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Evaluation of relationship between Enterobius vermicularis infection and bruxism in children

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Highlights

The relationship between E. vermicularis and bruxism, both important health issues, was evaluated in this study, using the BiteStrip® device.

Children with E. vermicularis had more severe bruxism than children without E. vermicularis, but the difference was not statistically significant.

BiteStrip® i can be used in children, developed to determine the activity of chewing muscles in the diagnosis of bruxism. It can be used to obtain comparable objective data in studies on bruxism.

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Abstract

Aim: To investigate the relationship between Enterobius vermicularis infection and bruxism in children. **Methods:** Twenty-six children (aged 3–10 years), who were systemically healthy, showed teeth-grinding at least once a week in the last 3 months, and applied to Aydın Adnan Menderes University Faculty of Medicine Hospital Child Gastroenterology Clinic were recruited and allocated into two groups: positive for E. vermicularis infection (Group 1, n = 13); negative for E. vermicularis infection (Group 2, n = 13). The children were examined clinically, and a survey was administered, to be filled in by the children's parents. BiteStrip® was used to determine the level of bruxism. **Results:** Sixteen males (mean age: 7.3±1.6 years) and 10 females (mean age: 7.3±2.4) were included in the study. There was no significant difference between genders. Severe bruxism occurred in 46.2% and 30.8% of Groups 1 and 2, respectively. No significant correlation existed between E. vermicularis infection and BiteStrip® scores. **Conclusions:** Enterobius vermicularis infection did not affect the occurrence of bruxism in the paediatric population evaluated.

Keywords: Bruxism, Child, Enterobius vermicularis, Parasites

INTRODUCTION

Bruxism is defined as a parafunction, characterised by teeth-grinding and involuntary non-functional activity of the masticatory system, and is most frequent in childhood.[1-3] Bruxism has many aetiologies, like occlusal interferences, malocclusion, malnutrition, psychological factors, allergies and gastrointestinal disorders. Among these gastrointestinal disorders, are various intestinal parasitic infections.[1]

Enterobius vermicularis (or pinworm) is a monoxenous parasite, and one of the most prevalent parasitic infections in humans. The nematode is widespread in primary-school-age children and temperate climates worldwide. Some of the most important symptoms of *E. vermicularis* include loss of appetite, nausea, diarrhoea, drooling, irritability, weight loss, nightmares, insomnia and teeth-grinding.[4]

Some studies have suggested the existence of an association between *E. vermicularis* infection and bruxism in children and that *E. vermicularis* infection increases bruxism.[4,5] Tehrani *et al.* [5] observed a significant correlation between intestinal, parasitic infections and bruxism in kindergarten children, indicating that pathogenic parasites might be responsible for initiating bruxism habits in children. The authors explained that parasites excrete substances that are toxic to humans and can trigger stress, sleep loss, and teeth-grinding, particularly in the presence of *E. vermicularis*, *Ascaris lumbricoides* and other parasites.[5]

This study aimed to evaluate the relationship between *E. vermicularis* infection and bruxism in *E. vermicularis*-positive and *E. vermicularis*-negative 3–10-year-olds children with bruxism, using portable electromyography devices "BiteStrip".

METHODS

The study was approved by the Aydın Adnan Menderes University Faculty of Dentistry Clinical Research Ethics Committee (2017/003-24.03.2017). An informed consent form, approved by the Aydın Adnan Menderes University Faculty of Dentistry Ethics Committee, was signed by all the patients and their parents.

A power analysis using G*Power 3.1.9.2 statistical software (two-tailed) yielded a sample size of 26 (n = 13 per group), given a standard confidence level of 0.05 and a recommended power of 0.80, to detect a significant difference between the two groups.

