AWARENESS OF BENEFITS AND RISKS OF FLUORIDATED TOOTHPASTE AMONG IIUM DENTAL AND SCIENCE STUDENTS

SUPA'AT, S.[1] – ARIFFIN, F. N. A.[2] – KHAIRUNNIZAM, K. S.[2] – ARDINI, Y. W.[2] – IBRAHIM, M. S. M.[1*]

[1] *Department of Paediatric Dentistry and Dental Public Health, International Islamic University Malaysia, Kuantan, Malaysia.*

[2] *Kulliyyah of Dentistry, International Islamic University Malaysia, Kuantan, Malaysia.*

**Corresponding author*
e-mail: shafiq[at]iium.edu.my

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Abstract. Dental caries is a significant health issue in Malaysia and globally. Thorough brushing with fluoridated toothpaste can help prevent caries. Although fluoridated toothpaste offers protection against dental caries, its overuse can result in negative effects. Therefore, it is essential to recognise the associated risks and weigh them carefully against its benefits. This study aimed to evaluate the awareness of the benefits and risks of using fluoridated toothpaste and its practice of usage among dental and science students. A cross-sectional survey was conducted using a structured questionnaire comprising three sections: demographic profile, awareness of benefits and risks, and usage of fluoridated toothpaste. A total of 296 students (148 dental and 148 science) participated. Results showed that dental students exhibited a higher level of awareness regarding the benefits of fluoridated toothpaste (95.1%) compared to science students (79.4%). Furthermore, dental students also had greater awareness of the associated risks (58.3%) than science students (33.6%). A statistically significant difference in awareness levels was observed between both groups ($p<0.001$). Among dental students, awareness increased progressively from Year 1 to Year 4, whereas no significant differences were found across academic years among science students. In conclusion, dental students demonstrated greater awareness of both the benefits and risks of using fluoridated toothpaste than science students. Increased awareness was associated with better oral hygiene practices. Future research could explore targeted interventions to enhance fluoride-related public awareness and promote effective oral health behaviours.
Keywords: *fluoridated toothpaste, awareness, benefit, risk*

Introduction

Fluoride, the ionic form of fluorine, is one of the most abundant elements in nature, ranked as the thirteenth most prevalent element in the Earth's crust. It is primarily sourced from water and occurs naturally in the environment through air and water exposure (Aoun et al., 2018). Initially, fluoride's systemic benefits were recognised for their contribution to tooth development; however, subsequent research has emphasised the significance of its topical effects in preventing and managing dental caries and tooth decay (Aoun et al., 2018). Topically, fluoride plays a vital role in oral health by forming fluorhydroxyapatite (HA), which facilitates the remineralisation of early enamel lesions and establishes reservoirs of calcium fluoride. The HA crystal coat enhances the structural stability of enamel, increasing its resistance to acid dissolution. Meanwhile, calcium fluoride serves as a fluoride ion reservoir, especially under neutral or acidic pH conditions, releasing ions into demineralized areas and helping reduce or halt the demineralization process (Wang et al., 2019). Fluoride also demonstrates significant

anticariogenic and antibacterial properties. According to Aoun et al. (2018), fluoride ions (F^-) lower the pH within bacterial cells through the release of hydrogen ions (H^+) and fluoride ions from hydrogen fluoride. This acidification disrupts bacterial enzymatic processes, such as those involving proton-releasing adenosine triphosphatase and enolase. As a result, bacteria expend more energy to regulate their internal pH, limiting their capacity to grow, reproduce, and produce harmful acids and carbohydrates.

Numerous studies confirm that fluoridated toothpaste is safe for adults with normal swallowing function, with a minimal risk of fluorosis from appropriate use (Wang et al., 2019; Gundavarapu et al., 2017). Nevertheless, excessive or improper use that leads to fluoride intake beyond recommended levels may result in dental fluorosis. This condition is characterized by developmental disturbances of dental enamel due to fluoride overexposure during tooth formation (Alshehri and Kujan, 2015; Alvarez et al., 2009). Regarding other potential risks, several studies have shown no conclusive evidence linking fluoride use in drinking water to osteosarcoma (Kim et al., 2020; Gelberg et al., 1995; Freni and Gaylor, 1992). However, long-term impacts on skeletal health remain an area of ongoing research (Chachra et al., 2010). In Malaysia, findings from the National Oral Health Survey of Adults (MOH, 2010) indicated a decrease in dental caries prevalence among adults, from 94.6% in 1990 to 88.9% in 2010. This improvement has been attributed to nationwide initiatives promoting the use of fluoridated toothpaste. Despite these efforts, caries continues to be highly prevalent, underscoring the need for enhanced public awareness regarding the appropriate and effective use of fluoride. To address this issue, the present study aims to assess the level of awareness regarding the benefits and risks associated with fluoridated toothpaste among undergraduate students at the International Islamic University Malaysia (IIUM). Science students are included as representatives of the general public due to their relatively limited exposure to dental health education, whereas dental students provide a comparative perspective due to their academic background in oral health. The insights obtained from this study will help identify gaps in knowledge and inform future educational strategies to improve fluoride-related awareness and promote effective public health practices.

