

Periodontal knowledge, awareness, attitudes, and practices among orthodontic patients: a cross-sectional study

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ABSTRACT

Objectives. The study aimed to determine the characteristics of craniofacial and dentoalveolar relationships based Background. Fixed orthodontic appliances may increase the risk of periodontal disease because they can make oral hygiene more difficult. Although periodontal health knowledge and awareness have been reported to be high, it remains unclear whether knowledge translates into appropriate oral hygiene practices among orthodontic patients in Basrah, Iraq. Therefore, this study was conducted to evaluate periodontal knowledge, awareness, attitudes, and practices among orthodontic patients and to relate them to clinical periodontal indices.

Methods. This cross-sectional study included 54 patients receiving treatment with fixed orthodontic appliances in Basrah, Iraq. Data were collected using a structured questionnaire covering awareness, knowledge, attitudes, and oral hygiene practices, along with a clinical examination. Oral hygiene status was assessed using the Plaque Index (PI), Gingival Index (GI), and bleeding on probing (BOP). The Kuder-Richardson Formula 20 (KR-20) was used to measure the internal consistency of the questionnaire domains. Because the data were not normally distributed, nonparametric tests were used.

Results. Participants generally reported good periodontal health knowledge and favorable attitudes. Clinical periodontal indices were more consistently associated with oral hygiene practices than with knowledge-related variables. Brushing frequency was associated with PI, GI, and BOP ($p < 0.001$, $p < 0.001$, and $p = 0.012$, respectively). The use of auxiliary cleaning aids was associated with lower PI and GI scores ($p = 0.036$ and $p = 0.008$, respectively), but not with BOP ($p = 0.307$). Knowledge-related variables were associated with GI and BOP ($p = 0.049$ and $p = 0.016$, respectively). Age, sex, and duration of orthodontic treatment showed no significant association with clinical periodontal indices ($p > 0.05$). The KR-20 value was acceptable for the awareness domain (0.79), but low for the knowledge and attitude domains (0.00 and 0.14, respectively).

Conclusions. Periodontal status in orthodontic patients appeared to be more consistently associated with oral hygiene practices than with periodontal knowledge. These findings suggest a gap between awareness and practice. Oral hygiene education focused on practical behavior should be included in orthodontic patient management.

Keywords: fixed orthodontic appliances, periodontal health, oral hygiene, patient awareness, gingival inflammation

INTRODUCTION

Periodontal health is an essential part of overall oral health, affecting both the function and longevity of teeth [1,2]. Good oral hygiene practices help control dental plaque, which is the main cause of

gingival inflammation and periodontal disease [3]. Inadequate plaque removal can lead to bleeding, swelling, and eventually more serious periodontal problems [3].

Patients undergoing fixed orthodontic treatment (FOT) are at higher risk of developing periodontal

problems [4]. Orthodontic appliances create additional areas for plaque accumulation and make routine oral hygiene more difficult. Even motivated patients often find it difficult to clean effectively around brackets and wires [4,5].

Knowledge and awareness of periodontal health are important factors that may influence oral hygiene behavior [6,7]. However, knowledge alone does not always result in good practice. Patients may understand the importance of oral hygiene but still fail to apply proper techniques consistently [7,8].

Although oral hygiene and periodontal status have been widely described, most reports have focused mainly on patient knowledge or clinical outcomes [8,9]. The association between knowledge, attitudes, and actual clinical periodontal outcomes in patients receiving orthodontic treatment remains insufficiently studied [9].

Furthermore, little research has been conducted in Basrah, Iraq, to assess orthodontic patients' knowledge of periodontal health and how this knowledge relates to their daily oral hygiene practices [10].

Therefore, the current study was conducted to assess periodontal knowledge, awareness, attitudes, and practices among FOT patients in Basrah, Iraq, and to evaluate their association with clinical periodontal indices.

MATERIALS AND METHODS

Study design and participants

This cross-sectional study was conducted in various clinical settings in Basrah, Iraq, from January 2025 to September 2025. Orthodontic patients from the College of Dentistry at the University of Basrah and several private dental offices were recruited.

