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Parafunctions, signs and symptoms of temporomandibular disorders (TMD) in children with attention deficit hyperactivity disorder (ADHD): the results of the SOPKARD-Junior study

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Summary

Aim. The aim of the study was to compare the prevalence of parafunctions and signs and symptoms of TMD in a population group of children with and without ADHD.

Material and methods. The study included all 5th grade children of all public primary schools in Sopot (untreated, unguided children). The reporting rate was 91%. At the first stage of the psychological-psychiatric study both parents and children filled in the CBCL and YSR questionnaires. At the next stage, in the group of children selected during the screening, a qualified child psychiatrist conducted a semi-structured diagnostic interview K-SADS-PL and diagnosed ADHD. Parafunctions, signs and symptoms of TMD were assessed by conducting a direct interview with a child and a clinical examination by a dentist.

Results. There were significant differences ($p < 0.05$) between children with ADHD and without ADHD associated with parafunctions such as chewing gum (76.47% vs. 46.07%), nail biting (70.59% vs. 40.45%) and bruxism (52.54% vs. 26.22%), the number of signs and symptoms of TMD (1 sign or symptom 0.0% vs. 32.21%; 4–7 signs or symptoms 17.65% vs. 3.75%).

Conclusions. In children with ADHD, symptoms of temporomandibular joint disorders and parafunctions were significantly more frequent. These studies suggest that children with ADHD constitute a group of increased risk for TMD in the future. Interdisciplinary treatment of an ADHD patient by a psychiatrist and a dentist is necessary.

Key words: preventive medicine, temporomandibular joint dysfunction syndrome, Child Behavior Checklist (CBCL)

Introduction

Oral parafunctions are unintentional, unconscious and often harmful motor habits of the masticatory system. Parafunctional activity involves intense, unphysiological activity of the masticatory system leading to the impairment of normal functions. Examples of parafunctions include nail biting, lip biting, teeth clenching, and teeth grinding, also called bruxism [1, 2]. Parafunctions are described in the literature as one of the basic causes of temporomandibular disorders (TMD) [1, 3]. Although temporomandibular disorders (TMD) are not life-threatening, they can significantly affect quality of life [4]. The first signs of TMD are tenderness in the temporomandibular joints (TMJ), restricted mobility of the mandible and acoustic symptoms in the TMJ, occurring spontaneously and verified during palpation. In a more severe stage of the disorder, patients report symptoms such as pain in the muscles of mastication and the TMJ while opening the mouth and eating, crepitations and clicks in the TMJ, excessive tooth attrition and headaches [5]. Early diagnosis of TMD is very important because these ailments often persist even in adulthood, with the risk of more intense somatic pain and psychosocial stress [4].

An increasing number of such disorders is observed in children. It has been shown that in adolescents the frequency of parafunctions is between 60 and 80% [6], and the frequency in children aged 7–11 years is 30–70% [6].

To date, the literature has shown the relationship between TMD and internalizing disorders as well as stress in children [4, 7]. All-Khotani et al. [4] have proven in their studies that there is a correlation between TMD and the level of anxiety, depression and somatic symptoms.

One of most frequent neurodevelopmental disorders in children is ADHD, however, the number of reports examining the frequency of the parafunctional behavior in externalization disorders such as ADHD is very low [7]. The prevalence of ADHD in children at an early school age is approximately 5% [8, 9]. In the etiopathogenesis of ADHD genetic factors play a significant role. It is a polygenic, heritable disorder. Among the environmental factors associated with the development of ADHD, numerous prenatal factors are mentioned (among others: prematurity, low birth weight, perinatal hypoxia, maternal smoking and alcohol consumption during pregnancy) [10].

A child with ADHD might be a frequent patient at the dentist or oral surgeon because of inadequate hygiene of the oral cavity as well as the higher risk of all injuries, including those in the oral cavity area. It is related to factors such as disorganization, impulsive behaviors and improper health habits [11].

Taking into consideration the character of the core and associated symptoms of ADHD, one can believe that these children belong to a group at higher risk for engaging in parafunctional activity. In clinical practice, it has been observed that the children with ADHD engage in numerous physical activities within the oral cavity to release the hyperactivity tension, which in turn may lead to the development of parafunctions.

The aim of this study was to compare prevalence of parafunctions and TMD signs and symptoms in a population of children with and without ADHD at the age of 10–12 years.

