Two-year longitudinal study of signs of mandibular dysfunction in adolescents

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Signs of mandibular dysfunction in adolescents were studied longitudinally from the age of 17 to 19 years. Totally, 27 subjects dropped out, leaving 258 for the longitudinal intraindividual comparisons. TMJ sounds were found in about one-fifth of the adolescents and were recorded significantly more often in girls than boys from the age of 18 years. The frequency of muscles tender to palpation fluctuated somewhat between the annual examinations. At the first and second examination muscle tenderness was statistically significantly commoner in girls than in boys. Except for TMJ sounds and muscle tenderness signs of mandibular dysfunction were rare. About half of the subjects had signs of mandibular dysfunction, mostly of mild character. Girls regularly had significantly higher dysfunction index (Di) values than boys. No change between the annual recordings was noted in 60% of the individuals, and impairment and improvement had occurred about equally often. In 29%, signs were recorded all years. □ *Bruxism; epidemiology; functional disturbances; temporomandibular joint syndrome*

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Signs of mandibular dysfunction are common findings in young samples as well as in adults (1–3). In a worldwide survey of epidemiologic studies (4) the range of prevalences was 33–86% for clinical signs, with a median value of 61%. The commonest signs have been palpation tenderness in muscles of mastication and temporomandibular joint (TMJ) sounds. Whether the generally mild signs of childhood and adolescence will develop into more severe signs as the child matures is not known, since there has been a lack of longitudinal studies in this field.

In a 5-year longitudinal study of adolescents from 15 to 20 years of age no change was observed between the two examinations in nearly half the individuals, and impairment and improvement had occurred about equally often (5). No single subjective or clinical variable or combinations of variables had any significant influence on the changes in the clinical dysfunction index between the two examinations.

The etiology of mandibular dysfunction is mostly considered to be multifactorial (6–8), and it has been suggested that the development of clinical signs is complex and includes numerous variables (5).

The aim of this study was to reexamine a sample of 285 previously studied adolescents 2 subsequent, following years with regard to signs of mandibular dysfunction.

Materials and methods

The study was carried out in the town of Skellefteå, in northern Sweden, from 1981 to 1983. The subjects were 17 years old at the start of the study. They comprised 285 subjects, all attending one of two public dental clinics. The total number of the specific age group living in the town of Skellefteå 1981 was 449.

During the examination period 27 subjects dropped out (9), leaving 258 subjects for the intraindividual comparisons in the longitudinal study. The reason for not participating was that they had moved from the district. No differences were found between the dropouts and the total sample with regard to subjective symptoms, clinical signs, or other variables.

When the adolescents came to the dental clinic for their routine annual check-up, each received a questionnaire and information about the study. After completing the questionnaire, they were examined clinically. The examiner did not know what answers had been given on the questionnaire before the clinical examination. The recordings of clinical variables and the various measurements have been described in detail in an earlier report (3) and comprised standard procedures used at departments of stomatognathic physiology and in clinical research. During all 3 years all recordings were made by the same observer (A. Wänman).

Some individuals who both needed and demanded stomatognathic treatment were given treatment. At the age of 17 years, 13 subjects were treated for their signs and symptoms of mandibular dysfunction. Another 6 subjects were treated, and 7 of the earlier subjects retreated at the age of 18 years, giving a total of 19 subjects (14 girls and 5 boys) who were treated during these 2 years. They were all given information and were advised to do jaw exercises; 9 subjects received bite splints, and in 11 selective grinding was performed.

Statistical methods

The data were processed in a computer (Control Data 3200) at Umeå University Computer Center (UMDAC), using standard programs (SPSS and SPSSX). The statistical calculation of differences between variables was made by the chi-square test. For analysis of the longitudinal development the nonparametric Friedman test of paired observations was used (10). The following symbols are used for different levels of significance in the tables: NS (not significant),

Table 1. Mean values, standard deviation (SD), and range of variation (range), in mm, for maximal mandibular mobility in 17-, 18-, and 19-year-old boys and girls. Statistically significant increased age differences ($\bar{d}$) are denoted: + = $p < 0.05$. The p value denotes the level of significant difference between sexes