The study included *E. vermicularis*-positive (Group 1, n =13) and *E. vermicularis*-negative (Group 2: n = 13) children aged between 3–10 years, who were admitted to Aydın Adnan Menderes University Faculty of Medicine Paediatric Gastroenterology Clinic. The diagnosis of *E. vermicularis* infection was verified by the adhesive cellophane-tape perianal swab method. All the patients displayed teeth-grinding at least once a week in the last 3 months before recruitment according to the criteria established by the American Academy of Sleep Medicine (AASM)[6], had class I occlusion according to the Angle classification, and presented a mesial step occlusion according to flush terminal plane.[5,7-10]

The cellophane-tape perianal swab method for detection of *E. vermicularis* infection was performed in the morning by the child's parents, to the anal area, without any cleaning, and the tape samples were given to the laboratory. If *E. vermicularis* eggs were detected, the children were diagnosed as enterobiasis, and if the first examination was negative, at least two samples were taken from the child.[11]

The following exclusion criteria applied to the study patients: (a) treated with anti-helminthic drugs in the last 2 months before recruitment; (b) had used drugs that could affect the central nervous system and prevent sleep (sedatives, anti-depressants, neuroleptics, anti-muscarinics, selective serotonin re-uptake inhibitors); (c) sleep disorders (snoring, insomnia, obstructive sleep apnoea, restless leg syndrome, sleep-related epilepsy); (d) psychiatric or neurological disorders; (e) upper respiratory system obstruction (last 15 days), with any systemic disease; (f) teeth erosion due to internal (reflux) or external (acidic drinks) factors; (g) dermatological problems, associated with the use of BiteStrip® (Up2dent, Inc., Pulheim, Germany); (h) unsuitable skin structure; (i) had previously been diagnosed and treated for bruxism; (j) had class II or class III occlusion according to the Angle classification.[1,5,7–10]

Survey

The parents of the patients were asked to complete a survey that included questions about the demographic data, medical history of the patient, clinical findings of *E. vermicularis* and bruxism, other harmful oral habits, family life and habits.[5,7-10]

Oral examination

According to the survey, the patients who had a teeth-grinding habit were invited to Aydın Adnan Menderes University, Faculty of Dentistry, Paediatric Dentistry Department, for clinical evaluation of bruxism. Patients were examined under a reflector light with inspection, palpation and mirror-sond.[5,7-10]

The extraoral examination evaluated mandibular asymmetry, joint sounds (crepitation, click),deviation/deflection during opening and closing actions, sensitivity to palpation of masticatory muscles and pain/tenderness, sensitivity to palpation of the temporomandibular joint and masseter muscle hypertrophy.[10]

The intraoral examination assessed the presence of wear facets on the teeth, according to a modification of the method by Johansson.[10,12] The assessed teeth included primary incisors, canines and molars, permanent incisors and lower first molars. Scores were calculated as follows: 0 = no wear (none); 1 = enamel wear only (mild); 2 = enamel and dentin wear (moderate); 3 = significant loss of tooth structure (severe).

BiteStrip®

For diagnosis of sleep bruxism, a single-use BiteStrip® device (Up2dent, Inc. Pulheim–Stommeln, Germany), including an electromyographic electrode, small display screen and lithium cell, was used to record the increased electromyographic activity of the masticatory muscles during sleep. [7,8] BiteStrip is a portable electromyography (EMG) device that gives disposable measurements by placing it on the area corresponding to the masseter muscle on the skin. It records in real time the EMG waves produced by the masseter muscle during sleep. Displays a score on the screen, providing information about the level of bruxism.[8, 13-15]

All recruited patients were described and demonstrated the correct usage of the BiteStrip®, according to the manufacturer's instructions, at Aydın Adnan Menderes University, Faculty of Dentistry, Department of Paediatric Dentistry. BiteStrip® instructions were distributed to the parents, who applied the device to their child's left masseter muscle, for at least 5 h at night.

In accordance with the instructions given, parents brought the used BiteStrip® to our clinic, and the BiteStrip® scores were recorded by the manufacturer. Suspicious or incorrect scores were repeated, and those patients who did not bring the BiteStrip® on time were excluded from the study. The BiteStrip® scores were graded as follows: L = no bruxism or very low level; 1 = mild bruxism; 2 = moderate bruxism; 3 = severe bruxism.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences Package software (SPSS 24, SPSS, Inc., Chicago, IL, USA). Chi-square analysis was used to determine the differences between the groups ($p < 0.05$). Descriptive statistics (mean, standard deviation) were used to evaluate the data.

