Universidad Europea

GRADUATION PROJECT

Degree in Dentistry

THE USE OF FLUORIDE DENTAL PRODUCTS IN UNIVERSITY STUDENTS

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RESUMEN

Introducción: El flúor es un pilar fundamental de la prevención dental. Sin embargo, su eficacia no solo depende de su presencia, sino también de su uso diario adecuado. Los estudiantes constituyen una población en la que la higiene dental se gestiona cada vez más de forma autónoma, lo que puede dar lugar a inconsistencias ; **Objetivo:** El objetivo principal fue evaluar la exposición al flúor y los comportamientos relacionados entre los estudiantes universitarios, y analizar su impacto en la prevención de la caries; los objetivos secundarios incluyeron evaluar la regularidad de la exposición al flúor, valorar los conocimientos y las actitudes respecto al flúor, así como su uso correcto ; **Materiales y métodos:** Se llevó a cabo un estudio transversal, observacional y descriptivo mediante un cuestionario anónimo administrado a 73 estudiantes universitarios matriculados durante el curso académico 2025/2026. La encuesta evaluó los hábitos de higiene bucal, el uso de productos que contienen flúor, los conocimientos y creencias sobre el flúor, la experiencia de caries dental declarada por los participantes y su estado de salud bucodental declarado ; **Resultados:** El uso diario de flúor a través de la pasta dentífrica era muy frecuente entre los estudiantes universitarios; la mayoría se cepillaba los dientes dos veces al día, aunque seguían padeciendo caries. No obstante, se observaron ciertas limitaciones en el uso óptimo del flúor, en particular en lo que respecta al enjuague inmediato tras el cepillado, la identificación incompleta de la concentración de flúor en la pasta dentífrica y el uso limitado de medidas complementarias de flúor. Los conocimientos y las actitudes hacia el flúor también fueron positivos, a pesar de cierta incertidumbre persistente. Cabe destacar también que los estudiantes de ciencias de la salud mostraron conocimientos, comportamientos y salud bucodental autoinformada más favorables en relación con el flúor que los estudiantes de otras disciplinas. Finalmente, podría ser beneficioso reforzar las medidas de prevención ; **Conclusión:** La exposición de los estudiantes universitarios al flúor es elevada, pero no óptima. El principal reto en materia de prevención no es la presencia de flúor, sino su uso adecuado y sistemático, basado en un conocimiento suficiente.

PALABRAS CLAVE

Odontología, Flúor, Estudiantes Universitarios, Prevención de Caries, Odontología Preventiva.

ABSTRACT

Introduction: Fluoride is a cornerstone of dental prevention. However, its effectiveness depends not only on its presence, but also on its correct daily use. Students constitute a population in which dental hygiene is increasingly self-managed, which can lead to inconsistencies ; **Objective:** The main objective was to assess fluoride exposure and related behaviours among university students, and to analyse their impact on caries prevention; secondary objectives included assessing the regularity of fluoride exposure, evaluating knowledge and attitudes regarding fluoride as well as its use ; **Materials and methods:** A cross-sectional, observational and descriptive study was conducted using an anonymous questionnaire administered to 73 university students enrolled during the 2025/2026 academic year. The survey assessed oral hygiene habits, the use of fluoride-containing products, knowledge and beliefs regarding fluoride, self-reported experience of dental caries, and self-reported oral health status ; **Results:** Daily use of fluoride via toothpaste was highly prevalent in university students', with the majority brushing their teeth twice a day but caries persists. Nevertheless, certain limitations in the optimal use of fluoride were observed, notably regarding immediate rinsing after brushing, incomplete identification of the fluoride concentration in toothpaste, and limited use of supplementary fluoride measures. Knowledge and attitudes towards fluoride were also positive, despite some lingering uncertainty. It is also worth noting that health students demonstrated more favourable fluoride-related knowledge, behaviours, and self-reported oral health than non-health students. Finally, strengthening prevention efforts may be beneficial ; **Conclusion:** University students' exposure to fluoride is high, but not optimal. The main challenge in prevention is not the presence of fluoride but rather its appropriate and systematic use, based on sufficient knowledge.

KEYWORDS

Dentistry, Fluoride, University Students, Caries Prevention, Preventive Dentistry.

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1 INTRODUCTION

1.1 Background and definition of fluoride

Fluoride is a cornerstone of preventive dentistry and one of the most studied agents in caries prevention. It is typically delivered via toothpastes, mouthrinses, water, varnishes, gels or even pills. Its main mode of action is topical; fluoride ions released in saliva promote enamel remineralisation, reduce demineralisation, inhibit the acidogenic bacteria in the biofilm and form complexes of fluorapatite that has a lower acid solubility than hydroxyapatite (1,2,3).

Systemic fluoride plays an important role before eruption of teeth by affecting the enamel matrix and forming fluorapatite. In definitive dentition, systemic administration is minor, having smaller effect on caries prevention than with topical (3,4).

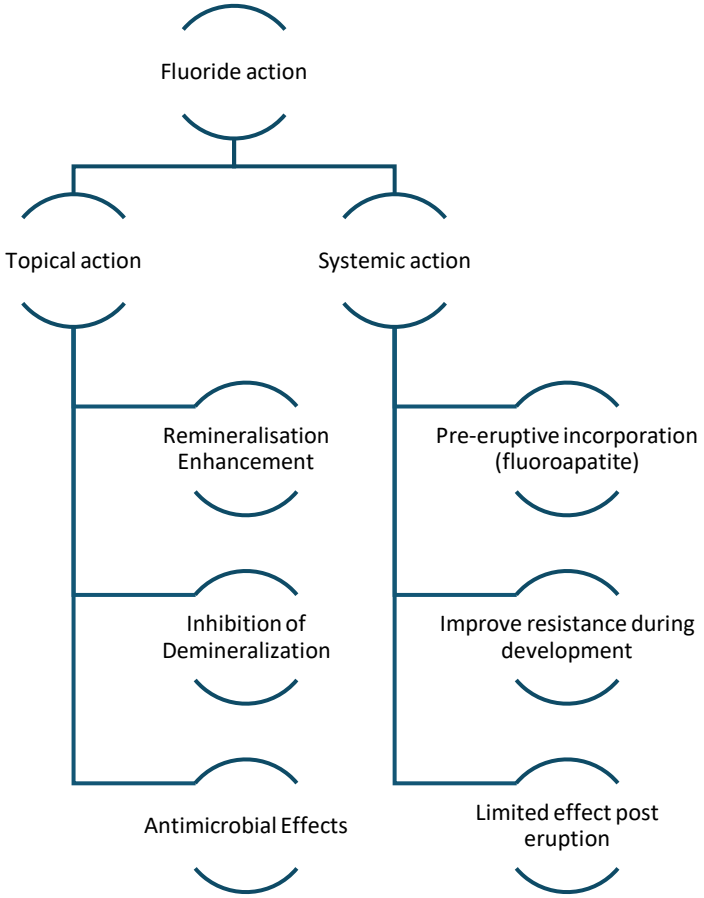


Figure 1. Mechanisms of action of fluoride (5,8,19-21).

Fluoride products have shown their efficacy over decades in reducing the incidence and progression of caries. The challenge in this study is not to demonstrate if or how fluoride works, that is well known and established, but to optimise its use via: concentration, dosage, frequency and behavioural in university students. University students radically change their lifestyle and habits, mainly through diet, self-care and healthcare (2,4–6). The point to demonstrate by empirical evidence is therefore how well fluoride dental products are used and how effective they are in the caries prevention of university students.

