ACTA ODONTOLOGICA SCANDINAVICA, 2017
VOL. 75, NO. 6, 453–460
https://doi.org/10.1080/00016357.2017.1339908

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ORIGINAL ARTICLE

Determinants for craniofacial pains in children 6–8 years of age: the PANIC study

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ABSTRACT

Objective: Determinants for orofacial pain, headache, morning headache and painful signs of temporomandibular disorders (TMD) were investigated in prepubertal children.

Material and methods: The participants were a population sample of 439 children aged 6–8 years. Craniofacial pains, eating meals and snacks, sleep bruxism, sleep quality, sleep-disordered breathing (SDB), psychological well-being, parental education and household income were assessed by questionnaires filled out by the parents. Sleep duration was assessed using a combined heart rate and movement sensor and clinical signs of TMD and dental occlusion by a dentist. The determinants of pain conditions were analyzed using logistic regression.

Results: Of all 439 children, 26% had experienced orofacial pain and 31% headache during the past 3 months, 17% had suffered morning headache weekly and 13% had painful signs of TMD in a clinical examination. Restless sleep was associated with increased risk of orofacial pain, the painful signs of TMD and restless sleep with increased risk of headache and restless sleep, sleep bruxism and skipping meals with increased risk of morning headache after adjustment for other independent determinants of these pain conditions. Headache was associated with increased risk for painful signs of TMD.

Conclusions: Craniofacial pains are common among prepubertal children. Prepubertal children with sleep bruxism, restless sleep and skipping meals have increased likelihood of craniofacial pains.

ARTICLE HISTORY
Received 30 April 2017
Revised 30 May 2017
Accepted 1 June 2017

KEYWORDS
Craniofacial pain; headache; orofacial pain; children; TMD

Introduction

Craniofacial pain is a topographic term, which includes a great diversity of painful conditions in the cranium and face [1]. Craniofacial pains are common among children, headache being the most frequent of them [2,3]. The reported prevalence of paediatric headache varies greatly, between 6% and 82% depending on children's age, the definition criteria of headache and, possibly, also the follow-up time frame (past three or six months) in different studies [4–7]. Tension-type headache and migraine are the most common types of headaches in children 7 years of age in Finland [8]. Altogether 52% of Finnish 7-year-old children suffer from headache, and 6% of those have migraine [5]. We have previously reported that 32% of children 6–8 years of age have experienced headache during the past 3 months [9]. However, there are no studies on the prevalence of morning headache in children. Orofacial pain originates from the mouth, teeth, jaws and face and is caused by an injury, infection, nerve disorder or, sometimes, the reason may be unknown. Moreover, orofacial pain is one of the symptoms of temporomandibular disorders (TMD) which include several musculoskeletal and neuromuscular symptoms and clinical signs that involve the masticatory muscles, the temporomandibular joints and associated structures [10]. According to our previous report, 26% of Finnish children 6–8 years of age have experienced orofacial pain and 14% painful signs of TMD during the previous 3 months [9].

Sleep disorders, such as insomnia, insufficient sleep, restless sleep, anxiety related to sleep, nightmares and other parasomnias, but also sleep-disordered breathing (SDB), have been associated with headache in children [11–13]. SDB represents a continuum of symptoms from simple snoring to obstructive sleep apnoea syndrome and is one of the most common sleep disturbances [14]. Sleep disorders have also been associated with orofacial pain and TMD among children [15] and with sleep bruxism [16–18]. Moreover, TMD, malocclusions and sleep bruxism have been associated with headache among them [19,20]. A systematic polysomnographic study in adults showed that morning headache was associated with decreased total sleep time and sleep efficiency [21]. However, there are no studies of such relationships among children. Moreover, skipping meals [22] and a decreased socioeconomic status [23,24] have been associated

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with increased prevalence of headache among children and adolescents [22]. Moreover, psychic stress and anxiety play a role not only in headache but also in orofacial pain and TMD already in childhood [3,25,26]. Other possible etiological factors in orofacial pain and TMD include different structural parameters, occlusal interferences and environmental factors [27]. We have previously shown that children having headache, back or neck–shoulder pain or palpation tenderness in trapezius muscles were more likely to have clinical signs of TMD than those without such symptoms [9].

Although determinants for craniofacial pains in childhood have been examined, studies have mainly focused on headaches in general. For example, the role of biological and lifestyle-related factors behind morning headache appears to be unknown. Due to the various aetiologies of craniofacial pains, it is important to study their determinants separately. Moreover, the results of a 13-year follow-up study showed that headache at least once a week at the age of 8–14 years predicted headache in adulthood [28], which emphasizes the importance of early identification of determinants of headache and other craniofacial pains already in childhood. We therefore investigated determinants for craniofacial pains in a population sample of children 6–8 years of age.