RESULTS

Demographic data

A total of 26 children were included in the study, including 16 males (mean age: 7.3±1.6) and 10 females (mean age: 7.3±2.4). No significant difference was found between the genders ($p > 0.05$). The children were divided into two different age groups, namely, 3–5 years (primary dentition) and 6–10 years (mixed dentition). The occurrence of *E. vermicularis* was 80% in primary dentition and 42.9% in mixed dentition, and no significant difference was found between them ($p > 0.05$). The relationship between the parents' ducation levels and *E. vermicularis* was investigated. The levels of education were evaluated in two sub-groups: under high school (elementary and middle school), and high school and higher education (high school, university and postgraduate). For the parents of the *E. vermicularis*-positive children, 92.3% (mothers) and 84.6% (fathers) had not completed high school while 7.7% (mothers) and 15.4% (fathers) had either completed high school or higher education ($p < 0.05$). A significant difference was found between the parents' education levels and enterobiasis in the children ($p < 0.05$).

The prevalence of *E. vermicularis* increased as the number of people living in the children's home increased, and this was statistically significant ($p < 0.05$). The data revealed that 76.9% of the *E. vermicularis*-positive children had 5 or more people living in their home (Table 1).

Table 1. Demographic findings of *Enterobius vermicularis*-positive and *Enterobius vermicularis*-negative patients

Category	Sub-category	*E.v*(+)†		*E.v*(-)‡		Total		p/chi-square*
		n	%	*n*	%	*n*	%	
Gender	Female	5	38.5	5	38.5	10	38.5	1.00
	Male	8	61.5	8	61.5	16	61.5	
Age (years)	3–5	4	80.0	1	20.0	5	100.0	0.135
	6–10	9	42.9	12	57.1	21	100.0	
Mother's education level	Under high school	12	92.3	6	46.2	18	69.2	0.011/6.500*
	High school and higher education	1	7.7	7	53.8	8	30.8	
Father's education level	Under high school	11	84.6	6	46.2	17	65.4	0.039/4.248*
	High school and higher education	2	15.4	7	53.8	9	34.6	
Mother's job	Housewife	11	61.1	7	38.9	18	100.0	0.285
	Officer	0	0.0	1	100.0	1	100.0	
	Worker	2	66.7	1	33.3	3	100.0	
	Education sector	0	0.0	2	100.0	2	100.0	
	Health sector	0	0.0	1	100.0	1	100.0	
	Private sector	0	0.0	1	100.0	1	100.0	
Father's job	Officer	1	25.0	3	75.0	4	100.0	0.118
	Worker	11	64.7	6	35.3	17	100.0	
	Education sector	0	0.0	3	100.0	3	100.0	
	Self-employment	1	100.0	0	0.0	1	100.0	
	Private sector	0	0.0	1	100.0	1	100.0	
Number of people living at home	3	1	7.7	2	15.4	3	11.5	0.021/7.703*
	4	2	15.4	8	61.5	10	38.5	
	≥5	10	76.9	3	23.1	13	50.0	
Water source	Network	10	76.9	13	100.0	23	88.5	0.22
	Well	3	23.1	0	0.0	3	11.5	

*: Statistically significant values are shown with the icon in the same column ($p < 0.05$). †: *Enterobius vermicularis*-positive, ‡: *Enterobius vermicularis*-negative

Five children had daytime teeth-grinding; 1 of them was *E. vermicularis*-positive, 4 of them were *E. vermicularis*-negative. There was a significant association between the incidence of *E. vermicularis* infection and pinworm (p < 0.05) (Table 2).

Table 2. Clinical findings of *Enterobius vermicularis*-positive and *Enterobius vermicularis*-negative patients

