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Prevalence, severity and explanatory factors of tooth wear in Arab populations

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ABSTRACT

Objectives: The aim of this study was to assess the prevalence and severity of tooth wear and related risk indicators in six Arab countries.
Methods: This multicenter, multinational cross-sectional study was conducted among 2924 participants between the ages of 18–35 years old from six Arab countries. Calibrated dentists assessed tooth wear using the Basic Erosive Wear Examination Index (BEWE). Participants were also asked to complete a questionnaire that assessed their dietary and oral health habits. Each participant was identified by the sextant with the highest BEWE score in the upper and lower jaws. Results: Odds ratios were estimated for correlates of tooth wear anterior and posterior regions. Oman had the highest prevalence of BEWE score 3 (N = 255 (60.2%)). Overall, the highest BEWE score 3 was observed on the incisal edge of the upper anterior teeth (N = 602 (20.6%)) and in the lower left posterior region (sextant 6) on the occlusal surface (N = 466 (15.9%)). Correlates of severe tooth wear in both regions were eating or drinking more than six times per day, age and education. Drinking soft drinks "once a day" was significantly associated with severe tooth wear in the posterior region (OR: 1.3, 95% CI:1.05, 1.6). Brushing teeth more than twice a day was inversely associated with tooth wear in the anterior region (OR:0.75, 95% CI: 0.57,0.97).
Conclusion: The prevalence of tooth wear in Arab populations is relatively high, specific preventive and therapeutic measures should be developed to target people at higher risk of this condition.
Clinical Significance: Tooth wear is now regarded as a significant oral health problems, dentists should advise their patients about dietary and oral health habits that can lead to severe tooth wear.

1. Introduction

Tooth wear results in irreversible loss of dental hard tissues [1,2] and is recognized as being increasingly important, especially with the increase in life expectancy and older people retaining their natural dentition. The condition is likely to be caused by several factors, such as, chemical, biological, behavioral, medications, gastrointestinal problems and acid regurgitation [3–6].

Tooth wear is a common clinical finding. In a pan European study, covering data from 7 countries for participants between the ages of 18–35 years, moderate or severe tooth wear was observed in 29.4% of the sample [2]. Van't Spijker et al [5] in a systematic review, reported that the predicted percentage of adults presenting with severe tooth wear increased from 3% at age 20 years to 17% at age 70 years, indicating a tendency for accumulative wear with age. In Japan, Kitasako et al [7] reported that in participants, aged 15–39 years old, drinking acidic juices was the main dietary intake that was associated with tooth wear, while in older people, aged 60–89 years old, consumption of

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acidic fruits were more associated with the increase in tooth wear. Recently, the European Federation of Conservative Dentistry [8] recommended that effective management of tooth wear should include clinical screening for early signs, followed by identification of possible etiological factors, such as oral hygiene habits, pain due to sensitive teeth and functional problems.

Compared to western populations, relatively fewer studies have been conducted in Arab populations to access the prevalence of tooth wear [9–14], but these studies mainly focused on children (9–11,13). Studies on young Arab adults, including selected groups, such as males (12) or dental students (14), have made it difficult to generalize the findings. Nonetheless, results from these studies suggest that factors associated with tooth wear may vary by culture (14). Therefore, assessment of the prevalence of tooth wear and its impact on patients is important to guide health professionals and policy makers in applying the necessary and appropriate measures to prevent or control the occurrence of this problem. In view of these considerations, the aim of this cross sectional multicenter, multinational study was to estimate the prevalence of tooth wear in 18–35-year-old Arabs on the occlusal/incisal and buccal/lingual surfaces in a general dental practice setting, across socioeconomic and demographic groups, and to assess the association with oral health behaviours and dietary habits.

2. Materials and methods

This cross-sectional study was implemented in six Arab countries: United Arab Emirates, Oman, Jordan, Egypt, Saudi Arabia and Kuwait, between February 2016 and December 2017. The study population comprised of healthy Arab males and females between the ages of 18–35 years old, who attended public and private dental practices. Patients who had fixed orthodontic appliances or did not understand the Arabic language were not eligible to participate in the study. Healthy participants seeking routine dental care were approached by their general practitioner and asked if they would like to consent to participate in the study. The study was approved by the Research Ethics Committee at the University of Sharjah and the appropriate ethics committee in each of the participating country. All subjects provided written informed consent for use of their data and were willing to answer the questionnaire.

