

## COMPARATIVE EFFECTIVENESS OF VERTICAL-HORIZONTAL VERSUS FONES-HORIZONTAL COMBINED TOOTHBRUSHING TECHNIQUES ON PLAQUE INDEX AMONG ELEMENTARY SCHOOL CHILDREN

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### Abstract

This study aims to determine and compare the effectiveness of the Vertical-Horizontal versus Fones-Horizontal combined toothbrushing techniques on the plaque index among elementary school children. A quasi-experimental study with a pre-test and post-test design was conducted involving 60 students aged 9 to 11 years at SD Negeri 13 Kubu Gulai Bancah, West Sumatra, Indonesia. The participants were randomly divided into two equal groups: Group A utilized the Vertical-Horizontal technique, while Group B used the Fones-Horizontal technique. Over a 14-day intervention period, both groups performed twice-daily supervised brushing. Plaque index scores were clinically evaluated before and after the intervention using disclosing agents and statistically analyzed using Paired and Independent t-tests. The results showed that both combined methods significantly decreased the mean plaque index ( $p < 0.001$ ), indicating that structured mechanical disruption successfully clears dental biofilms. However, the Independent t-test applied to the post-test scores demonstrated a statistically significant difference between the two groups ( $p = 0.004$ ), where the Fones-Horizontal technique achieved a notably lower plaque score (1.12) compared to the Vertical-Horizontal technique (1.32). This outcome is closely linked to childhood psychomotor development, as circular movements align more naturally with the gross hand coordination of school-aged children. It can be concluded that the Fones-Horizontal combined toothbrushing technique provides a more practical, developmentally appropriate, and clinically efficient approach. These findings suggest that school dental health programs (UKGS) should prioritize teaching this specific combination to maximize oral hygiene outcomes.

Keywords: Fones Method, Oral Hygiene, Plaque Index, School Children, Toothbrushing Techniques,

### 1. INTRODUCTION

Dental plaque is a soft, tenacious biofilm that adheres to intraoral surfaces, consisting of dense microbial communities embedded within a self-produced extracellular polymeric substance matrix [1]. If this biofilm is not mechanically disrupted through regular oral hygiene practices, the metabolic activities of the acidogenic bacteria within the plaque will initiate the demineralization of dental hard tissues, making it the primary etiological factor in the development of dental caries and periodontal diseases in children [2]. Elementary school children, particularly those aged 9 to 11 years, represent a highly vulnerable group because they are in the mixed dentition stage. During this transitional period, the active eruption of permanent teeth creates irregular anatomical architectures, cumulative food stagnation areas, and localized gingival inflammation, all of which accelerate plaque accumulation if effective oral hygiene is not maintained [3]. This clinical vulnerability is highly observable among school children in regional areas of Indonesia, including Bukittingi, West Sumatra, where local school-based preventive dental programs require continuous optimization.

In addition to these anatomical challenges, the psychomotor development of school-aged children heavily influences their plaque control efficacy [4]. At this developmental stage, children are gradually shifting from parental dependence toward autonomy in their personal care routines. However, they

frequently lack the fine motor skills, manual dexterity, and sustained motivation required to execute complex, multi-directional tooth-brushing techniques independently [5]. Consequently, single-motion or unidirectional brushing methods often fail to access all tooth surfaces thoroughly, leaving substantial biofilm deposits in interproximal spaces, cervical margins, and the deep pits and fissures of newly erupted permanent molars.

To overcome these physical limitations, the implementation of combined tooth-brushing techniques has been widely advocated in pediatric dentistry. Combined regimens strategically pair two distinct mechanical movements to clean different anatomical surfaces of the teeth efficiently within a single brushing session. The Vertical-Horizontal combined technique pairs an up-and-down sweeping motion (which is ideal for clearing food debris from interdental spaces and smooth vertical walls) with a back-and-forth horizontal scrubbing stroke. Conversely, the Fones-Horizontal combined technique integrates large, continuous circular motions—originally designed by Alfred Fones to enable young children to easily mass-clean buccal and labial surfaces—with the same horizontal scrubbing component [6]. While both combinations utilize the intuitive horizontal stroke to debride occlusal surfaces, they differ significantly in their clinical efficacy on smooth surfaces.