Materials and Methods

This study utilised a cross-sectional survey design using convenience sampling to assess awareness and usage practices regarding fluoridated toothpaste among undergraduate students at the International Islamic University Malaysia (IIUM) Kuantan Campus. The participants included were undergraduate students from Year 1 to Year 4 enrolled in either the Kulliyyah of Dentistry or the Kulliyyah of Science. Excluded from the study were postgraduate students and Year 5 dental students due to their advanced knowledge and exposure to fluoride toothpaste. The study employed a structured questionnaire divided into three sections. The first section covered the demographic profile of the participants, including age, gender, year of study, and the name of their kulliyyah. The second and third sections addressed participants' awareness of the benefits and risks of using fluoridated toothpaste, as well as their practices related to its usage. To ensure validity and reliability, the questionnaire underwent content and language validation by subject matter experts. A pilot study was subsequently conducted involving eight students from the Kulliyyah of Dentistry and the Kulliyyah of Allied Health Sciences to assess the instrument's clarity, internal consistency, and

reliability. Feedback from this pilot was incorporated into the final version of the questionnaire. Data collection was conducted via Google Forms following the obtaining of consent from the participants. This research was reviewed and approved by the International Islamic University Malaysia (IIUM) Research Ethics Committee (IREC No: IREC 2023-131).

Sample size calculation was performed using G*Power software version 3.1.9.7 with an independent t-test with an alpha of 0.05, a power of 90%, and a medium effect size (d=0.40); a minimum sample size of 266 participants was required. Considering a potential dropout rate of 10%, the final required sample size was 296 participants, resulting in 148 participants per kulliyyah. Data analysis was performed using IBM SPSS Statistics version 25.0 (IBM Corporation, Armonk, NY, USA) and Microsoft Excel 2016. Descriptive statistics, including frequencies and percentages, were used to summarise demographic characteristics and evaluate students' awareness and fluoride toothpaste usage practices. Inferential statistical analyses included the Mann-Whitney U test to compare awareness between dental and science students, and Spearman correlation to examine the association between awareness and usage practices. The Kruskal-Wallis test was utilised to identify differences in awareness across different years within each kulliyyah. A p-value less than 0.05 was considered statistically significant.

Results and Discussion

A total of 296 students participated in this study, equally comprising 148 students from the Kulliyyah of Dentistry and 148 students from the Kulliyyah of Science. Among the dentistry students, the majority were female (86.5%), while males made up only 13.5%. In contrast, the science students showed a more balanced gender distribution, with females representing 51.4% and males 48.6%. Participants from both kulliyyah were equally distributed across years of study, with 25% from each academic year (Year 1 to Year 4) as presented in *Table 1*.

Table 1. *Sociodemographic of the participants.*

Variable	Kulliyyah of Dentistry [n (%)]	Kulliyyah of Science [n (%)]
Gender		
Male	20 (13.5)	72 (48.6)
Female	128 (86.5)	76 (51.4)
Year of study		
Year 1	37 (25)	37 (25)
Year 2	37 (25)	37 (25)
Year 3	37 (25)	37 (25)
Year 4	37 (25)	37 (25)

Awareness of the benefits and risks of using fluoridated toothpaste

Based on *Figure 1*, both dental and science students exhibited a high percentage of correct responses to the first three questions concerning the benefits of fluoridated toothpaste. These questions aimed to assess students' understanding that fluoridated toothpaste can enhance tooth surface strength, improve oral hygiene practices, and increase resistance to dental caries. Although dental students recorded higher percentages than science students, both groups demonstrated a high level of awareness.

This is likely due to the general nature of these questions and the widespread public knowledge of these benefits. For the fourth to sixth questions, which explored other benefits such as slowing down acid production by bacteria, promoting tooth remineralisation, and preventing tooth demineralisation, dental students again showed a higher percentage of correct responses compared to science students. This indicates a deeper understanding of the mechanisms of fluoride among dental students. In addition, the awareness of risks linked to fluoridated toothpaste was assessed starting from question seven. Results showed that dental students had a greater percentage of correct answers compared to science students. A significant number of dental students recognised the risk of dental fluorosis, which affects the appearance of the tooth surface. However, awareness about skeletal fluorosis, a condition caused by excessive fluoride that alters bone structure, was relatively low in both groups (Dentistry: 53.4%; Science: 25%). Additionally, the awareness of a potential connection between fluoridated toothpaste and osteosarcoma was the lowest among all evaluated risks and benefits (Dentistry: 37.8%; Science: 8.8%). This low awareness may be due to the rarity of osteosarcoma.

