The Effect of a Teacher Led Oral Health Intervention In Rural Ethiopia Schools - A Cluster Randomized Trial

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AIM

To evaluate the short-term effect of a school-based, teacher led oral health supervised tooth brushing and oral health educational intervention on the gingival health of 6 to 15-year-old primary school children in rural Ethiopia

INTRODUCTION

The global prevalence of oral health conditions has seen a significant increase, affecting an estimated 3.5 billion individuals worldwide [1]. These diseases are influenced by socioeconomic factors, access to care, and cultural practices [2-4], leading to increased tooth loss in regions with limited dental care access [5]. Primary school settings present a promising opportunity for preventive interventions [6]. In Sub-Saharan Africa, recognizing the potential of school-based health programs, many countries, including Ethiopia, have initiated initiatives to improve children's health [7, 8]. Despite various health educational models, formal school-based interventions focusing on oral health are lacking. Existing informal oral health initiatives in Ethiopian schools lack coordination and evaluation [9], with limited evidence of effectiveness [10, 11]. Our study evaluates a three-armed school-based intervention in rural Ethiopian villages to improve children's gingival health, hypothesizing that a combined approach of supervised tooth brushing and oral health education delivered through locally trained teachers will yield superior outcomes. We employ a randomized cluster study design to assess intervention effectiveness comprehensively [12].

MATERIALS AND METHODS

We conducted a school-based cluster randomized pragmatic trial with 8-week follow-up among 1000 students.. We randomly assigned 19 primary schools located within 9 villages in **Koraro millennium village cluster** in in Tigray Region in Northeastern Ethiopia into three groups with equal probability. Two groups were the treatment (intervention) arms (Group 1 – oral health education; Group 2 (oral health education and supervised tooth brushing) and the third group was the control arm. Stratified random sampling was employed; strata were defined by the distance to the town center, and availability of water in the schools. The primary outcome was the difference in mean gingival index scores between baseline and post evaluation. Primary outcome differences between intervention and control groups were assessed utilizing generalized estimating equations (GEE) with an exchangeable working structure. We also adjusted for student-level and contextual factors. An intent-to-treat strategy was employed to address non-compliance. Additionally, post-hoc, an additional gingival health outcome was defined, and the number needed to treat (NNT) was calculated for each group. The post-hoc gingival outcome was defined as "favorable", if a 50% reduction in the number of tooth sites with moderate gingival inflammation was observed. This outcome was used to assess the effectiveness of the intervention on reversing gingival inflammation in this population within a short timeframe.

RESULTS

Group 2 – the supervised tooth-brushing group experienced a statistically significant decrease in their mean gingival index scores showing an improvement in their gingival health compared to the control group, no significant effect was noted for Group 1 in the crude model. That result remained significant even after adjusting for student and parent demographic and socioeconomic characteristics, baseline student oral health related knowledge, attitudes and practices, measured baseline oral hygiene status and community level covariates.

The odds of having at least a 50% reduction in number of sites with bleeding increased by 1.8-fold (95% CI: 1.03, 3.22 p=0.04) and **2.7-fold** (95% CI: 1.48, 4.82, p=0.001) among students attending schools randomized to Group 1 vs those in control schools, and students randomized to Group 2 vs control schools, respectively.

Based on calculated number needed for treatment (NNT) for each group, we concluded that to improve the gingival health of one student we would need to administer the intervention to 9 and 5 students in Group 1 & 2 respectively.