Delivery method	Topical effect	Systemic effect	Effective for
Toothpaste	+++	---	All ages
Mouthrinse	+++	---	Definitive dentition
Varnish/Gel	+++	---	All ages / High risk group
Fluorinated water	---	+++	Pre-eruptive (children)
Fluor tablets	---	+++	Pre-eruptive (children)

Table 2. Types of fluoride delivery and their effects (2,4-8,19-21).

1.2 Evolution of use of fluoride

In the 1930s and 1940s, fluoride was discovered and first studies were done. Dr. Frederick McKay and colleagues discovered fluoride through mottled enamel seen in certain U.S. states. They discovered that in these areas, water was naturally highly fluoridated and provoked an enamel discoloration, which is now known as enamel fluorosis. This population also had fewer caries. The first hypothesis emerged; small concentration of fluoride could prevent caries and in 1945, the first community water fluoridation trial began and showed that caries rate in children dropped significantly (1).

In the 1950s and 1960s, the first public health policy including fluoride emerged. Water fluoridation started in occident and fluoride tablets and drops were introduced as systemic supplements for children. During this period, search and acts focused on systemic action of fluoride.

In the 1970s and 1980s, public health focused on topical fluoride. In this time, researchers discovered that fluoride's main protective mechanism was topical after tooth eruption. This realisation changed public health to focus more on local application. Fluoride toothpastes, varnishes and mouthrinses emerged and caries rate in developped countries started to decline (1,2).

In the 1990s and 2000s, studies focused on optimal dosage and risk-based prevention. They examined fluoride toxicity and assessed the benefits and risks of fluoride. New formulations were made and more adapted preventive programs in a risk-based approach emerged (1,3).

Current and future approaches focus on behavioural use of fluoride, mainly on frequency, dosage and habits. It focuses on an equitable access to fluoride, prevention of high-risk groups with new preventive guidelines at higher concentrations up to 5000 ppm in toothpastes (1,5).

This historical evolution reflects an important shift:

- Prevention went from systemic to topical use to finally go to behavioural optimisation;
- Modern evidence shows that fluoride only works when used with various parameters:

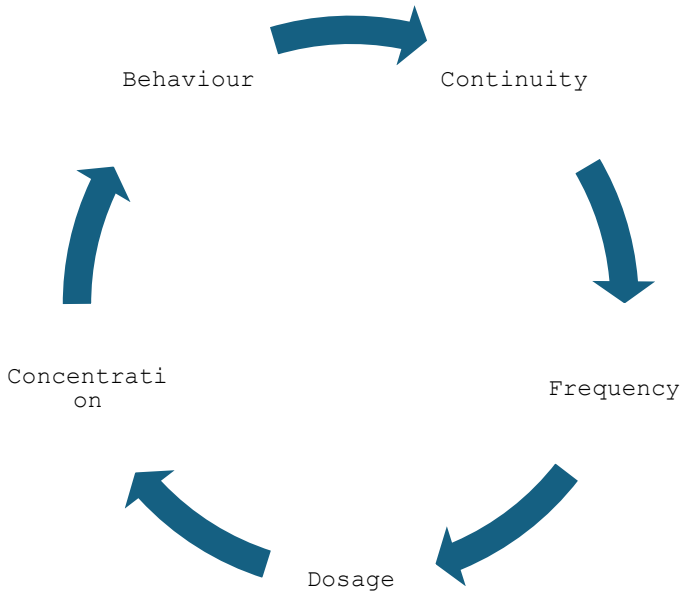


Figure 3. Pillars of effective fluoride use (4-6,8,18,21).

1.3 Current evidence and quantitative results of fluoride use

When we look at the efficacy in prevention of fluoride, we see that the most important variable is not only its presence but mainly its continuity of exposure, its good dosage and a correct use.

In many populations, fluoride is not used enough in early life. Only 26% of children only received professional fluoride treatment, in 93% of times varnish (2). This shows us that prevention strategies are more based on reaction rather than preventive.

During middle childhood, fluoride products are mainly used at home in the form of toothpaste. Studies show significant discrepancies from optimal levels, with 94.1% of children using less toothpaste than recommended by national guidelines (0.27 g compared to 0.5–0.75 g). Furthermore, only 37.7% use additional sources of fluoride, such as dental varnishes or tablets (6). This study demonstrates underutilisation of fluoride products and non-optimal uses that leads to unpredictable prevention of caries whatever socioeconomic status.

Longitudinal data also provide us interesting information about systemic fluoride intake from 6 to 17 years old (4). We can observe that more than half of fluoride intake derived from fluoridated water, which is an important intake for young population, declined with age (4). This shows us that systemic intake of fluoride is important in children but diminishes in adolescence and adulthood, but that maintenance of topical exposure becomes more crucial for this population.

Continued exposure to fluoride is also important in caries prevention, and daily use of toothpaste remains the principal measure to maintain an optimal caries prevention over time (18,21).

Even small deviations in use behaviour of fluoride can affect fluoride performance (5). Rinsing immediately after brushing provokes a major reduction in remineralisation efficiency compared to not rinsing (5). This highlights that use behaviour can be crucial to promote enamel repairs.

In summary, fluoride intake should be continued, be dose-adapted, have optimal delivery pathways and get appropriate behavioural practices.

Taken together, these findings delineate a clear quantitative relationship between fluoride exposure and caries prevention. Optimising these parameters represents the most evidence-based way to maximise caries prevention outcomes.

1.4 Justification

University students are at a stage of lifestyle change where oral hygiene and dietary habits are becoming increasingly self-directed. The preventive effect of fluoride depends not only on its use, but also on its correct use in terms of exposure, knowledge and usage behaviours. It therefore seems important to study how this population is exposed and uses fluoridated products.

1.5 Hypothesis

1.5.1 Study hypothesis

It is hypothesise that, among university students, although exposure to fluoride is common and knowledge about its use exists, it may be insufficient and inconsistent to ensure optimal effectiveness in the prevention of dental caries.

1.5.2 Null hypothesis

It is hypothesise that, among university students, there is frequent exposure to fluoride, as well as a high level of knowledge about its use, which enables sufficient, consistent, and optimal prevention of dental caries.

2 OBJECTIVE

2.1 General objective

- Evaluate fluoride exposure and use behaviours in university students and determine their impact on caries prevention.

2.2 Secondary objectives

- Identify potential change in fluoride exposure continuity in university students.

- Determine knowledge and attitudes regarding fluoride use in university students.

- Assess correctness of fluoride-related behaviours in university students.

- Develop recommendations for optimal use in university students.

3 MATERIAL AND METHODS

3.1 Study Design

A cross-sectional, observational, descriptive, and analytical study was designed using a qualitative questionnaire to evaluate fluoride behaviours and uses among university students. The study was performed to assess:

- Oral hygiene habits
- Use of fluoride products (toothpaste, mouthrinse, professional applications)
- Knowledge and beliefs about fluoride
- Self-reported caries experience

Current scientific literature was also used to contextualise the findings and conclusions using current scientific evidence on fluoride effectiveness and behavioural components playing a role in its efficiency.

3.2 Participants

Participants were university students enrolled during the 2025/2026 academic year in different fields (Health Sciences, Sciences, Engineering, Humanities, Business, etc.). A total of 73 responses were analysed.

Inclusion criteria were:

- Age ≥ 18 years;
- Currently enrolled in a university program (Bachelor, Master, PhD etc.);
- Voluntary participation with informed consent.

Exclusion criteria were:

- Incomplete questionnaires;
- Students under 18 years old;
- Refusal to give informed consent.