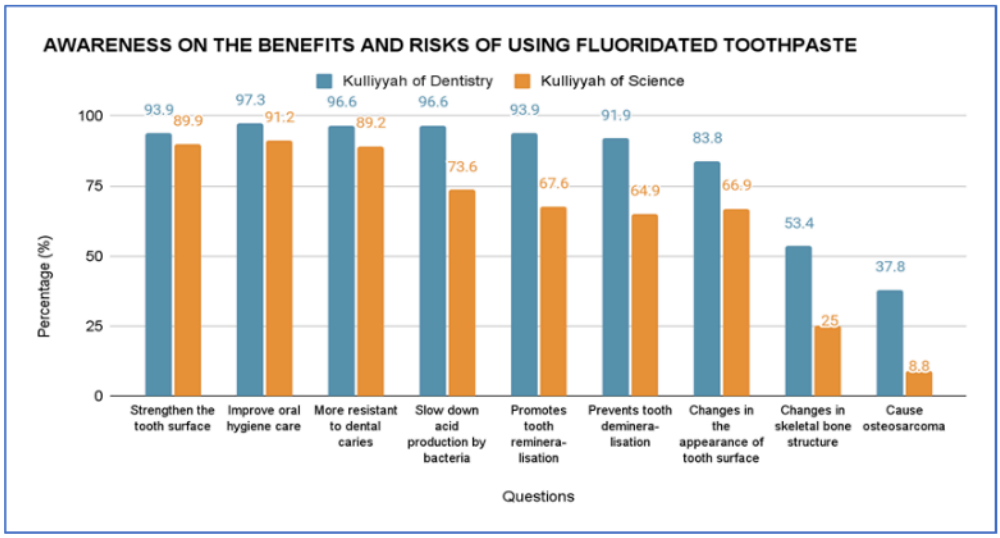

Figure 1. *Comparison on fluoride awareness of benefits and risks of fluoridated toothpaste between dental and science students.*

Based on *Table 2*, dental students have a significantly higher level of awareness (5.70±0.83) compared to science students (4.76±1.44) regarding the benefits of using fluoridated toothpaste. Similarly, dental students also demonstrate higher awareness (1.75±1.07) compared to science students (1.00±0.88) concerning the risks associated with using fluoridated toothpaste. Although both groups exhibit lower mean scores for risk awareness than for benefit awareness, the difference between the two groups remains statistically significant. These findings suggest that dental students generally possess a good understanding of both the benefits and risks of using fluoridated toothpaste, likely due to their academic exposure to dental health education. In contrast, science students show a notably lower level of awareness, particularly concerning potential risks. This highlights the need for targeted educational interventions to improve knowledge and awareness of fluoride use, especially among non-dental students who represent the broader public.

***Table 2**. Comparison of the mean on fluoride awareness of the benefits and risks of fluoridated toothpaste between dental and science students.*

Category	Kulliyyah of Dentistry Mean (SD)	Kulliyyah of Science Mean (SD)	p-value
Benefits	5.70 (0.83)	4.76 (1.44)	0.001
Risks	1.75 (1.07)	1.00 (0.88)	0.001

The usage of fluoridated toothpaste

Based on *Figure 2*, the findings indicate that both dental and science students generally maintain good oral hygiene practices, with high percentages reporting brushing their teeth at least twice daily (99.3% for dental students and 91.2% for science students). However, there are notable differences in the usage of fluoridated toothpaste and other related practices. Dental students (93.2%) reported higher usage of fluoridated toothpaste compared to science students (65.5%). This suggests that dental students have higher fluoride exposure through their oral care products. Some respondents answered "No" or "Don't know" regarding the type of toothpaste used, indicating potential variability in fluoride exposure between the groups. A higher percentage of dental students (76.4%) correctly reported using the recommended pea-sized amount of toothpaste compared to science students (59.5%). Furthermore, a significant majority of dental students (90.5%) reported spitting and not rinsing or rinsing with small amounts of water after brushing, which helps prolong fluoride exposure on the teeth. In contrast, fewer science students (54.7%) reported this practice. Most dental students (91.2%) reported brushing their teeth for the recommended duration of 2 minutes, while a lower percentage of science students (57.4%) adhered to this guideline. These findings underscore that while both groups generally adhere to basic oral hygiene practices, dental students tend to have better adherence to practices that maximise fluoride exposure and effectiveness, potentially due to their training and education in dental care.

