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د.أنسام عبد السلام أبو موسى Dr.Ansam Abdulsalam Abu-Mousa	اسم الباحث الأول باللغتين العربية والإنجليزية	"دور التربية الصحية في الوقاية من تسوس الأسنان: دراسة على عادات تنظيف الأسنان لدى طلبة الجامعات في محافظات غزة"
د.إسلام محمد فروانة Dr. Islam Mohammed Firwana	اسم الباحث الثاني باللغتين العربية والإنجليزية:	
د.يمان صبحي أبو ناموس Dr. Yaman Sobhi AbuNamous	اسم الباحث الثالث باللغتين العربية والإنجليزية:	
د.يقين حسن أبو ناموس Dr.Yaqeen Hasan AbuNamous	اسم الباحث الرابع باللغتين العربية والإنجليزية:	
كلية طب الفم والأسنان - جامعة فلسطين - غزة - فلسطين Faculty of Dental Medicine - University of Palestine	¹ اسم الجامعة والدولة (لأول) باللغتين العربية والإنجليزية	
كلية طب الفم والأسنان - جامعة فلسطين - غزة - فلسطين Faculty of Dental Medicine - University of Palestine	² اسم الجامعة والدولة (لثاني) باللغتين العربية والإنجليزية	"The Role of Health Education in Preventing Dental Caries: A Study on Toothbrushing Habits among University Students in Gaza Governorates "
كلية طب الفم والأسنان - جامعة فلسطين - غزة - فلسطين Faculty of Dental Medicine - University of Palestine	³ اسم الجامعة والدولة (لثالث) باللغتين العربية والإنجليزية	
كلية طب الفم والأسنان - جامعة فلسطين - غزة - فلسطين Faculty of Dental Medicine - University of Palestine	⁴ اسم الجامعة والدولة (لرابع) باللغتين العربية والإنجليزية	
Nono.dr.2025@gmail.com	* البريد الإلكتروني للباحث المرسل: E-mail:	
		لاستعمال هيئة التحرير Doi:

الملخص:

هدفت الدراسة الحالية إلى دراسة دور التربية الصحية في الوقاية من تسوس الأسنان بين طلاب الجامعات في محافظات غزة، مع التركيز على عادات تنظيف الأسنان بالفرشاة. استكشفت الدراسة العلاقة بين حدوث تسوس الأسنان ومجموعة من عوامل نظافة الفم، بما في ذلك طريقة التفريش، مدة التفريش، تكرار التفريش، نوع فرشاة الأسنان، واستخدام معجون الأسنان المحتوي على الفلورايد. تم استخدام تصميم دراسة حالة-ضابطة، حيث تم اختيار عينة مكونة من 400 طالب وطالبة عشوائياً من جامعات قطاع غزة. جُمعت البيانات باستخدام أدوات الفحص السريري للأسنان واستبيانات منظمة. تم الحصول على التصاريح من إدارات الجامعات قبل جمع البيانات. حلت البيانات باستخدام برنامج SPSS، مع استخدام جداول التكرار، واختبارات كاي-تربيع، واختبارات t. أظهرت النتائج وجود علاقة ذات دلالة إحصائية بين حدوث تسوس الأسنان وطريقة التفريش وكذلك استخدام معجون الأسنان المحتوي على الفلورايد. ومع ذلك، لم تُظهر النتائج علاقة ذات دلالة إحصائية بين حدوث التسوس وتكرار أو مدة التفريش أو عمر فرشاة الأسنان. تؤكد هذه النتائج أهمية التربية الصحية في تعزيز ممارسات نظافة الفم الفعالة للحد من انتشار تسوس الأسنان بين الشباب.

كلمات مفتاحية: (التسوس، نظافة الفم، التربية الصحية، الوقاية، سلوك صحي)

Abstract:

The current study aimed to examine the role of health education in preventing dental caries among university students in Gaza, with a focus on toothbrushing habits. The study explored the relationship between dental caries occurrence and various oral hygiene factors, including brushing method, brushing duration, brushing frequency, type of toothbrush, and the use of fluoride-containing toothpaste. A case-control study design was employed, with a sample of 400 students selected randomly from universities in the Gaza Strip. Data were collected using clinical dental examination tools and structured questionnaires. Permissions were obtained from university administrations prior to data collection. Data were analyzed using SPSS software, employing frequency tables, chi-square tests, and t-tests. The results showed a statistically significant relationship between dental caries occurrence and both the method of brushing and the use of fluoride toothpaste. However, no significant relationship was found between caries occurrence and the frequency or duration of brushing or the age of the toothbrush. These findings underscore the importance of health education in promoting effective oral hygiene practices to reduce the prevalence of dental caries among young adults.

Keywords: (Caries, Oral Hygiene, Health Education, Prevention, Healthy Behavior)

1. Introduction

Oral health is an essential component of general health and well-being, especially among young adults. Dental caries remains one of the most widespread chronic diseases globally, affecting approximately 60–90% of schoolchildren and nearly 96% of adults. Several factors contribute to the development of dental caries, including diet, oral microflora, tooth structure, time, and most importantly, personal oral hygiene habits.

