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ORIGINAL ARTICLE

Mandibular function, temporomandibular disorders, and headache in prematurely born children

LISELOTTE PAULSSON[1], EWACARIN EKBERG[2], MARIA NILNER[2] & LARS BONDEMARK[1]

[1]*Department of Orthodontics, Faculty of Odontology, Malmö University, Malmö, Sweden and* [2]*Department of Stomatognathic Physiology, Faculty of Odontology, Malmö University, Malmö, Sweden*

Abstract

Objective. To evaluate mandibular function, signs, and symptoms of temporomandibular disorders (TMDs) and headache in prematurely born 8- to 10-year-old children, and to compare the findings with matched full-term born controls. ***Material and Methods.*** Seventy-three preterm children were selected from the Medical Birth Register – one group comprising 36 extremely preterm children born before the 29th gestational week, the other group 37 very preterm children born during gestational weeks 29 to 32. The preterm children were compared with a control group of 41 full-term children matched for gender, age, nationality, and living area. The subjective symptoms of TMD and headache were registered using a questionnaire. Mandibular function, signs, and symptoms of TMD and headache were registered. TMD diagnoses were set per Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD). ***Results.*** No significant differences between groups or gender were found for TMD diagnoses according to RDC/TMD or for headache. The preterm children had smaller mandibular movement capacity than the full-term control group, but when adjusting for weight, height, and head circumference mostly all group differences disappeared. ***Conclusions.*** Prematurely born children of 8 to 10 years of age did not differ from full-term born children when considering diagnoses according to RDC/TMD, signs, and symptoms of TMD or headache.

Key Words: *Controlled study, headache, mandibular function, premature birth, temporomandibular joint disorders*

Introduction

During the past three decades, the great improvement in neonatal health and intensive care has led to increasing survival of very preterm (VPT) children born in gestation weeks 29–32 and of extremely preterm (EPT) born before the 29th gestation week [1–4]. Several studies have indicated that EPT and VPT children experience significant growth failure in their early childhood [5,6] and that compensatory catch-up growth occurs up to adolescence [1,6,7]. However, the majority of the children in these studies remained significantly shorter, weighed less, and had a smaller head circumference than full-term controls [1,6,7]. In addition, less muscle mass has been reported [8]. Although most preterm children fare well, the risk of neurodevelopmental disabilities increases with decreasing gestational age and birth weight [4]. The disabilities may affect the neurological, motor, cognitive, and behavioral domains [9]. It has also been shown that preterm children display a higher prevalence of behavioural management problems at dental care during preschool years [10]. Moreover, a recent investigation concluded that the prevalence of malocclusion traits and the professionally assessed need of orthodontic treatment were greater in a group of preterm children than in a control group of full-term children [11]. In addition, a number of craniofacial parameters differed significantly between the preterm and full-term born control children [12].

In 1990, Dworkin et al. [13] suggested that the term “temporomandibular disorders” (TMDs) described a cluster of disorders, and epidemiological studies have shown that signs and symptoms of TMD are common among children and adolescents [14–16]. The etiology of TMD is considered to be complex, and different contributing factors can be causative [17]. Parafunctional habits such as

Correspondence: Liselotte Paulsson, Malmö University, Faculty of Odontology, SE- 205 06 Malmö, Sweden. Tel: +46 40 6658476. Fax: +46 40 6658584. E-mail: liselotte.paulsson@mah.se

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bruxism, nail-biting, and non-nutritive sucking are common in children, and some authors consider them to be contributory factors to TMD [18]. Headaches, too, are common among children and adolescents [19–21] and often coexist with TMD pain [15,21].

It has not previously been studied whether prematurely born children differ from full-term born children in regard to mandibular function, signs, and symptoms of TMD and headache. The aim of this study was therefore to evaluate mandibular function, signs, and symptoms of TMD and headache in both extremely preterm and very preterm born 8- to 10-year-old children and to compare the findings with matched full-term born controls.