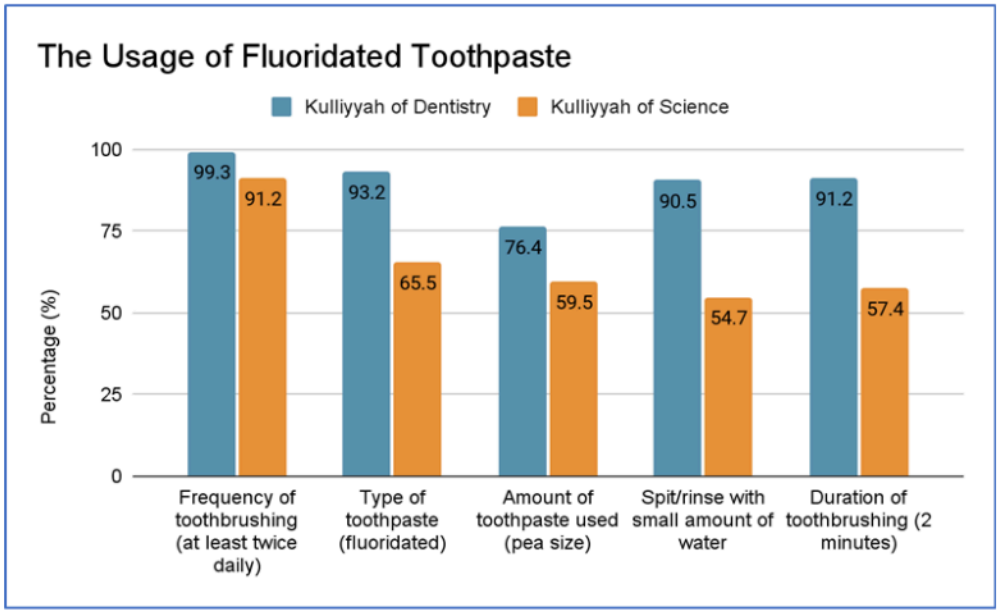

***Figure 2.** Comparison on the usage of fluoridated toothpaste between dental and science students.*

Relationship between awareness and usage of fluoridated toothpaste

Based on *Table 3*, there is a statistically significant positive correlation (r=0.426, p=0.001) between awareness of the benefits and risks of fluoridated toothpaste and its usage among dental students. This indicates that students in the Kulliyyah of Dentistry who possess higher awareness levels are more likely to practice appropriate usage of fluoridated toothpaste. In contrast, while science students also demonstrate a statistically significant correlation (r=0.200, p=0.015), the strength of the correlation is weaker. This suggests that although there is a relationship, awareness may not be the primary factor influencing the usage of fluoridated toothpaste among science students.

***Table 3**. Relationship between awareness and usage of fluoridated toothpaste.*

Category	Correlation coefficient (r)	p-value
Kulliyyah of Dentistry	0.426	0.001
Kulliyyah of Science	0.200	0.015

Level of awareness between years of study

Based on *Table 4*, the analysis reveals notable differences in the level of awareness regarding the benefits and risks of using fluoridated toothpaste among dental and science students across different years of study. Among students in the Kulliyyah of Dentistry, the median level of awareness increases progressively from Year 1 to Year 4, ranging from 6 (IQR 5,7) in Year 1 to 9 (IQR 8,9) in Year 4. The p-value of 0.001 indicates that this difference is statistically significant, suggesting that awareness among dental students improves as they advance through their academic training. In contrast, students from the Kulliyyah of Science show relatively consistent awareness levels across all four years of study. The median values range from 5 to 6, with overlapping interquartile ranges, and a non-significant p-value of 0.091. This suggests that the year of study does not significantly influence awareness levels among science students, potentially due to limited exposure to fluoride-related content. These findings emphasise the effectiveness of dental education in increasing fluoride awareness and highlight a need for broader oral health education strategies targeting science students.