A convenience sampling method was used among patients attending orthodontic clinics during the study period. Since no formal sample size calculation was performed, as the present study was exploratory in nature, the sample size depended on the number of available patients who met the eligibility criteria during the study period. Patients receiving fixed orthodontic treatment (FOT) and attending the dental clinics were recruited. Patients who were unwilling to participate, failed to complete the entire questionnaire, and/or had incomplete clinical periodontal examination data were excluded from the study. Complete-case data were analyzed by excluding patients with incomplete questionnaires or clinical periodontal examinations; no imputation was performed for missing data.

Data collection

Data were collected using two main components: a self-administered structured questionnaire and a

clinical periodontal examination. Each participant was first asked to complete the questionnaire, followed by a clinical examination performed by the investigator. The total time required for both procedures was approximately 15-20 minutes per participant.

Questionnaire development and validation

The questionnaire used in this study was derived from a previously published questionnaire developed by Alhaija et al. [11] and revised for this study to adapt it to the local population. To determine the content validity of the modified questionnaire, a panel of dental specialists, including orthodontists and periodontists, was consulted to assess the relevance, comprehensibility, and cultural suitability of the questionnaire items. Minor revisions were made according to the specialists' advice.

A pilot study was conducted using a sample of 10 patients who were not included in the final study sample. The aims of the pilot study were to test the clarity and comprehension of the questions, detect ambiguity, confusion, or difficulty with the questions, and estimate the time required for completion. Minor revisions to the flow of the questions were implemented after pilot testing.

The internal consistency of the questionnaire domains was evaluated using the Kuder-Richardson Formula 20 (KR-20), as the items were dichotomous [12].

Questionnaire structure

The questionnaire consisted of four main domains. The first domain collected personal and behavioral data, such as age, gender, education level, and place of residence, as well as data on oral hygiene practices, including orthodontic treatment duration, toothbrushing frequency and duration, brushing method and toothbrush type, adjunctive oral hygiene tools, and dental check-up habits. These were considered independent descriptive variables and were not included in the calculation of internal consistency, as they did not have a single latent structure.

The second domain tested participants' awareness of periodontal health based on common signs and symptoms, such as halitosis, irritation of the gingival tissues, gingival overgrowth, gingival pain, bleeding, and dental calculus or staining.

The third domain measured participants' knowledge of periodontal health, including the existence of periodontal diseases, sources of information about periodontal diseases and their prevention, and participants' awareness of the role of gingival bleeding in periodontal health.

The fourth domain measured participants' attitudes toward periodontal health, including the im-

pact of orthodontic appliances on periodontal health, perceived difficulty of oral hygiene while wearing orthodontic appliances, the importance of instructions for good oral hygiene, adherence to the dentist’s oral hygiene instructions, and the role of regular dental check-ups in periodontal health.

All questionnaire items were closed-ended and, when necessary, were explained in Arabic to ensure thorough understanding by all participants.

Clinical examination

Clinical periodontal status was assessed using three standardized indices: bleeding on probing (BOP), the Gingival Index (GI), and the Plaque Index (PI). BOP was recorded as the percentage of bleeding sites following probing at four sites per tooth, according to Ainamo and Bay [13]. BOP is also widely used as a contemporary clinical indicator of gingival inflammation [14]. GI was assessed according to Löe and Silness [15], and PI according to Silness and Löe [16]. These indices remain commonly used tools in clinical and epidemiological assessments of oral hygiene and gingival inflammation [17].

Variables

Variables were categorized into outcome, exposure, and descriptive variables for analysis. The clinical periodontal indices, PI, GI, and BOP, were considered outcome variables.

Oral hygiene practices, such as brushing frequency, brushing duration, brushing method, and use of auxiliary cleaning aids, were considered exposure variables.

The awareness, knowledge, and attitude domains were considered explanatory variables. These were analyzed as individual items rather than as a sum score, since they did not represent a single construct.

Bias

Several potential sources of bias were considered in this study. Selection bias may have occurred because of the use of convenience sampling from patients attending specific clinics. Information bias is possible, as oral hygiene practices were self-reported. In addition, all clinical examinations were performed by a single examiner without formal calibration, which may have introduced measurement bias.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 29 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. Variables derived from the questionnaire domains were analyzed according to their categorical structure. Categorical variables were presented as frequencies and percentages,

and continuous variables (PI, GI, and BOP) were expressed as median and interquartile range (Me [Q25-Q75]) because of their non-normal distribution. The normality of continuous variables was assessed using the Shapiro-Wilk test.