Based on previous reports [10,12,15], the prevalence of tooth wear was estimated to be 30%, using a 95% confidence interval and a margin of error of 5% for all countries except Egypt (margin of error was 3%), the calculated sample size comprised of at least 400 participants from each country, except Egypt where at least 790 participants were needed. Using an alpha level of 0.05 (two sided). It was estimated that, approximately five dentists would be needed in each of the participating countries.

The severity of erosive tooth wear was assessed per sextant using the previously validated Basic Erosive Wear Examination Index (BEWE) [16,17]. Briefly, all tooth surfaces were examined in dental chairs using good lighting and drying the surfaces before grading and the highest score for each sextant was recorded. The scoring criteria were as follows: score 0 = no erosive tooth wear; score 1 = Initial loss of surface texture; score 2 = distinct defect, hard tissue loss < 50% of the surface area; score 3 = hard tissue loss > 50% of the surface area. If there were extensive restorations covering more than 50% of the surface, the tooth was eliminated from the assessment. The third molar and any sextant with less than two teeth were excluded from the analysis.

Participating dentists were trained to conduct clinical assessments using the BEWE index [16]. All participating dentists received packages that included a hard copy of the manuals describing in detail the steps of oral examination and a training video. All Dentists attended a half-day training session with an experienced examiner (SBA) using BEWE index and who had been previously calibrated with another BEWE examiner (DB). The inter-examiners variations were evaluated giving a Kappa agreement at the end of the training session of at least 0.80. For each participant, the teeth were dried and cleaned using compressed air and examined without magnification using good lighting in a normal dental surgery setting. Each patient's clinical chart and completed questionnaire were coded. All questionnaires and clinical forms were sent to the PI (MA) for data entry, cleaning and analysis.

Patients were evaluated using standardized clinical examinations and a self-administered questionnaire which had been validated in a similar study [15]. The questionnaire included sociodemographic information, frequency of eating and drinking fresh citrus fruits, drinking fruit/vegetable juice, soft drinks and dairy products, For these questions, participants responded on a scale of 1–4 (1 is *once a day*, 2 is *once a week* and 3 *once a month* and 4 is for *never)*. Using the same scale, participants were also asked to indicate the frequency of occurrence of GERD (gastro-oesphageal reflux disease), about the frequency of brushing their teeth per day and the frequency of eating/drinking per day (1–3 times/day, 4–6 times/ day or more than 6 times/day).

3. Statistical analysis

Quality control procedures included a review of each questionnaire and clinical form. In addition, double data entry procedure was adopted to correct typographic errors. Co-investigators in each site also kept records of problems that occurred during data collection and any doubt was discussed and solved with the principal investigator. Interrater reliability was established using Cohen's kappa statistics for which values ranged from 0.81 to 0.84.

Data were analysed using SPSS (version 24, Chicago,USA) on the individual level. Descriptive statistics and frequencies of categorical variables and mean (Standard deviation) for continuous variables were reported. For each participant the highest BEWE score per sextant and location were identified and the sextant with the highest prevalence of severe tooth wear (BEWE score 3) was identified in the upper and lower jaw. Chi-square tests were used to analyse the relationship between independent variables (demographic, dietary and oral care factors) and the sextants with the highest prevalence of BEWE score 3. Additional logistic regression analysis was used to estimate the odds ratio and 95% confidence intervals for the association between severe tooth wear and sociodemographic factors, dietary and oral health habits. To address potential bias created from missing data, multiple imputation was applied to outcome variables. This statistical technique was designed to reduce bias that can occur from missing data by allowing participants with incomplete data to be included in the analyses. In this approach, a model was posited for the association between missing values and recorded values and used to generate several replicate "completed" data sets, containing imputed values in place of the missing values. Estimates of the parameters of interest in each completed data set, with their variance, are then pooled using multiple imputation rules [18]. Five separate imputation samples were generated. Statistical significant levels were set at $p < 0.05$.

