

Effectiveness of oral health programs according to their levels of prevention, applied in educational institutions in Chiclayo and Pimentel, Peru.

Efectividad de programas de salud bucal según sus niveles de prevención aplicados en instituciones educativas de Chiclayo y Pimentel, Perú.

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Abstract: Introduction: The process to evaluate the effectiveness of preventive programs involves follow-up and monitoring activities, assessing if these programs really contribute to the improvement of oral health conditions of the target population. Objective: To evaluate the effectiveness of oral health programs, according to their levels of prevention, applied to schoolchildren at educational institutions in Chiclayo and Pimentel, in the district of Lambayeque, Peru. Materials and Methods: A retrospective, longitudinal and descriptive study was carried out on 237 schoolchildren between 6 and 7 years of age, from four educational institutions located in Chiclayo and Pimentel. A record of the oral hygiene index and caries' incidence was carried out in four stages, including a baseline diagnosis and three follow-up evaluations every six months between 2016 and 2017, with a previously verified calibration process for the oral hygiene index ($k=0.86$) and for caries registration ($k=0.79$). Results: A greater effectiveness was observed in programs with level 2 prevention, achieving a progressive decrease in the oral hygiene index from a baseline mean of 2.04 to 1.98 at 6 months, 1.77 at 12 months and 1.64 at 18 months, with significant differences between them. Regarding the incidence of caries in permanent first molars, no significant differences were found in the effectiveness of programs with levels 1 and 2 of prevention, according to mixed factorial ANOVA ($p<0.05$). Conclusion: Programs with level 2 prevention have a greater effectiveness in terms of improving oral hygiene conditions, with significant differences in comparison to programs with level 1 prevention. No significant differences were found between the effectiveness of Level 1 and 2 programs regarding the incidence of dental caries.

Keywords: Program evaluation; oral health; health promotion; follow-up studies; preventive health services.

Resumen: Introducción: La efectividad como proceso de evaluación de los programas preventivos implica acompañamiento y seguimiento, permitiendo determinar si realmente contribuyen a mejorar las condiciones de salud bucal de una población. Objetivo: Evaluar la efectividad de programas de salud bucal según sus niveles de prevención aplicados a escolares de instituciones educativas de Chiclayo y Pimentel, Lambayeque-Perú. Material y Método: Se realizó un estudio descriptivo, retrospectivo y longitudinal, con 237 escolares entre 6 y 7 años de cuatro instituciones educativas de Chiclayo y Pimentel. El registro del índice de higiene oral y de incidencia de caries fue realizado en cuatro momentos, incluyendo un diagnóstico basal y tres evaluaciones de seguimiento cada seis meses entre los años 2016 y 2017, habiendo verificado un proceso previo de calibración para el índice de higiene oral ($k=0.86$) y para el registro de caries ($k=0.79$). Resultados: Se determinó una mayor efectividad en los programas con nivel 2 de prevención, logrando disminuir progresivamente el índice de higiene oral de una media basal de 2,04 a 1,98 a los 6 meses, 1,77 a los 12 meses y 1,64 a los 18 meses, encontrando diferencias significativas. En cuanto a incidencia de caries en primeras molares permanentes, no se encontraron diferencias significativas en la efectividad de los programas con niveles 1 y 2 de prevención, ANOVA factorial mixto ($p<0,05$). Conclusiones: Los programas con nivel 2 de prevención alcanzan mayor efectividad en cuanto a mejorar las condiciones de higiene oral, encontrando diferencias significativas en comparación a los programas con nivel 1. En cuanto a incidencia de caries, no se encontraron diferencias significativas entre la efectividad de los programas de nivel 1 y 2.

Palabras Clave: Evaluación de programas y proyectos de salud; efectividad; evaluación de eficacia-efectividad de intervenciones; promoción de la salud; salud bucal

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INTRODUCTION.