Comparisons between two independent groups were performed using the Mann-Whitney U test, while comparisons among more than two groups were conducted using the Kruskal-Wallis test. A p-value of <0.05 was considered statistically significant. To improve the reporting of estimate precision, median differences with 95% bootstrap confidence intervals (CIs) were calculated for the main comparisons. For brushing frequency, the main comparison was calculated as >3 times/day minus 1-2 times/day. For two-group variables, median differences were calculated as Yes minus No. Therefore, negative values indicate lower PI, GI, or BOP values in the “Yes” group, whereas positive values indicate higher PI, GI, or BOP values in the “Yes” group. Missing data were checked for all variables, and no imputation was performed.

RESULTS

Sociodemographic characteristics

A total of 54 patients undergoing FOT were included, with most participants aged 18-25 years and a slightly higher proportion of females. Most participants had an intermediate level of education, and the majority resided in urban areas (Table 1).

TABLE 1. Sociodemographic characteristics of the study sample

Variable	Category	n	%
Age, years	<18	12	22.2
	18-25	30	55.6
	>25	12	22.2
Gender	Male	23	42.6
	Female	31	57.4
Education	Preparatory	5	9.3
	Intermediate	35	64.8
	Graduate	14	25.9
Residence	Urban	36	66.7
	Rural	18	33.3

Internal consistency and reliability

The internal consistency of the questionnaire domains was assessed using the Kuder-Richardson Formula 20 (KR-20). Reliability analysis was conducted for the multi-item domains of awareness, knowledge, and attitudes, while descriptive analysis was performed for variables related to demographics and behaviors. The multi-item awareness domain showed adequate reliability, with a KR-20 score of 0.79. However, the knowledge and attitude

domains showed low internal consistency, with KR-20 values of 0.00 and 0.14, respectively. These low KR-20 values indicate that the items were not sufficiently homogeneous to be interpreted as measuring a single underlying construct. Therefore, knowledge-related items were analyzed separately rather than as a combined scale, and attitude-related findings were interpreted with caution because of their low internal consistency.

Oral hygiene practices

Most participants had been undergoing orthodontic treatment for more than six months (81.5%). Although most participants reported brushing their teeth at least twice daily, brushing duration was generally below recommended levels, suggesting suboptimal oral hygiene quality despite adequate brushing frequency (Table 2). Most participants reported using auxiliary oral hygiene aids, mainly interdental brushes; however, the reported brushing duration and brushing technique suggest that the quality of oral hygiene may still be suboptimal.

TABLE 2. Oral hygiene practices of the participants

Variable	Category	n	%
Duration of orthodontic treatment, months	<6 months	10	18.5
	6-12 months	23	42.6
	>12 months	21	38.9
Brushing frequency	1-2 times/day	17	31.5
	2-3 times/day	29	53.7
	>3 times/day	8	14.8
Brushing duration	<3 min	35	64.8
	3-5 min	17	31.5
	>5 min	2	3.7
Toothbrush type	Ordinary	42	77.8
	Orthodontic	12	22.2
Brushing method	Circular	9	16.7
	Vertical	10	18.5
	Horizontal	35	64.8
Use of auxiliary aids	Yes	36	66.7
	No	18	33.3
Type of auxiliary aids	Dental floss	5	13.9
	Interdental brush	22	61.1
	Toothpick	9	25.0

Moreover, the most frequently reported brushing method was horizontal brushing, suggesting that many participants may not have been using the most appropriate technique and that the effectiveness of plaque removal may have been reduced.

Awareness, knowledge, and attitudes

Participants reported generally favorable attitudes and high self-reported knowledge of periodontal

health, but awareness of specific periodontal signs and symptoms was variable and, for some items, relatively limited (Table 3). Although most participants recognized the importance of oral hygiene instructions and regular dental visits, awareness of signs such as halitosis, gingival pain, and dental calculus was less consistent.