Material and methods

Subjects

The preterm and full-term control children were recruited at the Faculty of Odontology, Malmö University, Sweden during 2002–2005. The children fulfilling the investigation were 36 EPT, 37 VPT, and 41 full-term controls (Figure 1). The study was approved by the Ethics Committee of the University of Lund, Sweden (ref. no. LU 61-01), which follows the guidelines of the Declaration of Helsinki, and access to the Medical Birth Register was obtained after receiving permission from the National Epidemiologic Center of the Swedish National Board of Health and Welfare. An epidemiologist at the Department of Epidemiology, University of Lund, selected from the register in creating a data file of all children born during gestational weeks 23 to 32 from 1992 through 1996 in the County of Scania, Sweden. These files contained information about gestational age, birth weight, gender, ethnic background, birth at hospital, and living area of 150 EPT children and 340 VPT children.

Included for participation in the study were children of 8–10 years of age who were born at the University Hospital of either Lund or Malmö and lived in the southwest part of the County of Scania, Sweden. Children with syndromes or with neuromuscular disorders, i.e. cerebral palsy, were excluded (7 EPT and 2 VPT children). Written information about the study was sent to the parents, and after 1–2 weeks they were contacted by telephone and given further information about the study and the opportunity to ask questions. Those who had not responded within 3 weeks were sent a reminder by post. After this, no further attempt was made to contact the families. Informed consent was obtained for each participant and was confirmed in writing by at least one parent. In the group of EPT children, 56 fulfilled the inclusion criteria and were invited to participate. Among the 184 VPT children who fulfilled the inclusion criteria, 52 were randomly