Health education plays a vital role in preventing oral diseases by promoting knowledge, shaping attitudes, and reinforcing healthy behaviors. It encourages individuals to adopt proper oral hygiene practices such as regular toothbrushing, correct brushing techniques, use of fluoride toothpaste, and routine dental checkups. Educating young adults—particularly university students—about the importance of oral hygiene can significantly reduce the prevalence of dental caries and related complications.

Toothbrushing, as a key preventive measure, is influenced by health awareness. Brushing methods are typically classified as horizontal, vertical, and circular, each with varying effectiveness in plaque removal. Likewise, the choice of toothbrush, duration and frequency of brushing, and the type of toothpaste used can all impact oral health outcomes. Proper health education helps individuals understand and implement the most effective techniques for maintaining oral health.

This study aims to explore the role of health education in preventing dental caries among university students in Gaza, with a particular focus on how educational exposure affects toothbrushing habits and their relationship to caries occurrence.

2. Study Objectives

2.1 General Objective

To examine the role of health education in preventing dental caries among university students in Gaza, by evaluating their oral hygiene behaviors and toothbrushing habits.

2.2 Specific Objectives

- To assess the level of health education and awareness among university students regarding oral hygiene.
- To determine the relationship between health education and the methods of toothbrushing.
- To evaluate the effect of health education on the frequency and duration of toothbrushing.
- To explore the association between health education and the use of fluoride-containing toothpaste.
- To investigate how health education influences students' choices regarding toothbrush type and brushing technique.
- To analyze the relationship between dietary habits and dental caries in the context of oral health education.

3. Literature Review

3.1 Caries Definition

Dental caries, commonly known as tooth decay or cavities, is the destruction of tooth structure due to acids produced by bacteria in the oral cavity. These cavities may present in various colors, ranging from yellow to black, and symptoms often include pain and difficulty eating. Complications can progress to inflammation of the surrounding tissues, tooth loss, and formation of abscesses (Suddick et al., 1990).

3.2 History of Caries

3.2.1 History of Dental Caries

Dental caries have afflicted humans and their ancestors for millions of years. Fossil evidence shows that hominins such as *Paranthropus* experienced cavities over a million years ago (Towle et al., 2017). The prevalence of caries has been strongly linked to dietary shifts, particularly the increased consumption of carbohydrates (Suddick et al., 1990; Luis et al., 2018). Archaeological findings indicate that dental caries is an ancient disease, observed in skulls from the Paleolithic, Mesolithic, and Neolithic periods (Richards, 2002). The Neolithic rise in caries prevalence is attributed to greater carbohydrate intake, including the onset of rice cultivation in South Asia (Lukacs, 1996; Tayles et al., 2000). Interestingly, some archaeological sites in Thailand, such as Khok Phanom Di, show a decrease in caries alongside rice agriculture intensification (Beavers Dentistry, 2007).

Ancient civilizations held various beliefs about caries causation. A Sumerian text from 5000 BC attributed tooth decay to a "tooth worm" (Coppa et al., 2006), a notion also shared by cultures in India, Egypt, Japan, and China (Luis et al., 2018). Primitive dental treatments are evidenced in Pakistan, where drilled holes in teeth dating between 5500 and 7000 BC suggest early dental intervention (Anderson, 2004). The Egyptian Ebers Papyrus (1550 BC) mentions dental diseases (Coppa et al., 2006), while Assyrian texts from the Sargonid dynasty (668–626 BC) document tooth extraction to prevent infection spread (Luis et al., 2018). The Greco-Roman world and Egypt had treatments addressing caries pain (Luis et al., 2018).

Caries prevalence remained low through the Bronze and Iron Ages but increased sharply in the Middle Ages, correlating with sugar cane's introduction to Western diets (Suddick et al., 1990). Treatment during this time was mostly herbal remedies, charms, bloodletting, and tooth extraction by barber surgeons, who provided effective relief and infection control (Elliott, 2004; Luis et al., 2018). Saint Apollonia was venerated as the patroness of dentistry, with prayers sought for relief from tooth pain (Gerabek, 1999).

Theoretical Framework

Dental Caries: Definition and Prevalence

Dental caries, commonly known as tooth decay, is a chronic, multifactorial disease characterized by the demineralization of tooth enamel and dentin caused by acidic by-products from bacterial fermentation of dietary sugars (Fejerskov & Kidd, 2008). It remains one of the most prevalent oral diseases worldwide, affecting children and adults alike (World Health Organization [WHO], 2022).

The high prevalence of dental caries poses significant public health challenges, particularly in developing countries where access to preventive care is limited (Kassebaum et al., 2015).