3.3 Methodology

3.3.1 Survey Instrument

A structured questionnaire was developed based on previously validated fluoride-related research and adapted for the university population. The survey included five sections:

1) **Demographics**
2) **Oral hygiene habits**
3) **Fluoride toothpaste use**
4) **Use of additional fluoride products**
5) **Knowledge and beliefs about fluoride**
6) **Self-reported caries experience**

Questions included multiple-choice questions, open questions and 5-point Likert scales.

3.3.2 Data Collection

The questionnaire was administered anonymously through Google Forms. Completion time was approximately 5 minutes and participants were recruited via WhatsApp and QR codes.

Data were collected between January and March 2025.

3.3.3 Evaluation Measures

Fluoride use: concentration, toothpaste quantity, rinsing habits, mouthrinse use, professional fluoride exposure.

Behavioural determinants: brushing frequency and technique, interdental cleaning, dental attendance.

Knowledge analysis: based on Likert-scale items about fluoride mechanisms, efficacy, and safety.

Self-perceived oral health and caries history.

These variables were useful for evaluating fluoride effectiveness and behavioural utilisation.

3.3.4 Literature Review

A narrative literature review was conducted using PubMed. Keywords included: *fluoride use*, *fluoride toothpaste*, *fluoride efficacy*, *behavioural factors*, *fluoride knowledge*, *fluoride mouthrinse*, *caries prevention*, *university students.*

The inclusion criteria for bibliographic references were:

- Publication within the last 10 years, exept for 2 articles.

- Direct relevance to oral hygiene, fluoride use and results of the study.

3.3.5 Data Analysis

Quantitative data were analysed using descriptive statistics:

- Absolute and relative frequencies;

- Percentages;

- Aggregated Likert scale categories.

- Descriptive comparison between health students and other students regarding exposure to fluoride, behavioural determinants and knowledge and perceptions regarding fluoride.

These results were analysed in conjunction with reference studies to assess the appropriateness of fluoride use in the university students population.

3.4 Ethical considerations.

Study only involved university students without clinical procedures.

Data were anonymously collected and with informed consent.

This study was approved by the research ethics committee of European University of Madrid under reference number OD.084/2526.

4 RESULTS

4.1 Sample description

73 people responded to the questionnaire entitled: "Questionnaire on fluoride use and perception, oral hygiene habits and caries experience among university students". All participants were university students, enrolled in the 2025/2026 academic year.

The results we collected enabled an analyse of the current situation in terms of fluoride use and effectiveness of existing preventive measures on university students.

Of these 73 people, 51 are studying in the field of health, representing 69.9% of the total sample (including 36 in dentistry) and 22 are studying in a field other than health, representing 30.1% of the total sample. All participants accepted informed consent. Only 4 participants did not meet the inclusion criteria. The remaining participants completed the survey correctly.

This study therefore allows analysis of the results in general university students' population and a comparison of the results between two distinct groups: students studying in the field of health and students studying in a different field.

The study covers five main areas: oral hygiene habits, the use of fluoride products (personal or professional), knowledge and beliefs related to fluoride, self-reported experience of caries and self-perception of oral health, all in relation to demographic factors collected in this study.

4.2 Oral hygiene habits

Most university students who responded to this survey said they brush their teeth twice a day, followed by those who do so more than twice a day, and finally those who do once a day (Figure 4). No one declared brushing their teeth less than once a day.

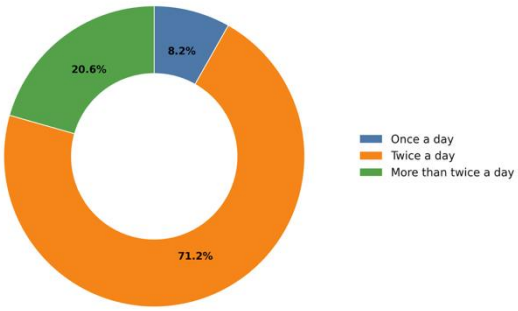


Figure 4. Q4. How often do you brush your teeth?

Most students reported brushing their teeth for two minutes, whilst a smaller proportion said they brushed for more than two minutes or for one minute (Figure 5). Again, no one declared brushing their teeth for less than a minute.

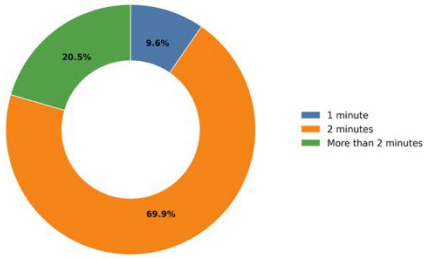


Figure 5. Q5. How long do you usually brush?

Most students reported using dental floss or interdental brushes. A large proportion said they used them daily, while two smaller groups reported using them on a weekly basis, occasionally, or even rarely (Figure 6 and 7).

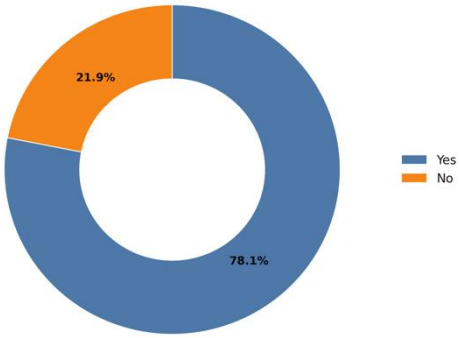


Figure 6. Q6. *Do you floss or use interdental brushes?*

Most participants visited the dentist once a year. Two smaller group of respondents either went twice a year or at a different frequency. (Figure 8). The group going at different frequency answers going to the dentist only occasionally (Figure 9).

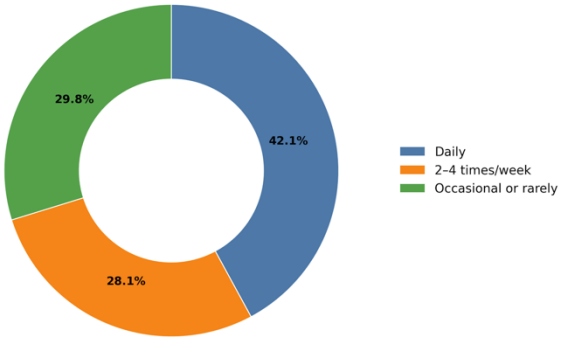


Figure 7. Q6b. Interdental cleaning frequency among users.

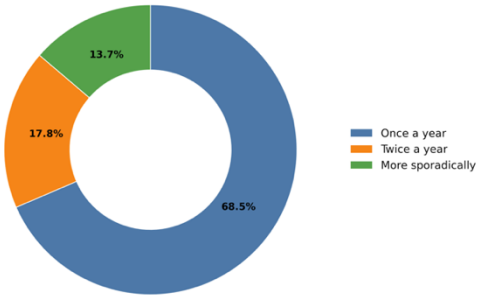


Figure 8. Q7. How often do you go to the dentist?

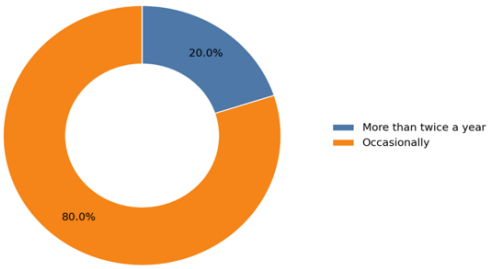


Figure 9. Q7. How often do you go to the dentist? Other than once or twice a year distribution.

4.3 Use of fluoride containing products

The use of fluoride toothpaste was highly prevalent among university students, with the vast majority using it and only a very small proportion either unaware of it or not using it (Figure 10).

Regarding fluoride concentration, most participants reported using toothpaste containing 1450 ppm of fluoride, whilst the others stated that they did not know the concentration or were unable to determine it (Figure 11).

