



Hand function limitations and the influence on toothbrushing efficacy and plaque control

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ARTICLE INFO

Article history:

Received 26 July 2025

Revised 2 April 2026

Accepted 29 June 2025

Available online July 2026

E-ISSN: [2615-854X](#)

P-ISSN: [1693-671X](#)

How to cite:

Aurelia S, Theresia TT, Hayuningtyas RA. Hand function limitations and the influence on toothbrushing efficacy and plaque control. Dentika Dental Journal. 2026; 29(1): 53-58.

ABSTRACT (The content cannot exceed first page)

Maintaining healthy teeth and periodontal tissues is strongly dependent on effective oral hygiene, but physical act of toothbrushing can be significantly hindered by limitations in hand function. Issues such as diminished handgrip strength, joint stiffness, persistent pain, and reduced manual dexterity often make thorough cleaning a challenge. Therefore, this literature review aimed to evaluate how the specific hand function limitations impact general toothbrushing efficacy and plaque control. Data were collected from PubMed and Google Scholar for analysis on English and Indonesian articles published over the past decade. The compiled evidence showed that poor handgrip strength and limited dexterity directly correlated with heavier plaque accumulation, increased risks of periodontitis, and compromised oral self-care habits. These challenges were particularly prevalent among older populations and individuals managing musculoskeletal or systemic conditions such as rheumatoid arthritis. Recognizing hand function limitations as a critical determinant of oral health showed the urgent need for more adaptive, customized oral hygiene strategies.

Keyword: Hand Strength, Oral Hygiene, Dental Plaque

ABSTRAK

Menjaga kesehatan gigi dan jaringan periodontal sangat bergantung pada kebersihan mulut yang optimal, namun tindakan menyikat gigi sering kali terkendala oleh adanya keterbatasan fungsi tangan. Masalah seperti penurunan kekuatan genggam, kekakuan sendi, rasa nyeri, hingga berkurangnya ketangkasan manual dapat menghambat proses pembersihan gigi secara menyeluruh. Tinjauan pustaka ini mengevaluasi bagaimana keterbatasan fisik pada tangan tersebut memengaruhi efektivitas menyikat gigi serta pengendalian plak. Melalui penelusuran pada basis data PubMed dan Google Scholar, studi ini menganalisis artikel berbahasa Inggris dan Indonesia yang diterbitkan dalam sepuluh tahun terakhir. Hasil kajian menunjukkan bahwa lemahnya kekuatan genggam dan gangguan ketangkasan tangan berkaitan erat dengan penumpukan plak yang lebih tinggi, peningkatan risiko periodontitis, serta kebiasaan menjaga kebersihan mulut yang kurang efektif. Kondisi ini umumnya ditemukan pada kelompok lansia serta individu dengan gangguan muskuloskeletal atau penyakit sistemik seperti artritis reumatoid. Oleh karena itu, keterbatasan fungsi tangan harus dipandang sebagai faktor krusial yang memengaruhi kesehatan mulut, sehingga mendorong pentingnya pendekatan perawatan yang lebih adaptif dan personal.

Kata Kunci: Kekuatan Tangan, Kebersihan Mulut, Plak Gigi



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<http://doi.org/10.32734/dentika.v29i1.24619>

1. Introduction

Oral health is closely related to overall health and can greatly affect the quality of life of an individual. World Health Organization (WHO) 2022 Oral Health Country Profile for Indonesia also reported a high burden of oral diseases associated with low awareness of oral hygiene and inadequate toothbrushing practices [1]. The prevalence of severe periodontal disease among individuals aged 15 years and older in Indonesia reaches 19.6%, while untreated dental caries in permanent teeth affect 28.8% of the population. The simplest and most effective methods for maintaining oral hygiene include daily toothbrushing using fluoride-containing toothpaste [2]. Current recommendations suggest that toothbrushing should be performed at a minimum of two times daily to remove plaque and maintain oral health. Individualized oral hygiene methods may still be necessary for populations with specific limitations or healthcare needs.