Study characteristics	N (%)	Control	Group 1	Group 2	P-value
Students randomized by intervention arm	1000	334 (33%)	364 (37%)	302 (30%)	
Mean age in yrs. (SD)	948 (94.8%)	10.5 (2.6)	10.1 (2.6)	10.4 (2.7)	>0.05
Gender	937 (94.8%)				
Females	454 (48.5%)	152 (33.5%)	164 (36.1%)	138 (30.4%)	0.9
Males	483 (51.5%)	161 (33.3%)	175 (36.2%)	147 (30.4%)	
*Mean Gingival Index (GI) Score (SD) at baseline (lower GI scores indicate better oral health)	948 (94.8%)	0.44 (0.3)	0.45 (0.4)	0.42 (0.3)	0.60
†Mean Oral Health Knowledge Score (SD) at baseline	951 (95.1%)	5.5 (2.2)	5.7 (2.6)	5.5 (2.2)	0.36
†Mean Oral Hygiene Index (OHI) Score (SD) at baseline (lower OHI scores indicate better oral health)	948 (94.8%)	1.4 (0.6)	1.3 (0.6)	1.4 (0.5)	0.05
Parental Education	969*(96.9%)	327 (33.7%)	356 (36.7%)	286 (29.5%)	
Didn't attend any school (no education)	610 (63%)	194 (32%)	217 (35%)	199 (33%)	0.08
Attended non-standard school	268 (27.6%)	100 (38%)	102 (39%)	21 (23%)	
Attended standard school	91 (9.4%)	33 (36%)	37 (41%)	21 (23%)	
School level covariates (Total number of schools N=19)					
Schools with optimal school hygiene infrastructure	5 (26%)	1 (20%)	2 (40%)	2(40%)	
Schools with nearby shops selling candy and sweets	7 (37%)	2 (29%)	3 (42%)	2 (29%)	

