



Analysis of Students' Understanding of the Use and Effects of Hydrogen Peroxide-Based Teeth Whitening: A Case Study of Uniandes

Jenny Carolina Paredes Balseca¹, Luz Amelia Granda Macías², Marco Antonio Zúñiga Llerena³, Galo Iván Sánchez Varela⁴

^{1,2,3,4}Universidad Regional Autónoma de Los Andes Ambato, Ecuador

¹E-mail: ua.jennyparedes@uniandes.edu.ec ORCID: 0000-0002-7448-5931

²E-mail: ua.luzgranda@uniandes.edu.ec ORCID: 0000-0001-5611-2819

³E-mail: ua.marcozuniga@uniandes.edu.ec ORCID: 0000-0002-7257-0008

⁴E-mail: ua.galosanchez@uniandes.edu.ec ORCID: 0009-0007-6990-2933

*Corresponding author's E-mail: ua.jennyparedes@uniandes.edu.ec

Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 11 Sept 2023	<p>Aim: Teeth whitening is a cosmetic treatment widely used to remove stains and improve dental appearance. They are made with hydrogen peroxide and carbamide peroxide, which act through an oxidation mechanism on enamel and dentin. Material and method: The effectiveness of teeth whitening varies depending on the underlying cause of the discoloration. The treatment may have adverse effects at the tooth-restoration interface and cause tooth sensitivity. Statistics and Result: It is essential that dental students have a detailed knowledge of bleaching agents and their management to supply effective treatment. In this work it is concluded that the inclusion of the subject of dental whitening in academic training is crucial, addressing indications, advantages, disadvantages, previous diagnosis, materials used and adverse effects.</p>
CC License CC-BY-NC-SA 4.0	Keywords: Dental Aesthetics, Dental Whitening, Student Knowledge, Training

1. Introduction

Aesthetic concern related to tooth appearance is a common problem in much of the economically active population, especially in Eurasians. The importance of having a good appearance has become a prerequisite for job placement, social media interactions and advertising. Although this expectation does not always translate into a tangible reality, the testimonies of dentists support the premise that there is a global concern to improve appearance, with the smile being one of the most relevant aspects (Lozada et al., 2023; Benites et al., 2022).

This process is known as teeth whitening and is done using two widely accepted products: hydrogen peroxide and carbamide peroxide. Hydrogen peroxide bleaching is performed in the office by applying photopolymerization, which triggers the peroxide-driven bleaching process. On the other hand, whitening with carbamide peroxide is considered an outpatient treatment, in which dental buckets are used for several hours a day. In both cases, the percentage of peroxide concentration will determine the release of hydroxyls to achieve the desired effect, which is carried out through the corresponding mechanism of action.

The effectiveness of teeth whitening is influenced by the underlying cause of the coloring. In cases where the coloration is the result of restorative materials containing silver or zinc-eugenol, in adult teeth where considerable time has passed since darkening occurred, the prognosis of whitening is reserved. Importantly, inflammation of periodontal tissues, as well as external root and bone resorption, most often occurs in young teeth. This is due to the larger diameter of the dentinal tubules,

which allows penetration of intracoronal whitening material from non-vital teeth into periodontal tissues (Barkhordar et al., 1998).

Soft tissue sensitivity, such as redness near whitened teeth or oral irritation at the beginning of the process, is directly related to the concentration of the peroxides used and the frequency of their application. Post-whitening tooth sensitivity appears to be associated with penetration of hydrogen peroxide through enamel and dentin, which can cause mild pulp irritation.

It is important to note that teeth whitening can have adverse effects on the interface between teeth and restorations, resulting in a decrease in the adhesive properties of the restoration. Therefore, it is recommended to wait at least a week after finishing the teeth whitening process to perform aesthetic restorations. However, other studies do not find a significant effect, which may probably depend on the concentration of the peroxides used (Schemehorn et al., 2004).

