

Seasonal Variation and Its Perceived Impact on Periodontal Health: Among Adults in Saudi Arabia

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Abstract Objectives: This study aims to evaluate the impact of seasonal variations on periodontal health as perceived and experienced by adults in Saudi Arabia. Data were collected via a self-administered questionnaire addressing periodontal symptoms including bleeding, swelling, halitosis and discomfort. Moreover, the study investigated various behavioral and environmental factors associated with these seasonal changes. **Objectives:** To determine whether adults perceive changes in their gum health based on seasonal variations. **Methods:** This cross-sectional study evaluated how adults in Saudi Arabia perceive the impact of seasonal variation on periodontal health and explored associated behavioral and environmental factors. A structured, self-administered online questionnaire was distributed between July and December 2025 to Saudi adults aged ≥18 years, recruited via social media platforms. The survey collected sociodemographic data, self-reported periodontal symptoms (gingival bleeding, swelling, pain and halitosis) across seasons and information on oral hygiene practices, hydration, smoking and stress. Data from 1,001 fully completed questionnaires were analyzed using descriptive statistics and chi-square tests. **Results:** The sample was relatively young (mean age 31.3 years), with 56.3% females and 39.5% students. Overall, 54.5% reported gingival bleeding while brushing, 46.9% gingival swelling, 48.0% gum pain and 48.8% persistent bad breath. Summer was the most frequently reported season of symptom exacerbation for bleeding (32.9%), swelling (27.9%), pain (27.5%) and halitosis (25.7), followed by winter. More than half (58.5%) perceived that their gum health changes across seasons and 62.2% believed that symptoms and related habits vary seasonally. Smoking prevalence was 15.3% and 44.2% reported that seasonal changes in stress levels affected their gum health. Knowledge scores about the impact of seasonal changes on periodontal health were low in 47.1% of participants and high in 29.9%, whereas awareness scores were high in 49.8% and low in 39.2%. Knowledge and awareness were significantly associated with educational level and awareness also varied by profession and self-rated general health. **Conclusion:** These findings indicate that a substantial proportion of Saudi adults perceive seasonal fluctuations in periodontal symptoms, particularly during summer and winter and link them to modifiable behaviors and environmental conditions, highlighting opportunities for season-sensitive preventive strategies.

Key Words Seasonal Variations, Periodontal Health, Gingival Health, Gum Bleeding, Oral Hygiene

INTRODUCTION

Periodontal diseases are multifactorial and their progression can be influenced by systemic and environmental factors [1]. Individuals with psychiatric illness and substance use disorders are at increased risk of developing periodontal

disease, with the strongest association being for substance use disorders and severe mental illnesses [2]. In most cases, halitosis arises from oral causes primarily inadequate tongue hygiene, followed by periodontal conditions [3]. The pathophysiology of periodontal disease is influenced by a

range of systemic and environmental factors. Among these, seasonal fluctuations play a significant but underexplored role. Seasonal variation affects key physiological modulators like vitamin D and melatonin, both of which have immunomodulatory and anti-inflammatory functions that may influence periodontal status [4].

The 1992 estimate reported 90% poor periodontal health in Saudis aged 25+, while recent studies show ~50%, with tobacco use significantly impacting periodontal status. The 2013 Saudi Health Survey included oral health but did not assess periodontitis prevalence [5]. A study in Riyadh among adults aged 18-40 found 100% prevalence of gingivitis, indicating moderate gum inflammation [6]. Periodontal disease remains a widespread public health concern in Saudi Arabia, with a pooled prevalence of approximately 51% among adults according to a recent meta-analysis of studies conducted between 1992 and 2023 [7]. Moreover, high-risk groups-such as individuals with obesity (71.3%) and diabetes (52.1%) demonstrate even greater vulnerability to periodontal conditions [8]. Employees occupying lower-grade occupational positions demonstrated higher CPI scores, indicative of more severe periodontal disease [9]. Smokers were 3.86 times more prone to periodontitis than nonsmokers in the present study [10]. Gingival bleeding, an early sign of periodontal disease, exhibits seasonal variations, with a decrease during the summer months [11]. A total of 321 participants (62.2%) reported experiencing gum bleeding over the last 12 months [12]. The prevalence of gingival bleeding was reported at 48.79%, indicating a substantial portion of the population is affected [13].