As for toothpaste used, the most common response was a strip of 1 to 2 cm, followed by a pea-sized amount. Fewer students reported using a drop or some other amount of toothpaste (Figure 12).

Rinsing immediately after brushing was very common. Only a third of the participants did not report this habit (Figure 13).

The use of mouthwash was limited in this population (Figure 14).

Regarding professional fluoride treatment, 12.3% of participants reported having received it, only once, compared with 87.7% who had never received it.

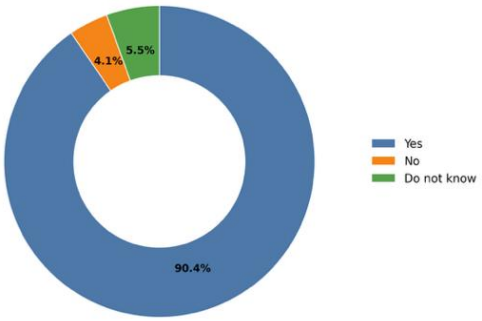


Figure 10 Q8. Do you use fluoride toothpaste?

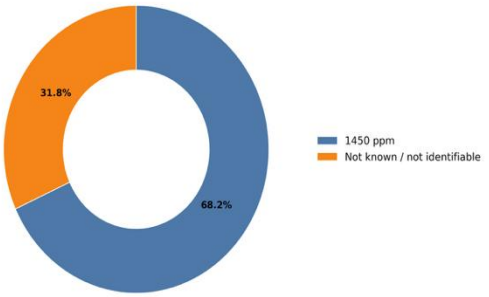


Figure 11. Q8b. What fluoride concentration (ppm) is written on the tube?

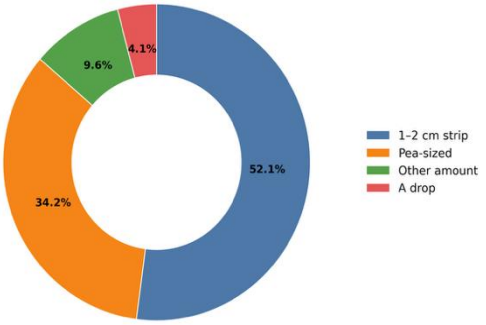


Figure 12. Q9. How much toothpaste do you use?

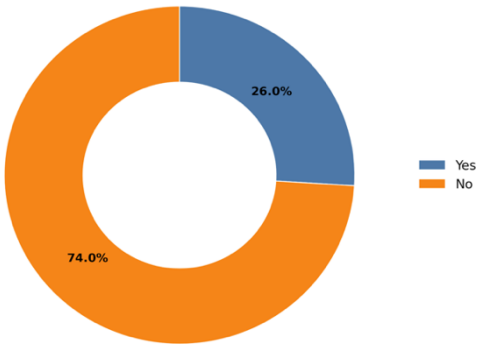


Figure 14. Q11. Do you use a mouthrinse?

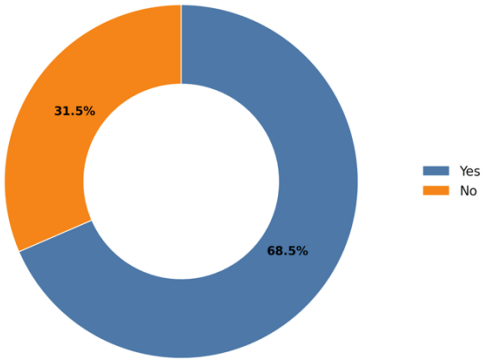


Figure 13. Q10. Do you rinse with water immediately after brushing?

4.4 Knowledge and beliefs about fluoride

Regarding knowledge and beliefs about fluoride, in response to the statement "fluoride helps prevent cavities", most responses were positive, with a total of 76.7% affirmative answers. Only 2.7% disagreed (Figure 15).

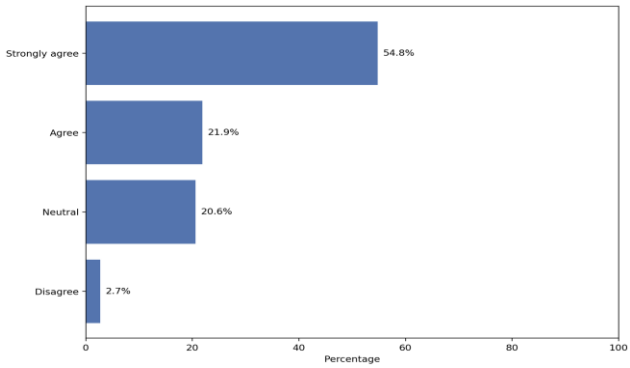


Figure 15. Q13. "Fluoride helps prevent cavities"

For the statement "Rinsing after brushing reduces fluoride benefits", most of surveyed agreed, with a total of 61.6% of positive responses. We should also note the significant number of neutral responses (Figure 16).

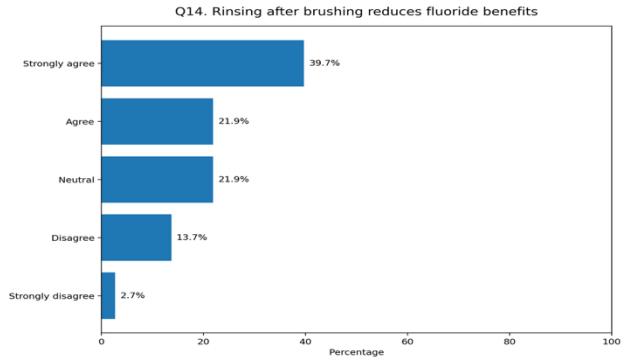


Figure 16. Q14. "Rinsing after brushing reduces fluoride benefits"

When asked whether the statement "Fluoride is dangerous" was true, most participants (63%) rejected this idea. It is interesting to note that a big proportion were also neutral (Figure 17).

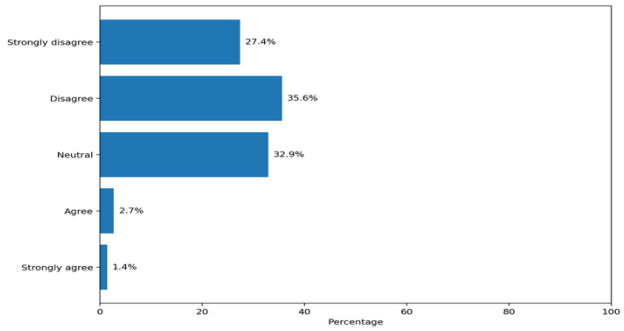


Figure 17. Q15. "Fluoride is dangerous"

Finally, when participants were asked "Do you feel well informed about fluoride", vast proportion of the answers were positive, while 15.1% were neutral, 17.8% disagreed and 2.7% strongly disagreed (Figure 18).

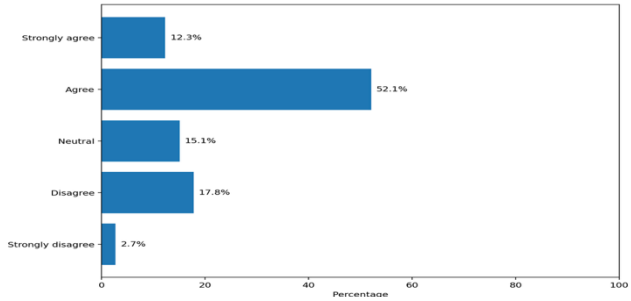


Figure 18. Q16. "Do you feel well informed about fluoride?"

4.5 Caries experience

A significant proportion of university students reported having had dental caries before the age of 18, while the other respondents reported never having experienced any. Among those affected before the age of 18, the most common pattern was two to three carious lesions, followed by a single lesion and four or more lesions. Caries reported in the last 12 months and during university studies were less common, although they were still present in a proportion of the sample (Figure 19).

