

Impact of an Educational Intervention on Oral Health Knowledge and Bacterial Plaque Control in Male Secondary School Students in a Peruvian Province: A Quasi-Experimental Study

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Background: The purpose of this study was to evaluate the effect of an educational intervention on oral health knowledge and bacterial plaque control in male secondary school students in a Peruvian province.

Methods: This quasi-experimental study evaluated 294 male secondary school students in southern Peru. Oral health knowledge was measured with a validated 20-item questionnaire. Bacterial plaque was measured with the Simplified Oral Hygiene Index (OHI-S). This was rated as Excellent: 0, Good: 0.1–1.2, Fair: 1.3–3.0 and Poor: 3.1–6.0, before receiving the educational intervention and after four weeks of receiving it. Variables such as age, area of residence, having health professionals as family members, educational level of mother and father, and living with parents were considered. A significance level of $p < 0.05$ was considered.

Results: The comparison between the level of oral health knowledge and the OHI-S, before and after 4 weeks of receiving the educational intervention, showed a significant improvement ($p < 0.05$) in all the categories of the variables studied. Likewise, before the educational intervention, there were significant differences in global knowledge about oral health among the categories of the following variables: age group ($p = 0.040$), area of residence ($p < 0.001$), educational level (father) ($p = 0.011$) and living with parents ($p < 0.001$). However, after four weeks of receiving the educational intervention, no significant differences were observed in all the variables studied ($p > 0.05$). Regarding the OHI-S, no significant differences were observed in any of the variables studied, both before ($p > 0.05$) and after four weeks ($p > 0.05$) of receiving the educational intervention.

Conclusion: After four weeks, the educational intervention significantly improved oral health knowledge and significantly reduced plaque bacterial plaque in male secondary school students in a Peruvian province, regardless of age, area of residence, having health professional family members, educational level of mother and father, and living with parents.

Keywords: educational intervention, bacterial plaque, level of knowledge, oral health, dentistry, secondary school students, Peru

Introduction

One of the most critical problems faced by several countries is the lack of knowledge regarding oral health care. This is reflected in the estimates published in the Global Burden of Disease study for the year 2019 that reported three and a half billion people affected by oral diseases, with dental caries being one of the most prevalent, since it has affected two thousand three hundred million inhabitants with permanent dentition and more than five hundred and thirty million children with primary dentition.^{1–5} In Peru, according to the last epidemiological study, the prevalence of dental caries was found to be 85.5% and 57.6% in the mixed and permanent dentition, respectively.^{6,7}

Factors associated with oral diseases include continued high intake of free sugars, insufficient exposure to fluoride and poor plaque removal,^{3,8,9} the latter being the main etiological agent of periodontal diseases and dental caries.¹⁰ Bacterial plaque is a relevant factor for the development of gingival diseases because it behaves as a chemical-microbial agent with high aggressiveness for the oral mucosa, essentially due to the very high content of cocci, gram-positive and negative bacilli, fusobacteria, spirilla and spirochetes.^{11,12} It is therefore essential to control bacterial plaque and it should be included in all preventive and therapeutic procedures in order to prevent or mitigate oral diseases.¹³

Several studies have reported that these oral diseases can be avoided by implementing permanent education programs that focus especially on oral health self-care.^{13–15} Permanent oral health education programmes are those actions that are sustainable over time, which promote the development of knowledge and can lead to the adoption of behaviours to improve the oral health of schoolchildren. These programmes are delivered in health centres, hospitals and educational institutions as part of each country's comprehensive school health policy.¹⁶ WHO has been promoting a school health initiative related to global health promotion through health education at all levels of government in each country.¹⁷

Oral health education comprises of deliberate teaching and learning activities intended to encourage voluntary actions that enhance the quality of life. It guides individuals to nurture and appreciate their oral structures through adopting appropriate habits to avoid risk situations.² Moreover, it facilitates the acquisition of sustained and collective responsibility for addressing significant oral health issues.^{2,18}

To date (September 2023), no study has been reported in which an educational intervention has been applied only in male schoolchildren, and this is of interest as some previous studies suggest that male sex is a risk factor for poor oral hygiene.^{19,20} In this sense, the virtual educational intervention could constitute an educational promotion strategy that contributes to improving the oral hygiene knowledge, attitudes and practices of schoolchildren in order to prevent oral diseases.¹⁶

Based on the above, the purpose of this study was to evaluate the effect of an educational intervention on oral health knowledge and bacterial plaque control in male secondary school students in a Peruvian province. The null hypothesis was that there are no significant differences when comparing oral health knowledge and bacterial plaque control in male secondary school students in a Peruvian province, before and after an educational intervention.