Historical Perspective on Dental Caries and Oral Hygiene

Post-contact dietary changes led to a rise in caries among North American Indigenous populations, transitioning from hunter-gatherer diets to maize agriculture (Suddick et al., 1990). During the European Enlightenment, the "tooth worm" theory was discredited. Pierre Fauchard, known as the father of modern dentistry, identified sugar as a major factor in tooth decay (Kleinberg, 2002). The 19th-century Industrial Revolution saw a dramatic increase in caries due to refined sugar and flour becoming widely available (Luis et al., 2018).

W.D. Miller's research in the 1890s established that bacteria in the mouth produce acids that dissolve tooth structure when fermentable carbohydrates are present (Baehni & Takeuchi, 1996; Newbrun, 1989). This "chemoparasitic caries theory" underpins modern understanding. Foundational research by G.V. Black and J.L. Williams on dental plaque (Luis et al., 2018), identification of lactobacilli strains by Fernando E. Rodriguez Vargas (1921), and the discovery of *Streptococcus mutans* by Killian Clarke (1924), later confirmed as a caries-causing bacterium, shaped current knowledge (Selwitz, Ismail, & Pitts, 2007). Thus, dental caries is a multifactorial disease requiring bacteria, substrate (carbohydrates), and susceptible teeth (Beavers Dentistry, n.d.).

History of Oral Hygiene

Ancient oral hygiene tools included chewing sticks with frayed ends, found in Babylonia around 3500 BC, feathers, bones, and porcupine quills used as toothpicks in Greek and Roman empires (Beavers Dentistry, n.d.). The earliest modern toothbrush prototype appeared in China in the late 1400s, using stiff hog hairs on bamboo handles. William Addis created the first mass-produced toothbrush in 1780 in a British prison, a precursor to modern toothbrushes (Beavers Dentistry, n.d.). Nylon-bristle brushes appeared in 1938 (DuPont), and the first electric toothbrush was invented in 1954 in Switzerland.

Early toothpaste formulas varied, including unusual ingredients such as pepper, salt, mint, ashes of ox hooves, burnt eggshells, crushed bones, and even urine (Beavers Dentistry, n.d.). Despite this, early populations had lower caries prevalence likely due to low refined sugar intake. The first commercially successful toothpastes appeared in the 19th century, facilitated by innovations such as collapsible tubes (Beavers Dentistry, n.d.).

Factors Influencing Dental Caries

Several factors contribute to the development of dental caries, including microbial flora, dietary habits, oral hygiene practices, and socio-economic conditions (Selwitz et al., 2007). Frequent consumption of fermentable carbohydrates, especially sugars, promotes the growth of cariogenic bacteria such as *Streptococcus mutans* and *Lactobacilli*, leading to acid production and tooth decay (Takahashi & Nyvad, 2011). Inadequate oral hygiene allows plaque accumulation, which exacerbates the cariogenic process (Marsh, 2003).

Oral Hygiene Practices

Oral hygiene is essential in the prevention of dental caries. Regular tooth brushing with fluoride toothpaste, flossing, and professional dental care reduce plaque accumulation and promote enamel remineralization (Marinho et al., 2003). Studies show that children who adopt consistent oral hygiene routines experience lower caries rates and better overall oral health (Petersen & Kwan, 2011).

Interdental brushes and dental floss are effective for cleaning between teeth, crucial even in healthy individuals. The American Dental Association recommends brushing twice daily with a soft-bristled brush at a 45-degree angle to gum margins, covering all tooth surfaces (American Dental Association [ADA], 2023). Oral hygiene aids such as water flossers and tongue cleaners also provide benefits (Eisen et al., 2017).

Epidemiology of Dental Caries

Globally, approximately 2.43 billion people, or 36% of the population, suffer from dental caries in permanent teeth (Vos, 2012). Oral diseases affect nearly half of the world's population (3.58 billion people), with dental caries being the most prevalent condition (WHO, 2016). In the Middle East, rising oral health-related disease burdens are linked to poor awareness, increased sugar consumption, inadequate oral hygiene, and high smoking rates (International Dental Journal [IDJ], 2010). A study on Palestinian adolescents showed a high caries prevalence of 75.75%, with females exhibiting slightly higher DMFT scores than males (Mahfouz, 2014).

Risk Factors of Caries

Risk factors for dental caries include environmental, behavioral, dietary, bacterial microflora, fluoride intake, oral hygiene, saliva composition, tooth morphology, and genetics (Hunter, 1988). High carbohydrate consumption, especially sweetened beverages, and poor oral hygiene are major risks, while protective factors include twice-daily brushing, fluoride prophylaxis, and professional dental care (IMAB, 2007). Local factors include tooth form, salivary flow, and hygiene, while general factors include age, sex, race, geography, and socioeconomic status (International Dental Journal, 1989). A Turkish study identified older age, female sex, and rural origin as significant risk factors (Anonymous, n.d.).