Material

This study was based on screening tests carried out within the framework of the prophylactic program SOPKARD-Junior. The main purpose of the SOPKARD-Junior program is to provide a comprehensive assessment of the health and health behavior of children, the prevalence and risk factors of diseases, as well as lifestyle and the relationship between major health problems and lifestyle in this group. A detailed description of all studies carried out under the program is provided in a separate publication [12]. All research within the project was free for children and their families. The only condition for inclusion in the SOPKARD-Junior program was written consent of the child's parent or legal guardian.

In 2016–2017, all 5th grade elementary school students in Sopot were invited to participate in the SOPKARD-Junior program. During the tests, the child's calendar age was calculated from the difference between the date of examination and date of birth, expressing the child's age using the decimal system. The group of 10-year-olds included children within the age range of ≥ 9.5 and < 10.5 and the groups of 11-, 12-, and 13-year-olds included children according to an established system.

This publication presents the results of a psychological-psychiatric examination and masticatory system assessment, which are one of many medical tests performed in children as part of the SOPKARD-Junior program. The requisite consent of the bioethics committee was obtained (NKEBN/510/2006, NKBBN/510-186/2015, NKBBN/510-386, 395/2015, NKBBN/278/2016).

Methods

During the dental part of the study, each participant underwent a two-stage examination of the masticatory system – a survey and a clinical trial. The first stage included a specialist dental interview carried out directly with the child in the form of a questionnaire regarding harmful oral habits.

Ten questions about the most common parafunctions in children were used in the analysis presented in this article; these parafunctions included unilateral chewing, teeth clenching and grinding (analyzed jointly as bruxism), nail biting, gum chewing, finger sucking, biting items such as pencils and pens, biting the upper and lower lip, sucking in the mucous membrane of the cheeks, tongue biting, and leaning chin on hands. In statistical analysis, each parafunction was analyzed separately, and the parafunctions were also analyzed as a group (however, the grouping was only for quantitative purposes). In the second part, each participant underwent palpation of the muscles of mastication and the temporomandibular joints as well as an analysis of mandibular mobility, conducted by one dentist experienced in the diagnostics of the TMJ. When assessing the muscles of mastication, muscle tone and palpation tenderness in the areas corresponding to the distal entheses of the masseter, temporal and lateral pterygoid muscles were taken into account. When assessing the temporomandibular joint, the occurrence of pain, crepitations, clicks, and pops during border movements was analyzed. Each parameter was analyzed twice during three replications. When analyzing the model of jaw mobility, the ranges of jaw movements were measured. The measurements were carried out with accuracy to 1 mm with the help of single-use rulers (TheraBite Range-of-Motion Scale, Atos Medical AB, Sweden, Europe). The following values were considered in the normal range: abduction movement – a range greater than or equal to 40 mm [13], lateral and protrusive mandible movements – a range greater than or equal to 8 mm. Additionally, the condition of the oral mucosa was assessed in the intraoral examination: the presence of dental impressions on the cheeks and tongue was taken into account. Moreover, the level of tooth wear was evaluated, i.e., the so-called pathological tooth attrition. To assess the attrition, the five-point tooth surface attrition index by Martin was used, where *T*0 means no signs of wear, *T*I – superficial tooth enamel attrition (cusps preserved), *T*II – progressive cusp attrition (dentine is visible in certain places), *T*III – the whole tooth enamel is removed, and *T*IV – tooth crown attrition down to the cervical area.

This article analyzes seven of the most common signs and/or symptoms of TMD:

(1) Muscular signs – in the case of increased muscle tone, teeth impressions on the cheeks or tongue;
(2) Mandible mobility dysfunctions – when the range of movements was smaller than the above-mentioned standards;
(3) Subjective acoustic symptoms – when the child heard crepitations, clicks and pops in the TMJ during mandible movements, which were not audible for the physician;
(4) Objective acoustic symptoms – when the doctor heard crepitations, clicks and pops in the TMJ during the movements;
(5) Pathological attrition – when Martin's index was *T*I or higher;
(6) Spontaneous pain in the area of TMJ – when the child reported pain in the area of TMJ and muscles during border movement of the mandible;
(7) Pain in the area of TMJ on palpation – pain reported by the child during palpation in the area corresponding to the location of the heads of the mandible and distal entheses of the masseter, temporal and lateral pterygoid muscles.

In the statistical analysis, each sign or symptom was analyzed separately, and the symptoms were also grouped, but only for quantitative purposes.