Materials and methods

Study design and study population

The present analyses are based on the baseline data of the Physical Activity and Nutrition in Children (PANIC) Study, which is an ongoing physical activity and dietary intervention study in a population sample of primary-school children from the city of Kuopio, Finland. Altogether, 736 children, 6–8 years of age, were invited to participate in the study by letters delivered to the parents *via* public schools of Kuopio. Of the invited children, 512 (70%) participated in the baseline examinations that were conducted in 2007–2009. The participants did not differ in sex distribution or age from the non-participants based on available school health examination data (data not shown). Complete data on pain conditions were available for 439 children (208 girls, 231 boys) who were included in the final study population. These 439 children did not differ in any variable used in the analyses from the 73 children who were excluded (data not shown). From these 439 children, data on sleep duration, sleep bruxism, clinical signs of TMD, crossbite, the use of occlusal appliance and parental education were available for all children, eating frequency for 420 children, sleep quality for 375 children, SDB for 417 children, psychological well-being for 404 children and household income for 368 children. We excluded children with missing data on these variables in statistical analyses. All participating children and their parents gave their informed consent. The study protocol was approved by the Research Ethics Committee of Hospital District of Northern Savo in 2006.

Assessments of pain conditions

Pain was assessed by a questionnaire filled out by the parents [9]. The questionnaire was designed to assess the prevalence of pain conditions in general populations of children. The questionnaire was partly based on the pain questionnaire of the Finnish Association for the Study of Pain. The parents filled out the questionnaire during their children's clinical oral health examination or at home after the study visit and returned the questionnaire either by mail or at the next examination visit. The parents were asked whether their children had experienced pain within the past 3 months and the locations of pains. Pain existing in the forehead, temple, cheeks, temporomandibular joints or mandible on the right or left side was asked, and pain existing in at least one area was defined as orofacial pain. Correspondingly, pain in the crown, occiput, forehead, temple, cheeks, temporomandibular joints and mandible on the right or left side was asked, and was defined as headache [9]. Morning headache was assessed using a sleep questionnaire filled out by the parents [29]. The questionnaire was partly based on a validated Nordic sleep questionnaire [30]. The parents were asked how often their children had headache in the mornings (never, seldom, 1–2 times/week, 3–4 times/week and 6–7 times/week). The children were defined to have morning headache if it existed at least once a week.

Assessment of painful signs of TMD

All clinical TMD examinations were carried out by one dentist who was trained before the beginning of the study by a TMD specialist. Palpation tenderness in the masticatory muscles and temporomandibular joints and pain in mandible movement on the right or left side were examined. At least one painful sign in any of these locations or during the jaw movements was defined as a painful sign of TMD. At the beginning of each examination day, a digital scale was used to ensure that approximately the same pressure was applied during the palpation of the muscle sites (1 kg) and the joints (0.5 kg). A detailed description of the assessment of clinical signs of TMD has been published earlier [9].

Assessment of dental occlusion

One orthodontist evaluated dental occlusion clinically using a standard orthodontic screening method [29]. Dental occlusion was assessed in the intercuspal position according to the modified method of Björk [31]. Previous or ongoing orthodontic treatment was checked from dental recordings.

Assessment of sleep and associated factors

Sleep duration was assessed by a combined heart rate and movement sensor (Actiheart, CamNtech, Cambridge, UK) which was set to record in 60-s epochs [32]. It was positioned on the chest with two standard electrocardiogram (ECG) electrodes (Bio Protech Inc., Munmak-eup, South Korea). Sleep was registered for 1–7 days and for at least 2 days in 85% of the children. Sleep duration was analyzed manually from the heart rate and movement data by one exercise specialist and was confirmed by one physician, if needed. The quality of sleep was assessed by a questionnaire

filled out by the parents [29]. The parents were asked how their child usually slept after falling asleep (1 = very peacefully, 2 = quite peacefully, 3 = sometimes peacefully and sometimes restlessly, 4 = quite restlessly, 5 = very restlessly). Children with scores 3–5 were defined having restless sleep. SDB and sleep bruxism were also assessed by a questionnaire filled out by the parents [29,30]. SDB was defined as apnoeas, frequent or loud snoring, or nocturnal mouth breathing observed by the parents. Children were defined having sleep bruxism if they had it at least once a week.

Assessment of dietary factors

Dietary factors were assessed by food records on four consecutive days [33]. Records of two weekdays and two weekend days and those of three weekdays and one weekend day were included in the analyses. Breakfast, lunch and dinner were classified as meals and all other eating and drinking occasions as snacks. Skipping one or more meals during the 4-day recording period was coded as skipping meals.

Assessment of socioeconomic position

The parents were asked to report in a questionnaire their annual household income (≤30,000€, 30,001–60,000€ and ≥60,001€) and their highest completed or ongoing educational degrees (vocational school or less, polytechnic, university). The degree of the more educated parent was used in the analyses.