The goal of preventive oral health programs is to crucially contribute to the improvement of oral health conditions within a certain population. This is especially important when dealing with communities that are most vulnerable to health-related problems.¹ Consequently, there is the need for implementing these programs within the context of national public health policies.²

While it is true that a greater responsibility lies with governments and their health ministries, the involvement of all the social actors that play a role in public oral health is essential.³ In order to ensure effectiveness, it is fundamental to consider economic, socio-demographic, and the cultural characteristics of the target population. Additionally, it is of utmost importance to start from a baseline diagnosis that reveals the community's oral health needs, along with overseeing the entire implementation process, and subsequently carrying out follow-up activities in the short, medium and long term. All this with the objective of assessing their legitimate impact on the population, as often only immediate results are assessed and quantified, which is not statistically significant and insufficient at best.^{3,4}

In order to evaluate preventive programs, it is convenient to be familiar with prevention level models such as the one proposed by Leavell and Clark. In it, the first level corresponds to health promotion and specific protection, while the second considers early diagnosis, timely treatment and damage control; with the third level being oriented towards rehabilitation.⁴⁻⁶

Evaluating the effectiveness of oral health preventive programs consists of measuring their capacity to fulfill the desired objective with the use of oral health indexes that enable the observation of expected consequences.^{1,3} The evidence of effectiveness is tied to the basis of strategies and activities that generate favorable changes in oral health conditions according to the levels of prevention they are intended to achieve.⁷ One of the primary objectives is to generate an understanding of the subject within the community and promote a culture in which health care plays a significant role.⁸

Regarding previous experiences, in 2012 and throughout the course of three years, Sánchez *et al.*,⁹ evaluated a preventive oral health program that was

applied in educational institutions based in San Juan de Lurigancho and El Agustino in Lima, on a total of 717 children, resulting in a significant increase in the number of preschoolers and schoolchildren with proper oral hygiene conditions compared with a control group. In an study carried out in 2014, Celis *et al.*,¹⁰ assessed a program applied to 83 preschool children ranging from 4 to 5 years of age, who belonged to the "Santa María" educational institution in Chiclayo. Results showed that a healthy oral hygiene index improved significantly. On the other hand, in 2015 Ghezzi *et al.*,¹¹ evaluated the effectiveness of an oral health education program, finding out that 78.8% of the children that were subject to a play-based educational experience significantly increased their knowledge about preventive oral health care.

Although there are many occasions when preventive oral health programs have proven to be successful, rarely have they strictly followed an organized prevention level model, consequently, objectives and activities were not necessarily established in an orderly and articulated manner, often resulting in ambiguous evaluation criteria. The present study tries to compensate for these shortcomings, as it is based on classifying programs according to the prevention levels they have reached, so as to establish criteria for comparison, standardization and evaluation.

The disadvantage of not having applied a proper evaluation of effectiveness in the past is that no weaknesses or strengths were identified at the right time, resulting in wasted potential regarding possible improvements on the quality of these programs. Subsequently, their contribution towards tackling the high prevalence of oral disorders, such as dental caries and periodontal disease (which have become a recurring public health problem in Peru for various decades), is thus hindered.

In the process of evaluating effectiveness, the present study also identifies previous preventive experiences with other shortcomings, such as not having performed calibration processes for the diagnostic, evaluation and follow-up stages, which unfortunately means that the results obtained are unreliable. Another drawback consists of the failure to carry out assessments in different

phases, including baseline diagnosis and follow-up measurements that would have allowed an evaluation of their impact. As such, carrying out this research and communicating its findings to the competent authorities is essential in order to standardize criteria for the design, implementation and evaluation of preventive programs, which also aims to promote the formulation of preventive oral public health policies.

With the previous considerations in mind, the aim of the study is to evaluate the effectiveness of oral health programs according to their levels of prevention in schoolchildren from educational institutions in Chiclayo and Pimentel.

MATERIALS AND METHODS.

The present research is of a retrospective, longitudinal and descriptive nature. The pre-research process took place during the months of January and February 2016 and consisted of the identification of eleven primary education institutions from the Lambayeque region in which preventive oral health programs were going to be applied.