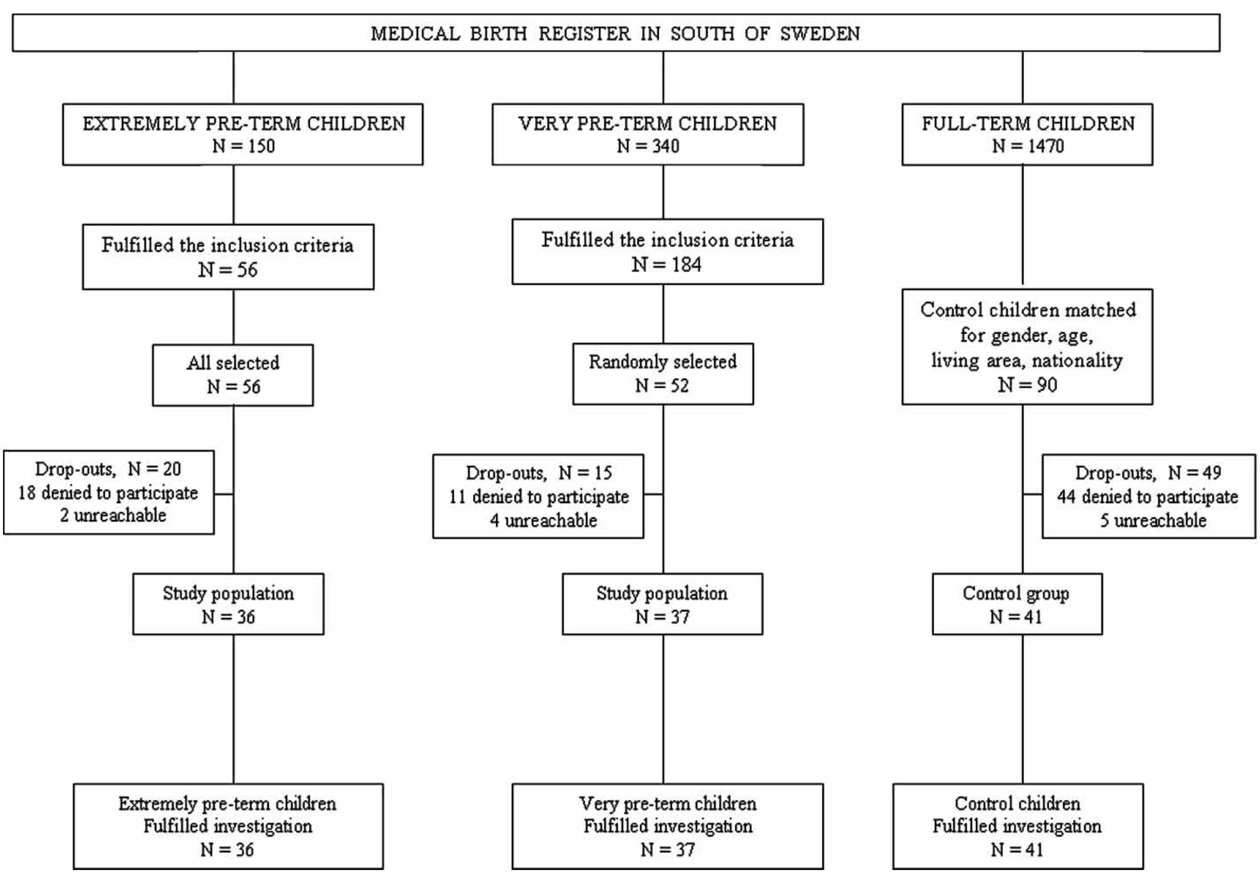

Figure 1. Flow chart showing recruitment of the preterm and full-term participants.

selected and asked to participate in the study. The study population finally comprised 36 EPT and 37 VPT children. Non-participants are described in the flow chart (Figure 1).

The control group was also recruited from the Medical Birth Register. A full-term normal birth weight child born at the same hospital, of the same gender and nationality, had come from the same living area, and was nearest in birth month ($\pm$1 month) to the preterm child was selected. To be included, the control children had not to have had any history of oral or nasal intubation. Furthermore, children with syndromes or with neuromuscular disorders were excluded (1 child). Three control participants for every preterm child were identified. If the first family contacted did not respond, or refused to participate, a second family, and if necessary a third family, was contacted. Ninety control children were consecutively asked to participate, but 5 were unreachable and 44 declined to participate (Figure 1).

Questionnaire

The children with their accompanying parent/parents answered a questionnaire concerning the state of general health, medication, awareness of oral parafunctions such as tooth-grinding, tooth-clenching, tongue thrust, nail-biting, lip- and cheek-biting or sucking habits. The questionnaire contained questions about location of subjective symptoms of TMD. Frequency and duration of TMD pain, temporomandibular joint (TMJ) clicking, and headache were registered – frequency was rated on a scale as follows: 0 = never, 1 = seldom, 2 = once a month, 3 = once a week, 4 = several times a week. Intensity of self-reported discomfort of TMD pain and headache was rated on a verbal scale as follows: 0 = no or minimal, 1 = moderate, 2 = severe, 3 = very severe. The children rated themselves on a visual analog scale (VAS) [22] from 0 to 10 regarding their: level of anxiety, with the endpoints "calm" and "nervous/anxious", and performance in school and comfort at home, with the endpoints "very good" and "not good at all". For all VAS used, the endpoints were supplemented with figures showing a happy/sad face to complement the text [23].

Clinical examination

The clinical examination was by one of two calibrated specialists in Stomatognathic Physiology (Ekberg and Nilner). To calibrate the examination technique between the two specialists with regard to the registration of clinical signs, eight subjects not included in the study were examined by both examiners before the study. At the examination, the specialist was unaware of the group to which the subject belonged.

The clinical examination included measurement of mandibular movements, registration of TMJ sounds, and tenderness of the TMJs and related muscles. Deflection >2 mm on opening of the mandible was registered. Sub-diagnoses of TMD were set per research diagnostic criteria for temporomandibular disorders (RDC/TMD) [24]. The diagnoses were divided into three groups:

1. Muscular disorders: (a) myofacial pain, (b) myofacial pain with limited opening.
2. Disk displacements: (a) disk displacement with reduction, (b) disk displacement without reduction, with limited opening, (c) disk displacement without reduction, without limited opening.
3. Arthralgia, arthritis, arthrosis: (a) arthralgia, (b) osteoarthritis of the TMJ, (c) osteoarthrosis of the TMJ.