Methods

Study Design

This study had an analytical, prospective and longitudinal quasi-experimental design. It was carried out from July to September 2022 in the Secondary School for Male Students “San Luis Gonzaga de Ica” located in a southern Peruvian province (Ica, Peru).

Population and Selection of Participants

The population consisted of 356 students enrolled in the 1st year of secondary education at the “San Luis Gonzaga de Ica” educational institution, Ica, Peru in 2022. The sample size calculation was based on statistics obtained in a previous study where an educational intervention was applied in Peruvian adolescents and OHI-S and knowledge level were assessed before and after the intervention.²¹ In the statistical package Epidat 4.2 a paired mean comparison formula for the OHI-S score (considering the difference to be detected 0.77, $SD_1 = 0.37$, $SD_2 = 0.76$, 95% confidence level and a statistical power of 80%) and a paired proportion comparison formula for the level of knowledge (considering $P_1 = 21.3\%$, $P_2 = 11.5\%$, 95% confidence level and a statistical power of 80%); obtaining a minimum sample size of 12 and 226, respectively. As the calculated sample size was smaller than the 1st year secondary school student population, it was then decided to include the entire population according to the eligibility criteria, including 329 students and subsequently excluding 35 students, so the total number of participants was $n = 294$. Inclusion criteria

- Students from the secondary school “San Luis Gonzaga de Ica” enrolled in first year of secondary school in 2022.
- Students whose parents gave their informed consent for the present study.
- Students who gave their informed assent voluntarily.
- Students with complete permanent incisor and molar teeth.

Exclusion criteria

- Students from the secondary school “San Luis Gonzaga de Ica” who did not complete the entire questionnaire ($n = 23$).
- Students who were undergoing orthodontic treatment ($n = 8$).
- Students who voluntarily withdrew while the study was being conducted ($n = 4$).

Variables

To evaluate the effect of the educational intervention, the level of oral health knowledge and the plaque index were considered as response variables. Age, area of residence, having health professionals as family members, educational level of mother, educational level of father and living with parents were considered as sociodemographic variables.

Instruments

A previously developed questionnaire with 20 closed-ended questions (Q1 - Q20) [[supplementary materials](#)] and multiple responses was validated to evaluate the general oral health knowledge of the students.²² The level of knowledge was defined according to the following score: poor (0–10 points), fair (11–13 points) and good (14–20 points). The cut-off points were set at 10.5 and 13.5 to determine the three levels of knowledge.^{23,24} These cut-off points were validated using Livingston's K^2 coefficient, yielding 0.784 and 0.786, respectively; these values were acceptable. One point was awarded for each correct answer.

The content of the instrument was validated by three experts in dental research with an Aiken V equal to 0.93 (95% CI: 0.90–0.95), which is acceptable. Regarding the reliability analysis of the questionnaire according to Cronbach's α was (α) = 0.748 (95% CI: 0.704–0.788), so it was considered acceptable. In addition, to assess the repeatability of the instrument, the questionnaire was administered at two different times to correlate the total scores over a lapse of 7 days to 30 students, altering the order of the questions to avoid recall bias, resulting in a Spearman's coefficient (Rho) = 0.939 (95% CI: 0.871–0.971), which was acceptable. This statistical test was performed because the scores were not normally distributed, according to the Shapiro Wilk test ($p < 0.05$).

The method used to assess the level of oral hygiene was observation and the indicator used was Greene and Vermillion's Simplified Oral Hygiene Index (OHI-S) comprising the simplified debris index (DI-S) and the simplified calculation index (CI-S).²⁵ To assess oral hygiene status, a standardized data collection form was used which included the participant's personal data, a table of 6 teeth with the vestibular and lingual sides as appropriate, as well as the coding criteria for assessing DI-S and CI-S with their respective scores, and a box for the final result.^{26,27} For the OHI-S, 6 teeth were evaluated and the vestibular surfaces of the upper right central incisor (tooth 1.1) and the lower left central incisor (tooth 3.1) were taken into account. If these teeth were missing, the left upper central incisor (tooth 2.1) or the right lower central incisor (tooth 4.1) was evaluated. In addition, for the posterior teeth, the vestibular surface of the upper right and left first molars (teeth 1.6 and 2.6, respectively) was examined, provided they were fully erupted, and in the absence of these teeth, the upper second molar (tooth 1.7 or 2.7) was evaluated. For the lower first molars (teeth 3.6 and 4.6) the lingual surfaces were taken into account and in case of absence of these teeth, teeth 3.7 or 4.7 were evaluated.^{26,27}

The score for the DI-S was 0 (absence of detritus with extrinsic stain), 1 (presence of detritus covering no more than 1/3 of the tooth surface or absence of detritus plus presence of extrinsic stain), 2 (presence of detritus covering more than 1/3 but not more than 2/3 of the examined tooth surface), and 3 (presence of detritus covering more than 2/3 of the examined tooth surface). For the final DI-S score, the total vestibular score plus the total lingual score, divided by the number of teeth assessed, were considered.^{26,27}