TABLE 3. Awareness, knowledge, and attitudes of the respondents

Domain	Variable	Category	n	%
Awareness	Gingival bleeding	Yes	23	42.6
		No	31	57.4
	Dental calculus	Yes	22	40.7
		No	32	59.3
	Halitosis	Yes	18	33.3
		No	36	66.7
Knowledge	Gingival pain	Yes	10	18.5
		No	44	81.5
	Knowledge of periodontal health	Yes	47	87.0
		No	7	13.0
	Source of knowledge	Dentist	24	44.4%
		School	4	7.4%
		Media	19	35.2%
		No periodontal-health knowledge	7	13%
	Bleeding indicates inflammation	Yes	50	92.6
		No	4	7.4
Attitude	Prevention method (brushing)	Yes	46	85.2
		No	8	14.8
	Brushing more difficult with FOT	Yes	49	90.7
		No	5	9.3
	Straight teeth easier to clean	Yes	50	92.6
		No	4	7.4
	Importance of dental advice	Yes	54	100
		No	0	0.0
	Importance of regular visits	Yes	52	96.3
		No	2	3.7

Note. All percentages were calculated using the total sample (n = 54)

A large proportion of respondents were aware of obvious signs and symptoms of periodontal disease, such as gingival bleeding. Respondents also recognized good oral hygiene and regular dental visits as important factors in periodontal health care. However, knowledge of specific signs and symptoms of periodontal disease, such as pain and halitosis, appeared to be limited.

High percentages of affirmative responses were consistently found for both knowledge and attitude items. This may have contributed to the limited vari-

ance and reduced discriminative ability of these two domains, which may also partially explain their poor internal consistency. Therefore, findings related to these domains were interpreted with caution, as both the knowledge and attitude domains showed low internal consistency.

Clinical periodontal indices

The clinical periodontal status of the participants is presented in Table 4.

The median values for PI, GI, and BOP indicated generally slight to moderate periodontal involvement. No statistically significant associations were found between PI, GI, or BOP and age group, gender, or duration of orthodontic treatment.

Association between behavioral and clinical factors and periodontal indices

Behavioral variables showed statistically significant associations with periodontal indices. Brushing frequency was associated with lower PI, GI, and BOP values. The use of auxiliary cleaning aids was associated with lower PI and GI scores, but showed no statistically significant association with BOP. Self-reported gingival bleeding was significantly associated with all clinical periodontal indices, suggesting consistency between patient-reported symptoms and clinical findings. Self-reported dental calculus was also associated with all clinical periodontal indices. Knowledge of periodontal health showed inconsistent associations with clinical periodontal indices, with statistically significant associations observed for GI and BOP, but not for PI.

For the main comparisons, median differences with 95% bootstrap CIs were calculated. Differences were expressed as Yes minus No for two-group variables and as >3 times/day minus 1-2 times/day for brushing frequency. The >3 times/day group had

lower values of PI, GI, and BOP, with differences of -0.72 (95% CI: -1.06 to -0.28), -0.90 (95% CI: -1.18 to -0.35), and -18.00 percentage points (95% CI: -25.00 to -2.75), respectively. For adjunctive cleaning aid use, median differences were -0.16 for PI (95% CI: -0.93 to 0.18) and -0.42 for GI (95% CI: -0.90 to -0.06). Although the Mann-Whitney U test indicated statistically significant differences for both PI and GI, the bootstrap confidence interval for the PI median difference included zero and should therefore be interpreted cautiously. Participants with self-reported gingival bleeding showed higher PI, GI, and BOP values, with differences of 0.30 (95% CI: 0.02 to 0.83), 0.55 (95% CI: 0.10 to 0.80), and 16.00 percentage points (95% CI: 3.00 to 18.70), respectively. These findings are consistent with the associations presented in Table 5.

DISCUSSION

The study assessed periodontal knowledge, awareness, attitudes, and oral hygiene practices in orthodontic patients and examined these variables in relation to clinical periodontal indices. The findings indicate that, in general, patients had fairly good awareness and attitudes toward periodontal health; however, clinical periodontal status was more consistently associated with hygiene behavior than with knowledge. Patients' daily toothbrushing behavior and the use of supplementary hygiene measures were associated with reduced plaque and lower gingival inflammation. Our findings align with prior research indicating that, among patients undergoing fixed orthodontic treatment, oral hygiene behaviors are more closely associated with plaque and gingival health than awareness or knowledge alone [11,18,19].

