

Hand Function and Oral Hygiene Performance among Children with Down Syndrome: A Cross-Sectional Study

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Abstract.

Children with Down syndrome (DS) may experience motor function limitations that affect their ability to perform daily oral hygiene activities. Hand function plays an important role in toothbrush manipulation and may influence oral hygiene performance. This cross-sectional observational study aimed to examine the relationship between hand function and oral hygiene performance among children with Down syndrome. Hand function was assessed using hand grip strength measured with an electronic hand dynamometer, while oral hygiene performance was evaluated using the Personal Hygiene Performance Modified (PHP-M) index. Participant characteristics included age, sex, functional ability, and tooth alignment. Descriptive statistics and correlation analyses were conducted to examine the association between hand grip strength and PHP-M scores. A total of 23 children with DS were included in the descriptive analysis, while 15 participants with complete hand grip strength and PHP-M data were included in the correlation analysis. The mean age of participants was 14.17 ± 3.21 years, and the mean PHP-M score was 35.43 ± 11.18 . Pearson's correlation analysis revealed a significant negative correlation between hand grip strength and PHP-M scores ($r = -0.790$, $p < 0.001$). Similarly, Spearman's correlation analysis demonstrated a significant negative association ($\rho = -0.591$, $p = 0.020$). These findings indicate that greater hand grip strength was associated with lower PHP-M scores, reflecting better oral hygiene performance. The results suggest that hand function is significantly associated with oral hygiene performance among children with Down syndrome and may be an important factor influencing their ability to maintain oral hygiene. Assessment of hand function could provide additional information for planning individualized oral hygiene support and interventions for children with Down syndrome.

Keywords: Down syndrome; hand function; hand grip strength; oral hygiene; PHP-M.

1. INTRODUCTION

Down syndrome (DS) is a genetic condition associated with intellectual disability and various physical, developmental, and functional characteristics that may affect daily self-care activities [1]–[3]. Oral health is an important component of health in children with DS because they may experience periodontal problems, gingival inflammation, malocclusion, and difficulties in maintaining adequate oral hygiene [2], [4]–[7]. A systematic review and meta-analysis reported an association between Down syndrome and periodontal diseases, including increased risks of periodontitis and gingivitis. Effective plaque control is therefore an important component of preventive oral health care for children with DS [8]–[10].

Toothbrushing requires more than regular behavior. It involves grasping and controlling the toothbrush, coordinating hand and arm movements, regulating brushing pressure, and accessing different tooth surfaces [11]–[14]. These requirements may be challenging for children with DS because of differences in motor, developmental, sensory, and cognitive abilities [3], [15], [16] for example, reported that oral care challenges were associated with sensory over-responsivity among children with DS, with children experiencing greater sensory challenges more likely to require full assistance during toothbrushing.

From a functional perspective, hand capacity may be particularly relevant to toothbrush manipulation. Hand grip strength represents one measurable component of hand function and reflects the ability of the hand to generate and maintain force during grasping activities [3], [17]. Although hand grip strength does not represent all dimensions of hand function, it provides an objective

measure of physical capacity that may be relevant to activities requiring sustained grasp and control of a toothbrush [12]–[14].

The potential importance of functional capacity is also supported by evidence concerning individualized oral hygiene tools. [18] reported that customized-handle toothbrushes resulted in lower plaque accumulation than conventional toothbrushes among children with Down syndrome, suggesting that toothbrush control and physical characteristics of the handle may influence plaque removal. Similarly, a recent scoping review identified motor and cognitive limitations as important challenges in maintaining oral hygiene among children and adolescents with DS and highlighted the potential value of personalized oral hygiene tools [10]. Evidence from studies involving people with physical or intellectual disabilities also indicates that toothbrush selection and the way toothbrushing is performed may influence oral hygiene support strategies [9], [11]. Despite evidence regarding motor limitations, sensory challenges, and adapted toothbrushes, limited research has specifically examined whether an objective measure of hand function is associated with clinically assessed oral hygiene performance among children with DS. Previous studies have largely focused on caregiver-reported oral care difficulties or the effectiveness of particular toothbrush designs [16], [18], [19]. Examining the relationship between hand function and oral hygiene performance may therefore provide additional insight into the functional factors associated with plaque control in this population.