4. Results

Table 1 shows that there was a total of 2924 adults recruited from seven Arab countries with a total of 1400 males and 1524 females with a mean age of 26.8 years (SD:4.7). Overall, there were 78,755 teeth, including 222,634 surfaces examined for tooth wear. Oman had the highest percentage of BEWE score 3 in any sextant, (N = 255 (60.7%)), and the least tooth wear was observed in Jordan (N = 66 (16%)). Table 2 shows that for the total sample, the highest percentage scores were the incisal edges of the upper anterior region (BEWE score 3) (N = 602 (20.6%)), and the occlusal surface of the lower left posterior teeth (N = 466 (15.9%)) Furthermore, the UAE had the highest percentage of BEWE score 3 in sextant 2 (upper anterior teeth) and Saudi Arabia in sextant 6 (lower left posterior).

Table 3 shows the results of the chi-square test for the association between severe tooth wear in sextant 2 and sextant 6 according to the

Table 1
Overall prevalence of severe tooth wear in study population.

Country	Total	Male/Female N (%)	age Mean (SD)	BEWE 0 N (%)	BEWE 1 N (%)	BEWE 2 N (%)	BEWE 3 N (%)
All	2924	1399 (48)/1523 (52)	26.8 (4.5)	22 (0.8)	437 (14.9)	1276 (43.6)	1189 (40.7)
UAE	481	255 (53)/226 (47)	27.3 (5.4)	0	53 (11.0)	191 (39.7)	237 (49.3)
Kuwait	406	140 (35)/226 (47)	26.3 (3.5)	4 (1.0)	99 (24.4)	175 (43.1)	128 (31.5)
Oman	420	293 (69)/127 (30)	26.7 (4.2)	0	8 (1.9)	157 (37.4)	255 (60.7)
Egypt	793	320 (41)/473 (59)	27.1 (4.6)	0	54 (6.8)	478 (60.3)	261 (32.9)
Jordan	400	156 (39)/244 (61)	25.7 (4.5)	9 (2.2)	174 (43.5)	151 (37.8)	66 (16.5)
Saudi Arabia	424	235 (55)/189 (45)	27.2 (5.1)	9 (2.1)	49 (11.6)	124 (29.2)	242 (57.1)

independent variables. In which, severe tooth wear (score 3) was positively associated with high school education in both sextants ($p < 0.05$), and tooth brushing three times or more per day was significantly associated with severe tooth wear in sextant 2 only ($p < 0.05$ and Table 3). Eating more than six times per day was also significantly ($p < 0.05$) associated with severe tooth wear in the both jaws. However, drinking soft drinks once a day, was only positively associated with tooth wear on the posterior teeth (sextant 6).

Tables 4 and 5 depict the results of the multivariate logistic regression analysis for the association between the dependent variable, severe tooth wear (BEWE score 3) in sextant 2 and sextant 6, and oral health habits, dietary habits and demographic factors, the independent variables in the study. Due to difference between countries these associations were adjusted for country of the participants. In these models having a university education negatively correlated with severe tooth wear in the anterior (Sextant 2) and posterior (Sextant 6) regions (OR: 0.51, 95% CI:0.41, 0.63, $p = 0.001$; OR: 0.76, 95% CI: 0.61,0.95, $p < 0.01$)). Eating or drinking more than six times per day was associated with an increase in severe tooth wear, both in the anterior and posterior regions (Anterior region: OR:2.72, 95% CI:1.92,4.23; Posterior region: OR:2.30, 95% CI:1.52,3.48; $P = 0.001$). Drinking soft drinks once a day increased the likelihood of severe tooth wear in the posterior region (Sextant 6) ($p < 0.05$).

5. Discussion

The present cross-sectional study is the first to be conducted in Arab populations to measure the prevalence of tooth wear and assess associated potential risk factors. We report an overall high prevalence of severe tooth wear (40%), but the proportion of BEWE score 3 varied between the countries. This finding should impact on health care provision across the Arab peninsula.

Similar to previous reports [14,19,20], the anterior maxillary teeth had the highest prevalence of tooth wear (20.6%). One plausible explanation for this finding is that these teeth are the first to contact acidic foods and drinks during swallowing and the upper anterior teeth are not close to any salivary ducts. They are also involved with mastication and any bruxism. It is notoriously difficult, if not impossible, to diagnose the cause of tooth wear from the appearance of teeth. This is equally, applicable to incisal edge of the anterior teeth that may have ditched areas indicating erosion. Furthermore, the upper central incisors and first molars erupt earlier than other teeth and are exposed to intrinsic and extrinsic etiological factors for a longer time [21,22]. Even so, the levels reported in this study are higher than a corresponding study in Europe [2].