Eight of these institutions are located in the towns of Chiclayo and Pimentel, while the other three schools are located in Eten, Reque and Monsefu. The inclusion criteria included schools in which the development of programs was backed up by a written commitment formally signed by the school authorities. It also included only institutions with clear expectations regarding the level of prevention they hoped to achieve. Furthermore, this study also considered schools, which having previously undergone calibration procedures, could provide baseline and follow-up data for indexes related to oral hygiene and the incidence of caries in permanent first molars.

Two excluding criteria were identified: educational institutions having compromised internal validity due to evidence of uncontrolled biases, and the lack of informed consent from the children's parents. For the development of this research, four educational institutions where preventive programs were being applied from March 2016 onwards were considered, with evaluation and follow-up procedures carried out during 2016 and 2017 in order to determine whether or

not there were differences in the levels of prevention of each program.

With these considerations in mind, from a population of 611 boys and girls aged between 6 and 7 years old that had participated in the development of the programs and that were in first and second grade of primary education in one of the four selected educational institutions, a sample of 237 schoolchildren was obtained, distributed proportionally and randomly by stratification in 96 students from the "Cosmo" Educational Institution, 93 students from the Educational Institution "Nicolás La Torre", 24 from the Educational Institution "Santa Julia", and 24 others from "San Isidro".

Regarding data collection, a review of dental records was carried out. Records included a universal odontogram and a subdivision for the registration of the Greene and Vermillion oral hygiene index, after verifying whether or not the evaluations had been performed by a team of three examiners. Prior to this, a calibration process was performed which resulted in ($k=0.86$) for the oral hygiene index, and in ($k=0.79$) for the dental caries registry.

Data recording was performed every six months in April and October of 2016 and 2017, allowing up to four instances for applying the oral hygiene index, as well as three assessments of the incidence of caries. Headmasters from the participating institutions provided authorization to access dental records. Regarding the principles of bioethics, this study complies with the Declaration of Helsinki, being approved by the Bioethics Commission and the Research Unit at Universidad San Martín de Porres, with Rector Resolution No. 518-2017-CU-R-USMP.

In order to compare the oral hygiene index as well as the incidence of caries in permanent first molars, the factorial ANOVA test was used at four different moments and according to the levels of prevention. For each level of prevention the ANOVA test was used with repeated measurements for the estimation of the oral hygiene index and the incidence of caries. For the univariate analysis, the means and their respective standard deviations were presented, as well as the lowest and highest values, using version 22 of the SPSS statistical package.

Figure 1. Profile that represents the effect of the interaction of time with the level of prevention considering the follow-up period of the oral hygiene index.

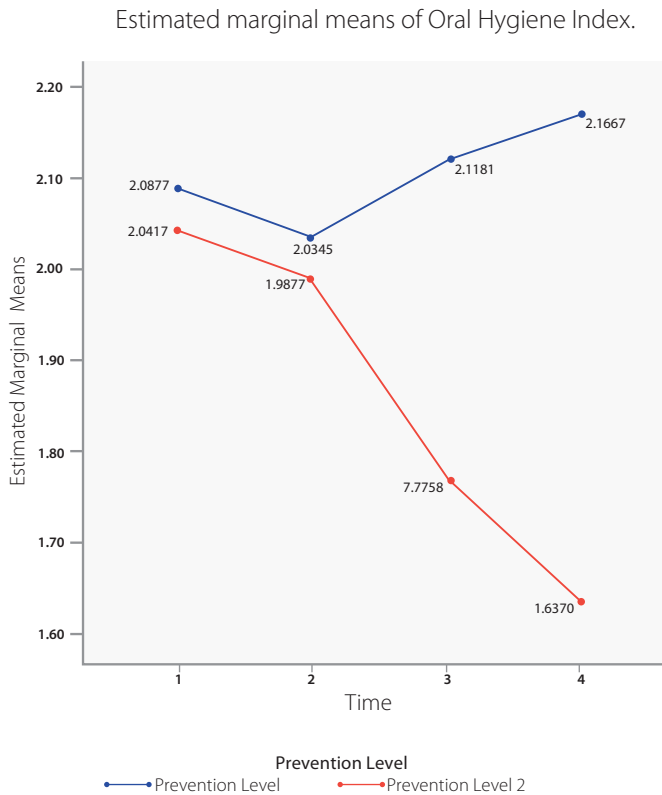


Figure 2. Profile showing the effect of the interaction of time with the level of prevention considering the follow-up of caries incidence in permanent first molars.