Other studies show that humanity seeks information on teeth whitening treatment between 16 and 54 years of age in an increasing way (Sierra et al., 2018), as well as in 2001 they were 11% and in 2003 it increased to 20%. At the same time for 2014, in the United Kingdom 28% of adults were not satisfied with the appearance of their teeth and up to 34% of Americans showed complaint or desire to improve aesthetics (Samaniego & Cevallos, 2018) and surely this year this percentage will triple.

One of the most common causes to opt for teeth whitening is discoloration or the presence of intrinsic and extrinsic stains, produced by factors such as the consumption of foods with dye, smoking, excess fluoride in water, red wine, curry, paprika, a situation that according to studies affects men by 31% and women by 21%. Although it is evident that teeth whitening is a commonly used, required treatment that has been shown to be biologically safe, highly effective and with minimal involvement, sensitivity has been reported as an adverse effect in 55% of the population and of these, 14% fail to complete the treatment. For this and many other aspects the population should be aware that although a healthy denture is synonymous with good health, its obsession can lead to blanchorexia which is a repetitive process of whitening without the supervision of a dentist which could lead to gingivitis, acute tooth sensitivity and the consequent loss of the tooth.

Once the aforementioned background has been analyzed, it is considered of utmost importance to identify the level of knowledge of the ninth and tenth semester students of the UAO Uniandes, on the use and effects of teeth whitening based on hydrogen peroxide, taking into account that in the near future this procedure will be executed in patients with various clinical situations and it will be relevant to know its use, Criteria and effects to be able to make an accurate diagnosis and a highly effective treatment.

2. Materials And Methods

This scientific article presents the methods used to obtain accurate data that allow defining the level of knowledge of ninth and tenth semester students at UAO Uniandes on the use and effects of teeth whitening based on hydrogen peroxide. Analytical, inductive and systemic approaches are used to understand the difficulties present and seek solutions as follows:

Analytical: they help to obtain data to define the level of knowledge in ninth and tenth semester students at Uniandes University with the theme of effects of teeth whitening based on hydrogen period.

Inductive: it allows to know the knowledge of the students about teeth whitening with hydrogen peroxide, its use and effects, and focuses on identifying the difficulties to later look for appropriate solutions.

In the systemic approach: it is based on the collection of information from ninth and tenth semester students who attend the Uniandes dental clinic, which provides real and scientific data to provide effective solutions.

The research instrumental techniques used include documentary analysis, which relies on supporting materials to obtain evidence on the use and effects of teeth whitening in ninth and tenth semester students of the Uniandes Dental Clinic. The instruments used in these research techniques include one-person surveys, the definition of population and sample, inclusion criteria and the line of

research. The importance of using individual surveys for more accurate analysis and information is highlighted.

The population and sample is defined as ninth and tenth semester students who provided care at the Uniandes clinic during the academic period from May to September 2021. These methods allow to obtain relevant data for the analysis and understanding of students' knowledge about teeth whitening with hydrogen peroxide. For the results, inclusion and exclusion criteria were taken into account, and given as a total sample of 123 students. After the collection of information, we proceed to make a scale and Microsoft Excel based only on 8 questions that were chosen randomly and being as follows:

Table 1: **Determination of ranges of the level of knowledge**

Level of knowledge	Rank
70-100%	Excellent
60-70%	Well
50-60%	Regular
40-50%	Bad boy

Source: Authors

3. Results and Discussion

The percentages collected based on a literature review on the effects of teeth whitening based on hydrogen peroxide were examined using graphs that allow a better understanding of the results of the 123 students of 9th and 10th semester who have provided care at the Dental Clinic of the UNIANDES University in the period May-September 2021. Since a survey of 13 closed and open questions was carried out to observe the degree of knowledge provided by 9th and 10th semester students.

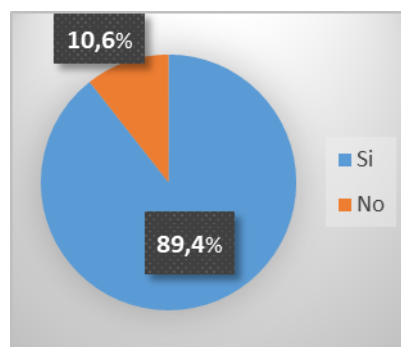


Figure 1. Knowledge about what teeth whitening is?