Legend
* Primary outcome: Mean Gingival Index Score
Group 1 (Oral Health Education); Group 2 (Oral health education & Supervised tooth brushing); Control: comparison group that represented the standard of care in Ethiopia
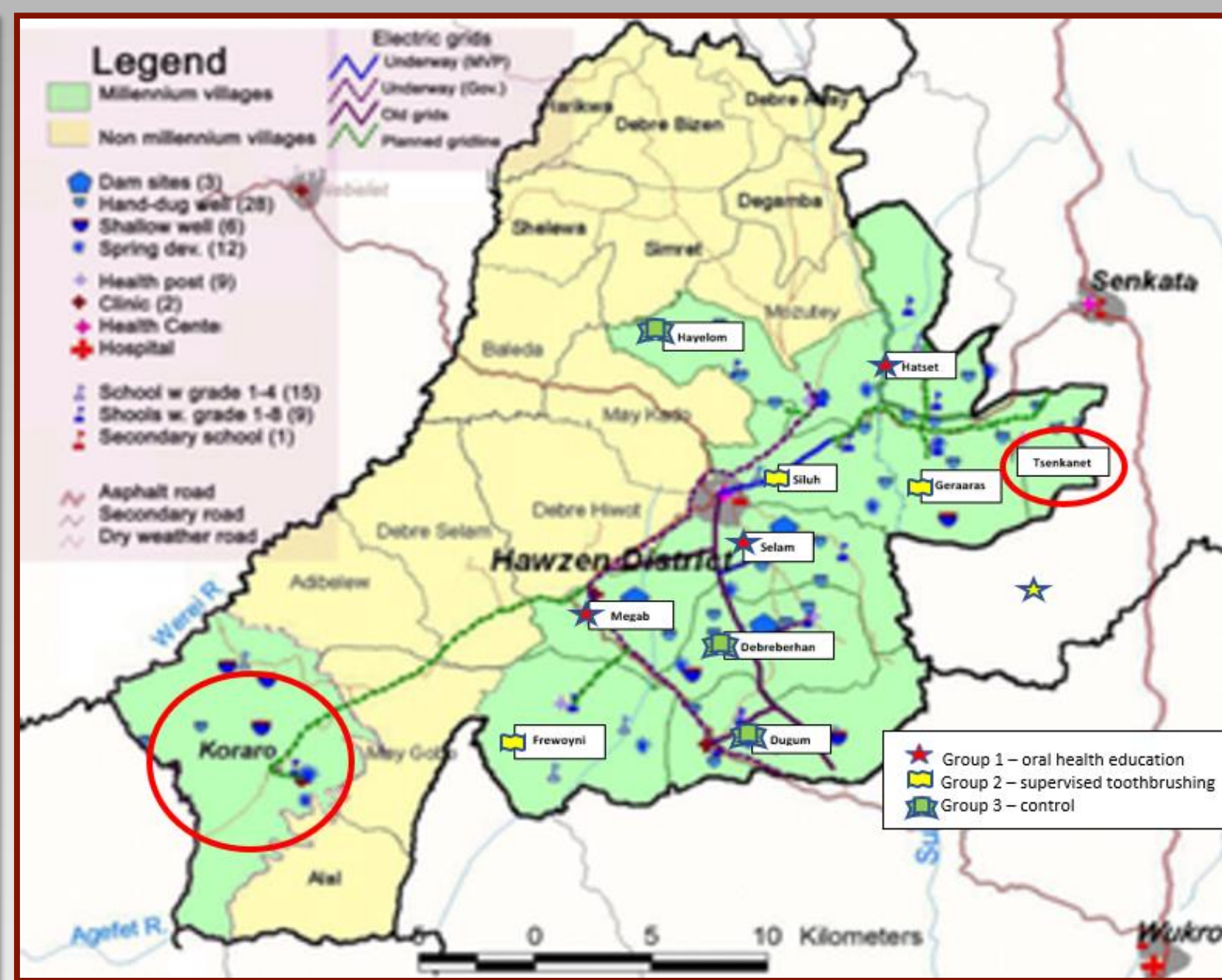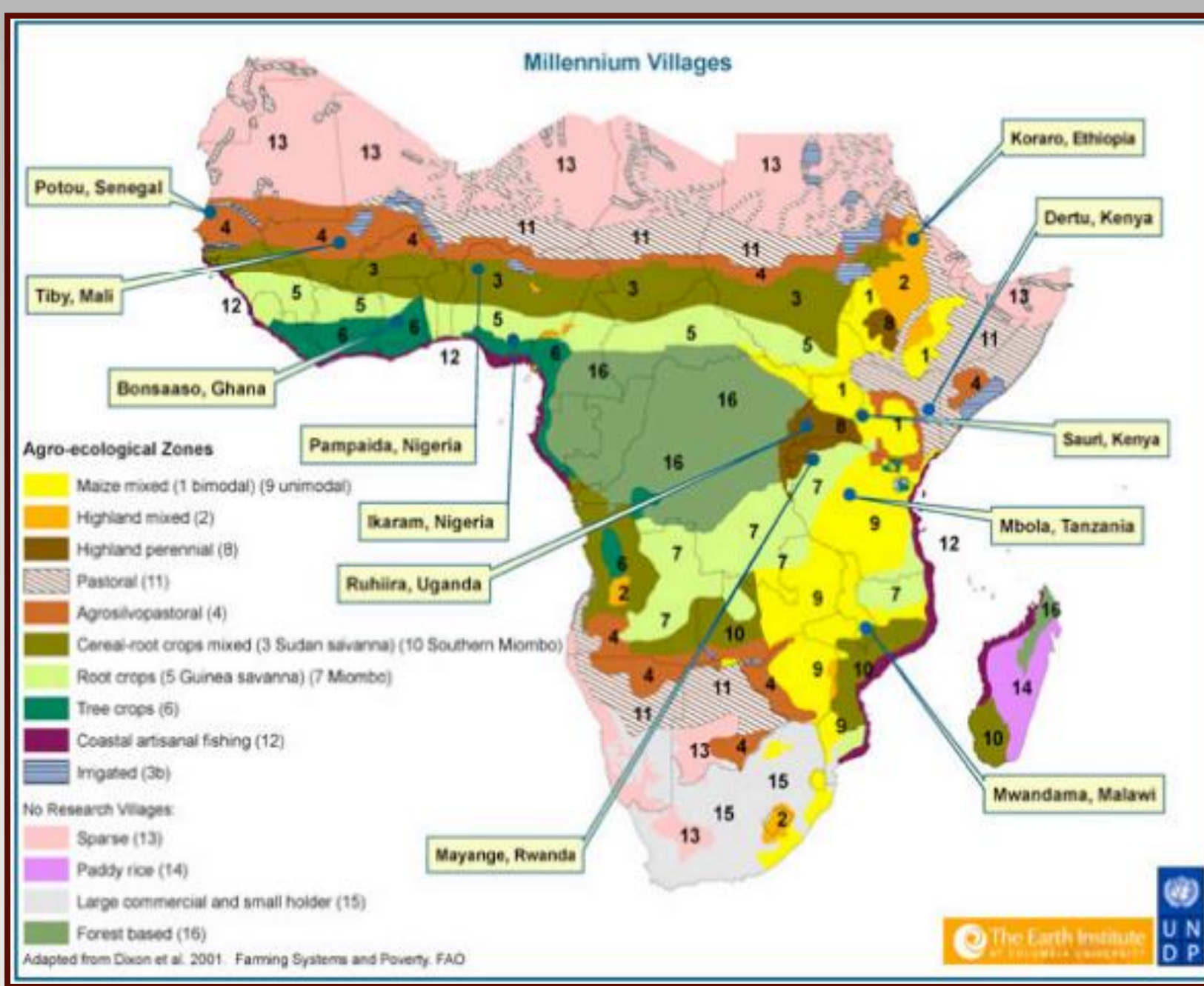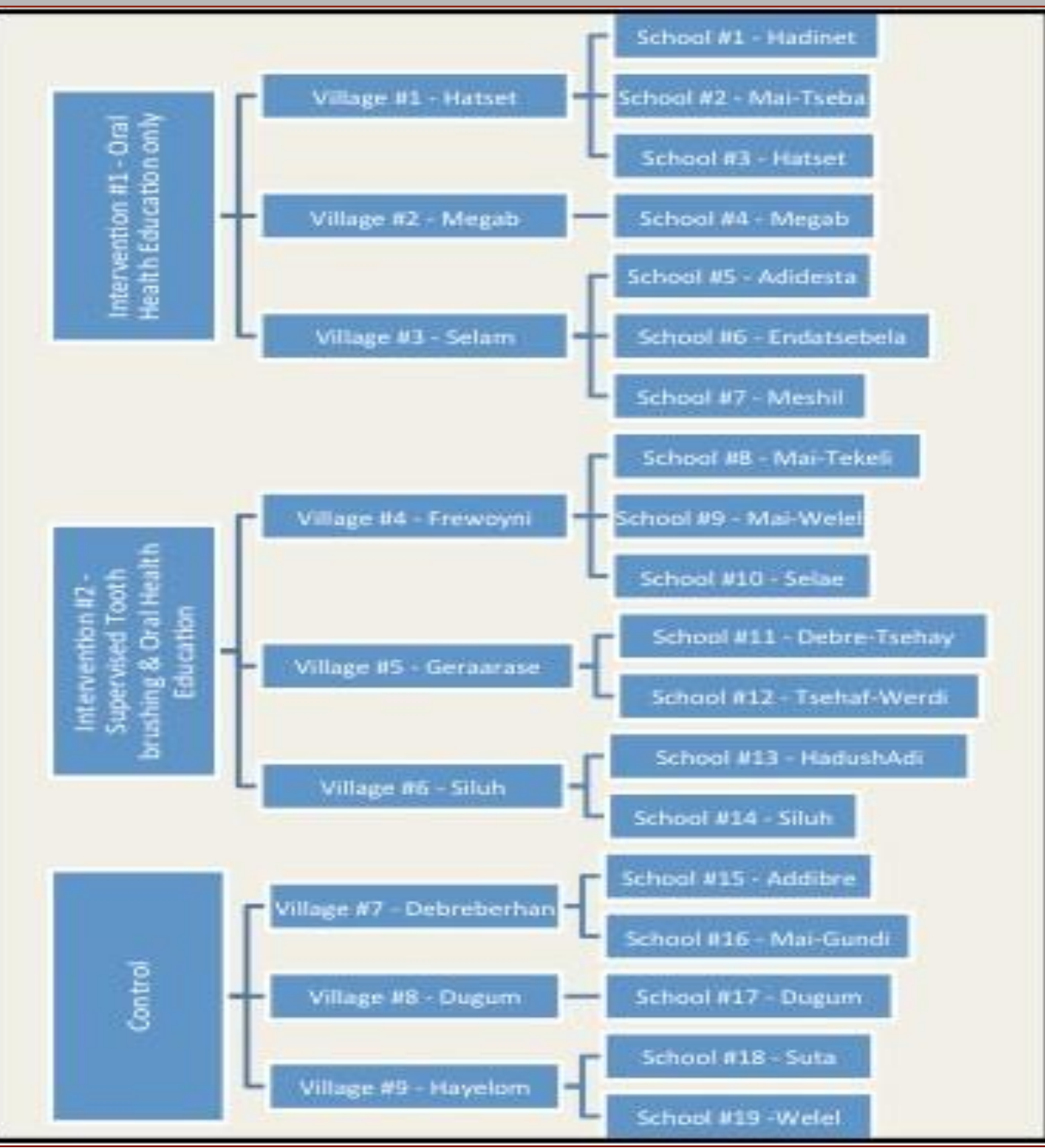