In the psychological part of the study, 2 screening questionnaires – by T.M. Achenbach and C. Edelbrock – were used: the parental Child Behavioral Checklist (CBCL) and Youth Self-Report (YRS). The CBCL/4–18 enables the assessment of competencies, behaviors and emotional problems of children and teenagers aged

4–18 years. The YSR is similar in its form to the CBCL and has been designed to assess individuals' own competences and problems at the age of 11–18. The information from a parent and their child allowed us to gain supplementary data about the child [14].

The screening procedure of selecting children for the psychiatric interview/assessment (test K-SADS-PL) was based on summing up points obtained in separate scales. Next, the obtained raw scores were converted into *T* rate (the raw result converted in the modified T-score scale) according to the relevant profiles. The profiles are diversified according to gender (girls and boys separately) and age (two age categories were distinguished: 6–11 years and 12–18 years). The children who have obtained *T*-rates within the cut-off point have been qualified to the screening group of ADHD children, which means that their scores have been higher than 70 according to the externalizing scale or 67 in the subscale of concentration disorder according to at least one of the questionnaires (CBCL and/or YSR).

At the second stage, psychiatric examination was conducted using the semistructured diagnostic questionnaire K-SADS-PL in the group of children and parents selected after screening. The children who met the criteria of attention deficit hyperactivity disorder (according to K-SADS-PL) were qualified into the group of "children with ADHD". The other children were qualified to the group "children without ADHD".

All studies were conducted by a research team composed of three people: a dentist, medical specialist in child and adolescent psychiatry and a specialist with master's degree in public health.

The chi-square test and Fisher's exact test were used to assess the differences between relevant groups. Furthermore, odds ratios were calculated. A p-value less than 0.05 was considered significant. Analyses were performed using the R software.

Results

There were 342 children invited to the SOPKARD-Junior program in 2016–2017. Parents or legal guardians of 311 (91%) children gave their written consent to participate in the program. The group of 10-year-olds constituted 24.6% of children, group of 11-year-olds 64.1%, group of 12-year-olds 10.9%, and 13-year-olds 0.4% of all study participants. The mean age of children was 10 years and 5 months. A group of 303 children participated in the psychological tests with the questionnaires (97.4% of all participants in the testing), and 287 children participated in the stomatognathic system examination (92.3% of all participants in the testing). A total of 284 pupils participated in both tests, and they belonged to the research group whose data were analyzed. Eighteen children were qualified for the K-SADS examination, but the criteria of being qualified into the group of "children with ADHD" were met by 17 children. The other 267 children were qualified as "children without ADHD" (Diagram 1).