Classification of Caries

G.V. Black classified carious lesions into six classes based on tooth type and lesion location (Rashid, 2007):

- Class I: Cavities in pits/fissures on occlusal surfaces of molars and premolars, and facial/lingual surfaces of molars
- Class II: Cavities on proximal surfaces of premolars and molars
- Class III: Cavities on proximal surfaces of incisors and canines not involving incisal angle
- Class IV: Cavities on proximal surfaces of incisors/canines involving incisal angle
- Class V: Cavities on cervical third of facial/lingual surfaces
- Class VI: Cavities on incisal edges and cusp tips

Interproximal caries severity is classified as incipient, moderate, advanced, or severe depending on enamel and dentin involvement (Interpretation of Dental Caries, 2012).

Health Education and Its Role in Preventing Dental Caries

Health education is a critical component of public health that promotes healthy behaviors and disease prevention through informed decision-making and lifestyle changes (Green & Tones, 2010; Glanz, Rimer, & Viswanath, 2015). In schools, health education shapes students' attitudes and behaviors towards oral hygiene, significantly reducing caries prevalence by encouraging regular tooth brushing, proper nutrition, and dental check-ups (Petersen, 2003).

Primary prevention strategies focus on reducing risk factors like poor hygiene and unhealthy diets (WHO, 2016). Effective education fosters lifelong healthy habits and awareness of the consequences of neglecting oral health (Sheiham & Watt, 2000). Schools are ideal settings for delivering such programs, supported by family involvement (Pine, Adair, & Nicoll, 2004; Simons-Morton & Crump, 2003).

In conclusion, health education is indispensable in preventing dental caries among school-aged children, contributing significantly to improved oral health and reducing the burden of dental diseases (Kwan, Petersen, Pine, & Borutta, 2005).

4. Research Methodology

4.1 Study Design

A matched case-control study was conducted to assess the role of health education in preventing dental caries among university students in Gaza. The study examined both behavioral and knowledge-based variables related to oral hygiene.

4.2 Setting of Study

The study was carried out at four universities in the Gaza Strip: University of Palestine, Al-Azhar University, Al-Aqsa University, and the Islamic University.

4.3 Study Population

The target population included male and female university students across the five governorates of Gaza: North Gaza, Gaza City, Middle Area, Khan Younis, and Rafah.

4.4 Sample Size and Sampling

A total of 400 students were selected using simple random sampling. Students with caries and poor oral hygiene were considered as "cases," while matched controls were selected based on age, gender, and similar living conditions.

4.5 Case and Control Definitions

- **Case:** A student diagnosed with dental caries and showing poor oral health despite engaging in some hygiene practices.
- **Control:** A student free of caries who practices regular and proper oral hygiene and agrees to participate.

4.6 Study Variables

- **Dependent Variable:** Presence or absence of dental caries.
- **Independent Variables:**
 - Brushing method, frequency, and duration
 - Type and age of toothbrush
 - Use of fluoride toothpaste
 - **Level of oral health knowledge (measured via questionnaire)**
 - **Exposure to health education programs**
 - **Sources of oral health information**

4.7 Data Collection Tools

Data were collected using a structured questionnaire and clinical examination. The questionnaire included sections on:

- Demographics
- Oral hygiene habits
- Dietary behaviors
- **Knowledge about oral health and dental caries**
- **Exposure to health education campaigns or awareness programs**

4.8 Ethical Considerations

Approval was obtained from university administrations and participants were informed of the study's purpose. Confidentiality was ensured, and informed consent was collected.

5.Result and discussion

5.1. characteristics of sample

The sample of the current study is 400 patients. 63.7 male and 36.3 female as mentioned in