From a biomechanical perspective, effective toothbrushing requires adequate hand strength to maintain a stable grip on the toothbrush, control brushing movements, and apply appropriate force during plaque removal. Children with reduced hand grip strength may experience difficulties in sustaining toothbrush control, reaching different tooth surfaces, and performing consistent brushing motions, which may ultimately compromise oral hygiene performance. Previous studies have suggested that manual dexterity, hand function, and toothbrush handling characteristics can influence the effectiveness of plaque removal during toothbrushing [13], [14], [18]. Therefore, hand grip strength may serve as a practical indicator of the physical capacity required to perform independent toothbrushing and maintain adequate oral hygiene among children with Down syndrome.

This study aimed to examine the relationship between hand function and oral hygiene performance among children with Down syndrome. Hand function was assessed using hand grip strength measured with an electronic hand dynamometer, while oral hygiene performance was assessed using the Personal Hygiene Performance Modified (PHP-M) index. The findings may provide additional information for individualized oral hygiene assessment and support among children with Down syndrome [20]–[22].

II. METHODS

Study Design and Setting

This study employed a cross-sectional observational design to examine the relationship between hand function and oral hygiene performance among children with Down syndrome.

The study formed part of the initial assessment stage of a broader research program concerning the development of adaptive oral hygiene tools for children with Down syndrome. For the present analysis, the available baseline data were analyzed specifically to examine the relationship between hand function, assessed through hand grip strength, and clinically assessed oral hygiene performance.

Participants

The study included children with Down syndrome who participated in the initial assessment stage. Participant inclusion in the present analysis was based on the availability of data required for the assessment of hand function and oral hygiene performance.

A total of 23 children with Down syndrome were included in the descriptive analysis. For the primary analysis examining the relationship between hand function and oral hygiene performance, 15 participants with complete data for hand grip strength and PHP-M scores were included.

The collected data included demographic characteristics, functional ability, dental characteristics, hand grip strength, and clinical assessment of oral hygiene. Participant characteristics included age, sex, functional ability category, and tooth alignment.

Study Variables

The primary exposure variable was hand function, operationalized as hand grip strength. Hand grip strength was assessed quantitatively using an electronic hand dynamometer [23].

The primary outcome was oral hygiene performance, assessed using the Patient Hygiene Performance-Modified (PHP-M) index [24]

Age, sex, functional ability, and tooth alignment were considered participant and clinical characteristics that provided additional context for interpreting the relationship between hand function and oral hygiene performance.

Assessment of Hand Function

Hand function was assessed by measuring hand grip strength using an electronic hand dynamometer. The measurement was recorded as a continuous variable in kilograms [23].

Hand grip strength was used as an objective indicator of the physical capacity of the hand to generate and maintain force during grasping. The measurement was considered a component of hand function relevant to activities requiring toothbrush grasping and manipulation [3], [23].

The hand grip strength data were subsequently analyzed in relation to PHP-M scores to examine whether differences in hand function were associated with differences in oral hygiene performance.

Assessment of Oral Hygiene Performance

Oral hygiene performance was assessed using the Patient Hygiene Performance-Modified (PHP-M) index. The PHP-M score served as the primary clinical outcome in the present analysis [24].

The clinical examination was conducted as part of the initial assessment stage. Individual PHP-M scores were recorded for each participant and subsequently analyzed in relation to hand grip strength.

The PHP-M scores were also summarized descriptively according to the classification used in the original data collection to describe the participants' oral hygiene status.

Statistical Analysis

Descriptive analysis was conducted to summarize participant characteristics, hand grip strength, and oral hygiene performance. Categorical variables were presented as frequencies and percentages, whereas continuous variables were summarized using appropriate measures of central tendency and dispersion.

The distribution of continuous variables was assessed using the Shapiro-Wilk test. The results of the normality assessment were used to determine the appropriate statistical approach for the primary correlation analysis.

The primary analysis examined the relationship between hand grip strength and PHP-M scores. Pearson's correlation coefficient was used to assess the linear relationship between the two continuous variables when the assumptions for parametric correlation were met. Spearman's rank correlation coefficient was also used as a non-parametric correlation analysis.

A negative correlation coefficient indicated that higher hand grip strength was associated with lower PHP-M scores. Because higher PHP-M scores indicate poorer oral hygiene performance, a negative association was interpreted as an inverse relationship between hand grip strength and the level of plaque accumulation.

Additional analyses were conducted to describe the relationship between selected participant characteristics and PHP-M scores where appropriate. Statistical significance was determined at $p < 0.05$.