The score for the simplified calculus index (CI-S) was 0 (absence of calculus), 1 (presence of supragingival calculus covering no more than 1/3 of the examined surface), 2 (presence of supragingival calculus covering more than 1/3 but not more than 2/3 of the examined surface or small portions of subgingival calculus around the cervical portion), and 3 (presence of supragingival calculus covering more than 2/3 of the examined surface or small portions of subgingival calculus around the cervical portion), and 3 (presence of supragingival calculus covering more than 2/3 of the examined surface or a continuous band of supragingival calculus around the cervical region of the tooth). For the final CI-S score, the total vestibular score plus the total lingual score, divided by the number of teeth assessed, was considered.^{26,27}

Finally, to obtain the OHI-S, the results of the DI-S and the CI-S were added, considering the following values for the clinical degree of oral hygiene: Excellent (0), Good (0.1–1.2), Fair (1.3–3.0) and Poor (3.1–6.0).^{26,27}

The OHI-S was measured by a single investigator, but to avoid measurement bias, a pre-study calibration was performed with 30 participants using the intraclass correlation coefficient (ICC), both intra-examiner (ICC = 0.996; 95% CI: 0.992–0.998) and inter-examiner with a specialist (ICC = 0.995; 95% CI: 0.989–0.998), yielding acceptable values.^{26,27}

Procedure

An initial face-to-face evaluation about oral health knowledge and OHI-S was conducted prior to the educational intervention, at a rate of one classroom per day. This was done in the tutoring hour of each of the 10 participating classrooms. Then, educational sessions (through the Zoom[®] platform) were conducted using the classroom projector in order to standardize the educational material, strategies and time used in each of the sessions. Thus, the educational session given by the main researcher (S.L.S.), was transmitted to the 10 classrooms in power point format. The 16 color slides, in parallel to the concise explanation of each slide, included four topics: oral cavity pathologies, oral health preventive treatments, oral hygiene habits and habits that influence oral health status.^{28–30} The educational sessions were held once a week for a month with a duration of 30 minutes.

The methodology used for the development of each of the educational sessions was the start phase, the transfer phase and the closing phase. The start phase consisted of motivating the student to awaken their interest in the subject, through the presentation of videos showing models of healthy and unhealthy behaviour and/or clinical cases of real situations centred on the main problem of each subject; in addition, previous knowledge on the subject was explored through open questions. The transfer phase lasted approximately 20 minutes and started with a brief overview of the topic, then the core contents were explained through attractive and dynamic images; and recommendations to improve oral health were shown. The final phase lasted approximately 5 minutes in which students were asked to demonstrate what they had learned through gamification tools and real time demonstrations of newly acquired skills according to the topic of each educational session in order to verify what they had learned and provide necessary corrections.^{5,31} Four weeks after the end of these cuatro educational sessions, a final evaluation about knowledge and OHI-S was carried out in a face-to-face manner.^{5,15,32,33}

Statistical Analysis

Data analysis was performed with the *Statistical Package for the Social Sciences* (SPSS) version 28.0. Descriptive statistics were applied to calculate absolute and relative frequencies for qualitative variables, the mean and standard deviation for age, and the median and interquartile range for the score of ordinal variables. To compare students' oral health knowledge and plaque index between two or more categories of the qualitative variables (before the educational intervention and four weeks after the intervention), the Mann Whitney *U*-test and the Kruskal Wallis test were used, respectively. In addition, the Wilcoxon signed-rank test was used for the comparison of related measures and the McNemar Chi-square test was used for the comparison of the proportion of correct answers for each questionnaire item. In all statistical tests a significance level of $p < 0.05$ was considered.

Bioethical Considerations

The present study respected the bioethical principles of the Declaration of Helsinki related to confidentiality, freedom, respect, and nonmaleficence.³⁴ In addition, we had the approval of an Institutional Ethics Committee of the San Juan Bautista Private University with resolution No. 293–2022-CIEI-UPSJB on March 3, 2022. Finally, parents and students were asked for voluntary informed consent and assent, respectively.