Significant differences in self-reported periodontal symptoms were found based on gender, age, income and education level, with women, older adults (especially those over 60), lower-income and less-educated individuals reporting higher rates of symptoms ($p < 0.01$). Gingival swelling was particularly more common among people in their 50s and 60s compared to other symptoms ($p < 0.01$) [14]. Provide evidence supporting the association of lifestyle habits, particularly daily smoking combined with consumption of sugary drinks, with increased severity of gingivitis among young Saudi males [15]. Chronic psychological stress negatively affects oral health by altering immune responses and increasing periodontal inflammation [16]. Although patients under Supportive Periodontal Therapy (SPT) have a stable periodontal condition, the acute symptom of chronic periodontal disease occasionally occurs without a clear reason [17]. Higher warm-season temperatures increase the risk of emergency visits for mental health conditions [18]. Understanding the mechanisms that account for inter-individual variations in seasonality is relevant to the development of individualized prevention and treatment for psychiatric disorders [19].

Despite the high prevalence of periodontal disease and the known influence of environmental and behavioral factors, the specific impact of seasonal variation on periodontal health has not been adequately studied-especially in Saudi Arabia. During our literature search, we found a clear lack of local studies addressing this topic and very limited

global research with inconsistent results and small sample sizes. Given the distinct climate changes and cultural habits across seasons in Saudi Arabia, such as shifts in diet, hydration and oral hygiene behaviors, this study is needed to fill a critical gap and provide evidence-based insight that may help guide future public health strategies and preventive dental care in the region.

Objectives

To assess the prevalence of self-reported periodontal symptoms gum bleeding, swelling bad breath among adults in different seasons. To identify associated behavioral and environmental factors oral hygiene, stress, hydration, smoking that may vary seasonally and impact periodontal health.

METHODS

Study Design and Setting

A cross-sectional study conducted between July to December 2025, based on a structured questionnaire. This study evaluates Saudi Arabian adults the impact of seasonal variations on periodontal health, including symptoms such as bleeding, swelling, halitosis and discomfort, in addition to examining certain behavioral and environmental factors associated with seasonal changes.

Subject: Participants, Recruitment and Sampling Procedure

A diverse sample of Saudi adults aged 18 and above, both male and female, was digitally recruited to share their seasonal periodontal health experiences through a structured self-reported questionnaire.

Sample Size

Using Raosoft with a 50% response rate, 5% margin of error and 95% confidence level, the minimum required sample size was calculated to be 384.

Inclusion and Exclusion Criteria

This study included adult individuals of both genders, aged 18 and older, living in the Kingdom of Saudi Arabia. Participants were chosen to evaluate their perceived impact of seasonal changes on periodontal health. Individuals under 18 or not residing in Saudi Arabia were excluded. Only participants who agreed and fully completed the questionnaire were included in the data analysis.

Method for Data Collection, Instrument

Data collection was carried out using a structured, self-administered questionnaire. The questionnaire was developed based on previously published and validated studies that examined periodontal symptoms and seasonal variations. Relevant items were adapted from tables and instruments reported in these studies:

- Part 1 introduced the purpose of the study and included the informed consent statement
- Part 2 gathered socio-demographic data such as age, gender, level of education, occupation, general health status and smoking behavior
- Part 3 addressed self-reported periodontal symptoms, including gum bleeding, gum swelling, gum pain and bad breath. Participants were asked to indicate the presence and severity of these symptoms across different seasons

- Part 4 assessed participants' perceptions of seasonal changes in their gum condition and their assumptions or explanations for such changes
- Part 5 explored behavioral and environmental factors such as oral hygiene routines, hydration levels, stress and smoking habits and whether participants believed these factors varied by season and influenced their oral health

Items included in the questionnaire were paraphrased and adapted from similar tools published in previous literature to suit the aim and context of the current study [20].