***Table 4**. Level of awareness towards the benefits and risks of using fluoridated toothpaste between years of study.*

Variable	Median (IQR)				p-value
	Year 1	Year 2	Year 3	Year 4	
Kulliyyah of Dentistry	6 (5,7)	7 (7,8)	8 (7,9)	9 (8,9)	0.001
Kulliyyah of Science	5 (4,7)	5 (4,7)	6 (5,7)	6 (5,7)	0.091

In Malaysia, several measures have been introduced to reduce dental caries through fluoride delivery, such as promoting fluoridated toothpaste, water fluoridation, and professional fluoride treatments. The Ministry of Health Malaysia recommends using over-the-counter fluoride toothpastes with concentrations of 1000-1500 ppm, with water fluoridation being the primary method for fluoride management. However, not all states have water fluoridation programs, making fluoridated toothpaste even more essential for preventing dental caries (Karim et al., 2020). This study, conducted at IIUM Kuantan, examined the awareness levels regarding the benefits and risks of using fluoridated toothpaste among dental and science students. Dental students demonstrated significantly higher awareness of its benefits, with correct response rates ranging from 91.9% to 97.3%. This higher awareness reflects their comprehensive educational

background and aligns with findings from prior studies by Ahmad et al. (2021), Sutharshan et al. (2020) and Wang et al. (2019). Additionally, awareness of fluoride-associated risks was greater among dental students (58.3%) than science students (33.6%), which may be attributed to the integration of both theoretical and clinical training within the dental curriculum. These outcomes support the continued emphasis on fluoride education within dental programs.

The study also revealed a progressive increase in fluoride awareness among dental students from Year 1 to Year 4, suggesting that continuous exposure and academic reinforcement contribute positively to knowledge acquisition. Similar trends were observed in a 2021 study conducted at the Faculty of Dentistry, Universiti Kebangsaan Malaysia (UKM), which reported higher awareness with advancing years of study (Ahmad et al., 2021). These findings imply that expanding practical training and continuous reinforcement of fluoride knowledge throughout the academic journey can further strengthen students' understanding and compliance with best practices. Conversely, science students exhibited moderate awareness of fluoride benefits, with an average correct response rate of 79.4%, ranging between 64.9% and 91.2%. However, their awareness of fluoride-related risks remained notably lower at 33.6%. These outcomes are consistent with findings from Reddy et al. (2014), who attributed the knowledge gap to the lack of dental-specific content in science curricula. To address this deficiency, the integration of fluoride-related topics into science courses, alongside interdisciplinary educational initiatives such as workshops and collaborations with dental students, could be beneficial. Moreover, the study observed no statistically significant differences in awareness levels across academic years among science students, implying a plateau in fluoride-related knowledge. This finding is understandable, as fluoride-related content is not formally embedded in the science curriculum. To improve this, it would be beneficial for science students to receive periodic awareness sessions conducted by the kulliyyah of dentistry, providing structured opportunities to gain insights into fluoride use and oral health best practices.

In terms of oral hygiene practices, the findings showed that 99.3% of dental students and 91.2% of science students brushed their teeth at least twice daily, in accordance with Malaysian Dental Council (MDC) guidelines (2021). Fluoridated toothpaste usage was significantly higher among dental students (93.2%) compared to science students (65.5%), many of whom were unaware of their toothpaste's fluoride content. Furthermore, 76.4% of dental students used a pea-sized amount of toothpaste as recommended, compared to 59.5% of science students. Regarding post-brushing habits, 90.5% of dental students spit or rinse with a small amount of water to retain fluoride's protective effect, while only 54.7% of science students followed this practice. Additionally, 91.2% of dental students adhered to the recommended two-minute brushing duration, in contrast to 57.4% of science students. These disparities underscore the need for targeted public health initiatives and hands-on demonstrations to promote best practices, particularly among non-dental populations. Overall, the study reinforces that dental students are generally more informed and exhibit better adherence to recommended fluoride usage and oral hygiene practices, a reflection of their specialised training. Science students, by comparison, display lower levels of awareness and adherence, highlighting a critical area for intervention. Consistent with Ahmad et al. (2021), who reported a 99% usage rate of fluoridated toothpaste among dental students, these findings demonstrate the effectiveness of dental education. To bridge the gap, targeted awareness campaigns, enhanced access to fluoride-related educational

materials, and interdisciplinary collaboration are recommended to improve knowledge and behaviors among all student populations.

Conclusion

Dental students demonstrated significantly higher awareness of the benefits and risks of using fluoridated toothpaste compared to science students, which correlated with more effective toothbrushing practices. Furthermore, dental students' awareness progressively increased with each year of study, highlighting the impact of continued education and clinical exposure. In contrast, science students, representing the general public, showed lower awareness, likely due to limited exposure to fluoride-related information. These findings underscore the need for broader public education initiatives to enhance awareness about fluoride's role in preventing dental caries. By empowering individuals through targeted education and interdisciplinary engagement, public health efforts can better support informed decision-making and encourage the adoption of effective oral hygiene practices across diverse populations.

Acknowledgement

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Conflict of interest

The authors declare that they have no potential conflicts of interest.

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