Results

Factor Analysis of the Knowledge Level Instrument

For the structural validity of the dimensions, a principal component factor analysis was performed with Varimax rotation and Kaiser normalization, identifying four dimensions. The first dimension (D1) consisted of eight items (Q1 - Q8)

related to the knowledge of the pathologies present in the oral cavity. The second dimension (D2) consisted of three items (Q9 - Q11) related to knowledge of preventive treatments on oral health. The third dimension (D3) consisted of three items (Q12 - Q14) related to oral hygiene habits. The fourth dimension (D4) consisted of six items (Q15 - Q20) related to habits that have an impact on oral health status. The item-total correlation determinant was equal to 0.042, the Kaiser-Meyer-Olkin (KMO) measure of adequacy was 0.824 and Bartlett's test of sphericity was $p < 0.001$, all resulting in acceptable values.³⁵

Sociodemographic Characteristics

The mean age of the 294 participants was 12.5 ± 0.6 years. The 54.4% of participants were between 11 and 12 years of age and 79.3% resided in an urban area. The 45.9% did not have a health professional as family member. The 54.8% had a mother with a higher education. The 48.0% had a father with a higher level of education. Finally, the 55.1% of the participants lived with both parents [Table 1].

Changes in Oral Health Knowledge and Bacterial Plaque Control

When comparing the correct answers regarding oral health knowledge before and after 4 weeks of receiving educational intervention, it was observed that there was a significant improvement in knowledge ($p < 0.05$) in all questions except Q15 (Which of the following foods do you think are harmful to teeth?), since the proportion of correct answers in both evaluations did not show significant differences ($p = 0.189$) [Table 2].

When comparing the level of total oral health knowledge, a significant improvement was observed in all categories of age group ($p < 0.001$), area of residence ($p < 0.05$), having a health professional as a family member ($p < 0.001$), educational level of the mother ($p < 0.05$) and father ($p < 0.05$), and living or not with parents ($p < 0.05$) [Table 3]. Likewise, before the educational intervention, when comparing oral health knowledge among the categories of each variable, there were significant differences in the age group ($p = 0.040$), area of residence ($p < 0.001$), educational level of the father ($p = 0.011$)

Table 1 Sociodemographic Characteristics of Male Students Belonging to an Educational Institution in a Peruvian Province

Variable	Category	Frequency	Percentage
Age group	11 and 12 years	160	54.4
	13 and 14 years	134	45.6
Area of residence	Urban	233	79.3
	Rural	49	16.7
	Marginal urban	12	4.1
Health professional as family member?	Yes (Dentist)	60	20.4
	Yes (Non-dentist)	99	33.7
	No	135	45.9
Educational level (Mother)	No education	14	4.8
	Primary	20	6.8
	Secondary	99	33.7
	Superior	161	54.8
Educational level (Father)	No education	21	7.1
	Primary	7	2.4
	Secondary	125	42.5
	Superior	141	48.0
Living with parents?	Only with mother	86	29.3
	Only with father	34	11.6
	Both	162	55.1
	None	12	4.1
Age	Mean	Median	SD
	12.5	12.0	0.6

Abbreviation: SD, Standard deviation.

Table 2 Comparison of Correct Answers About Oral Health Knowledge Before and After 4 Weeks of Receiving Educational Intervention

Questionnaire	Correct answers		
	Before	After	*p
	f (%)	f (%)	
Oral cavity pathologies related to poor oral hygiene.			
Q1. Dental caries is a permanently damaged area in the tooth just by consuming sugars in excess.	93 (31.6)	223 (75.9)	<0.001*
Q2. Can pain, sensitivity and loss of teeth be consequences of caries?	228 (77.6)	254 (86.4)	0.001*
Q3. What are the causes of dental caries?	212 (72.1)	243 (82.7)	<0.001*
Q4. Do sealants, fluoride supplements and fluoride toothpaste help prevent dental caries?	188 (63.9)	236 (80.3)	<0.001*
Q5. What is bacterial plaque?	144 (49.0)	226 (76.9)	<0.001*
Q6. What is periodontal disease?	168 (57.1)	239 (81.3)	<0.001*
Q7. What is gingivitis?	203 (69.0)	246 (83.7)	<0.001*
Q8. What are the consequences of gingivitis?	213 (72.4)	252 (85.7)	<0.001*
Preventive treatments in oral health.			
Q9. What are dental sealants?	171 (58.2)	246 (83.7)	<0.001*
Q10. Why are dental sealants necessary?	144 (49.0)	224 (76.2)	<0.001*
Q11. What are the benefits of fluoride?	202 (68.7)	239 (81.3)	<0.001*
Oral Hygiene Habits.			
Q12. How often at least should you visit the dental office?	107 (36.4)	202 (68.7)	<0.001*
Q13. At what time of the day should you brush your teeth?	235 (79.9)	259 (88.1)	<0.001*
Q14. According to the World Health Organization, how many times a day should I brush my teeth?	28 (9.5)	182 (61.9)	<0.001*
Habits influencing oral health status.			
Q15. Which of the following foods do you think are harmful to teeth?	268 (91.2)	275 (93.5)	0.189
Q16. What are the problems caused by tobacco in the mouth?	230 (78.2)	256 (87.1)	<0.001*
Q17. What happens if you use toothpicks to clean your teeth?	207 (70.4)	245 (83.3)	<0.001*
Q18. What are the correct elements of oral hygiene?	186 (63.3)	248 (84.4)	<0.001*
Q19. What are the characteristics of a good toothbrush?	141 (48.0)	249 (84.7)	<0.001*
Q20. What is the order of use of dental hygiene elements?	143 (48.6)	244 (83.0)	<0.001*