Determining which combination yields superior clinical outcomes is vital for designing effective promotional and preventive oral health protocols in schools. Some dental literature suggests that circular motions (Fones) are better suited to the natural rotary hand coordination of young children, whereas other studies argue that vertical sweeping provides superior interproximal clearance without pushing debris into the gingival sulcus [7]. However, direct empirical evidence comparing the clinical effectiveness of these two specific combined methods within elementary school populations remains limited. Therefore, this study aims to evaluate and compare the effectiveness of the Vertical-Horizontal versus Fones-Horizontal combined tooth-brushing techniques on the plaque index among elementary school children, establishing a data-driven foundation for school-based dental health programs [8].

## 2. METHODOLOGY

This study was designed as a quasi-experimental research project utilizing a pre-test and post-test two-group design to achieve a rigorous comparative analysis. The study was conducted at SD Negeri 13 Kubu Gulai Bancah, West Sumatra, Indonesia. The target population comprised elementary school children aged 9 to 11 years who were selected using a purposive sampling technique based on specific clinical inclusion criteria. These criteria required participants to have fully erupted permanent first molars, no active orthodontic appliances, and no history of systemic diseases that could impair salivary flow or manual motor skills. A total sample of 60 students met the criteria and was randomly allocated into two equal intervention groups of 30 participants each: Group A was assigned to the Vertical-Horizontal combined technique, and Group B was assigned to the Fones-Horizontal combined technique.

Prior to the operational phase of the trial, baseline oral hygiene statuses were meticulously established by measuring the initial plaque index of each participant using the standardized Silness-Löe Plaque Index system [2]. Following the baseline assessment, children in both groups received a structured, 15-minute dental health education session that included a live demonstration of their respective assigned combined brushing technique on a dental phantom model. The clinical intervention was carried out over a strict period of 14 days, during which the children performed supervised tooth-brushing twice daily—once in the morning after breakfast at school and once in the evening before bed at home. Post-intervention plaque scores were re-evaluated under identical clinical conditions using disclosing agents [15]. The gathered clinical data were statistically processed using univariate analyses to evaluate demographic distributions, while bivariate analyses consisting of the Paired t-test and Independent t-test were applied to determine the intra-group and inter-group significance of the plaque index reduction, respectively [16].

## 3. RESULTS AND DISCUSSION

The clinical evaluation successfully involved 60 elementary school students at SD Negeri 13 Kubu Gulai Bancah, West Sumatra, Indonesia, who completed the full 14-day supervised brushing trial. Baseline homogeneity tests confirmed that demographic characteristics, dietary habits, and baseline plaque index scores were uniformly distributed between Group A and Group B, thereby minimizing potential confounding variables.

The mechanical efficacy of both combined tooth-brushing methods was assessed by comparing pre-intervention and post-intervention plaque scores. Table 1 outlines the statistical summary of the clinical findings.

**Table 1.** Comparison of Pre-test and Post-test Plaque Index Mean Scores Between Vertical-Horizontal and Fones-Horizontal Techniques

Intervention Group	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Reduction	p-value (Intra-group)
Group A (Vertical-Horizontal)	2.45 (0.34)	1.32 (0.28)	1.13	< 0.001
Group B (Fones-Horizontal)	2.41 (0.31)	1.12 (0.22)	1.29	< 0.001
<b>p-value (Inter-group)</b>	<b>0.624</b>	<b>0.004</b>	-	-

Statistical analysis using the Paired t-test revealed highly significant intra-group plaque reductions for both cohorts ( $p < 0.001$ ), proving that structured, combined brushing regimens successfully disrupt dental biofilms. However, the Independent t-test applied to the post-test scores demonstrated a statistically significant difference between the two groups ( $p = 0.004$ ). This indicates that the Fones-Horizontal technique (Group B) achieved a significantly lower post-test plaque index average compared to the Vertical-Horizontal technique (Group A).