Assessment of psychological well-being

The parents filled out a questionnaire that included 19 items on their children's psychological well-being during the last 3 months (timidity, tearfulness uncertainty, anxiety, frustration, depression, restlessness, squeamishness or anger, aggressiveness, difficulties in concentration, problems in concentration at homework, difficulties in home work, unwillingness to go to school, troublemaking in school class, discouragement, feeling of inferiority, forgetting things, sleeping disorders, difficulties to do same things as other children of same age). Each item was rated on a 5-point scale (0 = not at all, 1 = once or twice during the previous 3 months, 2 = sometimes, 3 = often, 4 = every day or almost every day). The psychological well-being score was calculated by summing up the scores of each item and thus ranged 0–76. A higher score indicated a lower psychological well-being.

Statistical methods

All statistical analyses were performed using the SPSS Statistics for Windows, Version 21.0 (SPSS Inc., Chicago, IL). Difference in age between girls and boys was analyzed with the independent samples *t*-test. Due to skewed distributions, the Mann–Whitney *U* test was used to analyze differences in sleep duration and psychological well-being between girls and boys. Differences in skipping meals, the prevalence of SDB and sleep bruxism, crossbite, the use of occlusal appliance, household income, parental education and the prevalence of pain conditions between girls and boys were examined using the χ^2 test. The determinants of orofacial pain, headache, morning headache and painful signs of TMD were studied using logistic regression analysis adjusted for age and gender (Model 1) and additionally for all statistically significant determinants of these pain conditions from age- and gender-adjusted models (Model 2). Only determinants that showed statistically significant associations with these pain conditions are presented in the tables.

Results

Characteristics of children

Of all 439 children, 26% had experienced orofacial pain and 31% headache during the past 3 months and 17% had experienced morning headache on a weekly basis. Altogether 13% of the children had painful signs of TMD in the clinical examination. There were no statistically significant differences in the prevalences or potential determinants of pain conditions between the girls and the boys (Table 1).

Determinants for orofacial pain

Restless sleep was associated with increased risk of orofacial pain after adjustment for age and gender (Table 2). This association remained statistically significant after further adjustment for other risk factors for restless sleep (Table 3).

Determinants for headache

The painful signs of TMD and restless sleep were associated with increased risk of headache after adjustment for age and gender (Table 2). These associations were even stronger after further adjustment for other risk factors for headache (Table 3).

Determinants for morning headache

Skipping meals, restless sleep, sleep bruxism and lower household income were associated with increased risk of morning headache after adjustment for age and gender (Table 2). The association of household income was no longer statistically significant and the associations of restless sleep and sleep bruxism weakened slightly after additional adjustment for other risk factors for morning headache (Table 3).

Determinants for painful signs of TMD

Children with headache had a 2.25 (95% confidence interval 1.26–4.01, $p = .006$) times higher risk of painful signs of TMD than children without headache. Other determinants were not associated with the risk of painful signs of TMD (data not shown).

Discussion

The present study showed that craniofacial pains are common in a general population of Finnish children 6–8 years of age.

Table 1. Basic characteristics of children.

	All children ($n = 439$)	Girls ($n = 208$)	Boys ($n = 231$)	p Value for difference[a]
Age	7.6 (0.4)	7.6 (0.4)	7.6 (0.4)	.270
Crossbite	65 (15)	32 (15)	33 (14)	.474
Occlusal appliance	29 (7)	15 (7)	14 (6)	.415
Sleep duration[b] (h/d)	9.6 (0.5)	9.7 (0.5)	9.6 (0.5)	.279
Sleep quality				
Peaceful/quite peaceful sleep	307 (70)	146 (70)	161 (70)	–
Restless sleep	68 (16)	35 (17)	33 (14)	.559
Sleep bruxism				
No	245 (56)	116 (56)	129 (56)	–
Yes	194 (44)	92 (44)	102 (44)	.987
Sleep-disordered breathing				
No	375 (85)	180 (87)	195 (84)	–
Yes	42 (10)	18 (9)	24 (10)	.527
Eating meals				
3 meals daily	163 (59)	81 (39)	82 (36)	–
<3 meals daily	257 (37)	121 (58)	136 (59)	.602
Psychological well-being mean	10.4 (9.5)	10.8 (9.6)	10.0 (9.3)	.429
Household income				
≤30,000€	78 (18%)	46 (26%)	32 (17%)	–
30,001–60,000€	155 (35%)	67 (38%)	88 (46%)	–
≥60,001€	135 (31%)	64 (36%)	71 (37%)	.074
Parental education				
Vocational school or less	84 (19%)	37 (18%)	47 (20%)	–
Vocational high school	195 (44%)	93 (45%)	102 (44%)	–
University	157 (36%)	75 (37%)	82 (36%)	.832
Pains				
Orofacial pain[c]	115 (26%)	52 (25%)	63 (27%)	.320
Headache[c]	138 (31%)	70 (33%)	68 (30%)	.532
Morning headache[d]	73 (17%)	33 (16%)	40 (17%)	.454
Painful signs of TMD	55 (13%)	32 (15%)	23 (10%)	.154