Note: *Based on Mc Nemar's Chi-square ($p < 0.05$, significant differences).

and living or not with parents ($p < 0.001$). However, after 4 weeks of receiving the last educational intervention, the students did not present significant differences among the categories of all the variables considered in the study ($p > 0.05$) [Table 3].

When comparing the IHOS of the students, a significant reduction could be observed in all categories of age group ($p < 0.001$), area of residence ($p < 0.05$), having a health professional as family member ($p < 0.001$), educational level of the mother ($p < 0.05$) and father ($p < 0.05$), and living or not with parents ($p < 0.05$) [Table 4]. On the other hand, both before and after 4 weeks of receiving the last educational intervention, no significant differences were observed between the categories of any variable ($p > 0.05$) [Table 4].

Discussion

Oral cavity diseases, like other pathologies, have biological, psychosocial and emotional effects.³⁶ Oral diseases are chronic and progressive in nature, and the most prevalent are dental caries, periodontal disease, and oral cancer. These diseases constitute a major burden on families and health systems in many countries, affecting the quality of life in all age groups by causing pain, discomfort, disfigurement, and even death.^{8,14} Adolescence is a period in which the main variations in development occur, establishing attitudes that will form an important part of general and oral health care.^{8,37}

Table 3 Comparison of Oral Health Knowledge Before and After 4 Weeks of Receiving Educational Intervention According to Sociodemographic Variables

Variable	Categories	N	Level of Knowledge										**p
			Before					After					
			Poor = 1	Fair = 2	Good = 3	Med / IQR	*p	Poor = 1	Fair = 2	Good = 3	Med / IQR	*p	
			f (%)	f (%)	f (%)			f (%)	f (%)	f (%)			
Age group	11 and 12 years	160	47 (29.4)	46 (28.7)	67 (41.9)	2 / 2	0.040*	1 (0.6)	23 (14.4)	136 (85.0)	3 / 0	0.854	<0.001
	13 and 14 years	134	56 (41.8)	33 (24.6)	45 (33.6)	2 / 2		8 (6.0)	10 (7.5)	116 (86.6)	3 / 0		<0.001
Area of residence	Urban	233	72 (30.9)	62 (26.6)	99 (42.5)	2 / 2	<0.001*	7 (3.0)	26 (11.2)	200 (85.8)	3 / 0	0.256	<0.001
	Rural	49	21 (42.9)	17 (34.7)	11 (22.4)	2 / 2		2 (4.1)	7 (14.3)	40 (81.6)	3 / 0		<0.001
Health professional as family member?	Marginal urban	12	10 (83.3)	0 (0.0)	2 (16.7)	1 / 0		0 (0.0)	0 (0.0)	12 (100.0)	3 / 0		0.002
	Yes (Dentist)	60	22 (36.7)	18 (30.0)	20 (33.3)	2 / 2	0.390	2 (3.3)	7 (11.7)	51 (85.0)	3 / 0	0.408	<0.001
	Yes (Non-dentist)	99	35 (35.4)	32 (32.3)	32 (32.3)	2 / 2		7 (7.1)	10 (10.1)	82 (82.8)	3 / 0		<0.001
	No	135	46 (34.1)	29 (21.5)	60 (44.4)	2 / 2		0 (0.0)	16 (11.9)	119 (88.1)	3 / 0		<0.001
Educational level (Mother)	No education	14	8 (57.1)	4 (28.6)	2 (14.3)	1 / 1	0.060	0 (0.0)	3 (21.4)	11 (78.6)	3 / 0	0.308	0.002
	Primary	20	10 (50.0)	5 (25.0)	5 (25.0)	1.5 / 2		1 (5.0)	4 (20.0)	15 (75.0)	3 / 1		<0.001
	Secondary	99	36 (36.4)	24 (24.2)	39 (39.4)	2 / 2		2 (2.0)	9 (9.1)	88 (88.9)	3 / 0		<0.001
Educational level (Father)	Superior	161	49 (30.4)	46 (28.6)	66 (41.0)	2 / 2		6 (3.7)	17 (10.6)	138 (85.7)	3 / 0		<0.001
	No education	21	9 (42.9)	6 (28.6)	6 (28.6)	2 / 2	0.011*	2 (9.5)	3 (14.3)	16 (76.2)	3 / 1	0.593	<0.001
	Primary	7	6 (85.7)	0 (0.0)	1 (14.3)	1 / 0		0 (0.0)	1 (14.3)	6 (85.7)	3 / 0		0.020
	Secondary	125	46 (36.8)	40 (32.0)	39 (31.2)	2 / 2		5 (4.0)	12 (9.6)	108 (86.4)	3 / 0		<0.001
Living with parents?	Superior	141	42 (29.8)	33 (23.4)	66 (46.8)	2 / 2		2 (1.4)	17 (12.1)	122 (86.5)	3 / 0		<0.001
	Only with mother	86	24 (27.9)	25 (29.1)	37 (43.0)	2 / 2	<0.001*	3 (3.5)	9 (10.5)	74 (86.0)	3 / 0	0.714	<0.001
	Only with father	34	23 (67.6)	5 (14.7)	6 (17.6)	1 / 1		1 (2.9)	6 (17.6)	27 (79.4)	3 / 0		<0.001
	Both	162	48 (29.6)	48 (29.6)	66 (40.7)	2 / 2		4 (2.5)	17 (10.5)	141 (87.0)	3 / 0		<0.001
	None	12	8 (66.7)	1 (8.3)	3 (25.0)	1 / 2		1 (8.3)	1 (8.3)	10 (83.3)	3 / 0		0.008
Overall		294	103 (35.0)	79 (26.9)	112 (38.1)	2 / 2		9 (3.1)	33 (11.2)	252 (85.7)	3 / 0		<0.001

