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ORIGINAL ARTICLE

Effect of miswak (*Salvadora persica*) toothbrushing on salivary flow rate in children with Down syndrome: a pre–post controlled study

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ABSTRACT

Background: Saliva plays a vital role in maintaining oral health. Children with Down syndrome often experience reduced salivary flow due to salivary gland hypoplasia, increasing their risk of oral health problems. Miswak (*Salvadora persica*), a traditional toothbrush, provides both mechanical and chemical stimulation that may enhance salivary secretion. This study aimed to evaluate the effect of miswak toothbrushing on salivary flow rate in children with Down syndrome. **Methods:** A controlled pre-post study was conducted among 20 children with Down syndrome in SLB C-C1 Yakut Purwokerto and SLB ABCD Banyumas, Central Java, Indonesia. Participants were randomly assigned to a miswak group or a conventional toothbrush group. Saliva was collected using the spitting method before and after brushing. **Results:** The miswak group showed a significant increase in salivary flow rate (0.21 to 1.01 mL/min), compared to a modest increase in the control group (0.21 to 0.31 mL/min). The difference between groups was statistically significant ($p < 0.01$). **Conclusions:** These findings suggest that miswak toothbrushing may be an effective method to enhance salivary flow in children with Down syndrome, potentially contributing to improved oral health outcomes.

Keywords: *Down syndrome, salivary flow rate, Salvadora persica, oral health*

Pengaruh sikat gigi menggunakan miswak (*Salvadora persica*) terhadap laju aliran saliva pada anak dengan sindroma Down

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ABSTRAK

Latar belakang: Saliva berperan penting dalam menjaga kesehatan rongga mulut. Anak dengan sindrom Down sering mengalami penurunan laju aliran saliva akibat hipoplasia kelenjar saliva, sehingga meningkatkan risiko terjadinya berbagai masalah kesehatan gigi dan mulut. Miswak (*Salvadora persica*), sebagai alat pembersih gigi tradisional, memberikan stimulasi mekanis dan kimiawi yang berpotensi meningkatkan sekresi saliva. Penelitian ini bertujuan untuk mengevaluasi pengaruh penyikatan gigi menggunakan miswak terhadap laju aliran saliva pada anak dengan sindroma Down. **Metode:** Penelitian ini merupakan studi terkontrol dengan desain pra–pasca yang melibatkan 20 anak dengan sindroma Down di SLB C-C1 Yakut Purwokerto dan SLB ABCD Banyumas, Jawa Tengah, Indonesia. Subjek penelitian dibagi secara acak ke dalam kelompok miswak dan kelompok sikat gigi konvensional. Pengambilan saliva dilakukan dengan metode meludah (*spitting method*) sebelum dan sesudah penyikatan gigi. **Hasil:** Kelompok miswak menunjukkan peningkatan laju aliran saliva yang signifikan, dari 0,21 menjadi 1,01 mL/menit, dibandingkan dengan peningkatan yang lebih rendah pada kelompok kontrol, yaitu dari 0,21 menjadi 0,31 mL/menit. Perbedaan laju aliran saliva antara kedua kelompok secara statistik bermakna ($p < 0,01$). **Simpulan:** Hasil penelitian ini menunjukkan bahwa penyikatan gigi menggunakan miswak berpotensi menjadi metode yang efektif untuk meningkatkan laju aliran saliva pada anak dengan sindroma Down, sehingga dapat berkontribusi terhadap perbaikan kesehatan gigi dan mulut.

Keywords: *Sindroma Down, laju aliran saliva, Salvadora persica, kesehatan gigi dan mulut*

INTRODUCTION

Down syndrome is the most common chromosomal disorder caused by trisomy 21, with an incidence of approximately 1 in 700 live births worldwide [1]. In Indonesia, the National Health Surveys reported prevalence rates of 0.12% in 2010, rising to 0.21% in 2018 [2]. Children with Down syndrome present systemic features such as congenital heart defects, intellectual disability, and craniofacial anomalies, which collectively impact their overall health and quality of life [1].

Oral health issues such as gingivitis, periodontitis, and dental caries continue to pose significant challenges for individuals with Down syndrome. This particularly affected due to developmental abnormalities of the salivary glands and craniofacial structures, resulted in inadequate plaque control, and distinctive oral characteristics.. [3]. Aplasia and hypoplasia of the parotid and submandibular glands result in reduced salivary volume and flow rate [4]. Saliva is essential for maintaining oral homeostasis: it buffers acids, clears food debris, and provides antimicrobial defence. When salivary secretion is diminished, the protective capacity of saliva is compromised, accelerating bacterial colonisation [5]. Several studies have confirmed that children with Down syndrome exhibit significantly lower salivary flow rates and buffering capacity compared to non-syndromic peers, correlating with higher susceptibility to gingivitis, periodontitis and dental caries [3, 5, 6].