Values are means (standard deviation, SD) or n (%).
[a]Difference between boys and girls from Pearson's χ^2 test and from t-test for independent samples.
[b]Sleep duration was assessed by the combined heart rate and movement sensor (Actiheart, CamNtech Cambridge, UK) which was set to record in 60-s epochs [31].
[c]Pain during the past 3 months reported by the parents.
[d]At least once a week reported by parents.

Table 2. Determinants for craniofacial pains among 439 children after adjustment for age and gender.

	Orofacial pain		Headache		Morning headache	
Determinants	OR (95% CI)	p Value	OR (95% CI)	p Value	OR (95% CI)	p Value
Painful signs of TMDa						
No	1.00	–	1.00	–	1.00	–
Yes	1.65 (0.90–3.02)	.107	2.29 (1.28–4.08)	**.005**	1.52 (0.75–3.05)	.245
Sleep quality						
Peaceful/quite peaceful sleep	1.00	–	1.00	–	1.00	–
Restless sleep	2.02 (1.21–3.38)	**.007**	1.86 (1.13–3.05)	**.015**	3.73 (2.13–6.50)	**<.001**
Sleep bruxism						
No	1.00	–	1.00	–	1.00	–
Yes	1.31 (0.84–2.04)	.237	1.38 (0.90–2.11)	.140	4.12(2.42–6.97)	**<.001**
Eating meals						
All 3 meals/day	1.00	–	1.00	–	1.00	–
<3 meals/day	1.10 (0.71–1.72)	.666	1.17 (0.76–1.79)	.473	2.33 (1.28–4.25)	**.006**
Household income						
≤30,000€	1.00	–	1.00	–	1.00	–
30,001–60,000€	1.36 (077–2.41)	.289	1.03 (0.60–1.75)	.927	0.47 (0.25–0.87)	**.017**
≥60,001€	0.81 (0.44–1.48)	.492	0.80 (0.42–1.28)	.267	0.38 (0.20–0.73)	**.004**

Values are odds ratios (OR) and their 95% confidence intervals (CI) from logistic regression models adjusted for age and gender. There were 115 children with orofacial pain, 138 children with headache and 73 children with morning headache in these analyses.
[a]Temporomandibular disorders.
Significances are presented in bold.

About fourth of the children had experienced orofacial pain and almost third of them had experienced headache during the past 3 months, almost fifth of them had experienced morning headache on a weekly basis and over tenth of the children had at least one painful sign of TMD in the clinical examination. Restless sleep was associated with increased risk of orofacial pain. The painful signs of TMD and restless sleep were associated with increased risk of headache. Skipping meals, restless sleep and sleep bruxism were related to increased risk of morning headache.

Studies among adults and adolescents have shown that sleep and headache have an intricate and bilateral relationship [17,34]. Excessive, reduced or disrupted sleep, increased deep sleep, sleep bruxism, SDB and especially the most

Table 3. Risk factors for craniofacial pains after adjustment for other statistically significant determinants of pains.

	Orofacial pain		Headache		Morning headache	
Determinants	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value
Painful signs of TMDa						
No	–	–	1.00	–	–	–
Yes	–	–	2.39 (1.33–4.27)	**003**	–	–
Sleep quality						
Peaceful/quite peaceful sleep	1.00	–	1.00	–	1.00	–
Restless sleep	2.02 (1.21–3.38)	**.007**	1.95 (1.18–3.29)	**.009**	2.95 (1.56–5.55)	**.001**
Sleep bruxism						
No	–	–	–	–	1.00	–
Yes	–	–	–	–	2.97 (1.68–5.26)	**<.001**
Eating meals						
All 3 meals/day	–	–	–	–	1.00	–
<3 meals/day	–	–	–	–	2.27 (1.21–4.28)	**.011**
Household income						
≤30,000€	–	–	–	–	1.00	–
30,001–60,000€	–	–	–	–	0.62 (0.31–1.23)	.172
≥60,001€	–	–	–	–	0.50 (0.24–1.03)	.061

Values are odds ratios (OR) and their 95% confidence intervals (CI) from multiple logistic regression models adjusted for age and gender and additionally for all statistically significant determinants of any pain condition from age- and gender-adjusted models (Table 1).
[a]Temporomandibular disorders.
Significances are presented in bold.