Notes: *Based on the Mann Whitney U-test and Kruskal Wallis test for comparison of 2 independent groups or more, respectively ($p < 0.05$, significant differences). **Based on Wilcoxon signed-rank test ($p < 0.05$, significant differences). f, Absolute frequency.

Abbreviations: Med, Median; IQR, Interquartile range.

Table 4 Comparison of OHI-S Before and After 4 Weeks of Receiving Educational Intervention According to Sociodemographic Variables

Variable	Categories	N	OHI-S Level										**p
			Before					After					
			Fair = 1	Good = 2	Excellent = 3	Med / IQR	*p	Fair = 1	Good = 2	Excellent = 3	Med / IQR	*p	
			f (%)	f (%)	f (%)			f (%)	f (%)	f (%)			
Age group	11 and 12 years	160	132 (82.5)	26 (16.2)	2 (1.3)	1 / 0	0.080	10 (6.2)	112 (70.0)	38 (23.8)	2 / 0	0.669	<0.001
	13 and 14 years	134	120 (89.6)	14 (10.4)	0 (0.0)	1 / 0		14 (10.5)	87 (64.9)	33 (24.6)	2 / 0		<0.001
Area of residence	Urban	233	197 (84.5)	34 (14.6)	2 (0.9)	1 / 0	0.521	19 (8.2)	159 (68.2)	55 (23.6)	2 / 0	0.921	<0.001
	Rural	49	44 (89.8)	5 (10.2)	0 (0.0)	1 / 0		5 (10.2)	30 (61.2)	14 (28.6)	2 / 1		<0.001
	Marginal urban	12	11 (91.7)	1 (8.3)	0 (0.0)	1 / 0		10 (83.3)	2 (16.7)	0 (0.0)	2 / 0		0.002
Health professional as family member?	Yes (Dentist)	60	51 (85.0)	8 (13.3)	1 (1.7)	1 / 0	0.909	2 (3.3)	42 (70.0)	16 (26.7)	2 / 1	0.551	<0.001
	Yes (Non-dentist)	99	86 (86.9)	13 (13.1)	0 (0.0)	1 / 0		14 (14.1)	58 (58.6)	27 (27.3)	2 / 1		<0.001
	No	135	115 (85.2)	19 (14.1)	1 (0.7)	1 / 0		8 (5.9)	99 (73.3)	28 (20.8)	2 / 0		<0.001
Educational level (Mother)	No education	14	13 (92.9)	0 (0.0)	1 (7.1)	1 / 0	0.537	3 (21.4)	8 (57.2)	3 (21.4)	2 / 1	0.401	0.008
	Primary	20	19 (95.0)	1 (5.0)	0 (0.0)	1 / 0		0 (0.0)	15 (75.0)	5 (25.0)	2 / 1		<0.001
	Secondary	99	83 (83.8)	15 (15.2)	1 (1.0)	1 / 0		8 (8.1)	62 (62.6)	29 (29.3)	2 / 1		<0.001
	Superior	161	137 (85.1)	24 (14.9)	0 (0.0)	1 / 0		13 (8.1)	114 (70.8)	34 (21.1)	2 / 0		<0.001
Educational level (Father)	No education	21	18 (85.7)	2 (9.5)	1 (4.8)	1 / 0	0.475	3 (14.3)	14 (66.7)	4 (19.0)	2 / 0	0.576	<0.001
	Primary	7	5 (71.4)	2 (28.6)	0 (0.0)	1 / 1		0 (0.0)	5 (71.4)	2 (28.6)	2 / 1		0.038
	Secondary	125	111 (88.8)	13 (10.4)	1 (0.8)	1 / 0		7 (5.6)	86 (68.8)	32 (25.6)	2 / 1		<0.001
	Superior	141	118 (83.7)	23 (16.3)	0 (0.0)	1 / 0		14 (9.9)	94 (66.7)	33 (23.4)	2 / 0		<0.001
Living with parents?	Only with mother	86	73 (84.8)	12 (14.0)	1 (1.2)	1 / 0	0.905	7 (8.1)	52 (60.5)	27 (31.4)	2 / 1	0.032 ^a	<0.001
	Only with father	34	30 (88.3)	3 (8.8)	1 (2.9)	1 / 0		4 (11.8)	27 (79.4)	3 (8.8)	2 / 0		<0.001
	Both	162	138 (85.2)	24 (14.8)	0 (0.0)	1 / 0		13 (8.0)	113 (69.8)	36 (22.2)	2 / 0		<0.001
	None	12	11 (91.7)	1 (8.3)	0 (0.0)	1 / 0		0 (0.0)	7 (58.3)	5 (41.7)	2 / 1		0.001
Overall		294	252 (85.7)	40 (13.6)	2 (0.7)	1 / 0		24 (8.2)	199 (67.7)	71 (24.1)	2 / 0		<0.001