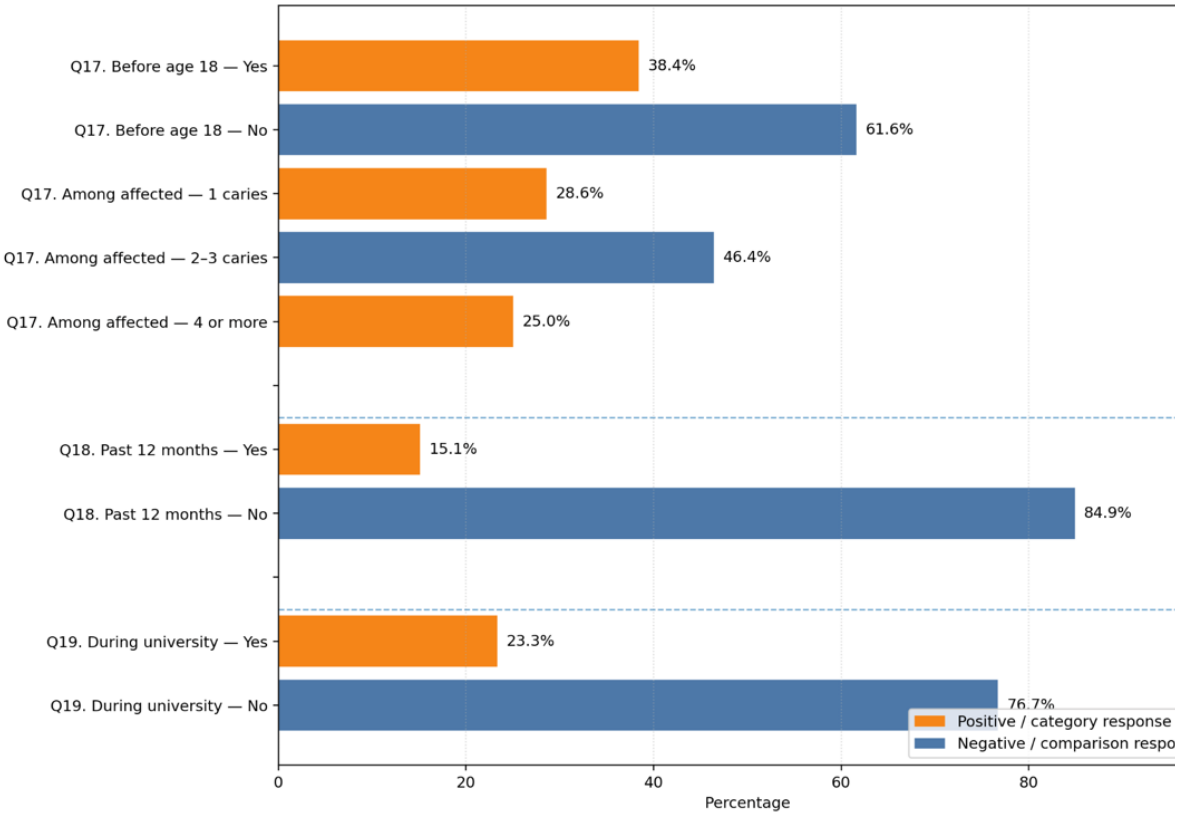


Figure 19. Self-reported caries experience

4.6 Self-rated perception of oral health

University students' self-assessment of oral health is generally positive, at 82.2%. The remaining students mainly rated their oral hygiene as neutral and finally a minority rated it as poor or very poor (Figure 23).

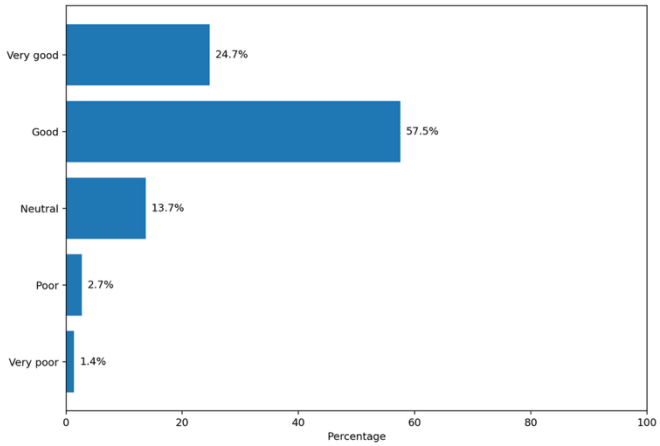


Figure 23. Q20. How would you describe your dental health?

4.7 Comparative results between health and non-health students

Looking at the high proportion of health students who responded, it is worth dividing the sample into health students and non-health students to analyse the results in further details.

In general, health students achieved better results in terms of fluoride prevention and oral hygiene behaviours than non-health students.

Regarding oral hygiene habits, the proportion of students reporting that they brush their teeth twice a day was similar (70.6% among health students and 72.7% among non-health students).

However, the rest of the distribution regarding this frequency was more favourable to health students, with students reporting that they brush their teeth more than twice a day (25.5% of health students, compared with 3.9% of non-health students) and students reporting that they brush their teeth once a day (9.1% of health students and 18.2% of non-health students)

Brushing duration also appeared to be more favourable among health students, with 72.5% of health students brushing for 2 minutes compared with 63.6% of non-health students, and 5.9% of health students brushing for 1 minute compared with 18.2% of non-health students.

However, the results regarding interdental cleaning showed the clearest difference between the two groups. 86.3% of health students reported doing so, compared with 59.1% of non-health students with a significant difference in the number of daily users as well (Figure 24).

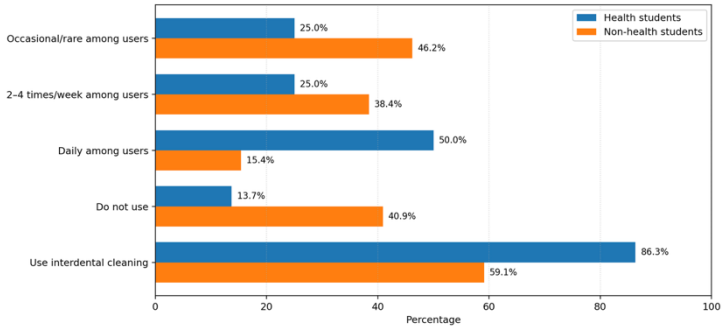


Figure 24. Q6. Interdental cleaning use and frequency. Health and non-health students comparison.

The frequency of dental appointments was also more regular among healthcare students, with 92.1% reporting at least one annual visits compared to 72.8% in the non-healthcare students.

Differences in the use of fluoride products were also highlighted. The use of fluoride toothpaste was more common or conscious among healthcare students than among non-healthcare students Furthermore, uncertainty regarding fluoride concentration was particularly pronounced among non-healthcare students while absent in healthcare students (Figure 25).

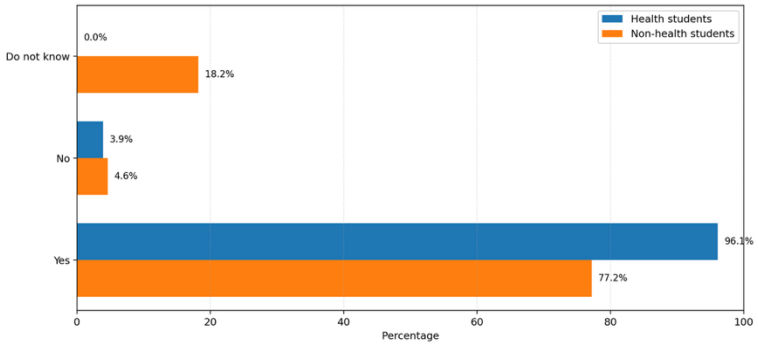


Figure 25. Q8b. Fluoride concentration identification on the tube. Health and non-health students comparison.

