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Validation of a Modified O'Leary Plaque Index Compared to the Standard OHI-S Among Elementary School Students at SDN Pudakpayung 02, Semarang

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ABSTRACT

Oral hygiene monitoring is essential in school-based prevention programmes, yet standard indices may be difficult to implement routinely outside dental settings. This study compared a modified O'Leary Plaque Index, restricted to labial and oral surfaces, with the standard Oral Hygiene Index-Simplified (OHI-S) debris index among elementary school students at SDN Pudakpayung 02, Semarang. A comparative within-subject design was used involving 192 students who underwent both examinations. Content validity was evaluated by five experts using Aiken's V, with all items scoring above 0.80. Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC). Descriptive findings were reported as proportions with 95% confidence intervals (CIs), while paired scores were analyzed using the Wilcoxon signed-rank test. The moderate oral hygiene category was most common for both methods: 45.3% (95% CI, 38.4–52.4) for OHI-S and 41.7% (95% CI, 34.9–48.7) for the modified index. No statistically significant difference was found between paired scores ($p = 0.225$), and the reported homogeneity test was also non-significant ($p = 0.862$). The ICC of 0.671 indicated moderate inter-rater reliability. Overall, both indices produced similar group-level oral hygiene distributions. However, these findings do not establish diagnostic equivalence or individual-level agreement. With adequate examiner training and calibration, the modified index warrants further evaluation as a practical screening approach for school-based oral health programmes, particularly where full dental examination resources are limited.

Keywords
Method Comparison
O'leary
OHI-S
Oral Hygiene Index
Plaque Index

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Introduction

Oral health has long been recognized as an integral component of overall health, a position reinforced by the Sixtieth World Health Assembly (WHA) in 2007, which emphasizes the importance of integrating oral health into general health promotion strategies [1]. Indonesia has implemented school-based oral health programs, including the Usaha Kesehatan Gigi Sekolah (UKGS), which promotes daily toothbrushing and self-care practices as part of broader health-promoting school initiatives [2].

Despite a reported national toothbrushing rate of 94.7%, only 2.8% of Indonesians brush their teeth at recommended times—after breakfast and before bedtime [3]. This gap between behaviour and technique contributes to persistent plaque accumulation and the continued burden of dental caries among school-aged children. Dental plaque is a complex biofilm that plays a central role in the development of caries and periodontal diseases [4]. National epidemiological data indicate that dental caries prevalence remains high, with substantial proportions of untreated decay, reflecting the need for strengthened preventive measures and early detection at the school level [3].

Assessment of oral hygiene status traditionally relies on the Simplified Oral Hygiene Index (OHI-S) established by Greene and Vermillion [5]. While widely accepted and standardized, OHI-S requires examination of six specific index teeth and is typically performed by trained dental personnel. Alternatively, the O'Leary Plaque Index provides detailed mapping of plaque across tooth surfaces and has been widely used in periodontal assessment [6], but it is relatively complex for community-based cadres to apply. In Indonesia, community participation in oral health efforts remains suboptimal, with prior studies showing that nearly one-fifth of health cadres were inactive in providing guidance [7].

Given the crucial role of UKS/UKGS teachers and cadres, national health policies emphasize promotive, preventive, early detection, curative, and rehabilitative oral health efforts within the Basic Package of Oral Care (BPOC) framework [8],[9]. In alignment with WHO recommendations, there is a growing need for simple, practical, and accurate tools that enable early detection of oral hygiene problems at the community and school levels [1].

To address this need, a modified version of the O'Leary Plaque Index—limited to labial/oral surfaces—has been developed. Clinically, labial surfaces are more accessible, easier to clean, and subject to natural mechanical cleansing during mastication. The persistence of

plaque on these surfaces may therefore indicate inadequate oral hygiene practices and reflect broader plaque accumulation patterns [11],[12]. However, despite its potential advantages, no formal validation of this modified O'Leary method for use by school health cadres has been conducted, representing a significant research gap.

Recent systematic reviews and meta-analyses indicate that school-based oral-health education can improve oral-health outcomes, plaque control, and oral-hygiene behaviours, particularly when interventions incorporate repeated reinforcement, behavioural components, and structured delivery [13]–[16]. Accordingly, this study compared group-level oral hygiene status using the modified O'Leary Plaque Index and the OHI-S debris index, and described the content validity and inter-rater reliability of the modified procedure. The findings are interpreted as a method comparison, not as proof of diagnostic equivalence.