The functional occlusion was examined by methods previously described and investigated for observer error [25]. Non-working side interferences within a lateral excursion of 3 mm, working side interference, protrusion interferences, the distance and direction of the slide between the retruded contact position (RCP) and the intercuspal contact position (ICP) were registered.

Height, weight, and head circumference of each child were registered. Height was measured to the nearest 0.5 cm with a stadiometer attached to the wall. Weight was measured on a digital scale with an accuracy of 0.1 kg, whereas head circumference was measured in the maximum fronto-occipital plane with a non-extensible plastic-coated tape measure.

Statistical analysis

All statistics procedures were carried out with the statistical package for the Social Sciences (SPSS Inc., Chicago, III., USA) v. 13.0 software program.

One goal of the proposed study was to test the null hypothesis that the positive proportion was identical in the three groups. The criterion for significance (alpha) was set at 0.05. The test was two-tailed, which means that an effect in either direction was interpreted. With the proposed sample size of 35 in each group, a power of 80% was yielded to discover a difference of 25% regarding signs and symptoms of TMD and headache. The difference of 25% was selected as the smallest difference in the sense that any smaller difference would be of no clinical or substantive significance.

For numerical data, mean and standard deviations were calculated and one-way analysis of variance (ANOVA) with Tukey's post-hoc test was used to test differences between groups. Analysis of covariance was used when corrections were made for the following background variables: gender, height,

Table I. General characteristic data of the extremely preterm (EPT group A), very preterm (VPT group B), and full-term control children (FT group C).

Variables	EPT group (A) $n=36$ (9.2 years) girls/boys 11/25		VPT group (B) $n=37$ (9.4 years) girls/boys 17/20		FT group (C) $n=41$ (9.5 years) girls/boys 19/22		Group differences
	Mean	SD	Mean	SD	Mean	SD	
At birth							
Gestational age (week)	26.8	1.0	30.8	1.1	39.8	1.0	A,B/C: $p=0.000$; A/B: $p=0.000$
Birth weight (kg)	0.939	0.241	1.639	0.341	3.581	0.470	A,B/C: $p=0.000$; A/B: $p=0.000$
At investigation							
Height (cm)	133.6	8.1	137.1	6.1	139.4	7.0	A/C: $p=0.002$; A/B and B/C:NS
Weight (kg)	29.5	6.8	32.7	7.4	36.5	7.3	A/C: $p=0.000$; A/B and B/C:NS
Head circumference (cm)	52.2	1.5	52.8	1.6	53.6	1.5	A/C: $p=0.000$; B/C: $p=0.046$; A/B:NS

NS indicates not significant, $p \geq 0.05$.
ANOVA with Tukey's posthoc test.

weight, and head circumferences. Chi-square test and Fisher's exact test were used to determine differences between groups regarding categorical data. To compute the differences between ranks and groups on VAS, the Kruskal-Wallis test was used.

Results

It was found that the EPT children were significantly shorter, had lower weight, and both the EPT children and the VPT children had smaller head circumference compared to the full-term control children (Table I). When corrections were made for gender, it was found that the girls in all three groups had a significantly smaller head circumference compared to the boys. According to the analysis of the non-participants, these did not differ within the final groups considering age, gender, ethnic origin, or living area.

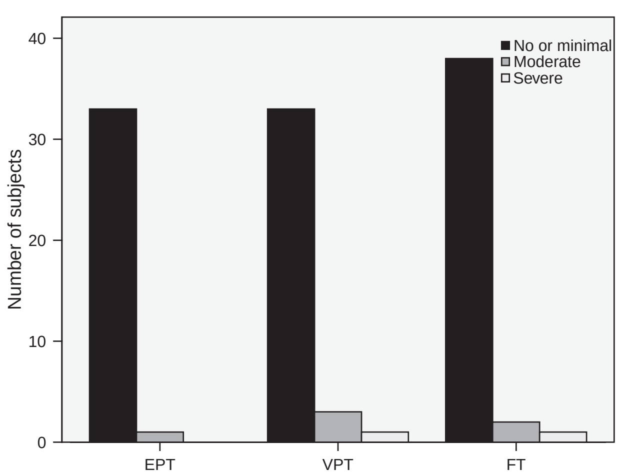

Figure 2. Intensity of self-reported discomfort of TMD pain in the extremely preterm (EPT), very preterm (VPT), and full-term control children (FT). No significant differences between the three groups. No subject reported very severe symptoms. (Chi-square analysis and Fisher's exact test.)