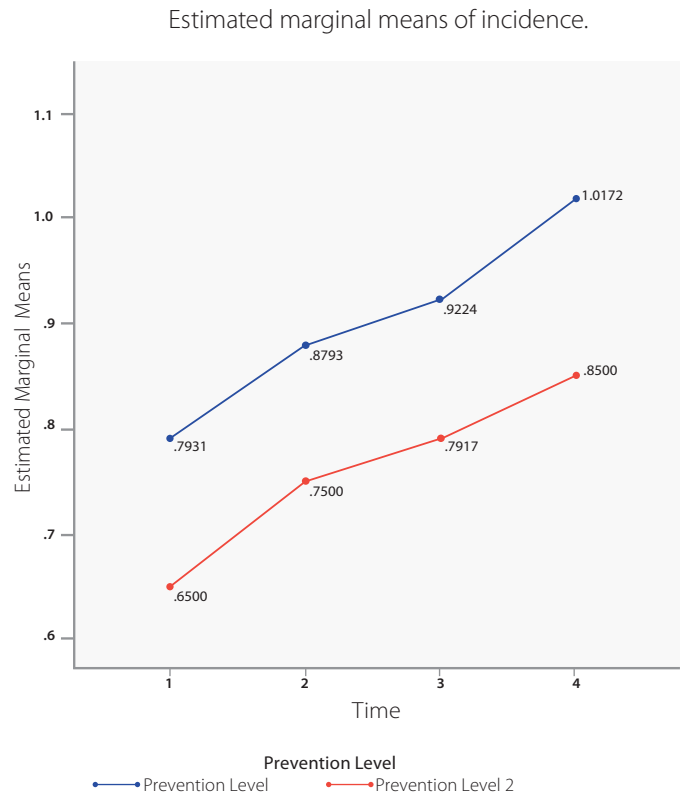


Table 1. List of educational Institutions of Lambayeque-Peru, with experiences in preventive oral health programs in the years 2016 and 2017, according to the inclusion criteria for the study.

City/District	Educational Institution	Research Institution	Com. Form	Calibration Process	OHI	Odontogram Data	Bias Control and consent	Level of Inst. Prevention
Chiclayo	Cosome	USMP	Yes	Yes	Yes	Yes	Yes	2
	Nicolas La Torre	USMP	Yes	Yes	Yes	Yes	Yes	1
	Karl Weiss	MINSA	No	No	No	No	No	1
	San José	MINSA	No	No	Yes	No	Yes	1
Pimentel	Santa Julia	USMP	Yes	Yes	Yes	Yes	Yes	1
	San Isidro	USMP	Yes	Yes	Yes	Yes	Yes	2
	Santa Rosa	Other	No	No	Yes	No	No	1
	San Martín	Other	No	No	No	No	No	1
Reque	Institución 10050	MINSA	No	No	Yes	No	Yes	1
Monsefu	María Auxiliadora	MINSA	No	No	Yes	No	Yes	1
Éten	Virgen María	Other	No	No	No	No	Yes	1

USMP: Universidad San Martín de Porres. MINSA: Ministry of Health. Other: Another university. OHI: Oral Hygiene Index. Com.: Commitment. Inst.: Level of Institution.

Table 2. Comparison of the Oral Hygiene Index in schoolchildren of four educational institutions in Chiclayo and Pimentel during 18 months of follow-up, between 2016 and 2017.

	Basal OHI basal	OHI 6 months	OHI 12 months	OHI 18 months
N	237	237	237	237
Mean	2.0643	2.0107	1.9441	1.8974
Standard deviation	.3832	.3919	.4233	.4564
Lowest	.8300	1.0000	.8300	.8300
Highest	3.0000	2.8300	2.8300	2.8300

OHI: Oral Hygiene Index. N: number of individuals.