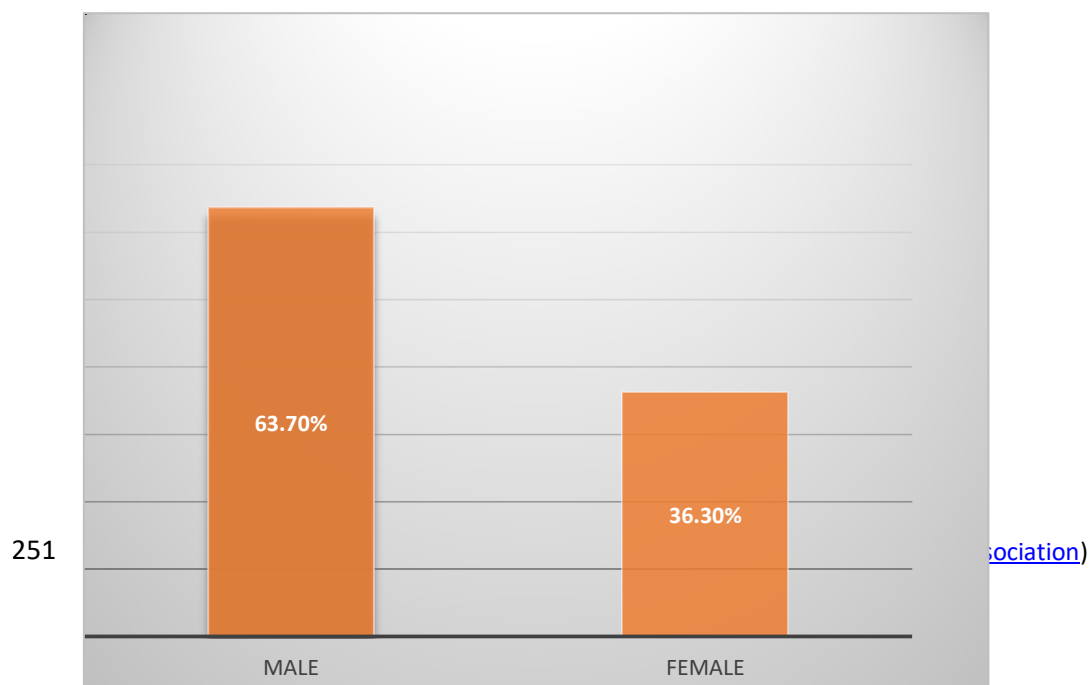


figure (4.1) . The average age of the patients is $22 + 3$ years.36% of them live in Gaza city , 22.1% live in middle , 17.5% live in khanyounes 13.9% live in rafah .and 10.6% live in north as mentioned in figure (4.2) . Also the average of brothers number is 3-5 , and 2-5 sisters .36% of them live city , 18.5% live in camp and 7.3% live in village as mentioned in figure (4.3). About 75% live in own house , while 81.8% drink filtered water , also 79.9% said that no pollution source near them , about 25% of sample undergone to previous surgery , 22.3% suffer from lack of calcium , while 17.9% suffer from bleeding in the gum , 13.3% have calculus in their teeth , 12.4% have pain at cold and 7.8% have pain at hot ,11% have inflamed gingiva , 9.2% mouth breather , 6.1% suffer from pain in ear & 5.5% have bad odor , 4.9% suffer from pain in there jaw & 4.6% suffer from pain while biting . as mentioned in figure (4.4).