Category	Sub-category	*E.v*(+)†		*E.v*(-)‡		Total		*p*/chi-square*
		n	%	*n*	%	*n*	%	
Daytime teeth-grinding	Yes	1	7.7	4	30.8	5	19.2	0.32
	No	12	92.3	9	69.2	2	80.8	
	Unknown	0	0.0	0	0.0	0	0.0	
Drooling	Yes	11	84.6	10	76.9	21	80.8	0.359
	No	1	7.7	3	21.3	4	15.4	
	Unknown	1	7.7	0	0.0	1	3.8	
Nightmares	Yes	8	61.5	5	38.5	13	50.0	0.239
	No	5	38.5	8	61.5	13	50.0	
	Unknown	0	0.0	0	0.0	0	0.0	
Irritability	Yes	9	69.2	7	53.8	16	61.5	0.42
	No	4	30.8	6	46.2	10	38.5	
	Unknown	0	0.0	0	0.0	0	0.0	
Insomnia	Yes	2	15.4	2	15.4	4	15.4	0.592
	No	10	76.9	11	84.6	21	80.8	
	Unknown	1	7.7	0	0.0	1	3.8	
Diarrhoea	Yes	3	23.1	2	15.4	5	19.2	0.619
	No	10	76.9	11	84.6	21	80.8	
	Unknown	0	0.0	0	0.0	0	0.0	
Weight loss	Yes	9	69.2	1	7.7	10	38.5	0.001/10.40*
	No	4	30.8	12	92.3	16	61.5	
	Unknown	0	0.0	0	0.0	0	0.0	
Anal pruritus	Yes	11	84.6	1	7.7	12	46.2	0.001/22.29*
	No	0	0.0	12	92.3	12	46.2	
	Unknown	2	15.4	0	0.0	2	7.7	
Night-time teeth-grinding	Yes	13	50.0	13	50.0	26	100.0	
	No	0	0.0	0	0.0	0	0.0	
	Unknown	0	0.0	0	0.0	0	0.0	
Pinworms detected	Yes	7	53.8	0	0.0	7	26.9	0.007/9.579*
	No	6	46.2	12	92.3	18	69.2	
	Unknown	0	0.0	1	7.7	1	3.8	
Masseter muscle hypertrophy	Yes	10	50.0	10	50.0	20	100.0	1.00
	No	3	50.0	3	50.0	6	100.0	

*: Statistically significant values are shown with the icon in the same column (p < 0.05). †: *Enterobius vermicularis*-positive, ‡: *Enterobius vermicularis*-negative

Clinical findings of bruxism

Five children had daytime teeth-grinding, among which, 3 had fatigue masticatory muscles, 2 had morning headaches, and 4 had teeth/gums tenderness/pain in the mornings. None of them had a mouth opening limitation in the mornings. Seven of the children were aware of their teeth-grinding habit.

Extraoral examination findings were normal. In the intraoral examination, tooth wear was recorded. Table 3 shows a significant loss of tooth structure with score 3 (severe wear), according to the Johansson method.[12]

Table 3. Severely worn teeth by patients' age

Age (years)	***n***	**Severely worn teeth number**
3	2	53-63-73-83
4	1	53-52-51-61-62-63-64-73-83
5	2	53-63-73-83
6	4	53-52-62-63-73-83
7	2	53-63-64-73-83
8	6	53-63-73
9	4	83
10	3	53-63-73-83

Data regarding the relationship between *E. vermicularis* and BiteStrip® scores revealed 46.2% of *E. vermicularis*-positive children and 30.8% of *E. vermicularis*-negative children, respectively, showed score 3 (severe bruxism). While none of the *E. vermicularis*-positive children had score L (no or very low bruxism), 30.8% of the *E. vermicularis*-negative children had score L. There was no significant difference between *E. vermicularis* infection and BiteStrip® scores ($p > 0.05$).

Findings concerning the relationship between BiteStrip® scores and masseter muscle hypertrophy demonstrated that 20 children had masseter muscle hypertrophy, including 10 *E. vermicularis*-positive children, of which, 6 had a score 3 (severe bruxism). Ten children who had masseter muscle hypertrophy were *E. vermicularis*-negative and 4 of them had score 3. Score 3 was not observed in children without masseter muscle hypertrophy. A significant relationship was found between the presence of masseter muscle hypertrophy and BiteStrip® scores ($p < 0.05$).

The findings on the relationship between BiteStrip® scores and tooth wear indicated no significant difference between permanent tooth wear and BiteStrip® scores ($p > 0.05$). Twenty-four children had tooth wear in primary dentition, including 13 that were *E. vermicularis*-positive and 11 that were *E. vermicularis*-negative. Of these 24 children, 8.3% had score L (no or very low bruxism), 16.7% score 1 (mild bruxism), 33.3% score 2 (moderate bruxism), and 41.7% score 3 (severe bruxism), respectively. A significant difference between BiteStrip® scores and primary tooth wear was observed ($p < 0.05$) (Table 4).