Scoring System

This study used 12 self-reported items to assess participants' awareness and health-related behavior regarding periodontal. Conditions and seasonal variation. Five additional demographic items were excluded from scoring.

Because the questionnaire did not include objective "correct" or "incorrect" answers, responses were evaluated based on alignment with positive health behaviors and awareness, as defined by current periodontal health guidelines. Participants' responses were scored with 1 point for positive periodontal health awareness or behaviors and 0 points for negative or unaware responses and based on a total of 12 points, Bloom's taxonomy classified awareness as low (0-7), moderate (8-9), or high (10-12).

Pilot Test

The questionnaire was distributed to 20 individuals and asked to fill it. This was done to test the simplicity of the questionnaire and the feasibility of the study. Data from the pilot study were excluded from the final data of the study.

Analyzes and entry method:

Data were entered into the computer using the "Microsoft Office Excel Software" program (2024) for Windows. The data were then transferred to the Statistical Package for the Social Sciences (SPSS), version 25 (IBM SPSS Statistics for Windows, Version 25.0, Armonk, NY: IBM Corp). Descriptive statistics were used to summarize demographic and clinical characteristics. Chi-square or Fisher's exact tests were used for categorical variables and independent t-tests or Mann-Whitney U tests were used for continuous variables, depending on normality. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1 displays various demographic parameters of the participants with a total number of (1001). The sample is relatively young, with 40.7% aged 24 or below and 21.6% between 31-40 years. Females constitute 56.3% of the respondents. Educational level is high as 38.6% are holding a bachelor's degree and 22.7% completing high school. Students account for 39.5% of the sample, while 31.3% are employed. 66.2% rate their health as excellent and only 1.9% report poor or very poor health.

Table 1: Sociodemographic Characteristics of Participants (n = 1001)

Parameter		No.	(%)
Age (Mean: 31.3, STD: 11.7)	21 or less	175	17.5
	22 to 24	232	23.2
	25 to 30	178	17.8
	31 to 40	216	21.6
	41 or more	200	20.0
Gender	Female	564	56.3
	Male	437	43.7
Educational qualification	High school	227	22.7
	College student	215	21.5
	Bachelor's degree	386	38.6
	Diploma	104	10.4
	Master's degree	29	2.9
	PHD	10	1.0
	Unknown	30	3.0
Profession	Student	395	39.5
	Employer	313	31.3
	Unemployed	118	11.8
	Retired	71	7.1
	Freelancer	104	10.4
How would you describe your general health status?	Excellent	663	66.2
	Good	230	23.0
	Fair	89	8.9
	Poor	16	1.6
	Very poor	3	.3

Do you experience gum bleeding while brushing?

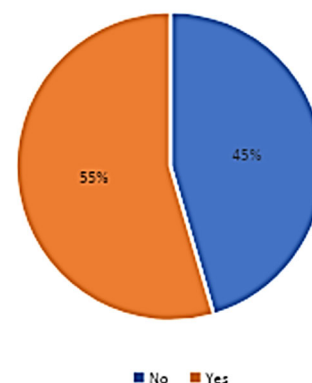


Figure 1: Illustrates Experiencing Gum Bleeding while Brushing Among Participants

As shown in Figure 1, the figure shows that 54.5% of participants reported experiencing gum bleeding while brushing, whereas 45.5% reported no bleeding.

Table 2 reveals knowledge of participants about impact of seasonal changes on periodontal health. Over fifty percent (54.5%) reported bleeding of the gums and summer (32.9) and winter (16.9) were the most frequent seasons of symptom increase. The same trends were followed by swelling and pain in the gums with 46.9% and 48.0% being affected respectively and summer once again resulting in maximum symptom increase. Almost half of them (48.8%) had persistent bad breath and the most common one was the aggravated one during summer (25.7%). It is interesting to note that 58.5% said that their gum health varies by season, with summer (31.4) and winter (21.3) being mentioned as times when they have more gum issues.