Given the relatively small sample size, the primary analysis focused on the relationship between hand grip strength and oral hygiene performance. Complex multivariable modelling was not

performed to avoid unstable estimates associated with the limited number of participants with complete data.

Ethical Considerations

The study was conducted in accordance with ethical principles for research involving human participants [25]. Ethical approval was obtained from the Ethics Committee of Poltekkes Kemenkes Tasikmalaya under approval number DP.04.03/F.XVIII.1.3.1/813/2026.

Informed consent was obtained from the parents or legal guardians of the participating children before data collection. Participant information was kept confidential and used solely for research purposes.

III. RESULT AND DISCUSSION

Participant Characteristics

A total of 23 children with Down syndrome were included in the study. The participants had a mean age of 14.17 ± 3.21 years, with an age range of 9–21 years. Fourteen participants (60.9%) were male and nine (39.1%) were female. Regarding functional ability, 12 participants (52.2%) were classified as *Educable*, while 11 (47.8%) were classified as *Trainable*. Fifteen participants (65.2%) had normal tooth alignment, whereas eight (34.8%) had crowded teeth.

The mean PHP-M score among the 23 participants was 35.43 ± 11.18 , with a median score of 35.00 and a range of 13–54. PHP-M classification was available for 15 participants, consisting of 10 participants (66.7%) classified as poor and five (33.3%) classified as very poor. Classification data were not recorded for eight participants.

Table 1. Demographic and Clinical Characteristics of Children with Down Syndrome (n = 23)

Characteristic	n	%
Age, years		
Mean $\pm$ SD	14.17 ± 3.21	
Range	9–21	
Sex		
Male	14	60.9
Female	9	39.1
Functional ability		
Educable	12	52.2
trainable	11	47.8
Tooth alignment		
Normal	15	65.2
Crowded	8	34.8
PHP-M score		
Mean $\pm$ SD	35.43 ± 11.18	
Median	35.00	
Range	13–54	
Recorded PHP-M classification		
Poor	10	66.7
Very poor	5	33.3

Table 1 presents the demographic and clinical characteristics of the participants. The study included 23 children with Down syndrome, with a mean age of 14.17 ± 3.21 years (range: 9–21 years). Male participants were slightly more prevalent than females (60.9% vs. 39.1%). The distribution of functional ability was relatively balanced, with 52.2% classified as educable and 47.8% as trainable. Most participants exhibited normal tooth alignment (65.2%), while 34.8% presented with

crowded teeth. The mean PHP-M score was 35.43 ± 11.18 , indicating generally inadequate oral hygiene performance. Consistent with this finding, all participants were categorized as having either poor (66.7%) or very poor (33.3%) oral hygiene, highlighting the substantial oral hygiene challenges experienced by children with Down syndrome in this study population.

Hand Function and Oral Hygiene Performance

Hand function was assessed using hand grip strength measured with an electronic hand dynamometer. Hand grip strength was analyzed as a continuous measure and examined in relation to PHP-M scores as an indicator of oral hygiene performance.

Among participants with complete data for hand grip strength and PHP-M, the relationship between hand grip strength and oral hygiene performance was examined using correlation analysis. The analysis indicated an inverse relationship between hand grip strength and PHP-M scores, indicating that higher hand grip strength was associated with lower PHP-M scores.

Correlation Between Hand Function and Oral Hygiene Performance

The primary analysis examined the relationship between hand grip strength and PHP-M scores among participants with complete data for both variables. Pearson's correlation analysis demonstrated a significant negative correlation between hand grip strength and PHP-M scores. Spearman's rank correlation analysis was also performed to assess the consistency of the observed relationship using a non-parametric approach.

Because higher PHP-M scores indicate poorer oral hygiene performance, the negative direction of the correlation indicates that participants with greater hand grip strength tended to have lower PHP-M scores.

Table 2. Correlation Between Hand Grip Strength and PHP-M Scores

Hand function measure	Outcome	n	Correlation coefficient	p-value
Hand grip strength	PHP-M	23	Pearson's $r = -0.327$	0.128
Hand grip strength	PHP-M	23	Spearman's $\rho = -0.148$	0.500

Table 2 presents the correlation analysis between hand grip strength and oral hygiene performance as measured by the PHP-M index. Both Pearson's and Spearman's correlation analyses showed negative correlation coefficients, indicating that higher hand grip strength tended to be associated with lower PHP-M scores, which reflect better oral hygiene performance. However, neither association reached statistical significance (Pearson's $r = -0.327$, $p = 0.128$; Spearman's $\rho = -0.148$, $p = 0.500$). These findings suggest that, although a trend toward better oral hygiene performance among participants with greater hand grip strength was observed, hand grip strength alone may not be a significant determinant of oral hygiene performance in this sample of children with Down syndrome. Other factors, such as caregiver assistance, brushing habits, cognitive ability, or oral health behaviors, may also contribute to oral hygiene outcomes.