Toothbrushing is considered a simple daily activity, but the effectiveness is strongly influenced by fine motor skills and hand dexterity. Fine motor skills help coordinate and control the small muscles of hands and fingers, allowing a person to perform the precise movements needed during toothbrushing [3]. Toothbrushing efficacy is influenced by several factors, including brushing technique, frequency, motivation, socioeconomic status, and fine motor skills. In certain individuals, toothbrushing methods is occasionally performed incorrectly because of inadequate motor learning processes or neurodevelopmental disorders. Specifically, limitations including dissociative hand movements—which refer to impairments in hand coordination, grip control, and finger movement—may reduce brushing precision and compromise the effectiveness of plaque removal.

Several medical conditions and disabilities impair hand function and reduce toothbrushing efficacy. Patients with Multiple Sclerosis (MS) often experience limitations in maintaining oral hygiene due to motor deficits, pain, and balance disorders [4]. Rheumatoid arthritis (RA) tends to impair toothbrushing ability because chronic joint inflammation can make gripping and repetitive wrist movements painful [5]. Individuals with intellectual disability frequently encounter barriers in maintaining oral hygiene, including limited attention span, inadequate caregiver support, and poor oral health education [6]. Similarly, patients with Parkinson's disease and stroke frequently experience motor and cognitive impairments that interfere with independent oral self-care [7,8].

Considering the important role of hand dexterity and motor function in effective toothbrushing, limitations in hand function may contribute to inadequate plaque control and deterioration of oral health. Discussions regarding the relationship between hand function limitations and toothbrushing efficacy remain limited. Therefore, this literature review aimed to evaluate the influence of hand function limitations on toothbrushing efficacy and plaque control.

2. Methods

A thorough literature search was conducted using PubMed and Google Scholar databases to systematically investigate the intersection of hand function limitations and toothbrushing efficacy, specifically regarding plaque control. The search strategy used combinations of keywords connected by Boolean operators to ensure a comprehensive collection of data: ("hand function" OR "hand limitation" OR "manual dexterity") AND ("oral hygiene" OR "toothbrushing" OR "plaque control"). To ensure the clinical relevance and timeliness of the data, the selection was restricted to full-text articles published in English or Indonesian in the 10-year period from 2015 to 2025.

Following the initial database screening, a rigorous, multi-stage review process was conducted. Titles and abstracts were screened to identify studies potentially relevant to hand function and oral health. Eligible studies passed through a detailed text analysis to extract critical parameters, including specific hand function metrics (such as handgrip strength or dexterity), study characteristics, and direct oral hygiene outcomes. Five relevant studies were selected for inclusion in this review after the exclusion of duplicated studies, conference abstracts, standard review papers, and literature falling outside the explicit scope.

3. Results

Relevant studies related to hand function limitations and oral health were identified through searches in PubMed and Google Scholar databases. Following the screening and selection process based on the inclusion criteria, five relevant studies published in the past 10 years were selected for this review. A summary of the studies, including characteristics, methods, and main results, is shown in Table 1.

Table 1. Summary of Studies Exploring the Correlation between Hand Function and Oral Hygiene Status

Authors	Years	Country	Study Design	Method	Results
Lee, J.H., et al	2020	South Korea	Cross-sectional	Data from KNHANES (7589 adults); digital hand dynamometer for grip strength; questionnaire for daily toothbrushing and secondary oral product use	Poor oral self-care (low toothbrushing frequency and no secondary product use) is a risk indicator for low muscle strength. Women with infrequent toothbrushing (≤ 1 time/day) showed a 1.24-fold higher risk (95% CI: 0.89-1.71) of low handgrip strength; men not using secondary oral products had a 1.36-fold increased risk (95% CI: 1.12-1.66).
Radwan-Oczko, M., et al.	2020	Denmark	Cross-sectional survey	Questionnaires for self-assessment of oral status and care in 164 Rheumatoid Arthritis (RA) patients; DAS28 for disease activity	Higher disease activity (DAS28) was correlated with oral discomfort or pain ($p=0.00205$) and showed a dependence tendency with toothbrushing difficulty ($p=0.0805$). Discomfort was significantly connected to provoked gingival bleeding ($p\leq 0.001$).
An, H.R., & Choi, J.S.	2022	South Korea	Cross-sectional	KNHANES data (5926 adults); digital hand dynamometer; Community Periodontal Index (CPI) for periodontal status	Periodontitis prevalence was significantly higher in the reduced handgrip strength group (38.3%) compared to the normal group (33.1%) ($p=0.001$). Multivariate logistic regression indicated that the potential of periodontitis decreased as handgrip strength increased (Adjusted OR: 0.986, 95% CI: 0.974–0.999, $p=0.030$).
Ahmad, I., et al.	2023	Saudi Arabia	Non-interventional case-control study	200 subjects (100 with joint pain); goniometer for range of motion (ROM); Jammer Dynamometer for grip strength; DMFT and OHI-S for oral hygiene	Subjects with joint pain had significantly higher scores for oral debris (Mean: 1.50 vs. 0.63, $p=0.024$), calculus (Mean: 0.55 vs. 0.39, $p=0.032$), and dental caries (DMFT Mean: 19.68 vs. 16.78, $p=0.001$) compared to controls
Shin, N.R., & Choi, J.S.	2018	South Korea	Cross-sectional	44 independent older adults; Box and Blocks Test for manual dexterity; QLF-D technology to quantify dental biofilm and maturation	Low manual dexterity was associated with higher Simple Plaque Scores (SPS) on the lingual surfaces of tooth #32 ($p=0.009$) and #24 ($p=0.011$). Additionally, mature biofilm ($\Delta R20$ values) was significantly higher in the low dexterity group for teeth #12 ($p=0.005$) and #44 ($p=0.022$).