Table 2: Parameters Related to Knowledge about Impact of Seasonal Changes on Periodontal Health (n = 1001)

Parameter		No.	(%)
Do you experience gum bleeding while brushing?	No	455	45.5
	Yes	546	54.5
If yes, in which season is it more frequent?	Autumn	22	2.2
	Spring	26	2.6
	Winter	169	16.9
	Summer	329	32.9
	No bleeding	455	45.5
Do you experience gum swelling?	No	532	53.1
	Yes	469	46.9
If yes, in which season does it increase?	Autumn	20	2.0
	Spring	22	2.2
	Winter	148	14.8
	Summer	279	27.9
	No swelling	532	53.1
Do you feel gum pain?	No	521	52.0
	Yes	480	48.0
If yes, please specify the season	Autumn	19	1.9
	Spring	22	2.2
	Winter	164	16.4
	Summer	275	27.5
	No pain	521	52.0
Do you suffer from persistent bad breath?	No	513	51.2
	Yes	488	48.8
If yes, is it worse in a particular season?	Autumn	14	1.4
	Spring	22	2.2
	Winter	195	19.5
	Summer	257	25.7
	No bad breath	513	51.2
Do you think your gum health changes with different seasons?	No	415	41.5
	Yes	586	58.5
In which season do you feel your gum problems increase?	Autumn	30	3.0
	Spring	29	2.9
	Winter	213	21.3
	Summer	314	31.4
	No change	415	41.5
Do you smoke?	No	848	84.7
	Yes	153	15.3
In which season does your smoking habit increase?	Autumn	3	0.3
	Spring	7	0.7
	Winter	51	5.1
	Summer	92	9.2
	No difference	848	84.7
Does your stress level increase during a certain season and affect your gum health?	No	559	55.8
	Yes	442	44.2

Do you think cold or dry weather worsens your gum health?

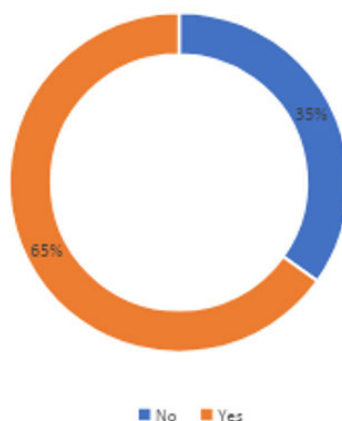


Figure 2: Illustrates Whether Participants Believe that Cold or Dry Weather May Worsen their Gum Health

The prevalence of smoking was not that high (15.3%), but some of them indicated seasonal variability. Also, 44.2 percent reported that seasonal variation impacts the levels of stress that has an impact on gum health.

As shown in Figure 2, the figure shows that 65.1% of participants believe that cold or dry weather may worsen their gum health, while 34.9% do not agree with this fact.

Table 3 indicates the awareness of the participants on the effects of season changes on periodontal health. Most of the respondents (65.1) felt that cold or dry climate deteriorated the health of their gums and 67.2% claimed that their oral care habit changed during summer. Four out of five (51.9) respondents admitted that they reduce the frequency of brushing and flossing when they are on vacation, which is behaviorally vulnerable. The vast majority (71.5) of the respondents said that they consumed less water during winter, potentially leading to oral drought. Seasonal mood or stress changes were also identified with 58.8 percent being affected during winter and 64.7 during the summer season. Moreover, 58.5% of them thought that their gum status fluctuates according to seasons and 62.2% admitted that the

symptoms and habits also change. With respect to perceived causes, almost half (46.9%) was caused by change due to time related lifestyle modification.

Table 4 indicates that nearly half (47.1%) showed a low knowledge level, while only 29.9% achieved a high score. A further 23.1% demonstrated moderate awareness.

Table 5 shows that half of the participants (49.8%) have high awareness regarding the impact of seasonal changes on periodontal health. However, 39.2% had low awareness and only 11.1% showed moderate awareness?

Table 6 shows that knowledge about impact of seasonal changes on periodontal health has statistically significant relation to educational qualifications ($p = 0.0001$). It also shows statistically insignificant relation to gender, age, profession, general health status.

Table 7 shows awareness about impact of seasonal changes on periodontal health has statistically significant relation to educational qualifications ($p = 0.0001$), profession ($p = 0.005$), general health status ($p = 0.027$). It also shows statistically insignificant relation to gender, age.