Table 3. Comparison of the oral hygiene index in schoolchildren of four educational institutions in Chiclayo and Pimentel during 18 months of follow-up, between 2016 and 2017.

	Baseline diagnosis	Incidence 6 months	Incidence 12 months	Incidence 18 months
N	237	237	237	237
Mean	0.720	0.810	0.860	0.930
Standard deviation	0.792	0.835	0.858	0.938
Lowest	0	0	0	0
Highest	3	3	3	4

N: number of individuals.

Table 4. Comparison of the Oral Hygiene Index according to the level of prevention achieved by the oral health programs applied to schoolchildren from four educational institutions in Chiclayo and Pimentel during 18 months of follow-up.

	Level of prevention 1*				Level of prevention 2*			
	OHI baseline	OHI 6 months	OHI 12 months	OHI 18 months	OHI baseline	OHI 6 months	OHI 12 months	OHI 18 months
N	117	117	117	117	120	120	120	120
Mean	2.0877	2.0345	2.1181	2.1667	2.0417	1.9877	1.7758	1.6370
Standard deviation	0.3660	0.3908	0.3400	0.3327	0.3994	0.3933	0.4291	0.4067
Highest	3.0000	2.8300	2.8300	2.8300	3.0000	2.8300	2.8300	2.3300
Lowest	1.1600	1.1600	1.3300	1.3300	.8300	1.0000	.8300	.8300

*: ANOVA with repeated measures ($p < 0.05$). OHI: Oral Hygiene Index. N: number of individuals.

Table 5. Comparison of the incidence of caries in permanent first molars according to the level of prevention achieved by oral health programs applied to school children from four educational institutions in Chiclayo and Pimentel during 18 months of follow-up.

	Level of prevention 1*				Level of prevention 2*			
	Baseline diagnosis	Incidence 6 months	Incidence 12 months	Incidence 18 months	Baseline diagnosis	Incidence 6 months	Incidence 12 months	Incidence 18 months
N	117	117	117	117	120	120	120	120
Mean	0.790	0.880	0.920	1.020	0.650	0.750	0.790	0.850
Standard deviation	0.860	0.876	0.906	1.004	0.718	0.791	0.809	0.866
Lowest	0	0	0	0	0	0	0	0
Highest	3	3	3	4	3	3	3	4

*: ANOVA with repeated measures ($p < 0.05$). OHI: Oral Hygiene Index. N: number of individuals.

RESULTS.

When reviewing the experiences of preventive oral health programs applied in Lambayeque schools, four educational institutions that met the inclusion criteria were selected. These correspond to the following public schools: "Cosome" and "Nicolás La Torre" from Chiclayo, and "Santa Rosa" and "San Isidro" from Pimentel. The calibration process for data registration regarding these institutions was verified, which was not possible in the case of other preventive experiences. (Table 1)

According to the observation and comparison of results from 18 follow-up months, the four educational institutions that applied oral health programs with prevention levels of 1 and 2 eventually managed to diminish the oral hygiene index score, resulting in a statistically significant mean difference. (Table 2)

Regarding the incidence of caries in permanent first molars, a statistically significant progressive increase is observed after the implementation of programs. (Table 3)

By comparing results according to the prevention levels achieved by the interventions, in programs with a prevention level of 1 the mean basal oral hygiene index of 2.0877 decreased to 2.0345 in 6 months, increased to 2.1181 at 12 months and had a value of 2.1667 after 18 months. On the other hand, when applying programs with a prevention level of 2, a progressive reduction in these indexes was achieved, finding statistically significant differences between programs with levels 1 and 2. (Table 4)

Based on this information, it can be clearly stated that the mean oral hygiene index in programs with a prevention level of 2 decreases over time, meaning a greater effectiveness was achieved when implementing these types of programs compared to those with a prevention level of 1. (Figure 1)

Finally, when comparing results regarding the incidence of caries, the average number of first permanent molars with dental caries ranged from a baseline diagnosis of 0.79 to an average incidence of 0.88 at 6 months, 0.92 at 12 months, and 1.02 at 18 months, after the application of programs with prevention level of 1. Regarding programs with a prevention level of 2, from a baseline diagnosis of 0.65, it was possible to observe an increase to an incidence of 0.75 at 6 months, 0.79 at 12 months, and 0.85 after 18 months, with these differences being statistically significant for both levels of prevention. (Table 5)

No significant differences were found regarding effectiveness, since an increase over time related to the incidence of caries was observed in programs with prevention levels of 1 and 2. (Figure 2)

DISCUSSION.