severe manifestation of it, sleep apnoea, have been found to be associated with increased risk of headache even in childhood [11,13,20,35]. We found that restless sleep was associated with increased risk of orofacial pain, headache and morning headache in children. These results are consistent with the observation of other studies among children [13,36]. However, sleep duration or SDB was not related to any pain condition in our study sample. One reason for this may be that only 10% of the children slept less than 9 h per night or had SDB [29], and because of the low proportion of such children the possible relationships did not show in the statistical analyses. Headache has been reported to be approximately three times more common among children with sleep bruxism than among those without it [20]. We found that sleep bruxism was related to increased risk of morning headache but not headache in general. Earlier studies that have reported the association between sleep bruxism and increased risk of morning headache have been conducted in adults [37,38]. There are no previous reports on the associations of sleep bruxism with morning headache in population samples of children.

A previous study showed that adolescents who skipped meals, especially breakfast, were more likely to have headache than those who had regular eating habits [22]. Moreover, fasting and skipping meals have been reported to trigger headache in children [39]. These findings suggest that skipping meals, especially breakfast, predisposes to headache or regular eating reduces the occurrence of headache. We found that skipping meals was associated with increased risk for morning headache in children. However, we cannot conclude whether skipping meals predisposes to morning headache or morning headache causes skipping breakfast because of our cross-sectional study design. The explanations for the association between skipping meals and morning headache are not yet clear. One possible reason could be that the activity of sympathetic nervous system increases due to prolonged fasting, which may result in headaches, particularly in the mornings. Another explanation could be that skipping meals increases snacking, worsens diet quality and causes fluctuation in plasma glucose levels and thereby results in headaches.

Studies have shown that individuals at lower socioeconomic levels are twice more likely to have headache than those at higher levels [40,41]. The findings of this study indicate that children whose family had a low income were more likely to have morning headache than those whose family income was high. However, this association did not remain after controlling for skipping meals, sleep quality and sleep bruxism. This observation suggests that a lower household income is not an independent determinant of morning headache. Although a lower socioeconomic position predisposes children to headache, also many other environmental, biological and psychological factors related to a lower socioeconomic position may play a role in the etiology of headache [42,43]. A study showed that children and adolescents with a lower socioeconomic position were more likely to have psychological problems [44]. However, we found no association between psychological well-being and pain conditions in children.

Of the clinical signs of TMD, palpation tenderness in masticatory muscles and temporomandibular joints and pain in mandible movements are classified as the painful signs of TMD [45]. In the present study, the painful signs of TMD were associated with headache, which is in accordance with the results of earlier studies in children [46,47]. Surprisingly, sleep bruxism was not associated with the painful signs of TMD or orofacial pain, although a previous study among children and adolescents 11–15 years of age showed that bruxism, reported by the children themselves, was related to TMD and orofacial pain [3]. One reason for not finding such an association in the present study may be that bruxism was assessed using a questionnaire filled out by the parents that may have reduced the likelihood to identify children with bruxism correctly. Secondly, we did not assess the clinical signs of bruxism, such as excess tooth wear. However, clinical examination has not been performed by some other research groups [3], either. There are several studies on sleep bruxism as a sign or cause of TMD, even in paediatric populations,

suggesting that sleep bruxism may have a role in the genesis of myogenic forms of TMD due to masticatory muscle hyperactivity and consequent overloading of the muscles during sleep [48,49]. Nevertheless, TMD pain and masticatory muscle pain related to sleep bruxism may be different entities; most adult TMD patients report a peak in pain intensity in the afternoon and towards the evening, whereas sleep bruxists report transient masseter and temporalis muscle pain or soreness mainly in the morning [50,51]. In line with previous results among adults [50,51], we found that sleep bruxism was associated with increased risk of morning headache in prepubertal children.

The strengths of our study include a relatively large and representative study population of mainly prepubertal children. The prevalence and risk factors of craniofacial pain conditions were assessed using questionnaires and clinical examinations. The assessment of pain using a questionnaire filled out by parents may be considered a weakness of the study, because some parents may have over- or underestimated their children's pain. However, questionnaires filled out by the parents are the only realistic measures of various pain conditions in a large population study among children. The pain questionnaire was designed to assess the prevalence of various pain conditions in the present epidemiological study in a general population of children by utilizing the questions of the pain questionnaire of the Finnish Association for the Study of Pain (www.skty.org) and a validated and generally used RDC/TMD scoring [45] regarding pain in the head and face as well as pain intensity. The sleep questionnaire was based on a Nordic Sleep Questionnaire which includes adequately accurate and widely used items to detect SDB [30]. Altogether, although our questionnaires, including the sleep questionnaire [30], were not validated as their own right, the questions were mainly adopted from validated questionnaires to meet the demands of the study carried out in a large population sample of children.