Figure 1 presents an analysis of students' knowledge of teeth whitening. The results reveal that a high percentage, specifically 89.4%, have knowledge about what teeth whitening is. This finding indicates a good general understanding of the subject among ninth and tenth semester students at Uniandes University. On the other hand, it is observed that there is a minority percentage, representing 10.6%, who are unaware of the issue of teeth whitening. These results highlight the importance of addressing and providing additional information on the topic to this group of students.

It is essential to provide them with the opportunity to acquire solid knowledge about teeth whitening, its techniques, effects and relevant considerations in the dental field. These data provide an initial view of the level of knowledge existing in the student population evaluated. Based on these results, educational and outreach strategies can be designed to improve the overall understanding of teeth whitening and encourage informed and responsible practices in oral health care.

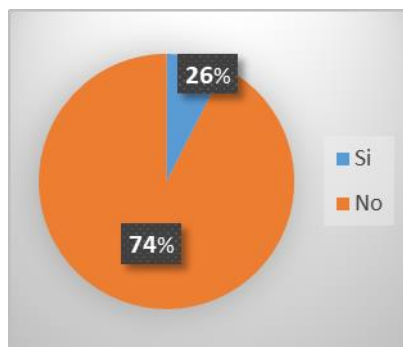


Figure 2. Professional practice of teeth whitening in a patient

Figure 2 analyzes the experience of students in terms of carrying out teeth whitening practices. The results reveal that a significant percentage, specifically 74%, mentions not having performed any teeth whitening practice in patients. These data reflect a lack of clinical experience in this field by the majority of students evaluated. However, it is important to note that a percentage of 26% of students have had the opportunity to practice teeth whitening in patients. These results indicate that a minority group has gained some experience in this specific procedure during their academic training.

These findings raise the need to provide clinical and hands-on learning opportunities in the area of teeth whitening to those students who have not yet had the opportunity to do so. It is essential that future dental professionals have the necessary skills and competencies to carry out this procedure safely and effectively. In addition, the results suggest the importance of promoting continuous training and professional development in the field of teeth whitening, since it is a practice increasingly demanded by patients in search of a whiter and more aesthetic smile. These data provide relevant information for the planning of educational and practical programs that allow students to gain clinical experience in teeth whitening, thus ensuring quality and up-to-date care in this field of aesthetic dentistry.

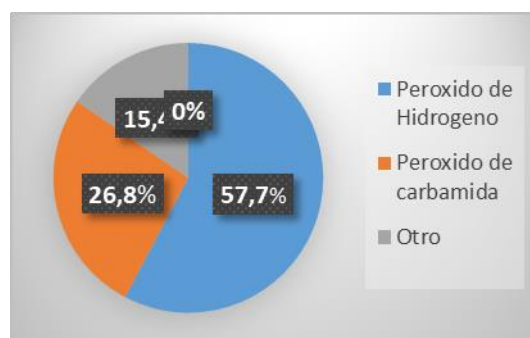


Figure 3. Materials used for teeth whitening

Figure 3 examines students' knowledge of the materials used in teeth whitening. The results show that a significant percentage, 57.7%, are aware that hydrogen peroxide is the material used in teeth whitening. This reflects an adequate understanding by most students of the bleaching agent most commonly used in this procedure. On the other hand, it is observed that 26.8% of students mention that carbamide peroxide is used in teeth whitening. These results indicate that a considerable percentage of students have knowledge about this other bleaching agent used in some specific cases. In addition, 15.4% of students say they know another material used in teeth whitening, such as whitening paste. This response demonstrates that a minority group of students are familiar with options in the field of teeth whitening. These data highlight the importance of a solid education regarding the materials used in teeth whitening. It is essential that students are informed about the most common bleaching agents and their properties, as well as the options that could be found in clinical practice. These results provide a basis for the design of educational programs that strengthen

students' knowledge about the materials used in teeth whitening, thus ensuring an informed and safe professional practice in this field.