In contrast, knowledge-related variables showed weak and inconsistent associations with clinical in-

TABLE 4. Association of clinical periodontal indices with demographic variables and duration of orthodontic treatment

Group	n	PI, Me (Q25-Q75)	p-value	GI, Me (Q25-Q75)	p-value	BOP (%), Me (Q25-Q75)	p-value
Age, years							
<18	12	0.59 (0.20-1.60)	0.862	0.50 (0.10-1.20)	0.650	10.20 (0.00-25.00)	0.134
18-25	30	0.44 (0.09-1.74)		0.54 (0.06-1.74)		0.74 (0.00-56.25)	
>25	12	0.62 (0.16-1.70)		0.41 (0.00-1.60)		0.08 (0.00-47.00)	
Gender							
Male	23	0.50 (0.08-1.69)	0.875	0.50 (0.08-1.58)	0.523	2.00 (0.00-55.83)	0.756
Female	31	0.45 (0.10-1.74)		0.50 (0.01-1.74)		0.78 (0.00-49.90)	
Duration, months							
<6	10	0.43 (0.37-1.60)	0.995	0.52 (0.40-1.75)	0.704	0.54 (0.00-13.60)	0.748
6-12	23	0.66 (0.08-1.66)		0.50 (0.01-1.68)		0.50 (0.00-49.43)	
>12	21	0.50 (0.20-1.75)		0.50 (0.04-1.70)		3.00 (0.00-57.73)	

Data are presented as medians and interquartile ranges [Me (Q25-Q75)]. P-values represent comparisons between groups within each variable using the Kruskal-Wallis test for age and duration of orthodontic treatment and the Mann-Whitney U test for gender. Abbreviations: BOP, bleeding on probing; GI, Gingival Index; PI, Plaque Index

TABLE 5. Association of clinical periodontal indices with behavioral and clinical factors

Group	n	PI, Me (Q25-Q75)	p-value	GI, Me (Q25-Q75)	p-value	BOP (%), Me (Q25-Q75)	p-value
Brushing frequency							
1-2 times/day	17	1.00 (0.10-1.70)	<0.001	1.20 (0.29-1.75)	<0.001	18.00 (0.00-58.00)	0.012
2-3 times/day	29	0.43 (0.10-1.74)		0.45 (0.06-1.65)		0.21 (0.00-46.05)	
>3 times/day	8	0.28 (0.10-1.20)		0.30 (0.00-0.70)		0.00 (0.00-23.90)	
Auxiliary cleaning aids							
No	18	0.56 (0.29-1.75)	0.036	0.85 (0.05-1.75)	0.008	2.89 (0.00-58.00)	0.307
Yes	36	0.40 (0.09-1.50)		0.43 (0.02-1.57)		1.25 (0.00-42.20)	
Gingival bleeding (self-reported)							
No	31	0.40 (0.09-1.17)	0.011	0.40 (0.01–1.35)	<0.001	0.00 (0.00-27.90)	<0.001
Yes	23	0.70 (0.11-1.75)		0.95 (0.11–1.75)		16.00 (0.09-57.48)	
Dental calculus							
No	32	0.42 (0.09-1.52)	0.013	0.43 (0.02–1.64)	0.008	0.30 (0.00-23.11)	0.010
Yes	22	0.85 (0.11-1.75)		0.78 (0.04–1.70)		12.80 (0.00-57.65)	
Knowledge							
No	7	0.70 (0.40-1.70)	0.071	1.10 (0.40–1.60)	0.049	16.00 (0.39-58.00)	0.016
Yes	47	0.45 (0.09-1.72)		0.50 (0.03–1.72)		0.50 (0.00-47.29)	

Data are presented as medians and interquartile ranges [Me (Q25-Q75)]. P-values represent comparisons between groups within each variable using the Kruskal-Wallis test or the Mann-Whitney U test, as appropriate. Abbreviations: BOP, bleeding on probing; GI, Gingival Index; PI, Plaque Index

dices. Similar patterns have been reported in orthodontic populations, where patients may understand the importance of oral hygiene, yet this knowledge may not be successfully applied in daily life [20,21].

No significant differences in periodontal status were found across demographic variables or duration of orthodontic treatment. This differs from some earlier reports that noted age- or gender-related differences in periodontal awareness or oral hygiene behavior [22-24], although such discrepancies may reflect differences in sample size, population characteristics, or study design.