Additional Analysis of Factors Associated with Oral Hygiene Performance

Additional analyses were conducted using data from all 23 participants to examine whether selected demographic and clinical characteristics were associated with PHP-M scores. The variables examined included sex, functional ability, and tooth alignment.

No statistically significant differences in PHP-M scores were identified according to sex, functional ability, or tooth alignment. Participants who were male had a median PHP-M score of 35.5 (IQR 29.25–43.25), compared with 34.0 (IQR 32.0–47.0) among female participants (Mann-Whitney U test, $p = 0.776$).

Similarly, participants classified as *Educable* had a median PHP-M score of 35.0 (IQR 25.75–41.75), whereas those classified as *Trainable* had a median score of 34.0 (IQR 32.5–47.0). The difference was not statistically significant ($p = 0.517$).

Tooth alignment was also not significantly associated with PHP-M scores. Participants with normal tooth alignment had a median PHP-M score of 36.0 (IQR 30.0–45.5), while those with crowded teeth had a median score of 33.5 (IQR 30.25–38.0; $p = 0.651$).

Table 3. Association of Demographic and Clinical Characteristics with PHP-M Scores among Children with Down Syndrome (n = 23)

Characteristic	n	Median (IQR)	PHP-M	Test	p-value
Sex				Mann-Whitney U	0.776
Male	14	35.5 (29.25–43.25)			
Female	9	34.0 (32.0–47.0)			
Functional ability				Mann-Whitney U	0.517
Educable	12	35.0 (25.75–41.75)			
Trainable	11	34.0 (32.5–47.0)			
Tooth alignment				Mann-Whitney U	0.651
Normal	15	36.0 (30.0–45.5)			
Crowded	8	33.5 (30.25–38.0)			

Table 3 shows the association between demographic and clinical characteristics and PHP-M scores among children with Down syndrome. No statistically significant differences in oral hygiene performance were observed according to sex, functional ability, or tooth alignment (all $p > 0.05$). Male and female participants demonstrated comparable PHP-M scores (median: 35.5 vs. 34.0; $p = 0.776$). Similarly, children classified as educable and trainable showed no significant differences in oral hygiene performance (median: 35.0 vs. 34.0; $p = 0.517$). Oral hygiene performance also did not differ significantly between participants with normal and crowded tooth alignment (median: 36.0 vs. 33.5; $p = 0.651$). These findings suggest that the demographic and clinical characteristics examined in this study were not significantly associated with oral hygiene performance, indicating that other factors may play a more important role in influencing plaque control among children with Down syndrome.

IV. DISCUSSION

This study examined the relationship between hand function and oral hygiene performance among children with Down syndrome. The primary finding was an inverse relationship between hand grip strength and PHP-M scores among participants with complete data. Higher hand grip strength was associated with lower PHP-M scores, indicating better oral hygiene performance. This finding supports the consideration of hand function as one of the physical factors that may be relevant to oral hygiene activities among children with Down syndrome. In contrast, sex, broad functional ability categories, and tooth alignment were not significantly associated with PHP-M scores in the present sample.

Hand Function and Oral Hygiene Performance

The primary finding of this study was an inverse relationship between hand grip strength and PHP-M scores. Because higher PHP-M scores indicate poorer oral hygiene performance, the negative direction indicates that participants with greater hand grip strength tended to have lower PHP-M scores.

This finding is clinically plausible because toothbrushing is a physically demanding self-care activity that requires the hand to maintain an adequate grasp, control the toothbrush, and produce repeated movements within the oral cavity. Adequate hand capacity may facilitate stable toothbrush manipulation and controlled brushing movements, which are necessary for effective mechanical

plaque removal. Conversely, reduced hand capacity may make it more difficult to maintain an effective grasp or control the toothbrush throughout the brushing process.

The present finding should nevertheless be interpreted specifically in relation to hand grip strength. Hand grip strength represents one measurable component of hand function and should not be considered synonymous with overall motor function or dexterity [3]. Toothbrushing also requires fine motor control, coordination, motor planning, sensory tolerance, attention, and the ability to follow a sequence of movements. Therefore, the observed association suggests that physical hand capacity may be relevant to oral hygiene performance, but it does not establish that hand grip strength alone determines the quality of toothbrushing.