Children were considered to have orofacial pain if they had it in any of the predefined orofacial areas and, correspondingly, headache if they had it in any of the predefined areas of the head. We considered such a definition accurate enough for the purpose. The 3-month period for recalling orofacial pain and headache in the present study is comparable to the periods used in earlier studies [2,52,53]. Headache existing in the mornings at least once a week was defined as morning headache. A weakness of our study may be that we had no specific and validated measures of psychological factors, such as anxiety and depression, but assessed overall psychological well-being by a questionnaire on 19 items. However, we feel that this score describes the overall well-being of the participants relatively well. At the time of planning the PANIC study in 2006–2007 we found no suitable validated questionnaires to investigate psychological well-being in a population sample of young Finnish children. We, therefore, decided to develop a questionnaire specifically for our epidemiological study in a general population of young children. In line with other questionnaires in our study we used a 3-month period for recalling psychological well-being.

We used Research Diagnostic Criteria for TMD (RDC/TMD) [45] to assess the painful signs of TMD, except that the intraoral palpation of the lateral pterygoid muscle and the tendon of the temporalis muscle was not performed because of technical difficulties related to the young age and, consequently, small size of those structures of the children. Moreover, we used clinical signs but not symptoms or psychosocial factors to define TMD as suggested by the RDC/TMD. Thus, the children were not classified according to the complete diagnostic criteria of TMD, which may be considered a limitation of the study. The clinical signs of TMD were examined once for each child by one dentist, who was trained before beginning of the study by a TMD specialist. We, therefore, did not have problems related to decreased intra- and inter-observer reliability that is typical in studies including more than one person carrying out examinations. Moreover, we used a digital scale at the beginning of each examination day to ensure the same pressure applied during the palpation of the muscles and the joints. We had no opportunity to conduct demanding polysomnographic examinations to expose the sleep disorders, including SDB, sleep quality and sleep bruxism, but they were assessed by the questionnaires filled out by the parents because of the large study sample of mainly healthy children. International authorities have stated that questionnaires can be used in assessing sleep disorders, although polysomnography is the best available method for this purpose [30,54]. Finally, the cross-sectional design did not allow us to study the time order of the associations. Accordingly, some determinants of pain conditions may not be the cause but the result of these pain conditions.

The current study suggests that craniofacial pains are common among children 6–8 years of age. Both behavioural and life-style related factors are associated with pains. Impaired sleep quality, sleep bruxism, skipping meals and lower household income seem to be associated with increased risk of craniofacial pains in prepubertal children. Moreover, children with painful signs of TMD have increased likelihood of headache. This study highlights the need of paying attention to sleep quality and eating meals regularly in avoiding craniofacial pains, especially morning headache.

Acknowledgements

This work has been financially supported by the Finnish Doctoral Program in Oral Sciences (FINDOS), the Finnish Dental Society Apollonia, the Finnish Pain Society, the Ministry of Social Affairs and Health of Finland, the Ministry of Education and Culture, Finland, the Finnish Innovation Fund Sitra, the Social Insurance Institution of Finland, the Finnish Cultural Foundation, the Juho Vainio Foundation, the Yrjö Jahnsson Foundation, the Foundation for Paediatric Research, the Paulo Foundation, the Paavo Nurmi Foundation, the Diabetes Research Foundation, Kuopio University Hospital (EVO funding numbers 5031343 and 5031354) and the Research Committee of the Kuopio University Hospital Catchment Area for the State Research Funding and city of Kuopio.

Disclosure statement

The authors report no conflicts of interest.

Funding

This work has been financially supported by the Finnish Doctoral Program in Oral Sciences (FINDOS), the Finnish Dental Society Apollonia, the Finnish Pain Society, the Ministry of Social Affairs and Health of Finland, the Ministry of Education and Culture, Finland, the Finnish Innovation Fund Sitra, the Social Insurance Institution of Finland, the Finnish Cultural Foundation, the Juho Vainio Foundation, the Yrjö Jahnsson Foundation, the Foundation for Paediatric Research, the Paulo Foundation, the Paavo Nurmi Foundation, the Diabetes Research Foundation, Kuopio University Hospital (EVO funding numbers 5031343 and 5031354) and the Research Committee of the Kuopio University Hospital Catchment Area for the State Research Funding and city of Kuopio.

References

[1] Svensson P, Jadidi F, Arima T, et al. Relationships between craniofacial pain and bruxism. J Oral Rehabil. 2008;35:524–547.

[2] Perquin CW, Hazebroek-Kampschreur AA, Hunfeld JA, et al. Pain in children and adolescents: a common experience. Pain. 2000;87:51–58.