Eating or drinking acidic foods/beverages more than six times a day was associated with a 2.9 and 2.3 times increase in the likelihood of severe tooth wear in the anterior region and posterior region, respectively. Several factors could contribute to this finding, including the type of diet consumed [23–27], as well as, environmental factors [28] and the method of drinking, such as swishing or holding the drink in the mouth (30). However, this significant association should be interpreted cautiously, because different foods or drinks may have dissimilar effects on teeth. Although, the association between consumption of fruit juices and tooth wear is biologically plausible [1,3], reports from epidemiological studies show inconsistent findings [2,21,23,29–33]. For example, Wei et al [23] and Bartlett et al [2] reported that, eating and drinking acidic foods was associated with significant increase in tooth wear. Whilst, Okunseri et al [19] showed that among a sample of 3773 adults over the age of 20, fruit juice was significantly associated with severe tooth wear ($p = 0.008$), except for apple juice, which was not associated with tooth wear and grape juice which was associated with less likelihood of having severe tooth wear (OR:0.41; $p = 0.01$). These contradictory findings suggest that future studies may consider collecting additional information about the frequencies and types of foods and drinks participants consume, as it appears that the pathological mechanism by which fruit juice affect tooth wear is not the same for all fruit juices [23].

Frequent consumption of soft drinks among younger populations has been linked to several health concerns [34–42] such as obesity [34,36], reduced bone density [39] and metabolic syndrome [35,39]. Our findings also emphasis the negative effects of soft drinks on oral health, in the form of severe tooth wear. Although in our study the increase in risk of severe tooth wear associated with frequent

Table 2
Distribution of severe tooth wear (BEWE 3) by sextant[a] in each country.

Total and Country	Number of Participants	Sextants[a] 1 N (%)	2 N (%)	3 N (%)	4 N (%)	5 N (%)	6 N (%)
All	2924	479 (16.4)	602 (20.6)	432 (14.8)	443 (15.2)	409 (14.0)	466 (15.9)
UAE	481	88 (18.3)	174 (36)	82 (17.0)	77 (16.0)	101 (21.0)	81 (16.8)
Kuwait	406	39 (9.6)	63 (15.5)	41 (10.1)	42 (10.3)	51 (12.6)	39 (9.6)
Oman	420	103 (24.5)	118 (28.1)	87 (20.7)	93 (22.1)	115 (27.4)	105 (25.0)
Egypt	793	86 (10.8)	100 (12.6)	80 (10.1)	91 (11.5)	58 (7.3)	103 (13.0)
Jordan	400	25 (6.3)	21 (5.3)	20 (5.0)	24 (6.0)	8 (2.0)	22 (5.6)
Saudi Arabia	424	138 (32.5)	126 (29.7)	123 (29.0)	116 (27.4)	76 (17.9)	116 (27.4)

[a] Sextant 1: Upper right posterior teeth; Sextant 2: upper anterior teeth; Sextant 3:upper left posterior teeth; Sextant 4: Lower left posterior teeth; Sextant 5: lower anterior teeth; Sextant 6: lower left posterior teeth.

Table 3
Sociodemographic and oral health habits according to severe tooth wear (BEWE 3) in upper anterior (sextant 2) and lower left posterior regions (sextant 6).