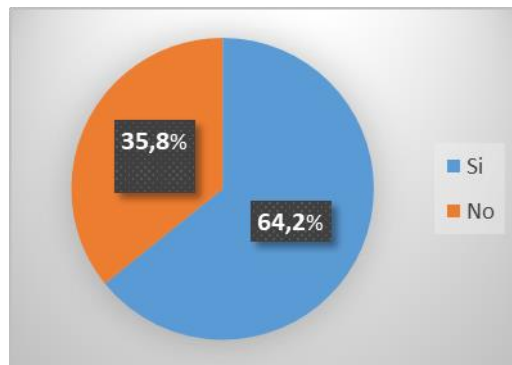


Figure 4. Indications of teeth whitening

Figure 4 examines students' knowledge of the proper indications for teeth whitening. The results reveal that a significant percentage, 64.2%, indicate that they do not know properly the indications to carry out teeth whitening. This data suggests a lack of understanding and adequate knowledge about the circumstances in which this procedure is recommended. In addition, it is observed that a percentage of 35.8% of students are completely unaware of the subject of indications for teeth whitening. This indicates that a considerable group of students is not familiar with the criteria and recommendations that guide the completion of this procedure.

These results highlight the need for more robust education regarding the proper indications for teeth whitening. It is essential that students acquire a solid knowledge about the cases in which teeth whitening is appropriate, as well as clinical considerations and factors to consider before performing the procedure. These data underscore the importance of strengthening academic training in the field of teeth whitening, ensuring that future dental professionals are equipped with the knowledge necessary to make informed decisions and provide quality care. Based on these results, it is suggested that educational programs be implemented that comprehensively address the indications for teeth whitening, providing students with a clear understanding of when and how to apply this procedure safely and effectively.

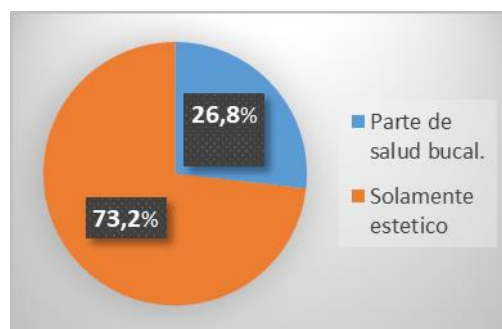


Figure 5. Teeth whitening considerations

Figure 5 discusses students' knowledge of the purpose of teeth whitening. The results show that a significant percentage, 73.2%, are aware that teeth whitening is a procedure with aesthetic purposes. This indicates that most students understand that the main goal of teeth whitening is to improve the aesthetic appearance of teeth.

On the other hand, it is observed that 26.8% of students consider that teeth whitening is part of oral health. These results reveal that a minority group of students associate teeth whitening with benefits beyond aesthetics, possibly related to oral health in general. These findings highlight the importance

of educating students about the goals and scope of teeth whitening. While it is true that teeth whitening has an aesthetic approach, it is also essential to provide clear information on aspects related to oral health, such as removing stains and improving the appearance of teeth, which can have a positive impact on the confidence and overall well-being of the patient. This data offers the opportunity to develop educational programs that address both the aesthetic and oral health aspects related to teeth whitening. In this way, it is ensured that students acquire a comprehensive knowledge about this procedure and can provide accurate and appropriate information to their patients in the future.

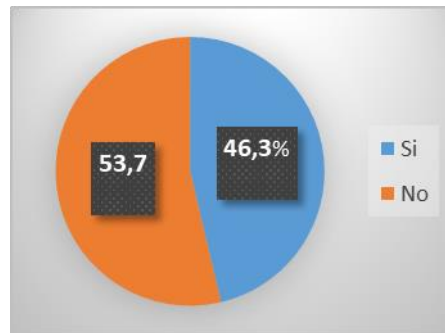


Figure 6. Contraindications of teeth whitening

Figure 6 examines students' knowledge of the contraindications to teeth whitening. The results reveal that a significant percentage, 46.3%, claims to know the contraindications associated with teeth whitening. This indicates that a portion of the students are familiar with the circumstances in which it is not recommended to perform this procedure due to possible risks or adverse effects. On the other hand, it is observed that a majority percentage, 53.7%, is unaware of the contraindications of teeth whitening. This suggests a lack of understanding and knowledge about situations where teeth whitening needs to be avoided or postponed due to clinical and health considerations. These results highlight the importance of more thorough education on the contraindications of teeth whitening. It is essential that students acquire a solid knowledge about conditions, such as pregnancy, periodontal or dentally compromising diseases, severe dental hypersensitivity, among others, that could contraindicate teeth whitening.