Anamnestic findings

Only a few children reported general symptoms from joints, muscles, or stomach, with no significant difference between the three groups. Significantly more children had an allergy or asthma in the VPT group ($n=12$) compared to the EPT group ($n=4$) and to the full-term control group ($n=1$) ($p=0.01$). None of the children in the three groups reported any history of orthodontic treatment.

The result for the children's self-reported discomfort of TMD pain and headache on a verbal scale showed no significant differences between the three groups or between genders (Figures 2 and 3). There were no significant differences between the groups or between genders concerning awareness of parafunctions, frequency of self-reported symptoms of TMD pain or headache or TMJ clicking (Table II).

For self-rated level of anxiety on VAS, the median was 0.5 or less in all three groups, and in the EPT group min-max ranged from 0 to 6.9; in the VPT group from 0 to 4.9, and in the full-term control group from 0 to 9.7. For self-rated level of school performance on VAS, the median was 0.4 or

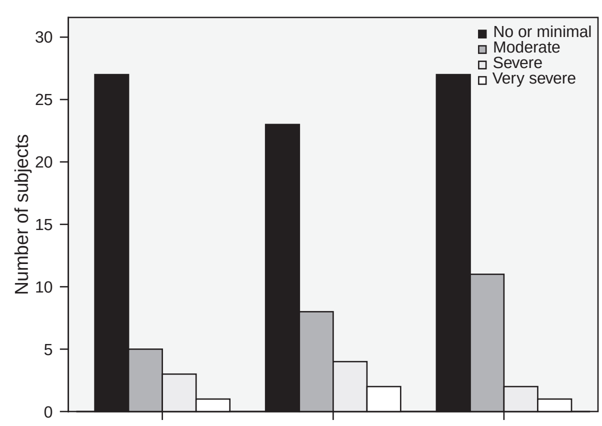

Figure 3. Intensity of self-reported discomfort of headache in the extremely preterm (EPT), very preterm (VPT), and full-term control children (FT). No significant differences between the three groups. (Chi-square analysis and Fisher's exact test.)

Table II. Distribution of self reported oral parafunctions and symtoms of temporomandibular disorders (TMD) and headache of the extremely preterm (EPT), very preterm (VPT) and full-term control children (FT).

	EPT group $n=36$	VPT group $n=37$	FT group $n=41$	Group differences
	n	*n*	*n*	
Symptoms once a week or more				
TMD pain	0	2	3	NS
headache	1	4	6	NS
TMJ clicking	0	1	1	NS
Parafunction				
Toothgrinding	3	5	8	NS
Toothclenching	3	5	3	NS
Tongue thrust	0	2	3	NS
Nail biting	9	11	15	NS
Lip- and cheek-biting	9	13	16	NS
Sucking habits	5	3	2	NS
Awareness of any parafunction	18	22	25	NS

NS indicates not significant, $p \geq 0.05$.
Chi-square test analysis and Fisher's exact test.

less in all three groups, and in the EPT group min-max ranged from 0 to 10.0, in the VPT group from 0 to 8.2, and in the full-term control group from 0 to 5.0. For self-rated level of comfort at home, the median was 0.2 in all three groups and in the EPT group min-max ranged from 0 to 3.8, in the VPT group from 0 to 9.7, and in the full-term control group from 0 to 5.0.

Clinical findings

The EPT and VPT children had significantly smaller maximum opening capacity compared to children in the full-term group (Table III). Furthermore, the VPT children had significantly smaller protrusion capacity and the EPT children smaller laterotrusion capacity to the right compared to the full-term children (Table III). When correction was made for gender, the group differences remained. However, when corrections were made for height, weight, and head circumferences, the only variable still significant was the laterotrusion capacity to the right (Table III). Even within the full-term group there were significant differences in maximum opening capacity, but when corrections were made for height, weight, and head circumferences the differences disappeared.