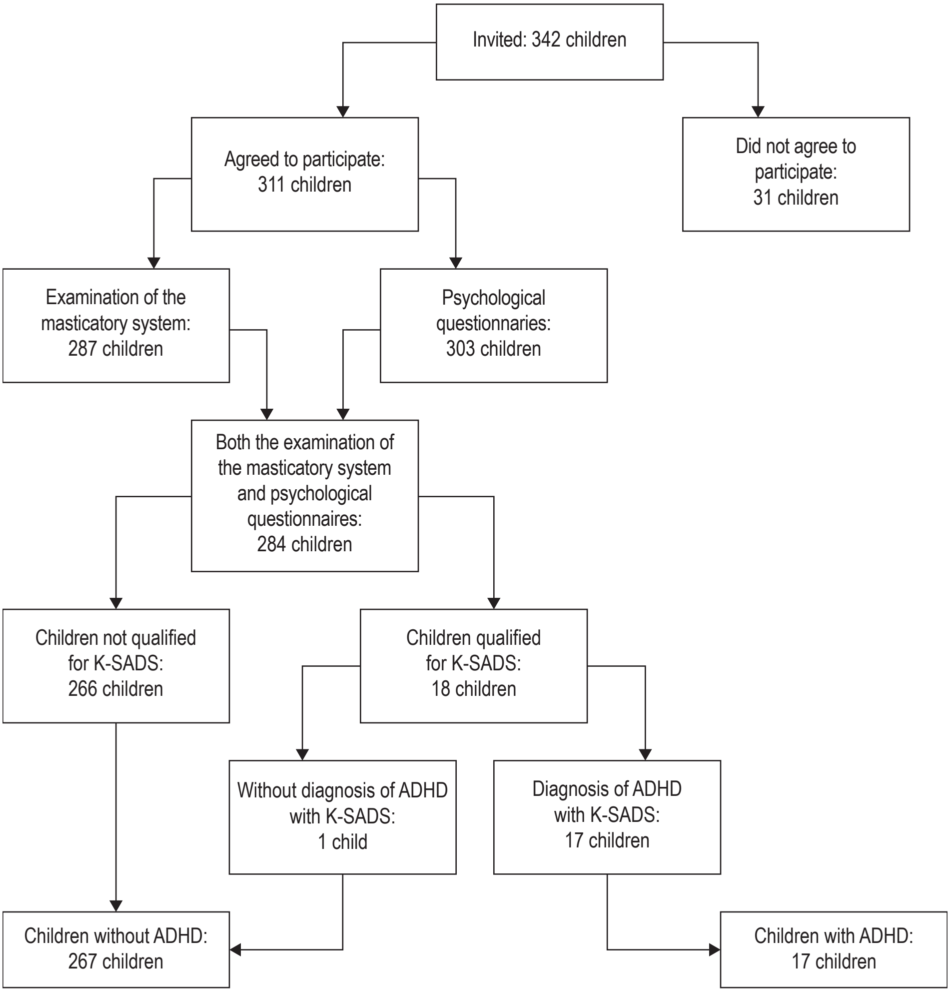

Diagram 1. **Diagram shows the way of selecting groups "children with ADHD" and "children without ADHD"**

Table 1 presents the results of the research on parafunctions with the division into children with and without ADHD. Comparing across groups, parafunctions such as chewing gum (76.47% vs. 46.07%) nail biting (70.59% vs. 40.45%) and bruxism (52.54% vs. 26.22%) were observed significantly more often in children with ADHD than in children without ADHD ($p < 0.05$); The prevalence of other parafunctions did not differ significantly between the two analyzed groups, which was also the case for the most common parafunction, which was leaning chin on hands (217 people, 76.41%).

Table 1. **Comparison of the incidence of individual parafunctions in children with and without ADHD**

Parafunctions	Number of children (%)	Children with ADHD (%)	Children without ADHD (%)	p value	OR	95% CI
Leaning chin on hands	217 (76.41)	12 (70.59)	205 (76.78)	0.56*	0.73	0.25–2.14
Chewing gum a few times a week/every day	136 (47.89)	13 (76.47)	123 (46.07)	0.015	3.80	1.21–11.97
Unilateral chewing	122 (42.96)	8 (47.06)	114 (42.7)	0.725	1.19	0.45–3.19
Nail biting	120 (42.25)	12 (70.59)	108 (40.45)	0.015	3.53	1.21–10.32
Biting foreign objects	88 (30.99)	7 (41.18)	81 (30.34)	0.349	1.61	0.59–4.37
Bruxism	79 (27.82)	9 (52.54)	70 (26.22)	0.025*	3.17	1.17–8.53
Lip biting	74 (26.06)	3 (17.65)	71 (26.59)	0.573*	0.59	0.17–2.12
Sucking and chewing on the cheek mucosa	57 (20.07)	3 (17.65)	54 (20.22)	1*	0.85	0.23–3.05
Tongue biting	45 (15.85)	5 (29.41)	40 (14.98)	0.16*	2.36	0.79–7.08
Finger sucking	13 (4.58)	0 (0)	13 (4.87)	1*	0	-

* – analysis using Fisher's exact test

A quantitative assessment of parafunctions was also carried out. A difference at the level close to significance ($p = 0.076$) was found between the analyzed groups of children with and without ADHD in performing 8 to 10 parafunctions (11.76 vs. 2.25%) (Table 2).

Table 2. **The incidence of parafunctions in children with and without ADHD**

Specification	Number of children (%)	Children with ADHD (%)	Children without ADHD (%)	p value	OR	95% CI
Without parafunctions	7 (2.46)	0 (0)	7 (2.62)	1*	0	-
At least one parafunction	277 (97.54)	17 (100)	260 (97.38)	1*	∞	-
1–3 parafunctions	155 (54.58)	7 (41.18)	148 (55.43)	0.252	0.56	0.21–1.52
4–7 parafunctions	114 (40.14)	8 (47.06)	106 (39.70)	0.548	1.35	0.50–3.61
8-10 parafunctions	8 (2.82)	2 (11.76)	6 (2.25)	0.076*	5.80	1.08–31.21

* – analysis using Fisher's exact test

There were no significant differences between the study groups in the incidence of signs and symptoms of TMD (Table 3).