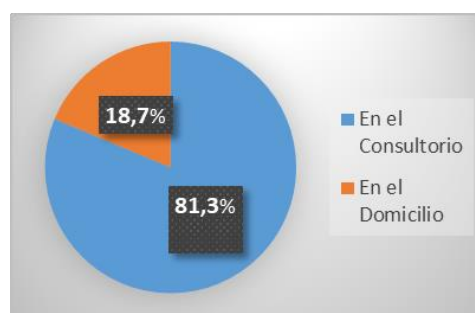


Figure 7. Considerations on the success of teeth whitening

Figure 7 discusses students' perception of where the greatest success in teeth whitening is obtained. The results reveal that a significant percentage, 81.3%, indicates that the most successful treatment is performed in the dental office. This suggests that most students consider teeth whitening carried out in the clinical setting, under the supervision and control of the dental professional, to offer the best results. On the other hand, it is observed that 18.7% of students indicate that the greatest success in teeth whitening is obtained when done at home. These results indicate that a minority group of students believes that teeth whitening performed at home, through the use of products and techniques

indicated by the dental professional, can achieve satisfactory results. These findings highlight the importance of offering choices and considering individual patient preferences when selecting the teeth whitening approach. Although the treatment in the dental office is widely recognized by students as the most successful, it is essential to also consider the feasibility and effectiveness of teeth whitening at home, always under the supervision and recommendations of the dentist.

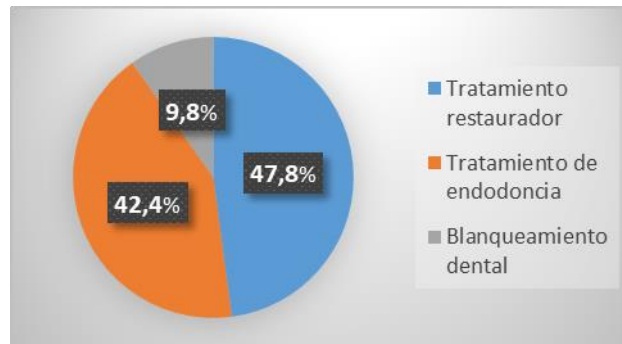


Figure 8. Importance of teeth whitening compared to other clinical actions

Figure 8 analyzes students' perception of the importance and excellence of different dental procedures. The results reveal that a significant percentage, 47.8%, adequately indicates that restorative treatment has a higher level of importance. This indicates that most students recognize the relevance and necessity of restorative treatments in dental practice. On the other hand, it is observed that 42.4% of students indicate that performing endodontic treatment is more excellent. This suggests that a considerable group of students consider performing endodontic treatments, such as root canal treatment, to be an outstanding and valued skill in dentistry. In addition, 9.8% of students say that teeth whitening is more expressive than other procedures. This indicates that a minority group of students consider teeth whitening to have a significant visual and aesthetic impact compared to other treatments. These results reflect students' individual perceptions of the importance and excellence of different dental procedures. It is important to note that the importance and level of excellence of a procedure may vary depending on the clinical context and the needs of the patient.

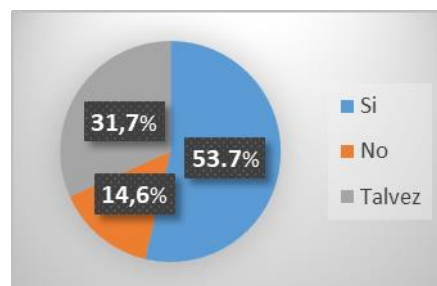


Figure 9. Involvement of tooth enamel by whitening

Figure 9 examines students' perceptions of the possible effects of teeth whitening on tooth enamel. The results show that a significant percentage, 53.7%, indicates that teeth whitening can have effects on enamel. This suggests that most students recognize that teeth whitening can have an impact on the structure and integrity of tooth enamel. On the other hand, it is observed that 14.6% of students indicate that teeth whitening does not present any type of affectation towards the enamel. Importantly, this perception may be based on limited knowledge or an incomplete understanding of the possible effects of teeth whitening on enamel.