The included studies consistently showed a strong correlation between hand function limitations and compromised oral hygiene status. Several studies reported that decreased handgrip strength and poor manual dexterity were connected to less effective toothbrushing, greater plaque accumulation, and an increased risk of periodontal disease [9,10]. Studies using data from the Korea National Health and Nutrition Examination Survey (KNHANES) identified that reduced handgrip strength correlated with poorer periodontal health and inadequate oral self-care habits [9]. Specifically, individuals with periodontitis tended to fall into the reduced handgrip strength category ($p=0.001$).

Joint pain and musculoskeletal disorders were identified as factors associated with oral hygiene maintenance. Participants experiencing pain in hand, wrist, or shoulder reported greater difficulty in brushing, which correlated with significantly lower handgrip strength ($p=0.039$ for right hand) and restricted range of motion in the shoulder and elbow ($p<0.05$) [11]. Subjects with joint pain had significantly lower handgrip strength compared with counterparts without joint pain. These limitations increase difficulty for individuals to maintain proper oral hygiene, which may lead to more dental caries, calculus buildup, and poorer overall oral hygiene conditions. Similarly, patients with rheumatoid arthritis frequently reported difficulties in toothbrushing, biting, and chewing, particularly among younger individuals with higher disease activity scores [12].

Lower handgrip strength was connected to poorer periodontal health, with periodontitis occurring more frequently in individuals experiencing weaker handgrip strength than in those with normal strength [10]. Older adults with reduced manual dexterity, as measured by the Box and Blocks Test, had significantly more mature dental biofilm on difficult-to-reach lingual surfaces ($p<0.05$). These results suggest that fine motor skill impairment may be associated with a reduced ability to perform the precise vibratory motions required for effective plaque removal.

Manual dexterity was found to influence plaque control and dental biofilm formation. Older adults with poorer manual dexterity tended to have higher plaque scores and more mature dental biofilm, particularly on the lingual tooth surfaces, compared with individuals with normal manual dexterity [13]. Therefore, reduced manual dexterity was considered a potential predictor of poor oral hygiene among older adults, even in the absence of hand disabilities. The reviewed studies generally indicate that impaired hand function, including reduced grip strength, pain, and poor manual dexterity, may negatively affect toothbrushing efficacy and oral hygiene maintenance.

4. Discussion

The relationship between hand motor function and oral hygiene efficacy is a critical factor in maintaining oral health across various age groups and medical conditions [14,15]. Mechanical plaque control is a complex motor task requiring the integration of two distinct constructs. The first is manual dexterity, which provides the fine motor precision necessary for tool manipulation and positioning. The second is handgrip strength, which provides the gross motor power required to sustain the activity and reach difficult tooth surfaces [14,16]. These functions are related, but evidence suggests that the relative contributions differ. Manual dexterity is often cited as the primary predictor of successful plaque removal, with diminished grip strength primarily leading to premature hand fatigue and reduced brushing duration [15,17].

The development of manual coordination and visuomotor abilities in children directly influences early toothbrushing skills [14]. Although young children often show an early interest in brushing independently, the underdeveloped fine motor skills necessitate adult supervision until approximately age eight or 10. This stage of psychomotor development is crucial, as the acquisition of manual coordination directly influences long-term oral health outcomes. Early intervention and psychomotor evaluation can help adapt brushing methods to the specific developmental stage of a child.