Table 3: Participants' Awareness about Impact of Seasonal Changes on Periodontal Health (n = 1001)

Parameter		No.	(%)
Do you think cold or dry weather worsens your gum health?	No	349	34.9
	Yes	652	65.1
Does your oral care routine (e.g., frequency of brushing) change in summer (holidays, travel, Ramadan)?	No	328	32.8
	Yes	673	67.2
How does your oral care routine change during vacation?	The frequency of brushing and flossing decreases	520	51.9
	The frequency of brushing and flossing increases	103	10.3
	It stays the same	378	37.8
Do you drink less water in winter compared to other seasons?	No	285	28.5
	Yes	716	71.5
With the cold weather and shorter days in winter, do you find that this affects your mood or makes you feel more stressed compared to other seasons?	No	412	41.2
	Yes	589	58.8
Does summer heat and sun affect your mood or stress, and in turn your gum health?	No	353	35.3
	Yes	648	64.7
Do you think there are seasonal changes in your gum condition?	No	415	41.5
	Yes	586	58.5
Do you think these factors (Gum bleeding, Bad breath, Oral hygiene routine, psychological stress, Mouth Dryness, Smoking) vary by season and affect your oral health?	No	378	37.8
	Yes	623	62.2
What do you think is the reason for these changes?	Chronic diseases	12	1.2
	Tooth decay is a cause of bad breath	1	0.1
	Subscription	2	0.2
	Time change	469	46.9
	Dietary change	157	15.7
	Aging	1	0.1
	Eye cleanser	353	35.3
	All of the above	6	0.6

Table 4: Shows Knowledge about Impact of Seasonal Changes on Periodontal health Score Results

	Frequency	Percent
High knowledge level	299	29.9
Moderate knowledge level	231	23.1
Low knowledge level	471	47.1
Total	1001	100.0

Table 5: Shows Awareness about Impact of Seasonal Changes on Periodontal Health Score Results

	Frequency	Percent
High awareness level	498	49.8
Moderate awareness	111	11.1
Low awareness level	392	39.2
Total	1001	100.0

Table 6: Relation between Knowledge about Impact of Seasonal Changes on Periodontal Health and Sociodemographic Characteristics

Parameters		Knowledge level		Total (n = 1001)	p value
		High or moderate knowledge level	Low knowledge level		
Gender	Female	291	273	564	0.331
		54.9%	58.0%	56.3%	
	Male	239	198	437	
		45.1%	42.0%	43.7%	
Age	21 or less	95	80	175	0.413
		17.9%	17.0%	17.5%	
	22 to 24	124	108	232	
		23.4%	22.9%	23.2%	
	25 to 30	85	93	178	
		16.0%	19.7%	17.8%	
	31 to 40	111	105	216	
		20.9%	22.3%	21.6%	
	41 or more	115	85	200	
		21.7%	18.0%	20.0%	
Educational qualification	High school	97	130	227	0.0001
		18.3%	27.6%	22.7%	
	College student	132	83	215	
		24.9%	17.6%	21.5%	
	Bachelor's degree	210	176	386	
		39.6%	37.4%	38.6%	
	Diploma	53	51	104	
		10.0%	10.8%	10.4%	
	Master's degree	19	10	29	
		3.6%	2.1%	2.9%	
Profession	Student	8	2	10	0.166
		1.5%	0.4%	1.0%	
	Unknown	11	19	30	
		2.1%	4.0%	3.0%	
	Employer	220	175	395	
		41.5%	37.2%	39.5%	
	Unemployed	163	150	313	
		30.8%	31.8%	31.3%	
	Retired	57	61	118	
		10.8%	13.0%	11.8%	
How would you describe your general health status?	Excellent	43	28	71	0.359
		8.1%	5.9%	7.1%	
	Good	47	57	104	
		8.9%	12.1%	10.4%	
	Fair	351	312	663	
		66.2%	66.2%	66.2%	
	Poor	128	102	230	
		24.2%	21.7%	23.0%	
	Very poor	45	44	89	
		8.5%	9.3%	8.9%	