Table 3. **The incidence of TMD signs and symptoms in children with and without ADHD**

Signs and symptoms	Number of children (%)	Children with ADHD (%)	Children without ADHD (%)	p value	OR	95% CI
Muscular symptoms	62 (21.83)	5 (29.41)	57 (21.35)	0.543*	1.54	0.52–4.54
Pain on palpation of TMJ	60 (21.13)	4 (23.53)	56 (20.97)	0.763*	1.16	0.36–3.69
Dysfunctions in mandibular mobility	54 (19.01)	2 (11.76)	52 (19.48)	0.749*	0.55	0.12–2.49
Subjective acoustic symptoms	34 (11.97)	2 (11.76)	32 (11.99)	1*	0.98	0.21–4.48
Pathological attrition	34 (11.97)	4 (23.53)	30 (11.24)	0.131*	2.43	0.74–7.94
Objective acoustic symptoms	29 (10.21)	4 (23.53)	25 (9.36)	0.082*	2.98	0.90–9.83
Spontaneous pain in TMJ area	25 (8.8)	3 (17.65)	22 (8.24)	0.179*	2.39	0.64–8.94

* – analysis using Fisher's exact test

However, there was a significantly higher percentage ($p < 0.05$) of children with ADHD in whom the number of symptoms and signs of TMD was 4–7 (17.65% vs. 3.75%), and there was a significantly lower proportion of children with ADHD with only one sign or symptom of TMD (0% vs. 32.21%; $p < 0.05$) (Table 4).

Table 4. **The incidence of TMD signs and symptoms in children with and without ADHD**

Specification	Number of children (%)	Children with ADHD (%)	Children without ADHD (%)	p value	OR	95% CI
Without signs and symptoms	83 (29.23)	6 (35.29)	77 (28.84)	0.587*	1.35	0.48–3.77
At least one sign or symptom	201 (70.77)	11 (64.71)	190 (71.16)	0.587*	0.74	0.27–2.08
One sign or symptom	86 (30.28)	0 (0)	86 (32.21)	0.005	0	-
2–3 signs or symptoms	102 (35.92)	8 (47.06)	94 (35.21)	0.323	1.64	0.61–4.38
4–7 signs or symptoms	13 (4.58)	3 (17.65)	10 (3.75)	0.035*	5.51	1.36–22.28

* – analysis using Fisher's exact test

Discussion

It is known that the occurrence of parafunctions in children may have a significant impact on the subsequent development of TMD and may lead to abnormalities in the structure of the masticatory system. Identifying the risk groups for parafunctions may be particularly important for proper prevention and care of children. There is a suspicion that children with ADHD may be at risk.

The results of this study indicated that the incidence of parafunctions in children with ADHD was significantly higher than in children without ADHD. The results of other studies show similar associations, although not all results are consistent and in the case of many parafunctions reports are missing [1, 7, 15–17].

According to our research, one of the most frequently observed parafunctions among children was habitual gum chewing, which was significantly more frequently practiced by children with ADHD. Naming chewing gum a parafunction, which means a harmful habit, is a particularly important issue because this activity is recommended by numerous psychiatrists because of its beneficial role in relieving anxiety and hyperactivity. Positive effects of chewing gum on cognitive functions have been described in numerous studies. Chewing gum can improve memory and concentration functions in healthy children and adults [18–20]. It has been suggested that gum chewing can influence cerebral blood flow and suppression of insulin secretion [21]. In the research by Sakamoto et al. [18], improvements in concentration were only noticeable when chewing took place before the work began and remained only during the first twenty minutes of cognitive work. There are also data that do not confirm the relationship between chewing gum and improvement in attention among ADHD children [19, 22, 23].

At the same time, from the dental point of view, the negative effect of habitual gum chewing on the stomatognathic system is indicated. Research by Gavish et al. [1] conducted among girls aged 15–16 has demonstrated that chewing gum over 3 hours a day has a potentially negative effect on the muscles of mastication and the temporomandibular joint. Another study of adults indicated that gum chewing causes crepitations and pain in the temporomandibular joint and that this relationship strongly depends on how long the gum is chewed. Intense gum chewing affects the occurrence of both unconscious signs and conscious symptoms of TMD [17]. Regular chewing of gum has been shown to increase the pain in the muscles of mastication in patients with TMD, and intense chewing for several hours per day has potentially adverse effects on temporomandibular joint muscles [24]. There are also individual reports indicating reversible side effects of prolonged gum chewing on the temporomandibular joint, i.e., pain and pops as well as earache [25].