DISCUSSION

Bruxism is defined as a habit that can be seen in a period of life of many people, including adults and children.[16] Bruxism has a multifactorial aetiology, including malocclusion, psychological factors, allergies and sleep disorders.[1] Systemic factors, such as parasitic infections, may also cause bruxism.[4,5] There is no empirical evidence of a relationship between parasitic infections and bruxism.[17] Nonetheless, some studies investigating the correlation between bruxism and intestinal parasites in children report that bruxism may be among the symptoms of parasitic infections, such as *E. vermicularis*, *Giardia lamblia*, *A. lumbricoides*, *Schistosoma matthei* and *Hymenolepis nana*.[18,19]

Table 4. Evaluation of oral findings of bruxism and factors that may play a role in the etiology of bruxism

				BiteStrip® score								*p*/chi-square*
				L		1		2		3		
				n	%	*n*	%	*n*	%	*n*	%	
Enterobius vermicularis	(+)			0	0.0	2	15.4	5	38.5	6	46.2	0.179
	(-)			4	30.8	2	15.4	3	23.1	4	30.8	
Muscle hypertrophy	Yes	*E.v*(+)†	10	0	5.0	1	15.0	3	30.0	6	50.0	0.028/9.100*
		E.v(-)‡	10	1		2		3		4		
	No	*E.v*(+)	3	0	50.0	1	16.7	2	33.3	0	0.0	
		E.v(-)	3	3		0		0		0		
Primary teeth wear	Yes	*E.v*(+)	13	0	8.3	2	16.7	5	33.3	6	41.7	0.008/11.92*
		E.v(-)	11	2		2		3		4		
	No	*E.v*(+)	0	0	100.0	0	0.0	0	0.0	0	0.0	
		E.v(-)	2	2		0		0		0		
Permanent teeth wear	Yes	*E.v*(+)	2	0	0.0	0	0.0	2	100.0	0	0.0	0.309
		E.v(-)	0	0		0		0		0		
	No	*E.v*(+)	7	0	21.1	1	10.5	3	31.6	3	36.8	
		E.v(-)	12	4		1		3		4		
Gender	Female	*E.v*(+)	5	0	10.0	1	30.0	2	30.0	2	30.0	0.412
		E.v(-)	5	1		2		1		1		
	Male	*E.v*(+)	8	0	18.8	1	6.3	3	31.3	4	43.8	
		E.v(-)	8	3		0		2		3		
Age (years)	3–5	*E.v*(+)	4	0	0.0	1	0.0	0	0.0	3	60.0	0.110
		E.v(-)	1	0		1		0		0		
	6–10	*E.v*(+)	9	0	19.0	1	9.5	5	38.1	3	33.3	
		E.v(-)	12	4		1		3		4		
Personal characteristics	Quiet	*E.v*(+)	2	0	0.0	0	20.0	0	20.0	2	60.0	0.154
		E.v(-)	3	0		1		1		1		
	Normal	*E.v*(+)	3	0	33.3	0	11.1	2	33.3	1	22.2	
		E.v(-)	6	3		1		1		1		
	Worried	*E.v*(+)	3	0	0.0	2	66.7	1	33.3	0	0.0	
		E.v(-)	0	0		0		0		0		
	Hyper	*E.v*(+)	5	0	11.1	0	0.0	2	33.3	3	55.6	
		E.v(-)	4	1		0		1		2		
Psychological changes	Yes	*E.v*(+)	3	0	12.5	1	12.5	0	25.0	2	50.0	0.885
		E.v(-)	5	1		0		2		2		
	No	*E.v*(+)	10	0	16.7	1	16.7	5	33.3	4	33.3	
		E.v(-)	8	3		2		1		2		
Who slept with	Mother	*E.v*(+)	5	0	11.1	2	44.4	1	11.1	2	33.3	0.104
		E.v(-)	4	1		2		0		1		
	Father	*E.v*(+)	1	0	0.0	0	0.0	0	50.0	1	50.0	
		E.v(-)	1	0		0		1		0		
	Alone	*E.v*(+)	2	0	28.6	0	0.0	0	14.3	2	57.1	
		E.v(-)	5	2		0		1		2		
	Sister	*E.v*(+)	5	0	12.5	0	0.0	4	62.5	1	25.0	
		E.v(-)	3	1		0		1		1		
Watching TV before sleep	Yes	*E.v*(+)	10	0	13.6	1	13.6	5	36.4	4	36.4	0.535
		E.v(-)	12	3		2		3		4		
	No	*E.v*(+)	3	0	25.0	1	25.0	0	0.0	2	50.0	
		E.v(-)	1	1		0		0		0		
Playing with tablet before sleep	Yes	*E.v*(+)	7	0	17.6	1	17.6	2	23.5	4	41.2	0.739
		E.v(-)	10	3		2		2		3		
	No	*E.v*(+)	6	0	11.1	1	11.1	3	44.4	2	33.3	
		E.v(-)	3	1		0		1		1		
Family smoking	Yes	*E.v*(+)	5	0	0.0	1	22.2	1	22.2	3	55.6	0.272
		E.v(-)	4	0		1		1		2		
	No	*E.v*(+)	8	0	23.5	1	11.8	4	35.3	3	29.4	
		E.v(-)	9	4		1		2		2		