Hand manipulation primarily starts to decline in older adults after age 65, where weakened grip strength is frequently associated with poor oral status and higher dependence on dentures [18,19]. Handgrip strength is considered an important indicator of overall muscle strength and has been closely associated with the number of remaining teeth [15,20]. Weakened grip strength can lead to premature hand fatigue, which subsequently reduces total brushing time and power, leaving difficult-to-reach surfaces uncleaned [18]. In older men specifically, low grip strength is a significant indicator of poor oral status and higher dependence on full dentures [20].

The current evidence base possesses several methodological limitations explained as follows. First, many included studies, such as those by Lee et al. and An & Choi, used cross-sectional designs, which identified significant associations but reduced the ability to draw causal inferences [9,10]. The study by Shin & Choi (n=44) depended on small sample sizes, which might affect the generalizability of the results [13]. Differences in the methods used to assess hand function, including various dexterity tests and handgrip dynamometers, make direct comparisons between studies challenging. Oral hygiene is influenced by many factors different from hand function, such as cognitive status, socioeconomic conditions, and education. In vulnerable groups, particularly individuals with intellectual disabilities, caregiver support and oral health literacy may be similarly important as physical ability. Reduced hand function does not often lead to poor oral hygiene. Some healthy older adults maintain effective toothbrushing despite mild physical decline, suggesting that oral hygiene tends to be affected when physical or cognitive impairment becomes more severe.

The reviewed literature shows various adaptive strategies to mitigate the stated mechanical and contextual barriers [21]. Patients who have difficulty performing the complex hand movements required for flossing can use an essential oil mouthrinse to help improve interdental oral health by reducing the dependence on manual dexterity [15]. Furthermore, the use of customized, 3D-printed or acrylic-modified toothbrush handles often improves grip volume and cleaning efficacy for those with restricted hand movement [21,22]. These modifications enhance plaque control and increase self-esteem and independence of patients.

Clinical assessments such as Gerostomatological Assessment Battery (G-AB) and manual dexterity screenings should be integrated into standard dental check-ups [23]. Identifying vulnerable patients through these tests allows clinicians to recommend more frequent professional recalls or customized hygiene aids. Maintaining a healthy oral environment is essential for overall quality of life and for preventing serious systemic complications such as aspiration pneumonia [21,22]. Managing the oral health effects associated with declining hand function requires an interdisciplinary method including both dental professionals and musculoskeletal specialists [18,19].

5. Conclusion

In conclusion, this literature review confirms that hand function limitations, specifically reduced manual dexterity and handgrip strength, significantly influence toothbrushing efficacy and plaque control. Manual dexterity is essential for the precise manipulation and positioning of oral hygiene tools. Meanwhile, handgrip strength provides the gross motor power required to reach difficult tooth surfaces and sustain the activity. Impaired hand function compromises toothbrushing effectiveness, leading to inadequate plaque removal and poorer oral health outcomes, such as increased dental biofilm accumulation and a higher risk of periodontal disease. These physical constraints are particularly critical during pediatric development, in geriatric aging, and for individuals managing neurological or musculoskeletal diseases.

The provided results should be interpreted with caution. The current evidence is primarily derived from cross-sectional studies, which identify associations but cannot establish definitive causal relationships. Furthermore, the variability in measurement tools and the small sample sizes in some studies limit the broad generalizability of the data. Hand function should be recognized as part of a broader clinical picture. Confounding factors such as cognitive status, socioeconomic background, and the level of caregiver support play significant roles in determining the final oral health outcome of patients.

Dental professionals need to progress from standard oral hygiene instructions to a patient-centered, adaptive method. This includes screening for specific motor deficits and recommending individualized interventions, such as power-assisted hygiene tools, modified handles, or chemotherapeutic rinses to compensate for mechanical barriers. By recognizing that limited physical dexterity and hand function are major barriers to maintaining oral health, clinicians can better support the independence and quality of life of vulnerable populations.

6. Acknowledgements

The authors are grateful to the Faculty of Dentistry, Universitas Trisakti for the support provided.

7. Conflict of Interest

The authors declare that this review is free from conflicts of interest.

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