Notes: *Based on Mann Whitney U-test and Kruskal Wallis test for comparison of 2 independent groups or more, respectively ($p < 0.05$, significant differences). **Based on Wilcoxon signed-rank test ($p < 0.05$, significant differences);

^aWith Bonferroni post hoc correction, it was observed that there were no significant differences between independent pairs ($p > 0.05$). f, Absolute frequency.

Abbreviations: Med, Median; IQR, Interquartile Range.

It is necessary at this stage to acquire sufficient knowledge and correct oral hygiene practices since these habits will be present during the growth process and will have a profound impact throughout their individual development.^{8,38} Therefore, the purpose of this study was to evaluate the effect of an educational intervention on oral health knowledge and bacterial plaque control in male secondary school students in a Peruvian province. Based on the results, the null hypothesis was rejected.

Although oral hygiene indices that require assessment of all tooth surfaces should be preferred, partial indices can be used as an alternative, the most suitable being those that assess 6 teeth, for example the IHO-S. This index is indicated in epidemiological studies and educational programmes, as it is easy to use and the examination can be performed without delay.³⁹ In contrast, although the Turesky-Gilmore-Glickman index is considered one of the best indices for plaque assessment in clinical studies, its application in daily clinical practice is considered impractical.³⁹ Therefore, the decision was taken in this research to use the IHO-S to assess the oral hygiene level of secondary school children, as it tested an educational intervention in which a quick and practical measurement by a single operator was needed, even more so when at the time of the present study there were certain restrictions on access to the population due to the Covid-19 pandemic.

The results obtained showed that when comparing the correct answers on oral health knowledge before receiving the educational intervention and after 4 weeks of the same, there was a significant improvement in the students' oral health knowledge. These results were consistent with those obtained by Movaseghi et al, Subedi et al and Haque et al¹⁴⁻¹⁶ who reported significant improvement of knowledge in adolescents from Iran, Nepal and Bangladesh respectively on the same topic. This reinforces the idea that educational intervention is an important tool to motivate adolescents to improve knowledge regarding oral health related topics.^{38,40} It should be noted that there was a significant improvement in knowledge in all questions except Q15 (Which of the following foods do you think are harmful to teeth?) as the proportion of correct answers in both assessments did not present significant differences. Perhaps it was because the respondents already knew that foods such as chocolate or candy are harmful to their teeth as they had received this information many times through parents, teachers and health professionals.^{41,42} Perhaps during the time that the educational intervention lasted, this knowledge was reinforced and helped the participants to improve their healthy habits as evidenced by the OHI-S.³⁷

Before the educational intervention, there were differences in the categories of some variables with respect to knowledge. With respect to OHI-S there were no significant differences. This showed that in some cases knowledge was bad while practices were not so bad. This is probably due to the fact that the older age of the schoolchildren and the area of residence (urban) gave them greater access to information on this topic, helping them to create awareness of good hygiene habits. Likewise, according to the results obtained, it may be that the presence of both parents or the greater academic preparation of the same allowed the students to be inculcated with good oral hygiene habits. In spite of the differences obtained on oral health knowledge, it was observed that at the end of the 4 weeks of receiving the educational intervention, the gaps in knowledge about this topic were closed in all the study variables to the point of not observing significant differences in their conceptual and procedural learning, which supports the idea that the educational intervention contributes to the acquisition of knowledge that motivates the modification of healthy behaviors and practices.^{14,43}