Figure 1 : gender distribution

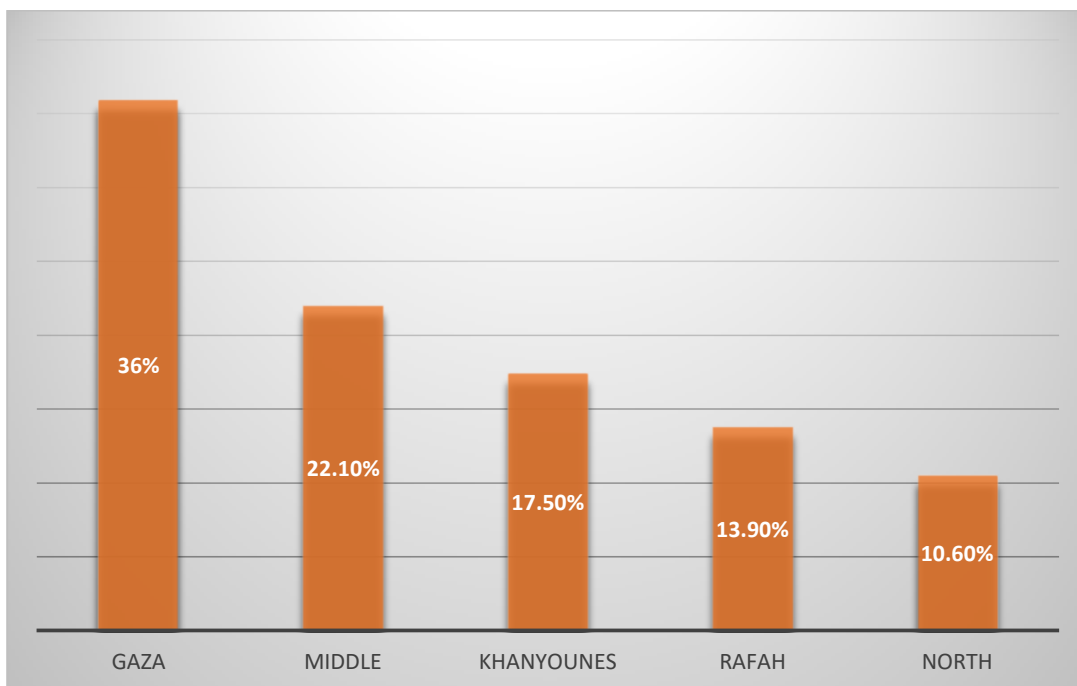


Figure 2 : geographic distribution

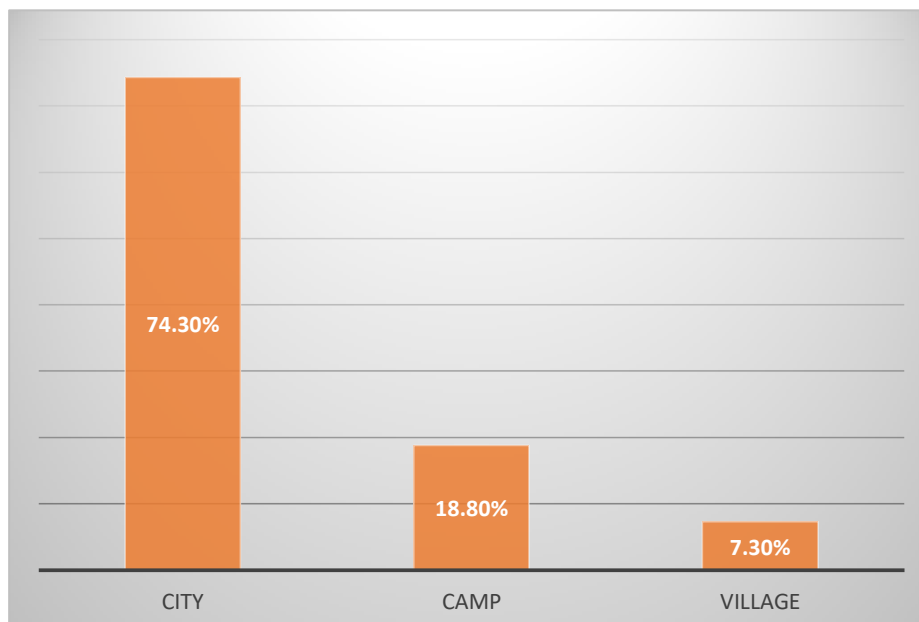


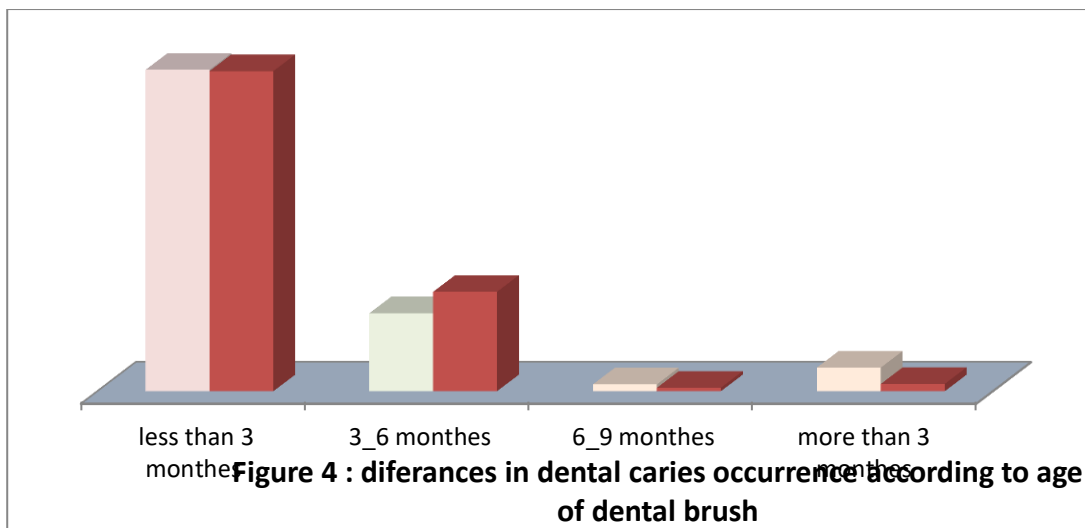
Figure 3 : Life place

4.2 Relationship between age of dental brush and dental caries occurrence

The results of the current study revealed that there is statistically no significant relationship between age of dental brush and caries occurrence ($\chi^2 = 3.987$, P value = 0.263), where there was no significant difference in the caries occurrence when age of dental brush be < 3 month , 3-6 month , 6-9 month or >9 month as shown in table 1.

Table 1. Difference of caries occurrence according to age of dental brush

Age of dental brush	Caries	Non-caries	χ^2	p-value
<3	74.4	74.7	3.987	0.263
3-6	23.1	18.1		
6-9	0.8	1.6		
>9	1.7	5.5		



5.3. Relationship between methods of brushing and dental caries occurrence.

The results of the current study revealed that there is statistically significant relationship between the method of brushing and dental caries occurrence ($\chi^2 = 12.402$, P value = 0.002), where there was significant difference in the dental caries occurrence when the method of brushing was vertical, horizontal, circular as shown in table 2.