In addition to biological deficits, children with Down syndrome face challenges in maintaining oral hygiene due to intellectual disability, reduced motor coordination, and limited awareness of oral health [7]. Families and caregivers often struggle to provide consistent oral care, resulting in higher caries prevalence and unmet dental treatment needs [3]. Consequently, oral health problem in Down syndrome is a biological consequence of impaired salivary gland function, compounded by difficulties in self-care.

Miswak (*Salvadora persica*), a traditional chewing stick, has been used for centuries as a natural toothbrush. Its mechanical action removes plaque, while phytoconstituents such as tannins and benzyl isothiocyanate provide chemical stimulation that enhances salivary secretion [8]. Miswak also demonstrates antibacterial properties against periodontogenic and cariogenic bacteria, reducing *Phorpiromonas gingivalis, Aggregatibacter accinomycetemcommitans, Streptococcus mutans, and Lactobacilli* colonies [9, 10]. Given its ease of use, low cost, and cultural acceptance, miswak may serve as a practical oral hygiene device for children with Down syndrome, potentially improving salivary flow and reducing caries risk. However, no prior study has specifically examined its effect on salivary flow in children with Down syndrome. This study aimed to evaluate the impact of toothbrushing with miswak (*Salvadora persica*) on the salivary flow rate of children with Down syndrome.

METHODS

Ethical clearance and subject recruitment

This study was approved by the Ethics Commission of Jenderal Soedirman University (Ref: 6636/KEPK/X/2019). Twenty children with Down syndrome, free of systemic disease and not on anticholinergic medication, were recruited from SLB C-C1 Yakut Purwokerto and SLB ABCD Banyumas with a total sampling method. Written informed consent was obtained from parents.

Intervention

All participants were randomly allocated into two groups: (a) Treatment group, using a miswak toothbrush with posterior–anterior strokes, and (b) Control group using a conventional toothbrush with horizontal strokes. Each participant and their parents were informed about the toothbrushing method using a conventional and a miswak toothbrush through video and live demonstrations. Saliva was collected using the spitting method, both before and after brushing (2 minutes each). Salivary volume was measured gravimetrically and converted to mL/min using a factor of 1.1 g/mL. Saliva was weighed three times using a digital scale and adjusted by the saliva container weight (g) [11, 12]. All procedures were conducted between 8:00 and 11:00 am.

Figure 1. The sequence of the procedures. (A) Pre-intervention saliva collection; (B) training of toothbrushing; (C) intervention in the miswak group (C.1) and the control group (C.2); (D) Post-intervention saliva collection. The duration of intervention and the pre- and post-intervention salivary collection was 2 minutes each.

Data analysis

Paired *t*-tests compared pre- and post-intervention values within groups. Independent *t*-tests compared differences between groups. Verification of the normality assumption is limited by the small sample size. A *p*-value <0.05 with a 95% confidence interval was considered statistically significant.

RESULTS

Baseline salivary flow rates were similar across groups (0.21 mL/min). Post-intervention, the miswak group showed a significant increase to 1.01 mL/min ($p = 0.000$), while the control group increased modestly to 0.31 mL/min ($p = 0.063$). An independent *t*-test confirmed significant differences between groups ($p = 0.000$).

The mean salivary flow rate of children with Down syndrome before the intervention in both groups was 0.2 mL/min. Toothbrush stimulation multiplies the salivary flow rates in each group. The traditional miswak (*S. persica*) toothbrush escalates the salivary flow rate 5-fold compared to the initial salivary flow rate. The conventional toothbrush only improves the salivary flow rate to 0.31 mL/min (Fig. 2).

The paired *t*-test between the pre- and post-intervention salivary flow rates of the treatment group showed a significant difference (p=0.000) but not in the control group (p=0.063). The mean salivary flow rate differences of post and pre-intervention amid groups (0.8± 0.2357 of the treatment group and 0.1±0.1491 of the control group) were analyzed by an independent *t*-test and showed significant differences (p=0.000).