The highly significant reduction in plaque scores observed in both groups emphasizes that combining two mechanical motions systematically targets multiple tooth surfaces. The inclusion of the horizontal component in both techniques ensured that the deep pits, grooves, and fissures of the newly erupted permanent first molars—which are highly susceptible to stagnation—were thoroughly debrided. This aligns with standard pedodontic guidelines indicating that simple horizontal scrubbing remains the most intuitive and effective method for children to clean occlusal surfaces [9].

The superior effectiveness of the Fones-Horizontal combination over the Vertical-Horizontal technique can be justified through the lens of childhood psychomotor development. Children aged 9 to 11 years are still refining their fine motor skills [10]. The Fones technique relies on large, continuous circular sweeping motions executed while the teeth are occluded. This broad rotary movement requires less tip-of-finger dexterity and maps naturally onto the developmental muscle memory and gross hand coordination of school-aged children [11]. Consequently, the children in Group B at SD Negeri 13 Kubu Gulai Bancah were able to achieve a highly consistent application of the bristles across the broad buccal and labial surfaces, leading to uniform biofilm disruption [12].

Conversely, the Vertical-Horizontal technique demands higher manual precision. Executing a proper vertical sweep requires the child to deliberately brush upper teeth downward and lower teeth upward, while strictly avoiding damaging back-and-forth horizontal movements on smooth surfaces [13]. Clinical observations during the intervention revealed that children using the vertical method struggled to maintain the correct stroke direction near the posterior segments and mandibular lingual surfaces. Due to uncomfortable hand positioning, they often reverted to uncontrolled scrubbing or missed the cervical margins entirely [14]. This physiological limitation explains the higher post-test plaque averages found in Group A. Furthermore, the continuous nature of the circular Fones stroke provides a light, therapeutic massaging effect on the marginal gingiva, which concurrently reduces localized soft tissue inflammation without causing tissue abrasion [15]. While the vertical method is mechanically sound for removing loose interdental debris, its steep learning curve makes it less practical for rapid, unassisted brushing routines in children. These findings strongly imply that the Fones-Horizontal combined technique provides a more practical, developmentally appropriate, and

clinically efficient approach for reducing plaque index scores in elementary school communities, making it an ideal candidate for school dental health programs (UKGS) [16]

#### 4. CONCLUSIONS AND RECOMMENDATIONS

Based on the clinical data and statistical analysis obtained from the 14-day intervention at SD Negeri 13 Kubu Gulai Bancah, it can be concluded that both the Vertical-Horizontal and Fones-Horizontal combined toothbrushing techniques are highly effective in reducing the plaque index among elementary school children [7]. Both methods systematically disrupt dental biofilms across different anatomical surfaces of the mixed dentition, especially when paired with continuous professional supervision [12]. However, the Fones-Horizontal combined technique demonstrated a statistically significant superior effectiveness in lowering post-test plaque index scores compared to the Vertical-Horizontal technique. This clinical superiority is closely linked to childhood psychomotor development, as large circular motions require less advanced finger dexterity and map more naturally onto the gross hand coordination and muscle memory of children aged 9 to 11 years [11]. Conversely, the Vertical-Horizontal method presents a steeper learning curve, often causing children to miss cervical margins or revert to improper scrubbing directions due to hand positioning discomfort [14].

Flowing from these clinical conclusions, several recommendations are put forward to optimize pediatric oral hygiene strategies. First, school dental health programs (Usaha Kesehatan Gigi Sekolah / UKGS) should officially prioritize and standardize the instruction of the Fones-Horizontal combined technique as the primary preventive measure for elementary school students [16]. Second, school authorities and teachers should collaborate with public health centers (Puskesmas) to establish sustainable, routine supervised tooth-brushing activities in schools to ensure children maintain correct habits [8]. Third, future researchers are encouraged to extend the follow-up duration of similar studies beyond 14 days and to investigate the long-term impacts of these combined techniques on specific dental caries incidence rates and gingival health indices.

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