This study aimed to compare the group-level oral hygiene status obtained using a modified O'Leary Plaque Index and the standard OHI-S debris index among elementary school students, while also evaluating the content validity and inter-rater reliability of the modified procedure.

Material and Methods

A. Study Design

This was a comparative cross-sectional within-subject method-comparison study [17]. No randomisation or intervention was undertaken. Each participant underwent two oral hygiene examinations during the same data-collection period: (1) the debris component of the standard OHI-S and (2) the modified O'Leary Plaque Index. Using the same participants for both methods enabled paired comparison of the two scores.

B. Setting and Participants

The study was conducted at SDN Pudakpayung 02, Semarang, in November 2023. The source population comprised 237 students in grades 1–6. Purposive sampling was used. Students were screened to confirm the presence of all six OHI-S index teeth and to exclude index teeth affected by caries or extraction. A total of 192 students met the eligibility criteria and participated in the study.

C. Measurement Procedures

Oral hygiene status was assessed using two methods. For the standard OHI-S debris index, the prescribed six index teeth and the indicated buccal, labial, or lingual surfaces were examined. Debris was scored from 0 to 3 according to the Greene and Vermillion criteria. The individual debris score was obtained from the examined surfaces and classified as good (0.0–0.6), moderate/fair (0.7–1.8), or poor (1.9–3.0).

For the modified O'Leary Plaque Index, plaque was visualised using a plaque-disclosing procedure and assessed on the labial/oral surfaces of the examined teeth. Each surface with

visible plaque staining was recorded as plaque-positive, while unstained surfaces were recorded as plaque-negative. The modified-index score was calculated as the percentage of plaque-positive surfaces divided by the total number of examined labial/oral surfaces and multiplied by 100. The percentage score was then categorised as good (<34%), moderate (34–67%), or poor (68–100%). This percentage-based procedure was retained in the revised manuscript based on author confirmation, and the sextant-based scoring description found in the full internal report was not used for the journal manuscript.

D. Validity and Reliability

Content validity was assessed by five experts using Aiken's V. The evaluation covered the clarity of the examination instructions, the appropriateness of limiting observation to selected accessible tooth surfaces, the plaque-disclosure procedure, scoring method, score calculation, and category interpretation [18]. An Aiken's V value of at least 0.80 was considered acceptable, and all evaluated items reportedly exceeded this threshold. Item-level Aiken's V values were not available in the archived validation materials provided for this revision; therefore, unverified item-level values were not reconstructed.

Inter-rater reliability was evaluated using the intraclass correlation coefficient (ICC). The available manuscript reports an ICC of 0.671, indicating moderate reliability. The original statistical output did not provide the 95% confidence interval, F statistic, or p-value required for more detailed reporting; therefore, the reliability result is presented using the verified ICC value available from the source manuscript.

E. Data Analysis

Descriptive statistics were used to summarise oral hygiene categories. Category proportions are reported with 95% CIs calculated using the Wilson method. Paired OHI-S and modified-index scores were compared using the Wilcoxon signed-rank test at $\alpha = 0.05$. The Wilcoxon result was interpreted as evidence of a difference or no detectable difference between scores; it was not interpreted as proof of diagnostic equivalence. The verified source manuscript and full research report provide $p = 0.225$ for the Wilcoxon test and $p = 0.862$ for the homogeneity test. Because the verified source records did not provide the complete participant-level paired cross-tabulation or statistical output, Wilcoxon effect size and weighted Cohen's kappa were not reconstructed from unverified data.

Results

A. Oral Hygiene Status Using the Standard OHI-S Debris Index

A total of 192 elementary school students were assessed using the standard OHI-S debris index. The moderate category was most frequent: 87 students (45.3%; 95% CI, 38.4–52.4). Seventy-four students were classified as good (38.5%; 95% CI, 31.9–45.6), whereas 31 were classified as poor (16.1%; 95% CI, 11.6–22.0) (Fig. 1).