In other studies, no evidence was found that gum chewing may cause muscular and facial pain and dysfunction of the masticatory system [26]. However, there is a lack of data on the epidemiology of gum chewing and its potential impact on the temporomandibular joint in people with ADHD.

It is worth considering the conflicting recommendations of psychiatrists and dentists regarding chewing gum. The dentist recommends limiting gum chewing to a few minutes after a meal to prevent tooth decay, while psychiatrists recommend this activity to focus and improve cognitive functions of people with ADHD. Therefore, there is a need to find a 'golden mean' and, in the future, to create guidelines for children with

ADHD regarding the intensity of gum chewing used to relieve hyperactivity, which is at the same time accepted from the dental point of view.

The next parafunction analyzed in our research was nail biting, which was much more frequently observed in ADHD children. Nail biting is classified under obsessive-compulsive and related disorders in DSM-5. ICD-10 classifies the practice as "other specified behavioral and emotional disorders with onset usually occurring in childhood and adolescence". This habit may be used to relieve tension and anxiety which are secondary to the primary disorder, just as observed with ADHD. It has been proven that there is a very high concomitance of psychiatric disorders among children biting nails – it is approximately 80%. In one study, in a group of children aged of 5–18 years who bit their nails, all of the boys and 81% of the girls had at least one psychiatric disorder [27]. In the next study, the group of children biting their nails was selected from children at the age of 5–18 years visiting the outpatient psychiatry clinic. The most frequently observed disorder in these children – out of all the psychiatric disorders – was ADHD (74.6%) [27]. These studies confirm our results, in which children diagnosed with ADHD performed the above-mentioned parafunction similarly often (70.59%). Studies have shown a significant difference in the incidence of nail biting in children aged 5–13 with ADHD and without ADHD (37.8 vs. 10.9%) [15]. A similar relationship was found in the study described in this article, however, the incidence of biting nails in children without ADHD from Sopot was significantly higher than in the study quoted above (70.59% vs. 40.45%).

The much higher incidence of this harmful habit in Sopot children may be associated with greater homogeneity of our group in terms of age. Therefore, it is not an isolated disorder, which should increase the diagnostic vigilance of physicians consulting such children. The coexistence of psychiatric disorders with nail biting is not related to the range of the plaque damage, the intensity of biting and the age at which the biting starts [27]. Considering the above-mentioned data, it is important to identify coexisting disorders/symptoms in order to deal with the treatment of nail biting more efficiently. Commonly used therapeutic methods are often ineffective because of neglected treatment of the coexisting disorders. Research shows that effective treatment of ADHD can significantly reduce nail biting [28].

Bruxism is another parafunction differentially distributed between the analyzed groups. It is defined as the clenching and/or grinding of teeth that can occur during sleep (sleep bruxism – SB) or while awake (awake bruxism – AB). In our study, bruxism was analyzed together, without the division into SB and AB. It was demonstrated that the incidence of bruxism among all children was 27.82% (79 children). Interestingly, among children with ADHD, the incidence of bruxism was 52.54%, which was twice as high as in children without ADHD (26.22%).

Similar results were obtained in a Brazilian study, where it was shown that the incidence of bruxism in a population of 851 children aged 6–12 was 28.2% and that the incidence of bruxism was significantly higher among children with ADHD. The study also proved that there was a significant positive correlation between bruxism and ADHD. Furthermore, it has been proven that the relationship between bruxism and ADHD was a direct effect and not mediated by parafunctions such as finger sucking, nail biting or biting other objects [29]. It has also been shown that children with ADHD are more likely to grind their teeth during the day, more often grind and clench their teeth at night and – according to parental observation – children's teeth are getting worn down. Group differences in the incidence of headaches, pain in the face and sounds in temporomandibular joints were not observed [30].

Other authors have indicated even more frequent occurrence of bruxism among children. Chau et al. [16] reported that the prevalence of bruxism among children with ADHD was 81.6%, and among children without ADHD, it was 48.4%. Atmetlla et al. [15] suggested the prevalence of bruxism in children aged 5–13 years with ADHD was very low – only 5.4%. In that study, however, the occurrence of bruxism was still significantly higher than in children without ADHD. These studies clearly indicated a higher incidence of bruxism in children with ADHD, however, the particular level of prevalence of bruxism varies depending on the study and the used methodology.