Variables	Total	Sextant 2		Sextant 6	
		Sextant with scores 0-2 N (%)	Sextant with score 3 N (%)	Sextant with scores 0-2 N (%)	Sextant with score 3 N (%)
Sex	1400	1074 (46)	325 (54)*	1145 (82)	254 (18)*
Male	1524	1248 (54)	277 (46)	1313 (86)	212 (14)
Female					
Education	920	640 (70)	280 (30)*	732 (80)	188 (20)*
School	2004	1682 (83)	322 (17)	1726 (86)	278 (14)
University					
Frequency of tooth brushing	522	432 (85)	90 (15)*	105 (81)	25 (19)
3 times or more per day	2402	1890 (79)	512 (21)	2353 (85)	441 (15)
Less than 3 times per day					
Gastroesophageal Reflux	162	132 (82)	30 (18)	134 (83)	28 (17)
Once a day	2762	2190 (79)	572 (21)	2324 (84)	438 (16)
Once a week/once a month/Never					
Eating fruits	1285	1060 (82)	227 (18)	111 (86)	176 (14)
Once a day	1639	1262 (77)	375 (23)	1347 (82)	290 (18)
Once a week/once a month/Never					
Drinking fruit and vegetables juice	1164	931 (80)	372 (20)	986 (85)	175 (20)
Once a day	1760	1391 (79)	230 (21)	1472 (84)	291 (16)
Once a week/once a month/never					
Soft drinks	942	740 (79)	202 (21)	761 (81)	181 (19)
Once a day	1982	1582 (80)	400 (20)	1697 (86)	285 (14)
Once a week/once a month/never					
Cheese	1809	1479 (82)	328 (18)*	1545 (85)	364 (15)*
Once a day	1115	843 (75)	274 (25)	913 (82)	202 (18)
Once a week/once a month/never					
Eating occasions	1726	1378 (80)	348(20)*	1459 (84)	267 (16)*
3 times per day	1036	846 (82)	190 (18)	885 (85)	151 (15)
times per day	162	98 (60)	64 (40)	114 (70)	48 (30)
> 6 times per day					

* $p < 0.05$, based on Chi-square test.

Table 4
Logistic regression analysis of factors associated with severe tooth wear in the anterior region*.

Variable	OR	95% CI	P-value
Sex	1.04	0.84,1.26	0.72
Male**			
Female			
Education	0.51	0.41,0.63	0.001
School**			
University			
Age	1.04	1.02,1.06	0.002
Gastroesophageal reflux	0.90	0.59,1.35	0.61
< Once a day**			
Once a day			
Eating occasions	0.87	0.72,1.04	0.37
1-3 times per day**	2.72	1.92,4.23	0.001
4-6 times per day			
> 6 times per day			
Frequency of tooth brushing	0.75	0.57,0.97	0.03
1-2 times a day**			
> 2 times a day			
Eating Fresh fruits	1.0	0.80, 1.25	0.06
Once a week/a month/never**			
Once a day			
Drinking fruit and vegetables juice	1.01	0.80,1.25	0.98
< Once a week/a month/never**			
Once a day			
Isotonic drinks	1.35	0.90,1.98	0.14
Once a week/a month/never**			
Once a day			
Soft drinks	1.04	0.83,1.30	0.71
< Once a week/a month/never**			
Once a day			
Eating cheese	0.83	0.66,1.02	0.08
< Once a week/a month/never**			
Once a day			

* Adjusted for country.
** Reference category.

consumption of soft drinks could be regarded as modest (OR:1.3), it is supported by reports from other studies [2,12,13,23]. This underscores the need for effective public health measures to reduce the intake of soft drinks that has accompanied a reduction in drinking healthier drinks such as milk [40].

Inconsistent findings are reported about the association between the frequency of tooth brushing and tooth wear, with some studies reporting a significant increase of tooth wear with increased frequency of tooth brushing [2,23] whilst others, report that it is the intensity rather than the frequency that may increase the likelihood of tooth wear [29]. In our study, participants who brushed their teeth 3 or more times per day, were significantly less likely to have severe tooth wear compared to those who brush their teeth less than three times per day (OR: 0.75, 95% CI: 0.57,0.97). One possible explanation for this finding is that participants who may suffer from sensitive teeth due to severe tooth wear are more likely to avoid frequent brushing.

Several studies among populations with different culture and dietary habits [2,23] report lower levels of education were associated with increased risk of tooth wear. Therefore, it could be implied that less educated patients may need additional instructions and advice regarding factors that may contribute to severe tooth wear. However, different cultural trends across the globe should also be considered. For example, the association between soft drinks consumption and socio-economic status was reported to be stronger in Arab culture compared to western culture [41,42].

In a systematic review, Marsicano et al [43] reported that the association between GERD and severe tooth wear was not consistent among studies. Contradictory findings among studies regarding this association could be explained at least in part, by the use of different indices [2,4,7] to measure tooth wear, which may differ in the magnitude and severity of tooth wear. Furthermore, studies showed that the effect of GERD on tooth wear is likely to be evident in the palatal surface of the maxillary teeth [7,15]. In our study, the highest

Table 5
Logistic regression analysis of factor associated with severe tooth wear in the posterior region.