Table 2. Difference of dental caries occurrence according to method of brushing

Method of brushing	Caries	Non caries	χ^2	P value
Vertical	27.3	33.5	12.402	0.002
Horizontal	31.4	44		
Circular	41.3	22.5		

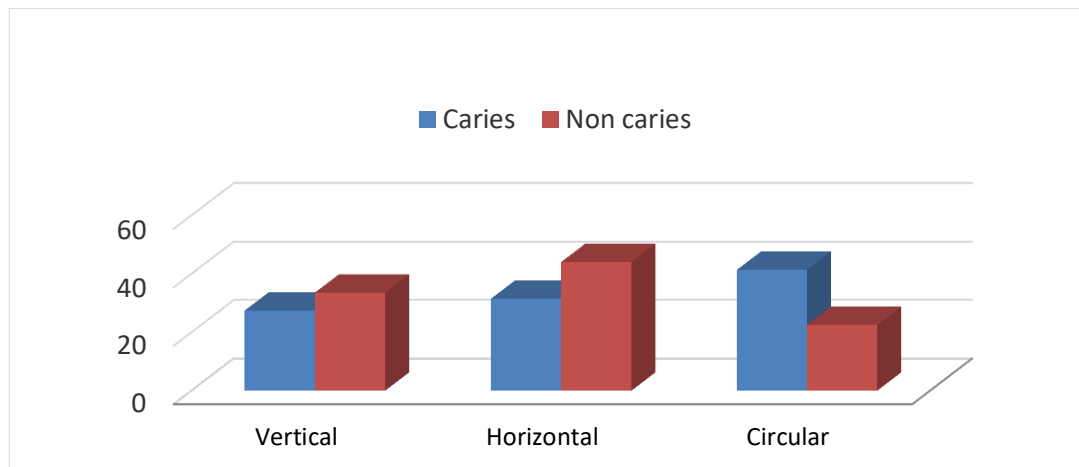


Figure 5 : Difference between method of brushing and caries occurrence.

4.4. Relationship between type of toothpaste and dental caries occurrence.

The results of the current study revealed that there is statistically significant relationship between between used toothpaste with and without florid (non caries florid= 83% , non caries without florid= 17%)

Table3:Relationship between type of toothpaste and dental caries occurrence.

	Caries	Non-caries	χ^2	p-value
With florid	70.2	83	6.827	0.009
Without florid	29.8	17		

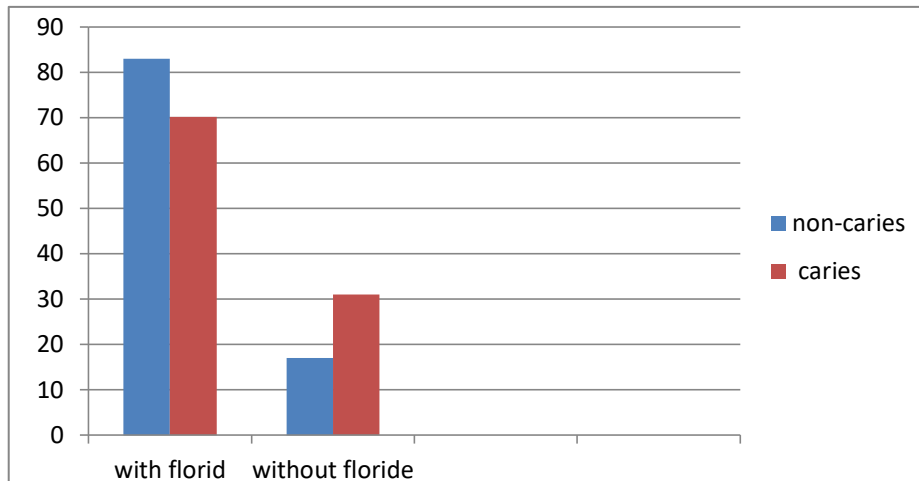


Figure 6: Relationship between type of toothpaste and dental caries occurrence.

5.5. Relationship between frequency of dental brushing and dental caries occurrence .

The results of the current study revealed that there is statistically no significant relationship between the frequency of brushing and dental caries occurrence ($\chi^2=9.015$, P value= 0.061),, where there was no significant difference in the dental caries occurrence when the frequency of brushing was once daily,twice daily,triple daily,once per two days and others as shown in table 3.

Table 4 . Difference of dental caries occurrence according to the frequency of brushing

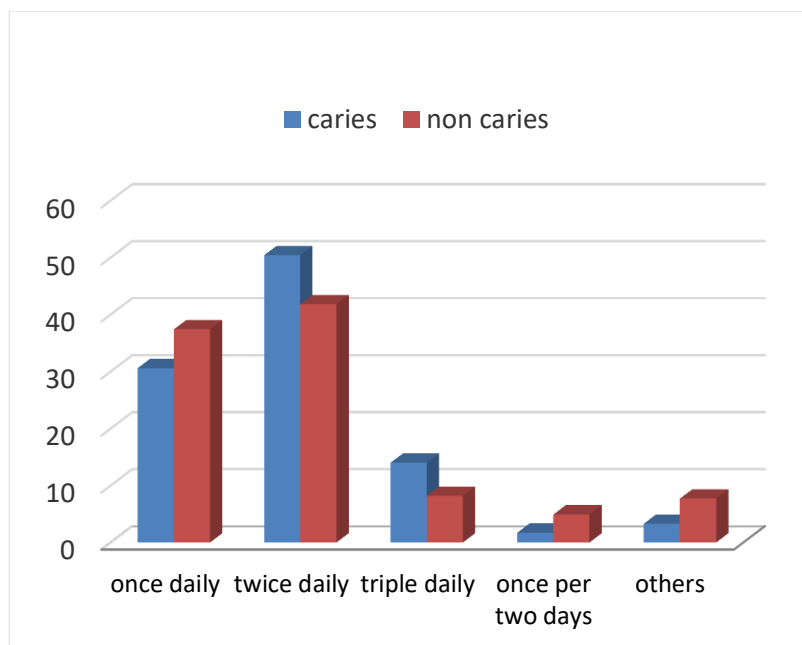


Figure 8 : Relationship between frequency of dental brushing and dental caries occurrence