In addition, 31.7% of students indicate that there may be some kind of effect on the enamel due to teeth whitening. This response reflects a more cautious or uncertain perception about possible effects on enamel and suggests the need for more information and clarity on this topic.

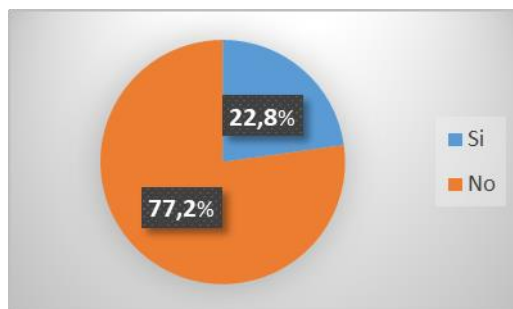


Figure 10. Teeth whitening in contrast to teeth cleaning

Figure 10 discusses students' perceptions of the relationship between teeth whitening and cleaning. The results show that a minority percentage, 22.8%, indicate that teeth whitening is the same as a dental cleaning. This suggests that a small group of students have an incorrect or incomplete understanding of the difference between these two dental procedures. On the other hand, it is observed that a majority percentage, 72.2%, mentions that teeth whitening and cleaning are totally different procedures. These results reflect an adequate understanding by most students about the different nature of these two procedures and recognize that teeth whitening focuses on improving the color and aesthetics of teeth, while dental cleaning focuses on removing plaque and dental calculus to maintain oral health.

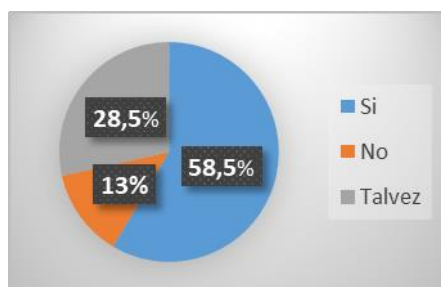


Figure 11. Sensitivity during teeth whitening

Figure 11 analyzes students' perception of sensitivity associated with teeth whitening. The results reveal that a significant percentage, 58.5%, think that teeth whitening produces sensitivity. This indicates that most students recognize that there is a high probability of patients experiencing tooth sensitivity as a side effect of teeth whitening. On the other hand, it is observed that 13% of students indicate that teeth whitening does not present sensitivity. It is important to note that this perception may be based on limited knowledge or lack of direct clinical experience in the management of cases of sensitivity associated with teeth whitening. In addition, 28.5% of students mention that teeth whitening may produce sensitivity. This response reflects a more cautious or uncertain perception about the possibility of tooth sensitivity occurring during or after teeth whitening.

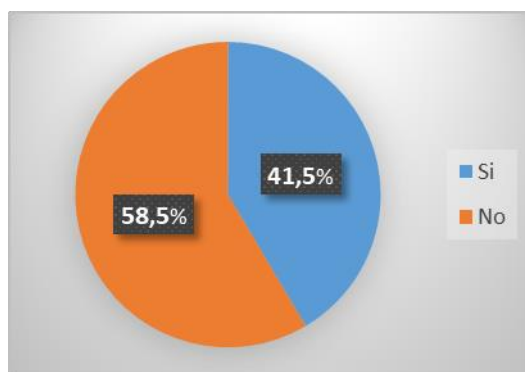


Figure 12. Effects of teeth whitening

Figure 12 examines students' knowledge of the effects of teeth whitening. The results reveal that a minority percentage, 41.5%, indicates that they do know the effects caused by teeth whitening. This suggests that a small group of students has an adequate understanding of the possible effects that may arise as a result of teeth whitening. On the other hand, it is observed that a majority percentage, 58.5%, does not know the effects that teeth whitening can produce. This indicates a lack of widespread knowledge and understanding about the potential effects that could arise during or after the teeth whitening procedure.