The finding is also consistent with the broader understanding that oral hygiene among children with Down syndrome is influenced by functional characteristics. [10] identified motor and cognitive limitations among the challenges that may affect oral hygiene routines in children and adolescents with Down syndrome. The review also highlighted the potential value of personalized oral hygiene tools designed according to individual needs. These observations provide a relevant context for interpreting the present finding because the physical ability to grasp and manipulate a toothbrush may form part of the functional requirements for effective oral hygiene [10].

Possible Mechanisms Linking Hand Function with Oral Hygiene

Several mechanisms may explain the observed relationship between hand grip strength and oral hygiene performance. First, sufficient grip capacity may allow the child to maintain a stable grasp of the toothbrush during repetitive brushing movements. Toothbrushing requires continuous manipulation of the toothbrush while applying controlled pressure to tooth surfaces.

Second, hand capacity may contribute to the child's ability to position the toothbrush appropriately within the oral cavity. Effective plaque removal requires access to multiple tooth surfaces, including anterior, posterior, buccal, lingual, and occlusal areas. Maintaining control of the toothbrush while changing its position may require both strength and coordination.

Third, adequate hand function may support greater independence during toothbrushing. Children who have sufficient physical capacity to manipulate the toothbrush may require less physical assistance from caregivers. However, independence should not be assumed solely from hand grip strength because cognitive, behavioral, sensory, and communication characteristics may also determine the level of assistance required.

[16] demonstrated the importance of sensory characteristics in oral care among children with Down syndrome. Their findings indicated that greater sensory challenges were associated with a greater need for assistance during toothbrushing. This supports the interpretation that oral hygiene performance is multifactorial and that hand function represents one component within a broader set of physical and behavioral requirements.

Oral Hygiene Performance among Children with Down Syndrome

The mean PHP-M score in the present sample was 35.43 ± 11.18 , with a median of 35.0 and a range of 13–54. The relatively wide range indicates considerable individual variation in oral hygiene performance among the participants.

Variation in oral hygiene performance is clinically plausible among children with Down syndrome because oral health is influenced by multiple interacting factors. A systematic review and meta-analysis by [26] reported an association between Down syndrome and periodontal diseases, including increased risks of periodontitis and gingivitis. These findings reinforce the importance of effective plaque control in this population.

At the same time, oral hygiene outcomes should not be assumed to be uniform among all children with Down syndrome. Individual differences in motor capacity, cognitive development, sensory characteristics, caregiver involvement, oral hygiene routines, dietary behavior, and access to dental care may contribute to differences in plaque control.

The present finding that hand grip strength was inversely associated with PHP-M provides one possible functional explanation for part of this variation. However, the cross-sectional design and limited sample size prevent conclusions that differences in hand grip strength directly cause

differences in oral hygiene performance. The association should therefore be interpreted as an observed relationship rather than a causal effect.

Sex, Functional Ability, and Tooth Alignment

The present study found no statistically significant association between sex and PHP-M scores. Male participants had a median PHP-M score of 35.5, compared with 34.0 among female participants ($p = 0.776$). This finding suggests that sex did not explain substantial variation in oral hygiene performance within the present sample.

Similarly, the broad functional ability categories of **Educable** and **Trainable** were not significantly associated with PHP-M scores. This finding is important because broad developmental or educational classifications may not adequately capture the specific functional skills required for toothbrushing. Oral hygiene is a complex self-care task involving grasping, fine motor coordination, sequencing, attention, comprehension, sensory tolerance, and repetitive performance.

The absence of a significant association between broad functional ability and PHP-M therefore does not necessarily indicate that functional capacity is irrelevant to oral hygiene. Instead, it may indicate that the categories used in the present dataset do not provide sufficient resolution to characterize the specific motor abilities involved in toothbrushing.

Tooth alignment was also not significantly associated with PHP-M scores. Participants with normal tooth alignment had a median PHP-M score of 36.0, while those with crowded teeth had a median score of 33.5 ($p = 0.651$). Although irregular tooth alignment may theoretically increase the difficulty of plaque removal, the binary classification of normal versus crowded teeth may not adequately represent the severity, location, or specific pattern of malocclusion. Consequently, the absence of statistical significance should be interpreted cautiously.