*p value was considered significant if ≤ 0.05

Table 7: Awareness about Impact of Seasonal Changes on Periodontal Health in Association with Sociodemographic Characteristics

Parameters		Awareness level		Total (n = 1001)	p value
		High awareness level	Moderate or low awareness level		
Gender	Female	271	293	564	0.222
		54.4%	58.3%	56.3%	
	Male	227	210	437	
		45.6%	41.7%	43.7%	
Age	21 or less	90	85	175	0.064
		18.1%	16.9%	17.5%	
	22 to 24	119	113	232	
		23.9%	22.5%	23.2%	
	25 to 30	96	82	178	
		19.3%	16.3%	17.8%	
	31 to 40	112	104	216	
		22.5%	20.7%	21.6%	
	41 or more	81	119	200	
		16.3%	23.7%	20.0%	

Table 7: Continued

Parameters		Awareness level		Total (n = 1001)	p value
		High awareness level	Moderate or low awareness level		
Educational qualification	High school	137	90	227	0.0001
		27.5%	17.9%	22.7%	
	College student	100	115	215	
		20.1%	22.9%	21.5%	
	Bachelor's degree	179	207	386	
		35.9%	41.2%	38.6%	
	Diploma	51	53	104	
		10.2%	10.5%	10.4%	
	Master's degree	8	21	29	
		1.6%	4.2%	2.9%	
Profession	Student	1	9	10	0.005
		0.2%	1.8%	1.0%	
	Unknown	22	8	30	
		4.4%	1.6%	3.0%	
	Employer	203	192	395	
		40.8%	38.2%	39.5%	
	Unemployed	141	172	313	
		28.3%	34.2%	31.3%	
	Retired	61	57	118	
		12.2%	11.3%	11.8%	
How would you describe your general health status?	Excellent	27	44	71	0.027
		5.4%	8.7%	7.1%	
	Freelancer	66	38	104	
		13.3%	7.6%	10.4%	
	Good	334	329	663	
		67.1%	65.4%	66.2%	
	Fair	101	129	230	
		20.3%	25.6%	23.0%	
	Poor	48	41	89	
		9.6%	8.2%	8.9%	
	Very poor	12	4	16	
		2.4%	0.8%	1.6%	
		3	0	3	
		0.6%	0.0%	0.3%	

*p value was considered significant if ≤ 0.05

DISCUSSION

The present study aimed to evaluate whether adults in Saudi Arabia perceive seasonal changes in their periodontal health and to explore the self-reported impact of seasonal variation on common periodontal symptoms such as gingival bleeding, swelling, halitosis and discomfort. By surveying a large community sample of adults using a structured, season-focused questionnaire, the study provides novel data on how laypersons experience periodontal signs and symptoms across different times of the year in a high-prevalence setting. These findings are particularly relevant in light of the substantial burden of periodontal disease reported in Saudi Arabia and globally.

In the current sample, more than half of respondents reported experiencing gingival bleeding during toothbrushing, indicating a high perceived burden of gingival inflammation in the community. This is consistent with epidemiological evidence showing that periodontal disease is highly prevalent among adults in Saudi Arabia, with a pooled estimate of periodontitis around 51% in a recent systematic review and meta-analysis of 15 observational studies. Another comprehensive systematic review focusing on periodontal disease in Saudi Arabia reported an overall pooled prevalence of 46.2%, with even higher rates in obese and diabetic adults,

again underscoring the widespread nature of periodontal pathology in this population. The high frequency of self-reported gingival bleeding in the present study therefore appears to parallel objective clinical data and suggests that community awareness of bleeding as a sign of gum disease is reasonably aligned with the true epidemiologic burden.