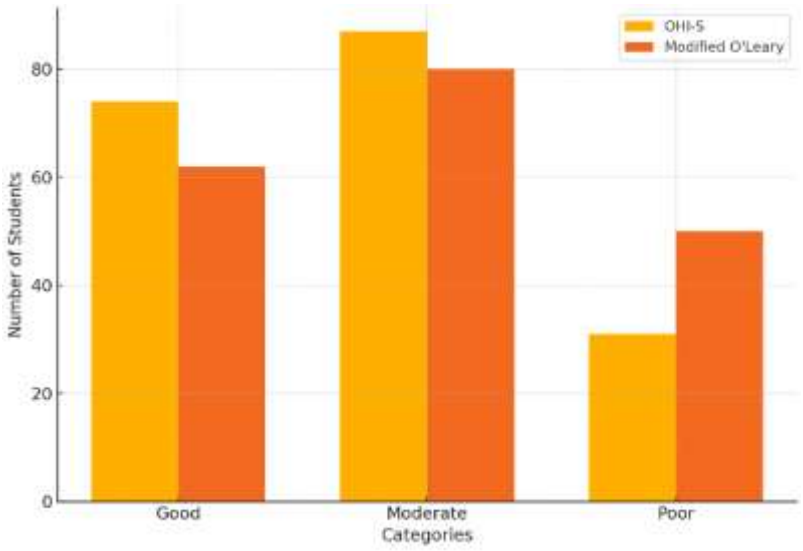

Fig. 1. Distribution of oral hygiene status using the OHI-S debris index (n = 192)

B. Oral Hygiene Status Using the Modified O'Leary Plaque Index

Using the modified O'Leary Plaque Index, 80 students (41.7%; 95% CI, 34.9–48.7) were classified in the moderate category. Sixty-two students were classified as good (32.3%; 95% CI, 26.1–39.2), and 50 as poor (26.0%; 95% CI, 20.3–32.7) (Fig. 2).

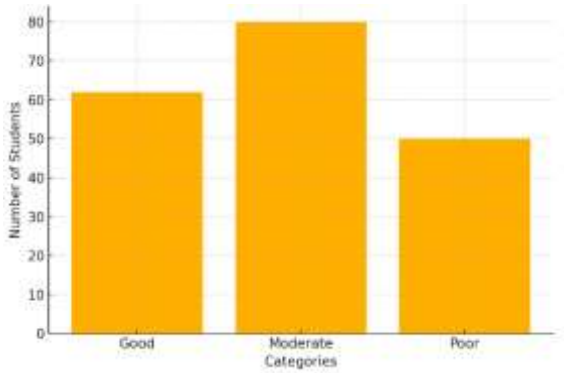

Fig. 2. Oral hygiene status using modified O'Leary Plaque Index (n=192)

C. Comparison Between the OHI-S Debris Index and the Modified O'Leary Plaque Index

The paired Wilcoxon signed-rank test yielded p = 0.225, indicating that no statistically detectable difference between the two score distributions was observed at α = 0.05. The homogeneity test reported in the full research report was also not statistically significant (p = 0.862). Formal agreement analysis, such as weighted Cohen's kappa, could not be performed from the verified aggregate results because the participant-level paired cross-tabulation was not available in the source records. Therefore, these findings are interpreted as showing similar group-level distributions rather than diagnostic equivalence or interchangeability.

These results indicate similar group-level distributions in this sample. However, a non-significant paired comparison does not establish diagnostic equivalence or individual-level agreement. Because the participant-level paired scores and the three-category cross-tabulation were not available in the source manuscript, an effect size for the Wilcoxon test and a weighted Cohen's kappa with 95% CI could not be derived reliably from the aggregate results.

Discussion

This study found that the modified O'Leary Plaque Index and the OHI-S debris index produced broadly similar group-level distributions of oral hygiene status among students at one elementary school. The moderate category was the most frequent classification with both methods, and the paired comparison did not show a statistically significant difference. These findings indicate that the modified procedure may have practical value for school-based screening. However, similarity in distributions and a non-significant paired test should not be interpreted as evidence that the two indices are diagnostically equivalent or interchangeable. Method-comparison literature emphasizes that absence of a statistically significant difference does not by itself establish agreement at the individual level [19].

The modified procedure reduces examination burden by restricting plaque scoring to readily accessible labial and oral surfaces. Such simplification is relevant in school settings, where examination time, equipment, and the availability of dental personnel may be limited. Previous work has shown that simplified or photograph-based plaque assessment can achieve useful reproducibility when examiners are trained and scoring protocols are standardized [20], [21]. Nevertheless, reducing the number of observed surfaces changes the information captured by the index. Plaque on proximal or less visible surfaces may be missed, potentially leading to underestimation in some students. The modified index should therefore be regarded primarily as a pragmatic screening indicator rather than a direct substitute for comprehensive clinical plaque assessment.