Health students also demonstrated a clearer understanding of fluoride concentration in toothpaste. 78.7% of health students were able to identify a toothpaste containing 1450 ppm, compared with 47.1% of non-health students, while the remaining responses indicated an inability to identify or interpret the concentration (21.3% versus 52.9%).

The amount of toothpaste used was also more favourable among health students, with 56.9% following the recommendation of a strip 1–2 cm long, compared to 40.9% of non-health students.

Nevertheless, rinsing after brushing remains a common practice in both groups and the difference in practice is minimal (Figure 26).

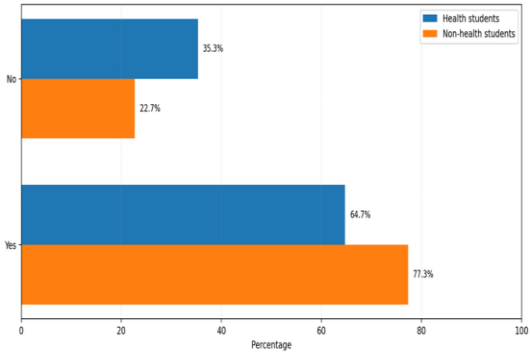


Figure 26. Q10. Do you rinse with water immediately after brushing? Health and non-health students comparison.

The use of mouthwash was also more common among health students (29.4%) compared to non-health students (18.2%).

Health students also received more professional fluoride treatments (13.7%) compared to non-health students (9.1%).

Regarding knowledge and beliefs about fluoride, when asked whether “Fluoride helps prevent cavities”, 80.4% of health students agreed, compared with 68.2% of non-health students. Furthermore, none of the health students gave a negative response (Figure 27).

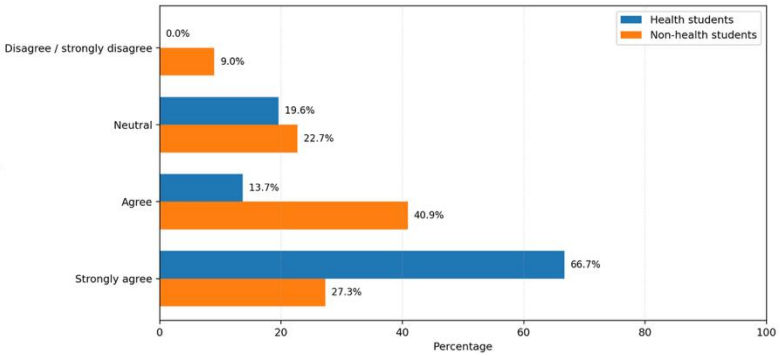


Figure 27. Q13. “Fluoride helps prevent cavities” Health and non-health students comparison.

Regarding the statement “Rinsing after brushing reduces fluoride benefits”, 72.6% of health students said they agreed or strongly agreed, compared with 36.3% of non-health students (Figure 28).

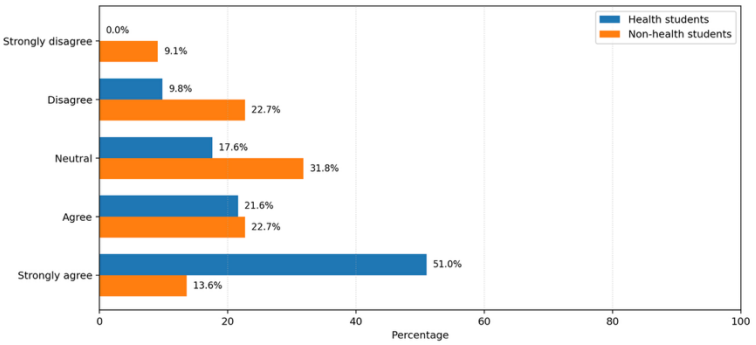


Figure 28. Q14. “Rinsing after brushing reduces fluoride benefits” Health and non-health students comparison.

Regarding the statement “Fluoride is dangerous”, no positive responses were recorded among health students, whereas 13.6% of non-health students agreed or strongly agreed (Figure 29).

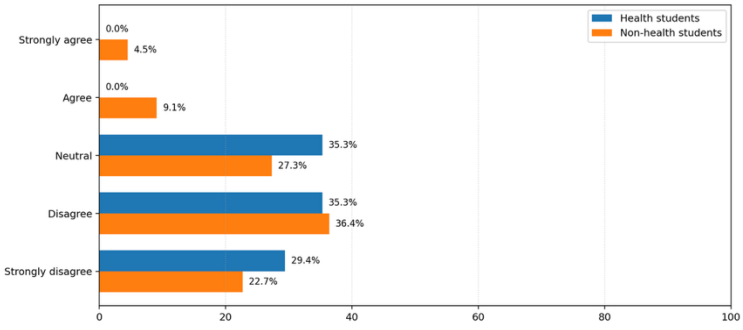


Figure 29. Q15. “Fluoride is dangerous” Health and non-health students comparison.

Finally, to the question “Do you feel well informed about fluoride?”, 78.4% of health students agreed or strongly agreed, compared with 31.8% of non-health students (Figure 30).

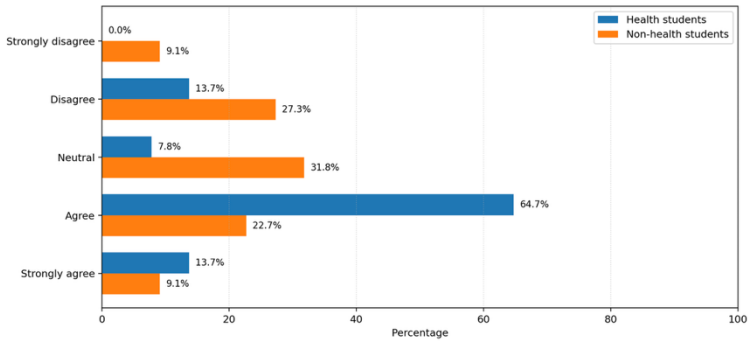


Figure 30. Q16. “Do you feel well informed about fluoride?” Health and non-health students comparison.

In relation to reported history of caries and oral health, non-health students also showed less favourable results. Non-healthcare students reported having had tooth decay before the age of 18 far more frequently than students studying in healthcare. Caries incidence in the last 12 months and after starting university were reported with a smaller difference, although still in favour of health students (Figure 31).

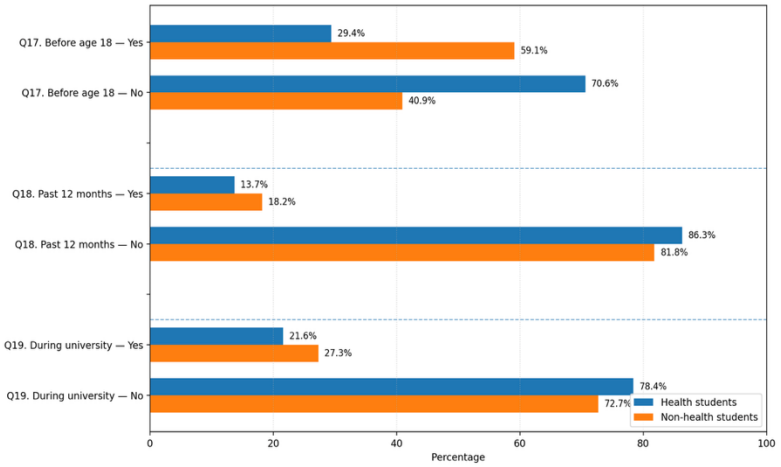


Figure 31. Self-reported caries experience. Health and non-health students comparison.