Table IV presents the distribution of clinical findings. There were no significant differences between the three groups or between genders considering pain on palpation of the TMJs and related muscles, deflection during opening or TMJ sounds.

No significant differences were found regarding occlusal interferences between the three groups or between genders (Table V).

Only a few TMD diagnoses according to RDC/TMD were found with no significant differences between groups or between genders. Myofascial pain was registered for four children in the EPT group and four in the VPT group compared to two children in the full-term control group. Disk displacements with reduction were found in three children in the full-term control group. One child in the full-term control group had arthralgia. No other diagnoses were registered.

Table III. Mandibular movement capacity (mm) in the extremely preterm (EPT group A), very preterm (VPT group B), and full-term control children (FT group C).

	EPT group (A) $n=36$			VPT group (B) $n=37$			FT group (C) $n=41$				
Mandibular movements	Mean	SD	95% CI	Mean	SD	95% CI	Mean	SD	95% CI	Group differences	$p^{\star}$
Opening capacity	47.5	3.9	46.2–48.8	46.9	4.9	45.3–48.5	50.0	4.9	48.5–51.6	A/C: $p=0.047$; B/C: $p=0.009$; A/B: NS	0.058
Laterotrusion, left	9.22	2.4	8.4–10.0	8.6	1.5	8.1–9.1	9.4	1.5	8.9–9.9	NS	0.140
Laterotrusion, right	8.3	1.6	7.7–8.8	8.9	1.3	8.5–9.3	9.5	1.9	8.9–10.1	A/C: $p=0.006$; A/B and B/C: NS	0.043
Protrusion	8.5	1.5	8.0–9.0	8.3	2.1	7.6–9.0	9.4	2.0	8.7–10.0	B/C: $p=0.037$; A/B and A/C: NS	0.085

NS indicates not significant, $p \geq 0.05$.
ANOVA with Tukey's post-hoc test.
*p-value adjusted for the children's height, weight, and head circumference at examination.

Table IV. Distribution of clinical signs of temporomandibular disorders (TMD) of the extremely preterm (EPT), very preterm (VPT), and full-term control children (FT)

	EPT $n=36$	VPT $n=37$	FT $n=41$	Group differences
Signs of TMD				
Pain on palpation				
Muscle pain $\geq$3 sites	4	5	3	NS
TMJ pain laterally and/or posteriorly	1	2	2	NS
TMJ sounds				
TMJ clicking during either on opening or closing	0	2	3	NS
Reciprocal clicking	0	0	1	NS
Crepitation	0	1	0	NS
Deflection >2 mm on opening of the mandible	9	9	10	NS

NS indicates not significant, $p \geq 0.05$.
Chi-square test analysis and Fisher's exact test.

Discussion

Preterm born children did not differ from full-term born children when considering diagnoses according to RDC/TMD, signs, and symptoms of TMD or headache. Overall, a significant difference was found between preterm and full-term children considering mandibular movements, and also within the full-term group in maximum opening capacity. When adjusting for weight, height, and head circumference, almost all differences registered for mandibular movements between the groups disappeared, as well as those registered within the full-term group. This implies that differences in mandibular movements between all three groups are explained by the size of the children and not by the differences between birth groups. The observation that the EPT children at 8–10 years of age were significantly shorter and weighed less, and both EPT and VPT children had significantly smaller head circumference, corresponds well with results from other investigations [1,7].

So far, this is the only study to evaluate mandibular function, TMD, and headache in preterm children, and thus comparisons with previous studies are not possible. Nevertheless, it can be pointed out that the results of mandibular opening capacity correspond well with those of a previous study of children in the same age group [26]. Also, the average mandibular movement capacity in the full-term group corresponds well with the results from an age group of 10- to 13-year-old German boys and girls [27].