Studies on the evaluation of preventive programs are quite justified in a scenario where oral diseases have reached endemic magnitudes. Dental caries are considered a public health problem due to the high prevalence reported worldwide.¹² In Peru, the Ministry of Health has reported a 90% incidence of caries within the school population and the average number of decayed, filled and missing teeth in deciduous dentition is 5.84.12 In 2012, Chumpitaz *et al.*,¹³ found a caries prevalence of 75.86% in 174 schoolchildren aged 6, and 91.24% in 137 schoolchildren aged 12, when conducting epidemiological surveillance on students from the "Cosome" school in Chiclayo.

In a study carried out in 2015 by Pomar *et al.*,¹⁴ involving 157 students from the "Sara A. Bullón" Educational Institution of Lambayeque, the reported caries prevalence was 96.15% for subjects aged 12, and 97.1% for those aged 15. Along the same lines, in 2016 Córdova *et al.*,¹⁵ conducted a study on a population of 109 girls aged 6 to 11 from the "Comandante Elías Aguirre" school in Chiclayo, and found a caries prevalence of 87.2%. Due to the statistical evidence from Peru and regions such as Lambayeque, the General Research Office of the Peruvian National Health Institute has set oral health as one of the national priorities for health research by 2021.¹⁶ Relating to this, Villena *et al.*,¹⁷ published a report on oral health needs from a research point of view, based on an analysis of the actions undertaken by the Ministry of Health's Oral Health Strategy, emphasizing the need to consider public oral health in all its dimensions as a priority in research,¹⁸ together with health education, as the essential basis of preventive programs.¹⁹

In this regard, in 2013 the General Directorate of Health Promotion of the Peruvian Ministry of Health designed the "Module for Promotion of Oral Health",²⁰ and later in 2017, through the General Directorate of Strategic Interventions in Public Health, issued the "Guide to Clinical Practice for the Prevention, Diagnosis and

Treatment of Dental Caries in Children".²¹ Both policies contributed to the goal of promoting and facilitating the application of preventive oral health programs.^{20,21}

In relation to the findings of this research, when evaluating oral health programs, statistically significant differences were found in the oral hygiene index between programs with a prevention level of 1 and those with level 2. Results showed that the latter achieved a greater effectiveness, progressively decreasing the oral hygiene index from a baseline of 2.04 to 1.98 at 6 months, 1.77 at 12 months and 1.64 after 18 months, an outcome not achieved by programs with a prevention level of 1. Regarding positive results where an improvement in the oral hygiene index was observed, assuming that oral health programs that will be cited reached at least the first level of prevention (although it was not explicitly mentioned), the following studies are included: In 2012, Sánchez *et al.*,⁹ performed an evaluation on a preventive oral health program applied during three years in schools in San Juan de Lurigancho and El Agustino, in Lima, where from a total of 717 subjects, the percentage of preschool children with proper oral hygiene conditions increased from 43.2% to 77.7%, and that of grade school children from 31.6% to 69.3%.

A year later, González *et al.*,²² compared the influence of two six-month-long programs applied on 224 preschool children (ages ranging from 3 to 5 years old) from the "Niño Jesús de Praga" Initial Educational Institution located in the San Luis district in Lima, and found that through the "Happy Smile" program coupled with a open, warm and play-based methodology, the initial oral hygiene index of 2.10 decreased to 1.57 at three months, and to 1.08 after six months. This is compared with the traditional program, which improved the oral hygiene index score from 2.28 to 1.84 at three months and to 1.56 after six months. In a subsequent study carried out in 2014, Celis *et al.* assessed the effectiveness of a program applied to 83 preschoolers aged between 4 and 5 years old from the "Santa María" school located in Chiclayo, reporting that the index of adequate oral hygiene improved from 25% to 80% in preschool children aged four, and changed from 14.3% to 61.9% in children aged five.¹⁰ In addition to this, in 2015 Barturén *et al.*, when comparing two programs applied to 87 schoolchildren from the "Santa Julia" and "San