Self-assessment of oral health followed the same trend, with 94.1% of health students describing their oral health as good or very good, compared with 54.5% of non-health students (Figure 32).

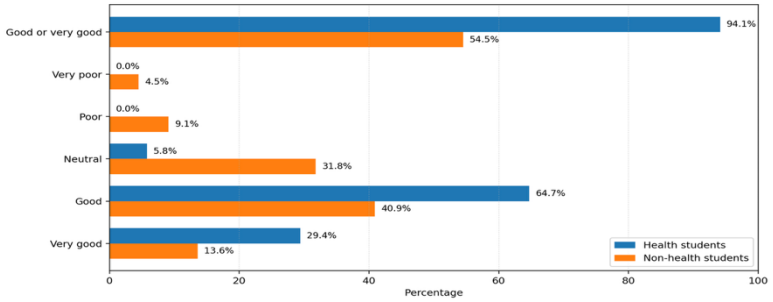


Figure 32. Q20. Self-rated oral health. Health and non-health students comparison.

5 DISCUSSION

The study suggests that university students generally have good preventive habits, with the majority using fluoride, but that this use is not always optimised. Most participants appeared to follow a daily oral hygiene and to use fluoride toothpaste. However, the specific habits and behaviours associated with the proper use of fluoride did not seem consistent. This distinction is crucial, as it suggests that among university students, the main challenge in prevention is not the presence of fluoride, but as implied in currents literature, rather its optimisation in terms of regularity and understanding (7,8,18,21).

One of the first findings was that students' oral hygiene habits appeared to be generally good. The majority report brushing their teeth twice a day, most for two minutes. Furthermore, many use interdental cleaning methods and visits to the dentist are generally annual. These tendencies are generally observed in other studies in general populations. However, in these studies, hygiene practices coexist with preventive knowledge that is generally more variable and a less systematic application of preventive oral health behaviours (11,13,14,16). Thus, the main preventive challenges in university students population appear to be more specific than those of the general population and mainly concern behaviours related to fluoride (5,11-13,16,21).

Regarding the general objective, fluoride exposure among university students seems to come mainly from toothpaste. This is an important and encouraging finding, given that toothpaste remains the first-line preventive measure against tooth decay and that the majority of students who responded were exposed to it on a daily basis (7,8,18,21). Nevertheless, exposure to fluoride was limited to toothpaste in most responses. The use of mouthwashes was infrequent and professional fluoride treatments were rare. These results hypothesise that caries prevention among these students relies almost exclusively on toothpaste.

The results also allow us to analyse the continuity of fluoride exposure. The results suggest that there is continuity in the use of fluoride but that this is self-managed and limited in its diversity. Continuity in caries prevention relies on toothpaste and, more rarely on complementary practices. The literature supports this observation, showing that patterns of fluoride exposure change with age and that, at university, fluoride-related preventive measures increasingly depend on individual habits rather than structured or supervised care (4,6). It is also important to note that discontinuing the use of fluoride has a negative effect on caries prevention, which reinforces the importance of

continuing fluoride use via toothpaste (3). Students hygiene behaviours and habits therefore have a direct influence on caries prevention, which is vulnerable to inconsistency (4,6,21).

Another very important point emerges from this study, concerning the correct use of fluoride products. The results indicate that, despite the extensive use of fluoride toothpaste, the majority of students were not using it in the most evidence-based way. The main example observed is rinsing after brushing, a practice followed by the majority of respondents. Indeed, studies show that rinsing after brushing reduces the topical effect of fluoride and the remineralisation of enamel, thereby diminishing the preventive effect of toothpaste (5,12). So, although toothpaste is used, part of its effect diminishes among the majority of students due to their behaviour. This finding therefore supports the idea that the effectiveness of fluoride depends not only on its presence, but also on understanding it and adopting the right behaviours (5,12,21,24).

The same principle applies to the concentration of toothpaste and the amount used. In fact, a significant proportion of students were unable to identify the fluoride concentration in their toothpaste. We can therefore assume that toothpaste is often used as part of a routine, without a real understanding of the fluoride concentration and its importance. This finding is important because the preventive effect of fluoride depends on it's concentration, which must be adapted to the risk of caries (17,18,21). Uncertainty regarding concentration should not be taken lightly, as it reflects insufficient knowledge and prevents individuals from making enlightened preventive choices. The amount of toothpaste used also remains non-optimal for certain respondents. These results indicate that the knowledge necessary to optimise the preventive effect of fluoride remains insufficient (6,17,18,21,23).

The findings regarding knowledge and attitudes toward fluoride further support this interpretation. Indeed, the majority of students responded favourably regarding the preventive effects of fluoride, while most responded unfavourably to the idea that fluoride is dangerous, and many feel well-informed. Fluoride is therefore generally well-accepted and viewed positively within this population. Other studies have reported similar results showing that broad support for preventive oral health practices can coexist with less comprehensive knowledge of specific recommendations related to fluoride (9,13,15,16). It should be noted, however, that the frequency of neutral responses to several of the questions mentioned above suggests that understanding is incomplete for many. Students may recognise the benefits of fluoride without having a sufficiently detailed understanding

of how it works or how it is used. This distinction is important because effective prevention depends not only on favourable attitudes, but also on precise and practical knowledge of how fluoride should be used to get the maximum benefits from it (9,13,16,21).

Based on the reported caries experience, a relationship between fluoride-related behaviours and reported history of caries can be suggested. This must nevertheless be done with caution as it is a cross-sectional study with no causal conclusion. In the reported results, the prevalence of caries was relatively low and the assessment of oral health was predominantly positive. However, the number of caries reported before the age of 18 was common, and some participants clearly stated that they had a carious lesion after starting university, as well as within the last 12 months. This indicates that, despite the widespread use of fluoride toothpaste, caries in this age group remains present and clinically revelant. Exposure to fluoride does not guarantee optimal prevention. Furthermore, this reinforces the idea that the effectiveness of fluoride is closely linked to good preventive behaviour and consistent exposure. This observation is consistent with existing studies demonstrating a link between fluoride use and preventive behaviours on the one hand, and oral health status and the risk of caries on the other (9,21).

A comparison of the survey results between health students and non-health students further supports the idea that a good understanding of preventive measures leads to more effective use of fluoride and better oral hygiene. Analysis of these two subgroups showed that health students generally had better oral hygiene habits, greater knowledge about fluoride, and a more positive perception of their dental health. They were better able to identify the fluoride concentration in their toothpaste, held a favourable view of it, and had a better understanding of prevention. These findings are consistent with various studies, supporting the fact that health students often demonstrate greater knowledge of oral health and more appropriate preventive behaviour (9,11,13,16). These findings suggest that university students should not be treated as a single group when it comes to prevention and knowledge related to good oral hygiene practices.

The parallel between health and non-health students therefore suggests that the main difference does not lie in the frequency of oral hygiene alone, but rather in the quality and accuracy of compliance with preventive measures. The results show that the frequency of brushing is similar, but that the difference lies in the use of interdental hygiene, the identification of fluoride concentration, beliefs regarding fluoride, and the perceived level of information. This result

suggests that the most marked difference between health and non-health students stems from the ability to know and apply prevention in daily practice. This suggests that non-health students may require greater emphasis on prevention, not because they reject the idea of fluoride or preventive measures but because they appear to have less accurate knowledge and less consistent behaviour regarding the use of fluoride and prevention (9,11,13,16).