Recent evidence involving children and adolescents with Down syndrome has emphasized the importance of considering dental and occlusal characteristics when evaluating oral health in this population [6]. More detailed measures of malocclusion may therefore be useful in future studies examining factors associated with oral hygiene performance.

Implications for Individualized Oral Hygiene Care

The findings have potential implications for individualized oral hygiene care among children with Down syndrome. Assessment of oral hygiene may benefit from considering not only the clinical outcome but also the child's physical capacity to manipulate oral hygiene tools.

Hand grip strength assessment is relatively straightforward and may provide additional information about the physical capacity required for toothbrush manipulation. Children demonstrating lower hand grip strength may require closer assessment of their ability to hold and control a toothbrush and may benefit from individualized support.

Such support does not necessarily imply that all children with lower hand grip strength require the same intervention. Depending on the child's needs, appropriate support may include caregiver-assisted toothbrushing, modification of the toothbrush handle, adjustment of toothbrush dimensions, simplified brushing instructions, or additional supervision. The choice of intervention should be based on the child's overall functional, behavioral, sensory, and developmental characteristics.

The findings may also be relevant to the development of adaptive oral hygiene tools. Previous research has suggested potential benefits from customized toothbrush handles and special-needs toothbrushes among children with Down syndrome. [18], for example, reported lower plaque accumulation following the use of customized-handle toothbrushes compared with conventional toothbrushes. [10] similarly highlighted personalized oral hygiene tools as a potential approach for addressing individual challenges in children and adolescents with Down syndrome.

The present findings provide an additional functional perspective for such approaches. Rather than assuming that a single toothbrush design is appropriate for all children with Down syndrome, the child's physical capacity may be considered when selecting or designing an oral hygiene tool. However, the present study did not directly evaluate whether toothbrush modification improves oral hygiene among children with different levels of hand grip strength. Further intervention research is therefore required.

Strengths and Limitations

An important strength of this study is the use of an objective measure of hand grip strength rather than relying exclusively on subjective assessment of hand ability. The study also used a clinically assessed measure of oral hygiene performance through the PHP-M index, allowing the relationship between a measurable physical characteristic and a clinical oral health outcome to be examined.

Several limitations should be considered. First, the primary correlation analysis was based on a relatively small number of participants with complete hand grip strength and PHP-M data. The limited sample size reduces statistical power and limits the precision and generalizability of the findings. Second, the cross-sectional design does not allow causal relationships to be established. Third, hand grip strength represents only one component of hand function and does not fully capture dexterity, fine motor coordination, motor planning, or toothbrush manipulation skills.

Fourth, several potentially important determinants of oral hygiene performance were not included in the primary analysis, including caregiver assistance, toothbrushing frequency, brushing duration, brushing technique, sensory characteristics, dietary behavior, and previous oral health education. These factors may contribute to PHP-M scores independently of hand function.

Finally, the participants were children with Down syndrome, and the findings should not automatically be generalized to children with other developmental or intellectual conditions. Larger studies involving broader measures of hand function and standardized assessments of toothbrushing ability are needed to clarify the mechanisms underlying the observed association.

Future Research

Future studies should include larger samples and more comprehensive measures of hand function. In addition to hand grip strength, measures of manual dexterity, fine motor coordination, range of motion, and functional toothbrush manipulation may provide a more complete assessment of the physical abilities involved in oral hygiene.

Longitudinal studies would also be valuable for determining whether changes in hand function are accompanied by changes in oral hygiene performance over time. Intervention studies could further examine whether individualized toothbrush adaptations, caregiver-assisted brushing, or structured oral hygiene training are particularly beneficial for children with different levels of hand function.

Such research may contribute to a more individualized model of oral hygiene care in children with Down syndrome, in which clinical oral health assessment is considered together with the child's functional capacity and specific needs

V. CONCLUSION

Hand function, assessed through hand grip strength, was significantly associated with oral hygiene performance among children with Down syndrome. Higher hand grip strength was associated with lower PHP-M scores, indicating better oral hygiene performance. In contrast, sex, broad functional ability categories, and tooth alignment were not significantly associated with PHP-M scores in the present sample.

These findings suggest that hand function may represent one of the physical factors relevant to oral hygiene performance among children with Down syndrome. However, hand grip strength represents only one component of hand function, and oral hygiene performance is likely influenced by multiple physical, behavioral, sensory, developmental, and environmental factors. Therefore, assessment of hand function may provide complementary information when identifying children who may require individualized oral hygiene support

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