The difference between the level of knowledge and clinical outcomes may suggest that knowledge alone is not sufficient to support favorable periodontal status. Oral hygiene practice may also depend on manual dexterity, motivation, consistency, and the use of appropriate hygiene methods during orthodontic treatment [25,26].

The association between higher brushing frequency and lower periodontal indices suggests a graded pattern, in which more frequent oral hygiene practices were associated with better clinical findings. Likewise, the association between the use of adjunctive oral hygiene aids and lower plaque and gingival indices is consistent with evidence that orthodontic appliances create plaque-retentive areas that are difficult to clean with brushing alone [19,21].

The association between self-reported gingival bleeding and clinical findings suggests reasonable awareness of visible signs of gingival inflammation. This indicates that many patients can recognize periodontal problems, although this recognition does

not always translate into optimal oral hygiene behavior [11,26].

This study adds to the literature by integrating knowledge, awareness, attitudes, behaviors, and clinical periodontal indices in the same orthodontic population. It also contributes local evidence from Basrah, Iraq, where published data on this topic remain limited.

An important methodological finding was the low internal consistency of the knowledge and attitude domains. This suggests that these sections may not function as single, unified constructs in this population and should therefore be interpreted cautiously [27]. Similar concerns have been reported in questionnaire research when items measure related but not fully homogeneous concepts.

Several limitations of the current study should be considered when interpreting the findings. The sample size was limited, and participants were recruited using a convenience sampling approach. Therefore, the findings may not be representative of the general population. As this was a cross-sectional study, no cause-and-effect relationships can be inferred. Several factors that were not explored may have influenced the results, including socioeconomic status, diet, smoking, and orthodontic treatment complexity. Information regarding oral hygiene behaviors was collected by self-report and is therefore prone to reporting bias. In addition, all clinical measurements were performed by a single investigator, and no calibration study was conducted, which may have affected measurement reliability.

Despite these limitations, our findings suggest that oral hygiene behavior, rather than knowledge

or attitudes alone, is more consistently associated with periodontal health in orthodontic patients. Therefore, greater emphasis should be placed on skill building, practical oral hygiene instruction, and repeated reinforcement of habits during orthodontic treatment.

Prospective, intervention-based studies of oral hygiene interventions are required to determine whether structured, behavior-focused instructions are more effective than knowledge-based or attitude-based approaches in supporting periodontal health among orthodontic patients.

Further research should explore psychosocial influences, such as motivation, self-efficacy, and parental influence, as well as other potential confounders, including socioeconomic status, diet, smoking, and orthodontic treatment complexity, preferably in multicenter settings.

CONCLUSIONS

The present study indicates that orthodontic patients generally have a high degree of knowledge and a positive attitude toward periodontal health. However, their clinical periodontal status was more consistently associated with reported oral hygiene behaviors than with periodontal knowledge. Good oral hygiene practices, such as brushing frequency and the use of adjunctive cleaning aids, were associated with lower plaque and gingival inflammation scores, while knowledge-related variables showed weaker and less consistent associations with clinical indices.

Our findings suggest that clinical management strategies involving hands-on instruction, repeated reinforcement, and behavioral modification may be useful in helping patients maintain gingival health while undergoing orthodontic therapy. Further studies should be performed to assess the role of periodontal knowledge and behavior in relation to clinical parameters in larger and more heterogeneous populations, using standardized and validated instruments.

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Ethical approval and consent to participate

This study was approved by the Institutional Review Board of the College of Dentistry, University of Basrah (protocol number 32, dated December 20, 2024). All participants provided written informed consent before participation.

Data availability

The data used in this study are available from the corresponding author upon reasonable request.

Use of AI

No AI tools were used for proofreading or data analysis. The authors carefully checked the data and take full responsibility for the manuscript.

Competing interests

The authors declare no competing interests.

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Authors' contributions

SAA: Conceptualization, data curation, methodology, resources, software, supervision, validation, writing – original draft, and writing – review and editing.

BBM: Conceptualization, data curation, methodology, project administration, validation, visualization, writing – original draft, and writing – review and editing.

ASH: Conceptualization, data curation, methodology, project administration, resources, writing – original draft, and writing – review and editing.

HHA: Conceptualization, data curation, investigation, methodology, writing – original draft, and writing – review and editing.

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