As observed by Malki et al. [30], not only ADHD itself but also its pharmacological treatment have an influence on dental health. According to their studies, children treated with methylphenidate derivatives had statistically significantly more worn down teeth than children with untreated ADHD and children without ADHD. Smith and Sharp [11] claim that pharmacological therapy of ADHD leads to dry mouth, which results in greater tooth wear. Pharmacological treatment of ADHD further increases the risk of tooth wear [11], which is the reason why it may be a more obvious sign for the dentist of the necessity to protect the patient's teeth. Such data are a precious suggestion for clinicians looking after ADHD children.

For the remaining seven parafunctions, no statistically significant association with ADHD was demonstrated..

Similar associations were observed in the quantitative analysis of signs and symptoms of TMD comparing both groups: children with ADHD more often had a higher number of signs and symptoms of TMD (4–7 signs and symptoms; 17.65% vs. 3.75%), while 1 sign or 1 symptom of TMD was observed much less frequently in the children with ADHD compared with children without ADHD (0% vs. 32.21%).

The strengths of the study

- This was a population study. All 5th graders of all public primary schools in Sopot were invited; it was an undirected and untreated group, and the respondent rate was as high as 91%;
- The K-SADS examination was performed by a qualified, trained child psychiatrist (all psychiatric consultations were performed by one child psychiatrist);
- The study results may be characteristic of Central European population in terms of culture.

Limitations of the study

- Due to the screening nature of the study, no additional instrumental examinations were performed;
- There was a small group of children with ADHD – resulting from the nature of the population-based study and the prevalence of ADHD in the general population;
- Due to the small number of children with ADHD, no individual subtypes of ADHD were identified and coexisting disorders were not described.

Conclusions

1. The following parafunctions: gum chewing, nail biting and bruxism are more often present in children with ADHD than in children without ADHD.
2. The incidence of parafunctions, signs and symptoms of TMD in children with ADHD is significantly higher than in children without ADHD.
3. Due to the widespread prevalence of parafunctions, signs and symptoms of TMD both in children with and without ADHD, it is necessary to sensitize parents and children to the negative impact of oral habits.
4. Children with ADHD require interdisciplinary treatment by and mutual consultation of a psychiatrist and a dentist when planning treatment.

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References

1. Gavish A, Halachmi M, Winocur E, Gazit E. *Oral habits and their association with signs and symptoms of temporomandibular disorders in adolescent girls*. J. Oral Rehabil. 2000; 27(1): 22–32.
2. Winocur E, Littner D, Adams I, Gavish A. *Oral habits and their association with signs and symptoms of temporomandibular disorders in adolescents: A gender comparison*. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod. 2006; 102(4): 482–487.
3. Vanderas AP, Papagiannoulis L. *Multifactorial analysis of the aetiology of craniomandibular dysfunction in children*. Int. J. Paediatr. Dent. 2002; 12(5): 336–346.
4. Al-Khotani A, Naimi-Akbar A, Gjelset M, Albadawi E, Bello L, Hedenberg-Magnusson B et al. *The associations between psychosocial aspects and TMD-pain related aspects in children and adolescents*. J. Headache Pain. 2016; 17(1): 30.
5. Okeson JP. *Temporomandibular disorders in children*. Pediatr. Dent. 1989; 11(4): 325–329.
6. Litko M, Kleinrok J. *Mandibular dysfunctions in children and adolescents – a review of the literature.* Protet. Stomatol. 2007; 2: 105-111.