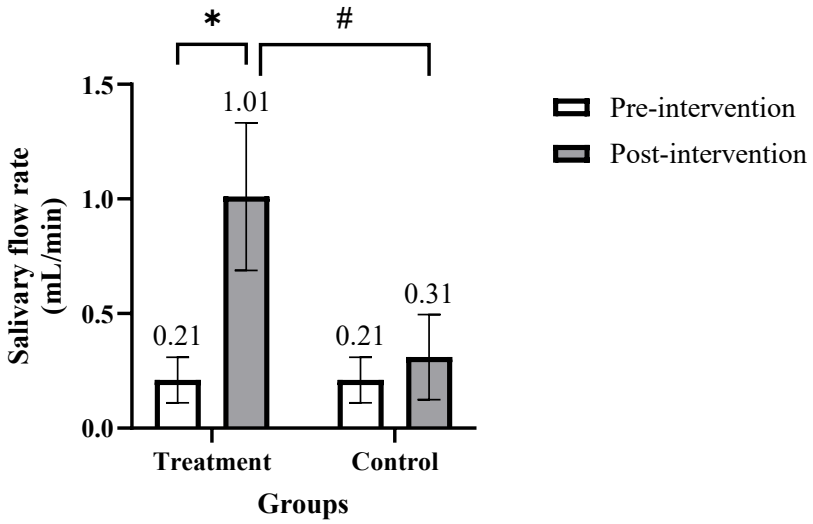

Figure 2. The salivary flow rate of treatment and control groups, pre- and post-intervention (*: significantly different with paired *t*-test; #: significantly different with unpaired *t*-test)

DISCUSSION

The velocity of salivary secretion varies among individuals and is influenced by the type of stimulation. Taste and mastication are recognised as the primary stimuli, although thought, sight, and smell can also contribute to salivary reflexes [13, 14]. In this study, the greater increase in salivary flow observed in the miswak group may not solely be attributed to its phytochemical components, but also to differences in mechanical stimulation during brushing. Therefore, the combined effect of brushing technique and natural fiber structure of miswak should be considered when interpreting these findings[15].

The mechanical stimulation of miswak arises from the friction of its fibrous silica strands against teeth, gingiva, and buccal mucosa. This sensory input activates oral mechanoreceptors, provoking salivary reflexes and increasing flow rate [15]. In addition, miswak contains organic compounds such as tannins and essential oils, which provide chemical stimulation. These phytoconstituents impart a distinctive taste and aroma that activate gustatory and olfactory receptors, initiating impulses through the afferent nervous system to the salivary nucleus. This process enhances parotid gland secretion and amplifies salivary flow [16–18]. Evidence from Kauret al study further supports that miswak immediately stimulates salivary flow via gustatory receptor activation, thereby improving both salivary volume and flow rate [18].

By contrast, conventional toothbrushes rely solely on mechanical stimulation. The friction of bristles against teeth and adjacent tissues can temporarily increase salivary flow, but this effect is short-lived, typically lasting only a few minutes

after brushing [19, 20]. This highlights the comparative advantage of miswak, which combines mechanical and chemical pathways to sustain salivary stimulation. Moreover, miswak's antibacterial properties against cariogenic bacteria such as *Streptococcus mutans* and *Lactobacilli* provide an additional preventive benefit, reducing microbial colonisation and supporting caries prevention [9, 10].

For children with Down syndrome who frequently present reduced salivary flow and oral motor challenges, natural brushing tools that provide enhanced mechanical stimulation may represent an adjunctive strategy in daily oral hygiene practice [15, 16]. Natural brushing tools such as Salvadora persica (Miswak), which provide both mechanical stimulation and antibacterial properties, may serve as a practical adjunct to conventional oral hygiene methods. For oral health professionals, incorporating such culturally accepted and low-cost tools into daily care routines could improve plaque control, stimulate salivary flow, and reduce caries risk [21]. These strategies, combined with patient-centered education and caregiver support, highlight the need for patience, adaptability, and commitment when delivering oral care to individuals with Down syndrome.

This study has several limitations that should be acknowledged. The sample size was relatively small, which may restrict the generalizability of the findings. Salivary flow was measured only immediately after brushing, without long-term follow-up to assess sustained effects. In addition, dietary factors were not controlled, and variability in toothbrushing training procedures may have introduced bias.Future research should aim to overcome these limitations by recruiting larger and more diverse cohorts, employing longitudinal designs to monitor salivary flow and oral health over time, and implementing strict dietary controls. Standardized and supervised toothbrushing training protocols should also be developed to ensure consistency in technique and reduce variability in results. These improvements would strengthen the evidence base and provide clearer guidance for integrating natural brushing tools into daily oral hygiene practices for individuals with Down syndrome.

CONCLUSION

This study concluded that traditional miswak (S. persica) toothbrushes effectively increase the salivary flow rate in children with Down syndrome. Miswak toothbrushing produced a greater immediate increase in whole salivary flow rate than a conventional toothbrush among children with Down syndrome. Further well-controlled trials with standardized brushing technique and longitudinal outcomes are needed.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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