Table 2 - Estimated cluster-adjusted differences in the primary outcome (mean gingival index scores) between Group 1 (oral health education), Group 2 (oral health education and supervised toothbrushing) compared to the control group between baseline and post-evaluation via generalized estimating equations for continuous outcomes, adjusted for selected *individual-level* variables

Model Variables	Model 1		Model 2		Model 3	
	Mean Score* (95% CI)	P-value	Mean Score* (95% CI)	P-value	Mean Score* (95% CI)	P-value
Group						
Group 1 (Oral Health Education) only vs Control	-0.06 (-0.19, 0.07)	0.33	-0.08 (-0.18, 0.01)	0.08	-0.08 (-0.17, 0.01)	0.07
Group 2 (Oral health education & Supervised tooth brushing) vs Control	-0.15 (-0.28, -0.02)	0.03	-0.18 (-0.28, -0.08)	<0.001	-0.19 (-0.29, -0.09)	<0.001
Other covariates						
Grand mean centered student age			-0.01 (-0.01, 0.003)	0.24	-0.01 (-0.01, 0.004)	0.32
Gender (Female vs male)			0.03 (-0.01, 0.07)	0.19	0.03 (-0.01, 0.07)	0.19
Student socioeconomic status			0.001 (-0.03, 0.03)	0.94	0.0002 (-0.03, 0.03)	0.99
Parent educational (PE‡)						
Attended non-standard school vs no education			0.05 (-0.01, 0.12)	0.10	0.21 (0.06, 0.37)	0.01
Attended standard school vs no education			0.0003 (-0.05, 0.05)	0.99	0.09 (-0.07, 0.25)	0.28
Baseline mean oral health knowledge			-0.004 (-0.02, 0.01)	0.55	-0.003 (-0.01, 0.01)	0.67
Baseline oral hygiene score (OHS†)			-0.08 (-0.15, -0.02)	0.01	-0.05 (-0.11, -0.001)	0.04
Visit to dentist (yes vs no)			-0.03 (-0.1, 0.04)	0.40	-0.03 (-0.1, 0.04)	0.36
Interaction (Baseline OHS*PE‡)						
*Baseline OHS*Attended non-standard school vs no education*					-0.12 (-0.25, 0.01)	0.08
Baseline OHS Attended standard school vs no education*					-0.07 (-0.19, 0.06)	0.28

Note. CI=confidence interval; ‡PE: Parental education; †OHS: Oral hygiene score
Model 1: Baseline model (Intervention Group and Difference in Mean Student Gingival Index (Post evaluation – Baseline)
Model 2: Model 1 + (Age, Gender, Student socioeconomic status, Parent education, Baseline mean oral health knowledge score, Baseline oral hygiene score, Visit to dentist (between baseline & post evaluation)
Model 3: Model 2 + (Interaction)
Adjusted Full Model:
$E(Y_{ij}) = \theta_0 + \theta_1 Group + \theta_2 Mean\text{-}centered\ student\ age_{ij} + \theta_3 Gender_{ij} + \theta_4 Student's\ socioeconomic\ status_{ij} + \theta_5 Parent\ education_{ij} + \theta_6 Student's\ baseline\ oral\ health\ knowledge\ score_{ij} + \theta_7 Student's\ baseline\ oral\ hygiene\ score_{ij} + \theta_8 Visited\ Dental\ Hygienist\ after\ baseline\ for\ treatment_{ij} + \theta_9 (Student's\ baseline\ oral\ hygiene\ score*Parent\ education)$