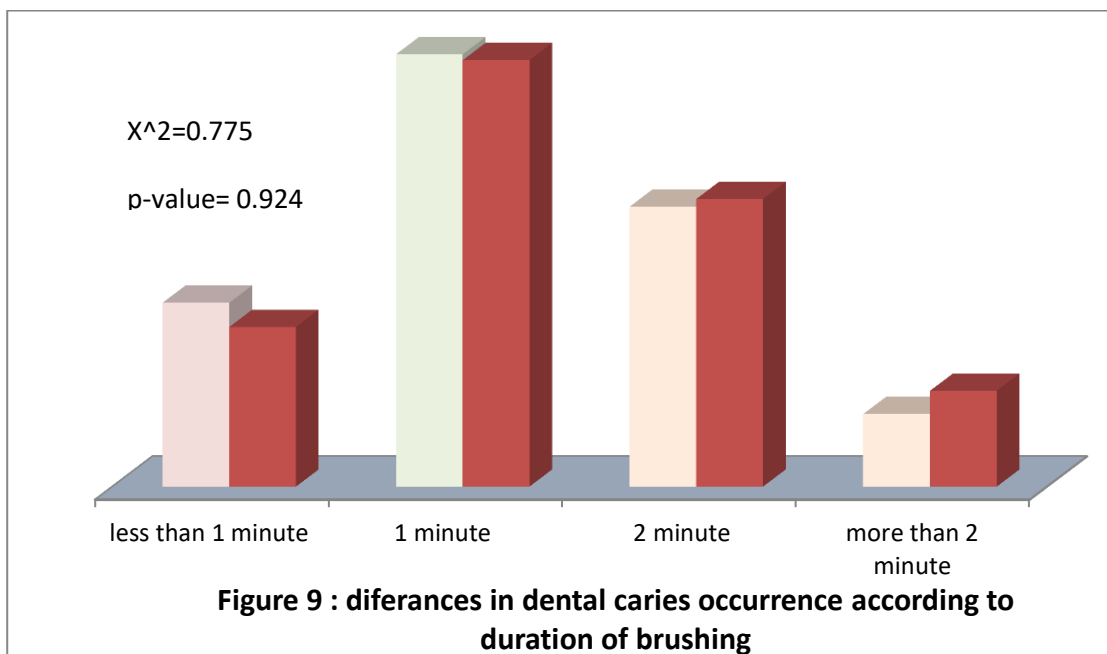
Frequency of brushing	caries	Non caries	X ²	P value
Once daily	30.6	37.4	9.015	0.061
twice daily	50.4	41.8		
Triple daily	14	8.2		
Once per two days	1.7	4.9		
Others	3.3	7.7		

Relationship between duration of dental brushing and dental caries occurrence.

The results of the current study revealed that there is statistically no significant relationship between duration of brushing and dental caries occurrence ($\chi^2 = 0.775$, P value= 0.942), where there was no significant difference in the dental caries occurrence when the duration of brushing be <1m , 1m , 2m or >2m as shown in table 5.

Table 5 : Difference of dental caries occurrence according to duration of brushing

Duration of brushing	Caries	Non-caries	X ²	P value
<1m	19	16.5	0.775	0.942
1m	44.6	44		
2m	28.9	29.7		
>2	7.5	9.9		



5.Conclusion and Recommendation

The study highlights the importance of both oral hygiene practices and health education in preventing dental caries among university students in Gaza. While brushing methods and fluoride use are statistically linked to caries outcomes, other behaviors such as brushing frequency and duration show no strong effect—likely due to a gap in proper knowledge and application.

This indicates that promoting dental health through health education is as critical as providing access to hygiene tools.

Recommendations

- **Implement targeted oral health education programs** in universities to raise awareness about correct brushing techniques, the importance of fluoride, and general oral hygiene.
- **Integrate oral health topics into university health curricula**, particularly for non-medical students.
- **Launch awareness campaigns** that address misconceptions about brushing frequency, duration, and fluoride use.
- **Encourage regular dental check-ups** through university health services or mobile dental units.
- **Distribute educational materials** (flyers, videos, social media content) that visually demonstrate proper brushing and oral care techniques.
- **Involve students in peer-led awareness initiatives**, creating a sustainable culture of oral health promotion on campus.
- **Further research is recommended** to assess the impact of health education interventions on long-term oral hygiene behavior and caries prevention.

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