The ICC of 0.671 obtained in this study indicates moderate inter-rater reliability. Guidance for ICC interpretation generally classifies values between 0.50 and 0.75 as moderate reliability, while also recommending consideration of the ICC model and confidence interval [22]. This result suggests reasonable scoring consistency, but further improvement is desirable before routine use by school health cadres. Oral-health survey research shows that calibration, benchmark examiners, written diagnostic criteria, practice cases, and periodic recalibration can improve inter-examiner consistency [21], [23]. Implementation should therefore include a written standard operating procedure, demonstration of plaque disclosure and binary scoring, supervised practice with positive and negative examples, and periodic calibration with dental personnel.

Future studies should complement the ICC with agreement statistics appropriate to the scale used. Cohen's kappa estimates agreement beyond chance, while weighted kappa is particularly relevant when categories have a natural order, such as good, moderate, and poor oral hygiene [24]. Reporting weighted kappa with a 95% confidence interval would provide more direct evidence regarding whether both indices classify the same students similarly. For continuous or quasi-continuous scores, method-agreement approaches should also be considered because correlation or a non-significant difference test alone cannot establish interchangeability [19].

The potential usefulness of the modified index should also be considered within school-based oral-health promotion. Systematic reviews and intervention studies indicate that sustained oral-health education can improve knowledge, oral-hygiene behaviour, plaque control, and gingival outcomes among schoolchildren [25]–[28]. An umbrella review similarly found improvements in plaque-related and behavioural outcomes, although evidence for longer-term clinical effects remains less conclusive [29]. School personnel may therefore contribute to reinforcing preventive behaviour. A pilot study in India reported that trained teachers providing frequent oral-health education and simple screening contributed to improvements in OHI-S and plaque scores, supporting the feasibility of involving non-dental school personnel within a structured programme [30]. In this context, the modified index could help identify students who may need additional toothbrushing instruction or professional referral.

Several limitations should be considered. Purposive sampling in a single school restricts generalisability to other schools and populations. Eligibility required the presence of the six OHI-S index teeth and excluded affected teeth, which may further reduce representativeness. Restricting observation to labial and oral surfaces may underestimate plaque elsewhere in the mouth. In addition, formal individual-level agreement analyses were not available from the aggregate data. Accordingly, the findings should be interpreted as preliminary evidence of feasibility and group-level similarity rather than validation of diagnostic equivalence.

Future multi-school studies should retain individual paired scores, include populations with different demographic and resource profiles, prespecify agreement analyses, and document examiner training and calibration. Weighted Cohen's kappa with 95% confidence intervals should be reported for ordinal categories. If the objective is to determine whether the modified index can replace OHI-S, a prespecified equivalence or method-agreement framework is required rather than reliance on a non-significant difference test alone [26]. Overall, the modified index appears to be a feasible candidate for school-based oral-hygiene screening when accompanied by standardized training, calibration, documentation, and a clear

referral pathway. Its role should remain complementary to professional dental assessment until stronger evidence of individual-level agreement and external validity is available.

Conclusion

Among students at SDN Pudakpayung 02, the modified O'Leary Plaque Index generated a group-level oral hygiene distribution that was similar to that obtained with the OHI-S debris index. No statistically detectable paired difference was observed, and the modified procedure showed moderate inter-rater reliability. The modified index may be considered for further development as a practical school-based screening tool when cadres receive structured training, calibration, and professional supervision. The present results do not establish diagnostic equivalence or interchangeability with OHI-S; additional individual-level agreement analysis is required before using the modified method as a replacement for the standard index.

Ethical Considerations

This study was conducted in accordance with ethical principles for research involving human participants. Ethical approval was granted by the Health Research Ethics Committee, Poltekkes Kemenkes Semarang, Ministry of Health, Semarang Health Polytechnic (Approval No. 1113/EA/F.XXIII.38/2026; January 20, 2026). The ethical approval declaration states that the protocol was ethically appropriate in accordance with the seven WHO 2011 standards, including social value, scientific value, equitable assessment of burden and benefits, risk, persuasion/exploitation, confidentiality and privacy, and informed consent, with reference to the 2016 CIOMS Guidelines. Participant information, voluntariness, confidentiality, and data anonymity were maintained throughout the study.

Written informed consent was obtained from all participants prior to their inclusion in the study. Participation was voluntary, and participants were assured of their right to withdraw from the study at any time without any consequences. Confidentiality and anonymity of participant data were strictly maintained throughout the research process. All data were used solely for research purposes. The study was conducted in accordance with the principles of the Declaration of Helsinki.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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