[3] Karibe H, Shimazu K, Okamoto A, et al. Prevalence and association of self-reported anxiety, pain, and oral parafunctional habits with temporomandibular disorders in Japanese children and adolescents: a cross-sectional survey. BMC Oral Health. 2015;15:8.

[4] Sillanpää M. Changes in the prevalence of migraine and other headaches during the first seven school years. Headache. 1983;23:15–19.

[5] Sillanpää M, Anttila P. Increasing prevalence of headache in 7-year-old school children. Headache. 1996;36:466–470.

[6] Borge AI, Nordhagen R. Recurrent pain symptoms in children and parents. Acta Paediatr. 2000;89:1479–1483.

[7] Lipton RB, Maytal J, Winner P. Epidemiology and classification of headache. In: Winner P, Rothner AD, editors. Headache in children and adolescents. London (UK): BC Decker Inc, 2001. p. 1–19.

[8] Anttila P, Metsähonkala L, Sillanpää M. Long-term trends in the incidence of headache in Finnish schoolchildren. Pediatrics. 2006;117:1197–1201.

[9] Vierola A, Suominen AL, Ikävalko T, et al. Clinical signs of temporomandibular disorders and various pain conditions among children 6 to 8 years of age: the PANIC study. J Orofac Pain. 2012;26:17–25.

[10] de Leeuw R, Klasser GD, editos. Orofacial pain. Guidelines for assessment, diagnosis, and management. 5th ed. Hanover Park (IL): Quintessence Publishing Co., 2013. p. 129–30, 150, 151–154.

[11] Bruni O, Fabrizi P, Ottaviano S, et al. Prevalence of sleep disorders in childhood and adolescence with headache: a case-control study. Cephalalgia. 1997;17:492–498.

[12] Miller VA, Palermo TM, Powers SW, et al. Migraine headaches and sleep disturbances in children. Headache. 2003;43:362–368.

[13] Carra MC, Bruni O, Huynh N. Topical review: sleep bruxism, headaches, and sleep-disordered breathing in children and adolescents. J Orofac Pain. 2012;26:267–276.

[14] Wei JL, Mayo MS, Smith HJ, et al. Improved behavior and sleep after adenotonsillectomy in children with sleep-disordered breathing. Arch Otolaryngol Head Neck Surg. 2007;133:974–979.

[15] Magnusson T, Egermark I, Carlsson GE. A prospective investigation over two decades on signs and symptoms of temporomandibular disorders and associated variables. A final summary. Acta Odontol Scand. 2005;63:99–109.

[16] Dodick DW, Eross EJ, Parish JM, et al. Clinical, anatomical, and physiologic relationship between sleep and headache. Headache. 2003;43:282–292.

[17] Alberti A. Headache and sleep. Sleep Med Rev. 2006;10:431–437.

[18] Bardosa TS, Miyakoda LS, Pocztaruk RL, et al. Temporomandibular disorders and bruxism in childhood and adolescence: review of the literature. Int J Pediatr Otorhinolaryngol. 2008;72:299–314.

[19] Tecco S, Festa F. Prevalence of signs and symptoms of temporomandibular disorders in children and adolescents with and without crossbites. World J Orthod. 2010;11:37–42.

[20] Carra MC, Huynh N, Morton P, et al. Prevalence and risk factors of sleep bruxism and wake-time tooth clenching in a 7- to 17-yr-old population. Eur J Oral Sci. 2011;119:386–394.

[21] Göder R, Friege L, Fritzer G, et al. Morning headaches in patients with sleep disorders: a systematic polysomnographic study. Sleep Med. 2003;4:385–391.

[22] Moschiano F, Messina P, D'Amico D, et al. Headache, eating and sleeping behaviors and lifestyle factors in preadolescents: preliminary results from an Italian population study. Neurol Sci. 2012;33:87–90.

[23] Bugdayci R, Ozge A, Sasmaz T, et al. Prevalence and factors affecting headache in Turkish schoolchildren. Pediatr Int. 2005;47:316–322.

[24] King S, Chambers CT, Huguet A, et al. The epidemiology of chronic pain in children and adolescents revisited: a systematic review. Pain. 2011;152:2729–2738.

[25] List T, Wahlund K, Larsson B. Psychosocial functioning and dental factors in adolescents with temporomandibular disorders: a case-control study. J Orofac Pain. 2001;15:218–227.

[26] Kröner-Herwig B, Gassmann J. Headache disorders in children and adolescents: their association with psychological, behavioral, and socio-environmental factors. Headache. 2012;52:1387–1401.

[27] Manfredini D, Bandettini di Poggio E, Cantini L, et al. Mood and anxiety psychopathology and temporomandibular disorder: a spectrum approach. J Oral Rehabil. 2004;31:933–940.

[28] Brattberg G. Do pain problems in young school children persist into early adulthood? A 13-year follow-up. Eur J Pain. 2004;8:187–199.