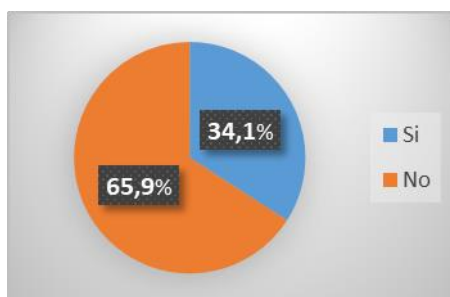


Figure 13. Have you done teeth whitening?

Figure 13 examines students' experience of performing teeth whitening. The results show that a minority percentage, 34.1%, says they have ever done teeth whitening. This indicates that a small group of students has had the personal experience of undergoing this procedure to improve the aesthetic appearance of their teeth. On the other hand, it is observed that a majority percentage, 65.9%, has not performed teeth whitening. This suggests that most students have not had the opportunity or need to undergo this procedure in the past. These data reflect the diversity of experiences and variation in demand for and access to teeth whitening among students tested. It is important to keep in mind that the decision to perform teeth whitening can be influenced by factors such as personal aesthetics, the recommendation of the dentist or the availability of financial resources.

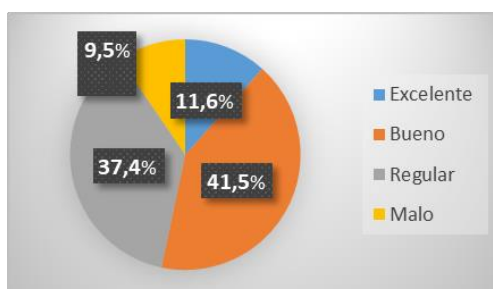


Figure 14. General level of knowledge of students

In figure 14, you can see the final result of the knowledge of the students surveyed in 9th and 10th grade, which obtained the following results: 11.6% of students are certain of having an excellent level of knowledge about the use of teeth whitening, 41.5% of students have a good level of knowledge, 37.4% of students maintain a regular knowledge and finally 9.5% of students have a bad or unfavorable knowledge. That is why it is necessary that you can teach topics on teeth whitening. The whitening of teeth with vital pulp was already carried out in 1868, by means of oxalic acid or pyrozone and later with hydrogen peroxide. In 1911 the use of concentrated and heated hydrogen peroxide, by means of an instrument or a light source, was considered an acceptable method in dental clinics (Fisher, 1911). Over-the-counter (OTC) clearance systems first appeared in the United States in the 1990s and contain low concentrations of hydrogen peroxide or carbamide peroxide, and are sold directly to consumers for home use (Haywood et al., 1990).

The current office whitening technique typically uses different concentrations of hydrogen peroxide, ranging from 3 to 40% with or without light and in the presence of gingival isolation (Ontiveros, 2011). This treatment that is applied to the teeth makes the color change reducing several tones, leaving the teeth brighter and whiter, the peroxide is not flammable since this can cross the enamel of the teeth, but does not cause any damage. Since today there are also several types of teeth whitening such as professional teeth whitening, mixed teeth whitening, home teeth whitening, internal teeth whitening. In general, the greater the amount of peroxide applied, the greater the power as a bleach, this is done within an office, and is considered an excellent treatment. In the present study it was analyzed how students do not manage to have an excellent knowledge about the use and annex of these substances, since it is not a topic that covers general dentistry has not been treated in the undergraduate contents and students of higher semesters have deficit on this subject treated, Therefore, as developing dentists, they should take technology hand in hand to obtain better knowledge and application. Of the need for prevention from school at any level. (Leon et al., 2021; Silva et al., 2003).