A key contribution of this study is the documentation of perceived seasonal variation in periodontal symptoms, with many respondents indicating more gum problems in summer and winter compared to other seasons. These findings resonate with emerging evidence that some periodontal parameters exhibit seasonal fluctuation. In a large practice-based cohort from Germany, Peikert *et al.* [4] found significantly higher probing pocket depths in summer compared with winter and a higher proportion of deep pockets (≥ 6 mm) in summer than in autumn, although the absolute differences were small and judged to be of limited clinical relevance. Similarly, Saho *et al.* demonstrated that acute exacerbations of chronic periodontal disease during supportive periodontal therapy were associated with climatic variables, particularly rapid decreases in barometric pressure and lower mean daily temperatures and that incidence tended to peak in colder periods. While those studies used clinical measures and meteorological data, whereas the present study

used self-report, the concordant signal that periodontal manifestations may show subtle seasonal modulation strengthens the biological plausibility of the patterns reported by participants.

The present findings concerning gingival swelling and discomfort that peak in warmer months may reflect a complex interplay between behavioural and environmental factors. Higher ambient temperatures can be associated with changes in oral hygiene routines, fluid intake and diet, all of which are known to influence periodontal inflammation. Large-scale data from Saudi Arabia indicate that behavioral risk factors such as suboptimal toothbrushing frequency and irregular dental attendance are important contributors to periodontal disease in different regions and subgroups. Moreover, dietary habits and obesity reported as major risk factors with particularly high periodontal prevalence among obese and diabetic subgroups in the Saudi population may also vary across the year and interact with heat stress and indoor living patterns. Although the cross-sectional design of the present study precludes causal inference, the alignment of self-reported seasonal symptom peaks with mechanistically plausible environmental and behavioral determinants is consistent with the broader literature.

Another interesting aspect of the current study is the high prevalence of self-reported halitosis, with many participants describing worsening during hotter months. While the present questionnaire did not attempt to clinically distinguish intra-oral from extra-oral causes, existing evidence suggests that periodontal pockets and tongue coating are principal intra-oral sources of malodor and that these are strongly linked to inflammatory periodontal disease. Population-based data indicate that Saudi adults have a high burden of plaque-related gingivitis and periodontitis, which would be expected to increase the prevalence of halitosis in the community. Environmental heat, reduced salivary flow due to dehydration and increased consumption of sugary or acidic beverages in summer may all promote volatile sulfur compound production and exacerbate malodor, providing a plausible explanation for the seasonal patterns reported in this study.

Self-reported season-dependent changes in stress and their perceived impact on gum health represent another important observation. Nearly half of respondents indicated that fluctuations in psychological stress across the year influenced their periodontal symptoms. This perception is well supported by contemporary clinical and mechanistic research. Macrì *et al.* [16] demonstrated, in a cross-sectional study of 203 adults, that perceived stress scores were significantly correlated with gingival bleeding and plaque indices and that patients with periodontitis had different stress and mindfulness profiles than those without periodontitis. Experimental and clinical work has shown that psychological stress can dysregulate the hypothalamic-pituitary-adrenal axis, elevate cortisol and alter cytokine profiles, thereby impairing host response and favoring a more destructive inflammatory milieu in the periodontium. In addition, stress is consistently associated with adverse health behaviors, including deteriorations in oral hygiene and increased tobacco use, both of which are

well-established risk factors for periodontal breakdown. The current finding that many participants subjectively link seasonal stress changes to gum symptoms is therefore in line with these psychoneuroimmunological pathways.

Hydration and fluid intake are also likely to mediate part of the relationship between season and perceived periodontal health. In the present study, summer was the season most often associated with symptom exacerbation, a pattern that may be partly explained by variations in water intake and salivary function. A large cross-sectional analysis from NHANES 2009-2014 found that adults in the highest quartile of plain water intake had significantly lower odds of periodontitis compared with those in the lowest quartile, even after adjustment for multiple confounders; the effect appeared particularly pronounced in men, with approximately 36% lower risk in the highest intake group. The same study observed that periodontitis patients tended to consume less plain water than periodontally healthy individuals, supporting a protective association of adequate hydration with periodontal status. Taken together, these data suggest that in hot climates, public health messages emphasizing sufficient water intake alongside conventional oral hygiene recommendations may offer an additional, low-cost strategy to mitigate seasonal worsening of periodontal symptoms.