These findings lead directly to the final objective, which is to draw up recommendations for the optimal use of fluoride among university students. The results suggest that prevention strategies aimed at this population should not be limited to promoting the use of fluoride toothpaste, as this practice is already widespread but instead, they should focus on improving the quality of this use. This involves, in particular, raising awareness of the appropriate fluoride concentration, encouraging the use of a sufficient amount of toothpaste and, most importantly, discouraging rinsing immediately after brushing. Furthermore, the marked differences between health students and others suggest that preventive interventions should focus particularly on students from non-health disciplines, who appear to have less knowledge of fluoride and less favourable preventive habits. Regular dental check-ups could also be used as opportunities for personalised advice on fluoride. These recommendations are consistent with current guidelines on topical fluoride, which increasingly emphasise behaviour-oriented and evidence-based use rather than the simple presence of fluoridated products (7,8,10,14,20-22).

This study also has certain limitations. Firstly, it is cross-sectional and self-reported, and therefore subject to response bias and bias linked to social desirability, particularly with regard to oral hygiene habits and a history of caries. The sample is also unbalanced towards students in the health sector and dentistry sector which have a better overall health profile. Also, as the study is cross-sectional and does not present any clinical examination, we cannot establish causal relationship and can only suggest associations and conclusions.

Future research could include a larger sample that is more representative of reality. We could also try to make the questionnaire more specific to obtain more accurate results on knowledge and use of fluoride. A clinical examination would also reinforce the results obtained.

6 CONCLUSION

The results of this study suggest that the main challenge for university students is not so much to increase the frequency of fluoride products use, but rather to optimise its utilisation and understanding. Thanks to the results obtained and their analysis, we can respond to the different objectives set out at the start of the study:

1. Fluoride exposure among university students was very high and mainly came from the use of fluoride toothpaste. Most participants reported using it daily, generally twice a day. However, the results suggest that this exposure is not optimal given the persistence of self-reported caries and of different behaviours that are not adapted to the proper effectiveness of fluoride.

2. Fluoride exposure among university students appeared to be consistent and was mainly due to the daily use of fluoride toothpaste, but the variety of products used was limited. Other fluoride-related measures such as the use of fluoride mouthwashes and professional fluoride treatments were much less common. This suggests that fluoride exposure among university students was largely self-managed and depended primarily on the daily use of toothpaste rather than a more comprehensive preventive strategy.

3. Knowledge and attitudes regarding fluoride were generally positive, but not fully consistent. Most students were aware of fluoride's preventive role and did not consider it to be dangerous. However, uncertainties remained regarding certain behavioural aspects of fluoride use, particularly among students outside the health sciences, suggesting that positive attitudes did not always go along with a complete understanding of its use.

4. Fluoride-related behaviours were only partially adequate. Although brushing frequency and overall oral hygiene habits were generally satisfactory, significant weaknesses remained in the practical use of fluoride. The most relevant were the high frequency of rinsing immediately after brushing, incorrect identification of the fluoride concentration in toothpaste, and variability in the amount of toothpaste used. These results suggest that the preventive benefits of fluoride may be reduced by non-optimal daily behaviours.

5. These findings highlight the importance of developing specific recommendations aimed at improving the quality of fluoride use among university students, particularly those not studying health-related subjects. Prevention strategies should not only promote the use of fluoride toothpaste, as is currently the case, but also improve knowledge about fluoride, encourage good post-brushing habits, raise awareness of fluoride concentrations, and make use of dental appointments to provide personalised advice on fluoride concentrations appropriate to the individual's preventive profile, as well as on behaviours to adopt for optimal fluoride use.

7 SUSTAINABILITY

This study seeks to support the community from a social, educational and economic level by highlighting the importance of improving university students' knowledge and behaviours regarding fluoride.

The results therefore suggest that preventive healthcare can be improved through education about fluoride, which still appears to be lacking among students. These differences are particularly evident among students in fields other than the health sciences, indicating that access to preventive knowledge is not equal, which may in fact contribute to differing health behaviours and outcomes. From a social and educational perspective, these results remind us of the importance of preventive education, so that everyone can make informed choices, have greater autonomy in personal care and healthier habits throughout their life.

Improving prevention through the use of fluoride could reduce the incidence of tooth decay and help reduce oral diseases, thereby improving the future quality of life for young adults. From an economic perspective, adopting these better preventive behaviours could prevent the onset of caries and thus reduce the need for costly future restorative treatment and the economic impact of this disease. This study finally highlights the importance of fluoride prevention as a sustainable approach to oral health.

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9 ANNEXES

Questionnaire

Questionnaire on fluoride use and perception, oral hygiene habits and caries experience among university students.

This questionnaire forms part of the Final Degree Project in Dentistry at the European University of Madrid entitled The use of fluoride dental products in University students, supervised by Professor X. The purpose of this study is to collect her information on the use and perception of fluoride, oral hygiene habits and experience with tooth decay among university students. The information will be collected through a short survey. Your participation in this study is voluntary, and you may request to be excluded from it without prior justification or prejudice to yourself. The information collected will be confidential and will not be used for any purpose other than this research and its dissemination. The data collected will be completely anonymous. No personally identifiable information will be requested. The data collected in the survey will be processed in accordance with the provisions of Organic Law 3/2018, of 5 December, on the Protection of Personal Data and the guarantee of digital rights.

For the purposes of the provisions of Organic Law 3/2018, of 5 December, on the Protection of Personal Data and Guarantee of Digital Rights, you are hereby informed and expressly consent to the use of the data provided in the survey for the purposes indicated above. This consent is granted without prejudice to all your rights in relation to the aforementioned regulations, and you may access, rectify, cancel and oppose the information provided at any time you wish. To do so, you must write to the tutor, Prof. X.

Do you consent to participating in the survey as a volunteer so that the survey results can be used in the Final Degree Project entitled The use of fluoride dental products in University students?

YES

NO

General information:

1) How old are you?

2) What is your academic field of study?

3) What is your current living situation?

Alone.

With family.

In shared accommodation.

In couple.

Oral hygiene habits:

4) How often do you brush your teeth?

Once a day.

Twice a day.

More. If more how many times per day?

Less. If less how many times per week?

5) How long do you usually brush?

1 minute.

2 minutes.

More.

Less.

6) Do you floss or use interdental brushes?

Yes. If yes, what is the frequency?

No.

7) How often do you go to the dentist?

Once a year.

Twice a year.

More. If more how many times per year?

Less. If less how often do you go?

Fluoride toothpaste use:

8) Do you use fluoride toothpaste?

Yes. If yes, what fluoride concentration (ppm) is written on the tube?

No.

9) How much toothpaste do you apply?

A drop.

A pea-size.

1-2 cm.

More than 1 or 2 cm.

10) Do you rinse with water immediately after brushing?

Yes.

No.

Other fluoride products:

11) Do you use a mouthrinse?

Yes.

No.

12) Have you ever received professional fluoride treatment (varnish, gel)?

Yes. If yes how much?

No.

Knowledge and beliefs about fluoride:

13) Fluoride helps prevent cavities.

(1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

14) Rinsing after brushing reduces fluoride benefits.

(1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

15) Fluoride is dangerous.

(1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

16) Do you feel well informed about fluoride ?

(1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

Caries experience :

17) Have you had a cavity before 18 years old?

Yes. If yes, how many?

No.

18) Have you had a cavity in the last 12 months?

Yes. If yes, how many?

No.

19) Have you had a cavity after starting university?

Yes. If yes, how many?

No.

20) How would you describe your dental health?

(1 = very bad, 2 = bad, 3 = normal, 4 = good, 5 = very good)