Table 3 – Estimated cluster-adjusted differences in the primary outcome (mean gingival index scores) between Group 1 (oral health education), Group 2 (oral health education and supervised toothbrushing) compared to the control group between baseline and post-evaluation (over 3 months) via generalized estimating equations for continuous outcomes, adjusted for selected *individual and contextual-level* variables

Model Variables	Model 1		Model 2		Model 3	
	Mean Score* (95% CI)	P-value	Mean Score* (95% CI)	P-value	Mean Score* (95% CI)	P-value
Group						
Group 1 (Oral Health Education) only vs Control	-0.06 (-0.19, 0.07)	0.33	-0.08 (-0.17,0.01)	0.08	-0.06 (-0.16,0.03)	0.20
Group 2 (Oral health education & Supervised tooth brushing) vs Control	-0.15 (-0.28, -0.02)	0.03	-0.17 (-0.28,-0.07)	0.001	-0.17 (-0.30,-0.04)	0.001
Other covariates						
Grand mean centered student age			-0.01 (-0.01,0.003)	0.21	-0.01 (-0.01,0.003)	0.21
Gender (Female vs male)			0.03 (-0.02,0.08)	0.19	0.03 (-0.02,0.08)	0.20
Student socioeconomic status			0.003 (-0.03,0.03)	0.86	-0.002 (-0.03, 0.03)	0.90
Baseline mean oral health knowledge			-0.004 (-0.02,0.01)	0.55	-0.004 (-0.02,0.01)	0.55
Baseline oral hygiene score (OHS†)			-0.09 (-0.15,-0.04)	0.01	-0.09 (-0.15,-0.01)	0.01
Visit to dentist (yes vs no)			-0.03 (-0.09,0.04)	0.40	-0.02 (-0.05,0.12)	0.46
School hygiene infrastructure (yes vs no)			-0.01 (-0.11,0.09)	0.88	0.03 (-0.21,0.32)	0.41
Interaction (Group assignment* School Hygiene Infrastructure)						
*Group 1*School Hygiene Infrastructure (yes vs no)*					-0.09 (-0.32,0.15)	0.46
*Group 2*School Hygiene Infrastructure (yes vs no)*					-0.02 (-0.18,0.13)	0.75

Note. CI=confidence interval.
Model 1: Baseline model (Intervention Group and Difference in Mean Student Gingival Index (Post evaluation – Baseline)
Model 2: Model 1 + (Age, Gender, Student socioeconomic status, Baseline mean oral health knowledge score, Baseline oral hygiene score, Visit to dentist (between baseline & post evaluation), School hygiene infrastructure)
Model 3: Model 2 + (Interaction)
Adjusted Full Model:
$E(Y_{ij}) = \theta_0 + \theta_1 Group + \theta_2 Grand\ Mean\text{-}centered\ student\ age_{ij} + \theta_3 Gender_{ij} + \theta_4 Student's\ Socioeconomic\ status_{ij} + \theta_5 Visited\ Dental\ Hygienist\ after\ baseline\ for\ treatment_{ij} + \theta_6 School\ Hygiene\ Infrastructure_{ij} + (Group*School\ Hygiene\ Infrastructure)$

DISCUSSION, CONCLUSION AND POLICY IMPLICATIONS

Our study, to our best knowledge, is the **first pragmatic, large-scale, cluster randomized controlled trial conducted in rural Ethiopia** that assesses the effect of school-based, teacher-led interventions aimed at improving the gingival health of primary school children. We observed that implementing simple, locally lead, school-based interventions had a positive effect on students' gingival health, even with the presence of contextual factors, compared to the control population. National public health and academic institutions, the government and the private sector play an important role in the implementation and evaluation of population-level interventions that should promote social and oral health equity and take into consideration the sociocultural context affecting the oral health of their communities.