José" Educational Institutions in Chiclayo, determined that 41.5% of schoolchildren who participated in the "multiple intelligences" program improved their oral hygiene index from deficient to adequate, in comparison to students who attended the traditional program, with only 15.4% of those subjects managing to improve their oral hygiene index.²³ In another experience that also yielded favorable results, Rufasto *et al.*,²⁴ performed similar research in 183 adolescents from the "República de Colombia" Educational Institution located in the city of Lima, finding a basal oral hygiene index of 2.54, which improved to 1.77 after 90 days, and to 1.50 after 180 days from the program's application.

It should be emphasized that, regarding the cited references, an identification of the prevention levels achieved by the programs analyzed has not always been carried out. For this reason, in addition to considering experiences with results relating to the oral hygiene index, it is possible to mention studies based upon the measurement of the level of knowledge regarding oral healthcare.

This is the case of a study performed in 2015 by Ghezzi *et al.*,¹¹ that evaluated the effectiveness of an oral health education program applied to 60 third-grade primary school students from the "Miguel Grau" school located in Lima, finding that 78.8% of children to whom a play-based experience was applied managed to significantly increase their level of knowledge regarding preventive oral health care. In 2016, Cardozo *et al.*,²⁶ in Argentina determined the effectiveness of an educational program applied to 114 preschoolers, aged 3 to 5, from a kindergarten based in the city of Corrientes, with results showing that 63.15% of the children increased daily brushing to 4 times and decreased the consumption of sugary foods to 3 times a day.

Regarding results relating to the incidence of caries in permanent first molars, no significant differences were found in effectiveness after the application of programs with prevention levels of 1 and 2, because in both cases incidence increased over time. However, through the application of programs with a prevention level of 2, better results were achieved, varying from a basal average of 0.65 to an incidence of 0.75 at 6 months, 0.79 at 12 months, and 0.85 after 18 months. Although it has not been possible to identify a history of preventive programs

that reflect their influence on the control of caries' incidence, the need to perform preventive interventions in which their long-term impact is assessed is evident, proving a pending task for pertinent authorities of the Peruvian health unit to carry out longitudinal studies with such goals.

It is crucial that preventive programs, as well as the evaluation of their effectiveness, extend to populations other than school communities. Serrano *et al.*,²⁷ demonstrated the effectiveness of an oral hygiene promotion program applied through social media networks to 38 young university students from Bogotá, achieving an adequate control of previously diagnosed gingivitis. It is also important to mention the experience of Aguirre *et al.*,²⁸ who, after applying an educational intervention strategy involving collective games for 50 patients with Down Syndrome from the "Milagroso Niño de Jesús" institute located in the city of Lima, managed to significantly reduce the oral hygiene index scores.

Going beyond the limitations placed by the lack of more similar experiences in Chiclayo, that would allow a broader discussion, the contribution of this study lies in the promotion of preventive health policies, beginning with the standardization of oral health programs of a higher quality according to their prevention levels, so as to improve and facilitate their management, execution and evaluation, allowing for a proper measurement of their

effectiveness and their real impact on the population, especially on vulnerable communities.

CONCLUSION.

Programs with a prevention level of 2 reached greater effectiveness in terms of improving the oral hygiene conditions of the group of schoolchildren, finding significant differences when compared to programs with a prevention level of 1. However, regarding the incidence of caries, when comparing the effectiveness of programs with a prevention level of 1 to those with a level of 2, no significant differences were found, so it is recommended to replicate these studies using a longer timeframe.

Conflict of interests: The authors declare no conflict of interest in relation to published results.

Ethics approval: The present study was approved by the Research Unit of the Universidad Privada Antenor Orrego, Resolution 1376 – 2015 – FMEHU-UPAO.

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