On the other hand, when comparing the OHI-S before and after 4 weeks of receiving the educational intervention, a significant reduction was observed in all the categories of the study variables. These results were similar to those reported by Subedi et al and Movaseghi et al^{14,15} who found a significant reduction in the levels of bacterial plaque after an educational intervention in schoolchildren, showing that this type of intervention has a positive effect on the oral hygiene of students by reducing bacterial plaque as students improve their oral health knowledge.^{44,45}

In this research, the educational intervention was chosen to be carried out with male secondary school students because some studies reported that they have poor oral hygiene attitudes and practices, and that they make fewer visits to the dentist,^{19,42,43,46,47} which is why they are more exposed to developing oral diseases.⁴⁷ Likewise, Rajabzadeh et al, Rajeh and Woelber,⁴⁸⁻⁵⁰ reported that females scored higher mean scores in relation to oral hygiene practices than males, according to them this could be because females had better self-care attitudes and better willingness to make more frequent visits to the dentist.⁴⁸⁻⁵⁰ In addition, it has been reported that women are more concerned about their general health in order to improve their appearance and self-esteem.^{47,48,51} In that sense, it was considered necessary to address specific strategies to decrease these inequalities between women and men.⁴⁷

Maintaining the tooth surface free of bacterial plaque is the cornerstone of the prevention of more prevalent oral diseases such as dental caries and periodontal disease.⁴⁵ The continuous and regular interruption of plaque formation as well as oral health literacy, awareness creation and the establishment of healthy habits at an early age play a fundamental role in the reduction and control of these pathologies, so the present educational intervention is an essential strategy to fulfill this purpose.^{16,43}

The present study had some limitations such as carrying out the educational intervention in 4 weeks (short term), which did not allow the long-term results to be evaluated. In addition, attitudes and other healthy oral health practices, such as proper nutrition, frequency of brushing, use of fluoride toothpaste and use of mouthwashes, were not assessed. Another limitation of this study was that it was conducted at the height of the pandemic when the government decreed compulsory social isolation,⁵² so only one public school authorized the study. However, this was one of the schools with the largest student population in the province of Ica. On the other hand, it should be noted that this research may have been influenced by the Hawthorne effect, as the schoolchildren, being aware that they are part of a study, may have made more effort to acquire good practices by changing their behaviour. Therefore, it is not certain that the desired effects or behaviours will be maintained in the long term.⁵³ Finally, although this study worked with a larger number of adolescent male students from the province of Ica than the minimum sample size required, it must be recognized that the results of this study are not applicable to adolescent female students from that province, nor are these results extrapolable to adolescent students from the whole country, and it is therefore suggested that similar studies be developed that include different Peruvian regions.

Based on the results obtained, it is recommended that oral health education interventions be included in the school health plan of each institution so that students acquire healthy habits at an early age that are sustainable throughout their lives.^{14,15,45} On the other hand, it is recommended that schools be accompanied not only by a psychologist or doctor on a permanent basis, but also by a dentist who periodically evaluates the level of oral hygiene of schoolchildren. It is necessary for parents to monitor the oral hygiene of their adolescent children, as poor oral health practices have been reported at this stage.⁸ In addition, it is recommended to train and raise awareness among parents and their children to promote the development of oral health self-care skills. Finally, longitudinal studies are recommended to evaluate the effectiveness of different educational techniques on oral hygiene knowledge, attitudes and practices in school children together with their parents or guardians.

Conclusion

After four weeks, the educational intervention on topics related to pathologies present in the oral cavity, preventive oral health treatments, oral hygiene habits and habits that have an impact on oral health status, significantly improved oral health knowledge and significantly reduced bacterial plaque in male secondary school students in a Peruvian province, regardless of age, area of residence, having a health professional as family member (dentist or not), educational level of the mother or father, and living or not with parents. Oral health literacy, awareness and reinforcement of healthy habits in early adolescence are recommended, as they play a key role in the prevention of dental caries and periodontal disease.

Data Sharing Statement

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Ethic Approval and Consent to Participate

The present study respected the bioethical principles for medical research on human beings of the Declaration of Helsinki, related to confidentiality, freedom, respect and non-maleficence. It was also approved by the Institutional Research Ethics Committee of the Universidad Privada San Juan Bautista with resolution No. 293-2022-CIEI-UPSJB dated March 3, 2022. Finally, parents and students were asked for voluntary informed consent and assent, respectively.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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