4. Conclusion

In conclusion, teeth whitening is an aesthetic treatment widely used and demanded by the population. Its main purpose is to remove stains and improve the aesthetic appearance of teeth. The bleaching agents used in this procedure act through an oxidation mechanism that diffuses through the enamel and dentin. There are several causes that can lead to the need for teeth whitening, such as the consumption of foods with dyes, smoking, the presence of excess fluoride in water, the consumption of red wine, curry, and other factors that can contribute to tooth pigmentation. It is important to consider these factors in the diagnosis and treatment of teeth whitening. It is essential that ninth and tenth semester students of the dentistry career at Uniandes have a clear and detailed knowledge about the use, selection criteria, possible side effects and management of bleaching agents. This will allow them to make an accurate diagnosis and offer highly effective treatment to their patients. It is of great relevance that the subject of teeth whitening is incorporated adequately in the semesters that cover the professionalizing subjects of the dentistry career. Essential contents such as the indications, advantages and disadvantages of teeth whitening, the necessary previous diagnoses, the materials used, the different types of whitening available, possible adverse effects, contraindications and other relevant aspects must be addressed..

References:

- Armijos Briones, F. M., Sánchez Granja, P. F., Bravo Benavides, M. A., & Mena Silva, P. A. (2023). Effectiveness of the use of silver diamine fluoride for the prevention of dental caries. *HIV Nursing*, 23(3), 1785-1791.
- Barkhordar, R. A., Kempler, D., & Plesh, O. (1998). Effect of whitening of non-vital teeth on microfiltration of composite restorations. *Quintessence (ed. esp.)*, 11(4), 209-212.
- Benites, R. M., Morales Cobos, J. D., & Sánchez Sánchez, J. E. (2022). Neutrosophic Linguistic Scale for the Assessment of Knowledge of Natural and Traditional Medicine in Dental Students. *Neutrosophic Sets and Systems*, 52(Special Issue: Neutrosophic in Latin America, progress and perspectives), 326-331.
- Fisher, G. (1911). The bleaching of discolored teeth with H₂O₂. *Dent Cosmos*, 53, 246-247.
- Haywood, V. B., Leech, T., Heymann, H. O., Crumpler, D., & Bruggers, K. (1990). Nightguard vital bleaching: effects on enamel surface texture and diffusion. *Quintessence Int.*, 21(10), 801-804.

- León González, Y., Rodríguez Cuéllar, Y., & García Rodríguez, B. (2021). Educational strategy for the prevention of dental fluorosis aimed at pregnant women in Huachi Grande, Ambato. *University and Society*, 13(6), 572-576.
- Lozada López, F. R., Salame Ortiz, V. A., & López Torres, R. G. (2023). Influence of the quality level of dental care on patient satisfaction in dental care in La Merced Parish of Ambato Canton. *HIV Nursing*, 23(3), 1842-1848.
- Ontiveros, J. C. (2011). In-office vital bleaching with adjunct light. *Dent Clin North Am*, 55(2), 241-253.
- Paredes Balseca, J., Granda Macías, L., Peñaloza Perez, N., & Miranda Coello, K. (2023). CAD/CAM system in the manufacture of total dental prostheses. *Cuban Journal of Biomedical Research*, 42(1), E1174.
- Samaniego, M., & Cevallos, S. (2018). DENTAL THINNING IN VITAL TEETH. Review Article. *Rev. OACT UC*, 3(3), 63-70. [Available in: <https://oactiva.ucacue.edu.ec/index.php/oactiva/article/view/267>]
- Schemehorn, B., Gonzales-Cabezas, C., & Joiner, A. (2004). A SEM evaluation of a 6% hydrogen peroxide tooth whitening gel on dental material; in vitro. *Journal of Dentistry*, 32, 15.
- Sierra, J., Carrasco, M., & Avendaño, V. (2018). Aesthetics in restorative dentistry. *Rev. Polo. Con.*, 2(9), 237-249. [Available in: <https://polodelconocimiento.com/ojs/index.php/es/article/view/804>]
- Silva Lara, K. S., Salame Ortiz, V. A., López Torres, R. G., & Lozada López, F. R. (2023). Importance of preventive and dental care during pregnancy. *HIV Nursing*, 23(3), 1827-1832.