*: Statistically significant values are shown with the icon in the same column ($p < 0.05$). †: *Enterobius vermicularis*-positive (*E.v*(+)), ‡: *Enterobius vermicularis*-negative (*E.v*(-))

The most common pathogenic intestinal parasites in children are *E. vermicularis* and *G. lamblia*.[5] There are currently a limited number of studies on the interaction between *E. vermicularis* infection and bruxism in the current literature. [1,4,5]

Enterobiasis is usually endemic in overcrowded conditions, such as nurseries, day care centres, kindergartens and schools, due to the ease of transmission from infected to uninfected children and the inattention of children to personal hygiene.[20] In previous work examining whether intestinal parasites can cause bruxism, Tehrani *et al*.[5] included 3–6-year-olds, and Díaz-Serrano *et al*.[1] examined children aged 6–11 years. Based on these and allied literature, and considering the period in which parasitic infections are most common, it was deemed appropriate to assess children aged 3–10 years, in the current study.

The eggs of *E. vermicularis* are laid in the perianal area, and the stool procedure is inadequate for diagnosis of these parasites. A definitive diagnosis can be made by examining the sample taken from this region. For this purpose, the adhesive cellophane-tape perianal swab method is used[21], as adopted in the current study.

Various devices, as well as surveys, anamnesis, and extraoral and intraoral clinical examinations can be used to diagnose bruxism.[22] The questionnaires and clinical findings alone are not as reliable as diagnostic criteria for the diagnosis of bruxism, and these methods may be inadequate, especially in children who sleep alone.[23,24]

Electrophysiological recording systems are the most reliable methods to diagnose sleep bruxism.[25] This method relies on laboratory recording systems and portable recording systems to detect masticatory muscle activity during sleep. Unlike surveys, clinical findings and oral appliances, this system measures the actual bruxism activity detected by an electrode or sensor, without inserting any device into the mouth.[26] However, the biggest limitation of the sleep laboratories is that possible changes in the sleep environment can affect the natural sleep habit and bruxism disorder. Another limiting factor is that sleep laboratories are not practical in terms of use.[27]

Another approach to diagnosing bruxism is BiteStrip®, which provides an electromyographic evaluation of the masticatory muscles, and has proven reliability. It is suggested that BiteStrip® can be used in children effectively, in determining the presence or absence of bruxism and bruxism severity.[7,8]

When comparing the BiteStrip® scores and masseter muscle electromyographic recordings of 6 patients with sleep bruxism, 4 patients with obstructive sleep apnoea, and 8 symptom-free controls, Shochat *et al*.[8] observed a strong relationship between the two methods. The sensitivity and the specificity were also statistically acceptable.

More recently, a natural sedative, anxiolytic and anti-spasm tincture containing *Melissa officinalis* L. was administered to 6–10-year-olds with bruxism, and a placebo solution applied to the control group.[7] Pre- and post-treatment evaluations of the bruxism severity, using the BiteStrip® test revealed no significant differences either between or within the two groups.