In all three groups, the occurrence of RDC/TMD diagnoses was low and few individuals reported symptoms of headache. In a previous Swedish study, adolescents with self-reported TMD pain were compared with a matched control group without self-reported TMD pain, and it was found that the different RDC/TMD diagnoses ranged between 38% and 80% in the TMD pain group compared to between 3% and 10% in the control group [21]. Furthermore, 63% of the adolescents in the TMD group reported episodic tension-type headache compared to 43% in the control group [21]. In previous studies of children and adolescents, the prevalence of TMD pain and headache increased with age [16,28]. Since this study has evaluated 8- to 10-year-old children and not adolescents, it can be assumed that RDC/TMD diagnosis and headache will increase. An age group of 8–10 years was selected deliberately because, from the time of birth, a reasonable time has passed for possible catch-up growth among preterm children. Moreover, this age group usually represents individuals who are in mixed dentition; therefore the time is appropriate for assessment of orthodontic treatment need and selection of those who are to receive orthodontic treatment.

A strength of the present study is that two strictly divided groups of preterm children, according to gestational age and birth weight, were compared with a well-defined and well-matched control group of full-term children. Strictly defined age groups are important when different studies concerning TMD and headache in growing individuals are compared, since TMD fluctuates over time and seems to increase with age during adolescence [16]. The

Table V. Distribution of occlusal interferences in the extremely preterm (EPT), very preterm (VPT), and full-term control children (FT)

	EPT $n=36$	VPT $n=37$	FT $n=41$	Group differences
Sagittal distances between RCP and ICP $\geq$0.5 mm	7	9	12	NS
Vertical distances between RCP and ICP $\geq$0.5 mm	7	7	10	NS
Lateral deflection between RCP and ICP $\geq$0.5 mm	3	4	4	NS
Laterotrusion interferences	2	1	0	NS
Mediotrusion interferences	6	5	5	NS
Protrusion interferences	5	3	3	NS

NS indicates not significant, $p \geq 0.05$.
Chi-square test analysis and Fisher's exact test.

variation in TMD prevalence is partly a result of differences in diagnostic criteria, examination procedures, population sampling, and the definition of TMD. The use of RDC/TMD in this study allows standardization and replication of the most common forms of muscle and joint-related TMD [24]. In a previous study of a Swedish population of children and adolescents, it was found that physical diagnoses according to the RDC/TMD classification were reliable [29].

Other strengths of this study are that clinical registration of mandibular function, signs of TMD, and functional occlusal interferences were performed by standardized methods. The reliability of these methods has been evaluated and found to be acceptable [21]. Furthermore, the reliability of the methods used for clinical registrations was improved by calibrating the examination technique between the two examiners. In an attempt to be as objective as possible, the specialists were not informed about which group the subjects belonged to.

A weakness of the present study is the number of non-participants. The goal was to include one control for each preterm child, but this was not possible because many control families declined to participate due to lack of time. Also, in the preterm groups the most common reason for denying was lack of time; however, some of the non-participants denied because they had already participated in several other medical research studies. Nevertheless, according to the analysis of non-participants, these individuals did not differ from the final groups in terms of age, gender, ethnic origin, or living area. Even though the number of non-participants was high, the control groups and the preterm groups included an adequate number of participants, according to the original sample size calculation. It should also be stressed that other studies have reported similar problems with recruiting full-term controls [30,31].

Recently, it was reported that extremely immature children (<26 weeks of gestation) had significantly greater health problems and special health-care needs at 11 years of age compared to full-term controls [31]. In that perspective, it is positive that our results of the preterm 8- to 10-year-old preterm children did not differ regarding signs and symptoms of TMD and headache compared to full-term born children. However, one can assume that signs and symptoms will increase in the adolescent period and the question then is whether the preterm children will still have the same amount of these as the full-term born children. Therefore, a follow-up study of the preterm children in this study is planned.

Conclusion

Prematurely born children of 8–10 years of age did not differ from full-term born children when considering diagnoses according to RDC/TMD, signs, and symptoms of TMD or headache.

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Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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