The burden of periodontal disease in Saudi Arabia described in recent systematic reviews provides an important context for interpreting the present findings. Hakeem *et al.* [7] reported that about half of Saudi adults examined in studies between 1992 and 2023 had periodontitis, with some clinical subgroups exhibiting prevalence as high as 70-80%. Alsharari *et al.* [8] further highlighted that obese adults and those with diabetes showed pooled prevalence estimates of 71.3 and 52.1%, respectively and that gingivitis prevalence exceeded 60% in some provincial samples. The self-reported high frequency of gingival bleeding, swelling and halitosis in the current study, even among participants who generally rated their overall health as excellent, is therefore congruent with a background of widespread but underdiagnosed periodontal disease in the population. These converging data reinforce the need for community-level screening, education and targeted preventive programs tailored to high-risk groups such as obese, diabetic and low-income adults.

The present study also contributes methodologically by focusing specifically on seasonality, a dimension that has been underrepresented in previous epidemiologic work. Clinical cohort data from Germany and Japan indicate that seasonal and climatic factors can modify both chronic periodontal parameters and the incidence of acute periodontal episodes, likely through effects on immune function, vitamin D status, melatonin and circulatory dynamics. The current findings extend this paradigm by demonstrating that laypersons in a different climatic and cultural context recognize seasonal patterns in their own periodontal symptoms. This supports the notion that future periodontal research and surveillance in Saudi Arabia should incorporate timing and season as potential modifiers when designing studies and interpreting clinical data.

Several limitations must be acknowledged when interpreting these results. First, the study relied on self-reported symptoms rather than clinical periodontal examination, introducing potential misclassification of disease status and limiting direct comparability with studies that use probing depth and attachment loss as primary endpoints. Second, the cross-sectional design precludes causal inferences regarding the influence of season, stress, or hydration on periodontal outcomes; longitudinal designs following the same individuals across different seasons would be better suited to confirm temporal relationships. Third, recruitment through online and social media channels may have introduced selection bias toward younger, more educated and more health-conscious individuals, so the findings may not be generalizable to older adults or those with limited internet access. Fourth, important biological mediators such as serum vitamin D, salivary flow rate and melatonin levels were not measured, preventing direct assessment of mechanistic pathways suggested by experimental and cohort studies from other settings. Finally, residual confounding by unmeasured factors including dietary patterns, use of mouthrinses and concurrent systemic diseases cannot be excluded.

Despite these constraints, the present study provides clinically relevant, community-based evidence that perceived periodontal health in Saudi adults varies across the year and is closely linked in the public mind to seasonal changes in stress, lifestyle and environmental conditions. When viewed alongside high-quality epidemiologic data documenting a heavy burden of periodontitis and strong associations with modifiable risk factors such as smoking, obesity, poor oral hygiene and inadequate water intake, these findings support the integration of season-sensitive education and prevention messages into ongoing national oral health initiatives. Further longitudinal and interventional research that combines objective periodontal measurements with detailed assessment of behavioral, climatic and psychosocial variables will be essential to clarify causal pathways and to develop targeted, seasonally informed strategies for reducing periodontal disease burden in Saudi Arabia.

CONCLUSION

The present study demonstrates that a substantial proportion of Saudi adults perceive clear seasonal variation in their periodontal health, with summer and winter most frequently associated with increased gingival bleeding, swelling, pain and halitosis. These subjective reports are consistent with the high objective burden of periodontitis documented in recent national systematic reviews, which show that approximately half of Saudi adults are affected, particularly those with obesity and diabetes. The observed associations between seasonal symptom peaks and changes in oral hygiene routines, hydration, stress and smoking highlight the importance of behavioral and environmental modifiers that may amplify an already heavy baseline periodontal disease load.

Acknowledgement

We acknowledge all volunteers who provided samples for this research.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Funding

This study did not receive any funding from public, commercial, or non-profit funding agencies.

Informed Consent

Written informed consent was obtained from all study participants.

Data and Materials Availability

All data generated or analyzed during this study are included in this published article.

Ethical Statement

The study was fully explained to all participants and it was emphasized that participation was voluntary. Written informed consent was obtained from each participant prior to enrollment. All collected information was securely stored and used exclusively for research purposes.

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