Given its reliability and validity as a screen for bruxism, the BiteStrip® test was applied to determine the bruxism scores in the current trial. The most important advantage of the BiteStrip® as compared with other portable recording systems is that it records contractions that exceed 30% of the maximum voluntary clenching muscle (masseter) activity. In this way, events during sleep that activate the masseter muscle, such as speech, swallowing and grunting, but are not specific to sleep bruxism, are not included in the recording data.[8]

Some demographic data and the symptoms of *E. vermicularis* were included in the parent-filled questionnaire used in the current study. No significant relationship was evident between gender and *E. vermicularis* infection, corroborating previous findings.[28]

Yazgan *et al.*[4] found the prevalence of *E. vermicularis* in primary-school-age children in Kayseri (Turkey) was significantly associated with the house structure, the number of rooms in the house, teeth-grinding at night and abdominal pain. In the current study of children, all of whom had teeth-grinding at night, anal pruritus and weight loss positively correlated with *E. vermicularis* infection. They concluded that *E. vermicularis* was seen in the children's parents with low levels of education. Likewise, a significant relationship between parental education levels and *E. vermicularis* occurred in the present investigation.

There was no significant difference between *E. vermicularis* infection and BiteStrip® scores. Based on this result, it is concluded that *E. vermicularis* infections may not be seen as the cause of bruxism in children. This finding concurred with Díaz-Serrano *et al.*,[1] who recorded a higher prevalence of gastrointestinal parasitic infestation in the controls (41%, $n = 11$) than the bruxism group (30%, $n = 9$) in children aged 6–11 years, implying no relationship between parasitic infections and bruxism. However, Tehrani *et al.*[5] criticized the conventional technique of spontaneous sedimentation used in the parasitologic analysis and small sample size (30 bruxism cases and 27 controls) compared to their survey and parasitological evaluation of 3–6-year-olds with ($n = 50$) and without bruxism ($n = 50$), which concluded that *E. vermicularis* was the most common parasite in the bruxism group.

Emodi-Perlman *et al.*[10] evaluated tooth wear according to the Johansson method[12] for diagnosing bruxism in 244 children aged 5–12 years, but could not find any association between bruxism and tooth wear. The same approach was used in the current study, which demonstrated no significant difference between permanent tooth wear and BiteStrip® scores because the children in the chosen age range had unerupted teeth. There was a statistically significant difference between BiteStrip® scores and primary tooth wear.

No statistical relationship existed between dentition periods and BiteStrip® scores. In this instance, the teeth identified as the most common according to the patients' age group, were evaluated according to the age group of the child. It was concluded that the teeth exhibiting the most frequent wear were seen in primary canine teeth, in almost every age group. However, there may be different reasons for tooth wear in children with primary and mixed dentition.

Although the relationship between tooth wear and bruxism is not yet clear, it is thought that the wear may be physiological (dependent antagonist tooth).[29,30] Lussi *et al.*[31] reported that more wear might be observed in primary teeth, due to structural differences in primary and permanent teeth, because primary teeth enamel is less mineralised than that in permanent teeth. Following the mixed dentition period, different changes occur, owing to differentiation in bite forces, independent of growth and development, depending on the growth behaviour of the human bony facial profile. As a result of occlusal disturbances that occur during these dynamic events, which interact with each other, bruxism can be seen.[32,33]

In terms of ease of selection, the age range of the children with *E. vermicularis* chosen in this work included those with both primary and mixed dentition. Hence, the appearance of bruxism may be thought to be influenced by numerous factors. In order to eliminate these factors, studies that can be done in children of a wider age range are needed.

CONCLUSIONS

In this study, the relationship between *E. vermicularis* infection and bruxism in children was evaluated using BiteStrip®. As a result, 46.2% *E. vermicularis*-positive children and 30.8% *E. vermicularis*-negative children showed severe bruxism (score 3). None of the *E. vermicularis*-positive children had score L (no or very low bruxism) while 30.8% *E. vermicularis*-negative children had score L. However, there were no significant differences between *E. vermicularis* infection and bruxism that could support a statistically positive relationship.

To date, no other study has objectively evaluated the relationship between *E. vermicularis* infection and bruxism in children, highlighting a need for more studies with a larger population.

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