7. Habib Jorge J, Gonçalves DAG, Petzet Barreiros A, Ceregatti T, Sapienza G, Hermana Neppelenbroek K et al. *Relationship of psychological factors to temporomandibular disorders in children*. N Y State Dent. J. 2017; 83(1): 39–43.
8. Polanczyk G, De Lima MS, Horta BL, Biederman J, Rohde LA. *The worldwide prevalence of ADHD: A systematic review and metaregression analysis*. Am. J. Psychiatry. 2007; 164(6): 942–948.
9. Polanczyk G, Salum GA, Sugaya LS, Caye A, Rohde LA. *Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents*. J. Child Psychol. Psychiatry. 2015; 56(3): 345–365.
10. Sciberras E, Mulraney M, Silva D, Coghill D. *Prenatal risk factors and the etiology of ADHD-review of existing evidence*. Curr. Psychiatry Rep. 2017; 19(1): 1.
11. Smith A, Sharp HK. *Children with ADHD: What the treating dentist needs to know*. Journal of Pediatric Dental Care. 2007; 13(3): 14–17.
12. Suligowska K, Czarniak P, Krawczyk M, Szcześniak P, Król E, Kusiak A et al. *An assessment of health status and health behaviours in adolescents: Main points and methods of the SOPKARD-Junior programme*. Arch. Med. Sci. 2018; 14(1): 38–51.
13. Okeson JP. *Leczenie dysfunkcji skroniowo-żuchwowych i zaburzeń zwarcia*, 2nd ed. Lublin: Czelej; 2018. P. 70–81.
14. Wolańczyk T. *Zaburzenia emocjonalne i behawioralne u dzieci i młodzieży szkolnej w Polsce*. Habilitation thesis. Medical University of Warsaw; 2002.
15. Atmetlla G, Burgos V, Carrillo A, Chaskel R. *Behavior and orofacial characteristics of children with attention-deficit hyperactivity disorder during a dental visit*. J. Clin. Pediatr. Dent. 2006; 30(3): 183–190.
16. Chau Y C, Lai KY, McGrath CP, Yiu CK. *Oral health of children with attention deficit hyperactivity disorder*. Eur. J. Oral Sci. 2017; 125(1): 49–54.
17. Tabrizi R, Karagah T, Aliabadi E, Hoseini SA. *Does gum chewing increase the prevalence of temporomandibular disorders in individuals with gum chewing habits?* J. Craniofac. Surg. 2014; 25(5): 1818–1821.
18. Sakamoto K, Nakata H, Kakigi R. *The effect of mastication on human cognitive processing: A study using event-related potentials*. Neurophysiol. Clin. 2009; 120(1): 41–50.
19. Wilkinson L, Scholey A, Wesnes K. *Chewing gum selectively improves aspects of memory in healthy volunteers*. Appetite. 2002; 38(3): 235–236.
20. Baker JR, Bezance JB, Zellaby E, Aggleton JP. *Chewing gum can produce context-dependent effects upon memory*. Appetite. 2004; 43(2): 207–210.
21. Hirano Y, Obata T, Kashikura K, Nonaka H, Tachibana A, Ikehira H et al. *Effects of chewing in working memory processing*. Neurosci. Lett. 2008; 436(2): 189–192.
22. Johnson AJ, Miles C. *Evidence against memorial facilitation and context-dependent memory effects through the chewing of gum*. Appetite. 2007; 48(3): 394–396.
23. Tucha O, Mecklinger L, Maier K, Hammerl M, Lange KW. *Chewing gum differentially affects aspects of attention in healthy subjects*. Appetite. 2004; 42(3): 327–329.
24. Farella M, Bakke M, Michelotti A, Martina R. *Effects of prolonged gum chewing on pain and fatigue in human jaw muscles*. Eur. J. Oral Sci. 2001; 109(2): 81–85.
25. Elman ES. *Gum chewing and the temporomandibular joint*. J. Am. Dent. Assoc. 1965; 71(6): 1416–1418.
26. Christensen LV, Tran KT, Mohamed SE. *Gum chewing and jaw muscle fatigue and pains*. J. Oral Rehabil. 1996; 23(6): 424–437.

27. Ghanizadeh A. *Association of nail biting and psychiatric disorders in children and their parents in a psychiatrically referred sample of children*. Child Adolesc. Psychiatry Ment. Health. 2008; 2(1): 13.
28. Ghanizadeh A. *Can behavioral sensory processing problems guide us to a better pharmacological management of children with attention deficit hyperactivity disorder? A case report*. Psychiatry. 2009; 6(12): 40–43.
29. Mota-Veloso I, Celeste RK, Fonseca CP, Soares MEC, Marques LS, Ramos-Jorge ML et al. *Effects of attention deficit hyperactivity disorder signs and socio-economic status on sleep bruxism and tooth wear among schoolchildren: Structural equation modelling approach*. Int. J. Paediatr. Dent. 2017; 27(6): 523–531.
30. Malki G, Zawawi K, Melis M, Hughes C. *Prevalence of bruxism in children receiving treatment for attention deficit hyperactivity disorder: A pilot study*. J. Clin. Pediatr. Dent. 2004; 29(1): 63–67.

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