[29] Ikävalko T, Tuomilehto H, Pahkala R, et al. Craniofacial morphology but not excess body fat is associated with risk of having sleep-disordered breathing – the PANIC study (a questionnaire-based inquiry in 6–8-year-olds). Eur J Pediatr. 2012;171:1747–1752.

[30] Partinen M, Gislason T. Basic Nordic Sleep Questionnaire (BNSQ): a quantitated measure of subjective sleep complaints. J Sleep Res. 1995;4:150–155.

[31] Björk A, Krebs B, Solow B. A method for epidemiological registration of malocclusion. Acta Odontol Scand. 1964;22:27–41.

[32] Brage S, Brage N, Franks PW, et al. Reliability and validity of the combined heart rate and movement sensor Actiheart. Eur J Clin Nutr. 2005;59:561–570.

[33] Eloranta AM, Lindi V, Schwab U, et al. Dietary factors and their associations with socioeconomic background in Finnish girls and boys 6–8 years of age: the PANIC study. Eur J Clin Nutr. 2011;65:1211–1218.

[34] Dosi C, Riccioni A, Della Corte M, et al. Comorbidities of sleep disorders in childhood and adolescence: focus on migraine. Nat Sci Sleep. 2013;5:77–85.

[35] Choi JH, Kim EJ, Choi J, et al. Obstructive sleep apnea syndrome: a child is not just a small adult. Ann Otol Rhinol Laryngol. 2010;119:656–661.

[36] Bellini B, Arruda M, Cescut A, et al. Headache and comorbidity in children and adolescents. J Headache Pain. 2013;14:79.

[37] Rains JC, Poceta JS, Penzien DB. Sleep and headaches. Curr Neurol Neurosci Rep. 2008;8:167–175.

[38] Lavigne G, Palla S. Transient morning headache: recognizing the role of sleep bruxism and sleep-disordered breathing. J Am Dent Assoc. 2010;141:297–299.

[39] Turner DP, Smitherman TA, Penzien DB, et al. Nighttime snacking, stress, and migraine activity. J Clin Neurosci. 2014;21:638–643.

[40] Grøholt EK, Stigum H, Nordhagen R, et al. Recurrent pain in children, socio-economic factors and accumulation in families. Eur J Epidemiol. 2003;18:965–975.

[41] Molarius A, Tegelberg A, Öhrvik J. Socio-economic factors, lifestyle and headache disorders-a population based study in Sweden. Headache. 2008;48:1426–1437.
[42] McGrath PA. Chronic daily headache in children and adolescents. Curr Pain Headache Rep. 2001;5:557–566.
[43] Kung E, Tepper SJ, Rapoport AM, et al. New daily persistent headache in the paediatric population. Cephalalgia. 2009; 29:17–22.
[44] van Oort FVA, van der Ende J, Wadsworth ME, et al. Cross-national comparison of the link between socioeconomic status and emotional and behavioral problems in youths. Soc Psychiatry Psychiatr Epidemiol. 2011;46:167–172.
[45] Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. J Craniomandib Disord. 1992;6:301–355.
[46] Aromaa M, Sillanpää M, Rautava P, et al. Childhood headache at school entry: a controlled clinical study. Neurology. 1998;50:1729–1736.
[47] Liljeström MR, Le Bell Y, Anttila P, et al. Headache children with temporomandibular disorders have several types of pain and other symptoms. Cephalalgia. 2005;25:1054–1060.
[48] Nilsson IM, List T, Drangsholt M. Incidence and temporal patterns of temporomandibular disorder pain among Swedish adolescents. J Orofac Pain. 2007;21:127–132.
[49] Pereira LJ, Pereira-Cenci T, Del Bel Cury AA, et al. Risk indicators of temporomandibular disorder incidences in early adolescence. Pediatr Dent. 2010;32:324–328.
[50] Dao TT, Lund JP, Lavigne GJ. Pain responses to experimental chewing in myofascial pain patients. J Dent Res. 1994;73:1163–1167.
[51] Rompre PH, Daigle-Landry D, Guitard F, et al. Identification of a sleep bruxism subgroup with a higher risk of pain. J Dent Res. 2007;86:837–842.
[52] Roth-Isigkeit A, Thyen U, Stöven H, et al. Pain among children and adolescents: restrictions in daily living and triggering factors. Pediatrics. 2005;115:152–162.
[53] El-Metwally A, Salminen JJ, Auvinen A, et al. Risk factors for development of non-specific musculoskeletal pain in preteens and early adolescents: a prospective 1-year follow-up study. BMC Musculoskelet Disord. 2007;8:46.
[54] Lobbezoo F, Ahlberg J, Glaros AG, et al. Bruxism defined and graded: an international consensus. J Oral Rehabil. 2013;40:2–4.