%). In terms of timing, most brushed their teeth in the morning after waking up (78.96%) and at night before dinner (63.17%). Only 2.63% demonstrated proper brushing technique. The distribution of hand grip strength in children with intellectual disabilities can be seen in Table 4 as follows:

Table 4
Hand Grip Strength in Children with Intellectual Disabilities

Variable	Category	n	Percentage
Grip Types	Palmar grip	25	65.79
	Digital grip	9	23.68
	Pincer grip	1	2.63
	Cylindrical grip	3	7.89
Strength Control	Weak	31	81.58
	Moderate	5	13.16
	Strong	2	5.26
Independence	Independent	11	28.95
	Needs minimal assistance	23	60.53
	Needs full assistance	4	10.53
Grip Duration	< 5 seconds	31	81.58
	5-10 seconds	5	13.16
	> 10 seconds	2	5.26
Grip Stability	Stabil	6	1.79
	Not Stabil	32	84.21
Grip Precision	Low	29	76.32
	Medium	6	15.79
	High	3	7.89

Note. Based on the author's analysis, 2024.

Table 4 shows that for handgrip strength, 65.79% used a palmar grip type, 81.58% had weak grip strength, 60.53% required minimal assistance and 81.58% could maintain grip for less than five seconds. Most showed unstable grip control (84.21%) and low grip precision (76.32%), indicating fine motor limitations.

The Spearman correlation test revealed significant relationships between several aspects of toothbrushing behavior—particularly brushing frequency, brushing duration and brushing time (morning/evening)—and handgrip strength characteristics ($p < 0.05$). In contrast, brushing technique showed no significant correlation with any handgrip variables.

Brushing frequency, duration and brushing times (morning/evening) are generally significant for most of the grip characteristics. However, brushing technique has a high p-value and is not significant for almost all characteristics.

Characteristics of Participants

This study found that most participants with intellectual disabilities (ID) were male, consistent with previous findings showing a higher prevalence of ID among males, often linked to X-chromosome–related genetic vulnerabilities that increase the risk of developmental disorders (Posserud et al., 2021). Most children had mild intellectual disabilities, enabling them to follow toothbrushing instructions and participate in fine motor assessments. Their higher adaptive and motor capacity supports the potential use of toothbrushing activities as a practical means to strengthen fine motor function. These demographic characteristics indicate that children with mild ID represent a key target group for interventions linking daily self-care routines with motor skill development.

Toothbrushing Behavior

Despite this potential, the toothbrushing behavior of children with ID remains suboptimal. Most do not brush regularly, use improper techniques or brush for too short a duration. These findings are consistent with previous research showing that children with ID face challenges in forming self-

care routines due to cognitive and adaptive limitations (Hovey, 2024)(Ramos et al., 2024). Other studies have shown that brushing behavior is influenced by understanding of oral hygiene importance (Son & Ahn, 2023) and that these children need ongoing support from parents or caregivers (Gill et al., 2021). Adult supervision and visual-based learning strategies—such as videos or image guides—have proven effective in improving understanding and technique (Koushik & Kane, 2022). In the context of inclusive education in Indonesia, these findings highlight the relevance of adapting *Usaha Kesehatan Gigi Sekolah* (UKGS) and school-based oral health promotion programs to meet the needs of children with disabilities. These results reaffirm the importance of structured, supervised and visual-based oral health education for children with intellectual disabilities.

Hand Grip Strength

Findings also revealed limitations in fine motor ability, as indicated by weak handgrip strength, low stability and poor precision. Previous research indicates that children with intellectual disabilities have weaker grip strength compared to peers without disabilities (Farrokhian et al., 2021), largely due to low muscle tone (hypotonia) and limited fine motor control (Ha & Sung, 2023). Other studies also confirm that the palmar grip type is more dominant in children with ID (Akpinar, 2024), while grip duration and stability are influenced by cognitive and perceptual-motor factors (Rattanavichit et al., 2022). Activity-based interventions, such as using rubber balls, puzzles, block games or sensory play, have been shown to enhance grip strength, stability and precision through repetitive hand–finger movement (Işık & Zorba, 2020)(Arrigoni, 2022)(Million, 2022). Fine motor limitations among children with ID underline the need for integrated treatment programs that strengthen hand coordination and endurance through repetitive and engaging activities.

Correlation Analysis

Importantly, this study demonstrated a significant relationship between toothbrushing behavior and handgrip strength characteristics, including grip type, strength control, independence, duration, stability and precision. Regular toothbrushing with adequate frequency and duration can act as fine motor training, improving muscle control and coordination. Previous research supports this link, showing that daily activities involving fine motor movement, such as toothbrushing, improve grip strength and control in children with intellectual disabilities (Mafla et al., 2022)(Raut et al., 2021)(Palanisamy et al., 2023)(Mohamed et al., 2021). Repeated fine motor actions during toothbrushing help strengthen hand muscles, improve grip control, stability and precision and stimulate the nerves responsible for fine motor coordination (Merchan-Garcia et al., 2020). The significant correlation between brushing behavior and grip strength demonstrates that a daily self-care activity can serve as a form of functional fine motor training.

Implications and Novelty

From an inclusion perspective, these findings emphasize that everyday activities can serve as dual-purpose interventions—promoting both oral hygiene and fine motor development. Integrating toothbrushing-based motor exercises into inclusive school and community programs can empower children with ID to achieve greater independence in self-care and health maintenance. This approach aligns with Indonesia's inclusive health agenda, encouraging active participation and equality in oral health practices among children with special needs.

The novelty of this study lies in linking oral hygiene behavior with fine motor strength—two domains typically examined separately. While prior studies have focused independently on oral health or motor training, this study demonstrates their interconnection and mutual reinforcement. The results suggest that functional daily activities such as toothbrushing can be reframed as accessible treatment exercises that support both hygiene and motor skill development.

This study contributes to dental public health science, treatment and special education by introducing a dual-functional perspective on oral hygiene behavior as a vehicle for fine motor enhancement. The findings inform parents, teachers, therapists and policymakers about the importance of integrating motor skill exercises into daily hygiene routines, promoting independence and inclusive health practices for children with intellectual disabilities. This study provides both conceptual and practical contributions that advance inclusive oral health promotion and functional motor treatment in Indonesia.

Future research could extend this approach through intervention-based studies that combine educational and motor training components to strengthen inclusion-oriented health promotion for children with intellectual disabilities.

D. Conclusion

The study concludes that tooth brushing behavior has a significant relationship with handgrip strength in children with intellectual disabilities. The frequency, duration and timing of brushing influence grip type, control, stability and precision, indicating that repetitive tooth brushing activities can strengthen fine motor skills that support independence and quality of life.

This finding provides scientific evidence that oral hygiene routines can contribute beyond dental health by enhancing motor function. It implies the need for integrating tooth brushing programs into motor skill development interventions. However, as a cross-sectional study, causal relationships cannot be confirmed; thus, further longitudinal research is recommended to validate and expand these results.

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