Variable	OR	95% CI	P-value
Sex	0.98	0.79,1.22	0.89
Male*			
Female			
Education	0.76	0.61,0.95	0.01
School*			
University			
Age	1.01	0.99,1.04	0.65
Gastroesophageal reflux	1.03	0.67,1.60	0.82
< Once a day*			
Once a day			
Eating occasions	0.95	0.74,1.23	0.71
1-3 times per day*	2.30	1.52,3.48	0.001
4-6 times per day			
> 6 times per day			
Frequency of tooth brushing	0.94	0.71,1.24	0.68
times a day*			
≥ 2times a days			
Eating fresh fruits	0.82	0.64,1.03	0.11
Once a week/a month/never*			
Once a day			
Drinking fruit and vegetables juice	1.02	0.81,1.29	0.86
Once a week/a month/never*			
Once a day			
Isotonic drinks	1.31	0.86, 1.99	0.19
Once a week/a month/never*			
Once a day			
Drinking soft drinks	1.30	1.05,1.64	0.02
Once a week/a month/never*			
Once a day			
Eating cheese	0.39	0.91,1.13	0.39
< once a week/a month/never			
Once a day			

* Reference category.

prevalence of tooth wear was on the incisal edge of the maxillary anterior teeth, which may also explain the lack of association.

Dentists who participated in this study were trained and calibrated on the use of the BEWE index, as none had previous experience in using this index. However, remarkable differences between countries in tooth wear were observed. For example, Saudi Arabia and Oman had the highest prevalence of severe tooth wear (57.1% and 60.7%, respectively). The kappa scores indicated good reliability and whilst differences between examiners cannot be ruled out, it is also possible that levels of wear vary between countries. This finding was also observed in the pan European Study [2]. This could also be attributed to additional risk factors other than those usually known to cause tooth wear. Factors such as, environmental factors or non-dietary oral health habits, such as unilateral chewing [44] may also have contributed to the observed prevalence of severe tooth wear. The BEWE index was selected because other multi-centre studies have also used it (2) and it was designed from a consensus meeting (16). The accuracy and reproducibility of the index has been reported by other researchers (17) and whilst all indices have limitations transferring a change in shape to a numerical code, the BEWE is gradually achieving widespread use.

In this study we opted to identify each participant by the highest BEWE score, whilst other studies have used the BEWE sum score (0–18) [22]. The later may be regarded as more comprehensive; however, identifying patients by the most severe BEWE score and associated risk factor could provide strong evidence regarding the importance of management and advice to be provided to those at risk of severe damage to their teeth. Furthermore, in this study pointing out to the most affected anterior and posterior regions may provide clinical important information that could be used in the implementation of suitable preventive measures.

Future studies in Arab populations could also consider specific dietary habits that are the customary in these populations. For example, in Europe, cheese was found to be associated with reduction in the risk of tooth wear [2]. This was not the case in this study, possibly due to cultural difference, as Arabs tend to mix cheese with other foods, rather than eat it alone. Future studies may also ask patients' about their preferred chewing side and frequency of drinking water during meals [23] as potential factors that may have an impact on the risk of tooth wear.

As evidence builds regarding the clinical implications of tooth wear, there is a growing need to have a better understanding of the causal role of dietary and oral health habits, as well as, other factors on the development and severity of tooth wear. Moreover, recent studies have shown that tooth wear can have detrimental effects on quality of life [45]. Therefore, psychological well- being should be integrated in health education and promotion efforts that are tailored to reduce the burden of this condition on people whom their oral function and esthetics may be affected.

6. Conclusion

To conclude, in this study the prevalence of severe tooth wear was relatively high (40%). We found that severe tooth wear was the highest on the incisal edge of maxillary anterior teeth and on the occlusal surface of the posterior mandibular teeth. The results of multiple logistic regression analysis showed higher risk of severe tooth wear among participants who eat or drink more than six times per day compared with subjects with less intake. In addition, age, level of education and frequent consumption of soft drinks showed significant association with severe tooth wear.

Conflict of interest

The authors declare no conflicts of interest with respect to the authorship and/or publication of this article.

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