Movement, sex, age (years)	Mean	$\bar{d}$	SD	Range	p
Maximal opening capacity					
Boys 17 (n = 146)	57.8		6.8	44–78	
Boys 18 (n = 142)	58.0	+	6.6	40–75	
Boys 19 (n = 138)	59.4		6.9	43–84	*
Girls 17 (n = 139)	54.8		5.3	43–72	
Girls 18 (n = 133)	55.1	+	5.0	45–67	
Girls 19 (n = 126)	55.7		5.8	26–68	
Laterotrusion to the right					
Boys 17	10.0		1.8	5–17	
Boys 18	9.5		1.8	6–16	
Boys 19	9.8		1.8	5–15	
Girls 17	9.7		2.0	2–15	
Girls 18	9.2		1.8	0–16	
Girls 19	9.6		1.8	2–16	
Laterotrusion to the left					
Boys 17	9.9		1.8	4–14	
Boys 18	9.5		1.8	5–14	
Boys 19	10.1		1.6	5–14	
Girls 17	9.6		1.8	4–15	
Girls 18	9.4		1.8	5–15	
Girls 19	9.3		1.9	6–16	
Protrusion					
Boys 17	9.6		1.8	5–17	*
Boys 18	10.0	+	2.0	5–16	**
Boys 19	10.1		1.6	7–15	*
Girls 17	8.9		2.1	5–14	
Girls 18	9.2	+	2.1	0–16	
Girls 19	9.3		1.9	2–15	

$p > 0.05$; * $0.05 \geq p > 0.01$; ** $0.01 \geq p > 0.001$; and *** $0.001 \geq p$.

Results

The largest maximal opening capacity was recorded for 19-year-old boys and girls, and their mean was 57.6 mm, whereas their mean maximal horizontal mobility was 9.7 mm. The maximal opening capacity had increased significantly ($p < 0.01$) for both boys and girls, and for 19-year-olds a statistically significant sex difference with higher values in boys was recorded ($p < 0.05$) (Table 1). The protrusion had also increased sig-

Table 2. Prevalence of clinical signs included in the clinical dysfunction index (Di) at 17, 18, and 19 years of age Statistically significant sex differences are indicated *. Statistically significant age differences ($\bar{d}$) are denoted + = increase, $p < 0.05$; − = decrease, $p < 0.05$

	Age (years)						
	17 (n = 285)		18 (n = 275)		19 (n = 264)		$\bar{d}$
TMJ sounds							
Boys	19.9	NS	12.0	**	14.5	*	
Girls	24.5		24.8		26.2		
Total	22.1		18.2		20.1		
TMJ pain							
Laterally							
Boys	0.0		0.7		2.2		
Girls	0.7		1.5		3.2		
Total	0.4		1.1		2.7		
Posteriorly		NS		NS		NS	+
Boys	0.0		0.0		0.0		
Girls	0.0		0.0		1.6		
Total	0.0		0.0		0.8		
Muscle tenderness							
1–3 sites							
Boys	24.0		12.7		25.4		
Girls	29.8		30.1		26.2		
Total	26.8		21.1		25.8		
4 sites		**		***		NS	
Boys	8.9		5.6		10.1		
Girls	20.1		12.0		19.8		
Total	14.4		8.7		14.8		
Impaired mandibular mobility							
Slightly							
Boys	4.8		8.5		1.4		
Girls	11.5		13.5		2.4		
Total	8.1		10.9		1.9		
Severely		NS		NS		NS	−
Boys	0.0		0.0		0.0		
Girls	0.7		0.8		1.6		
Total	0.4		0.4		0.8		
Pain on movement							
1 movement							
Boys	0.0		0.7		0.7		
Girls	0.0		0.0		1.6		
Total	0.0		0.4		1.1		
≥2 movements		NS		NS		NS	+
Boys	0.0		0.0		0.0		
Girls	0.0		0.0		1.6		
Total	0.0		0.0		0.8		

nificantly for both boys and girls ($p < 0.05$) during the subsequent recordings. Boys were able to protrude significantly more than the girls at all the examinations ($p < 0.05$, $p < 0.01$, and $p < 0.05$, respectively) (Table 1).

Impaired mandibular mobility was primarily found for horizontal movements and mostly in the range of 4–6 mm. A significant improvement was found longitudinally ($p < 0.001$), and at the age of 19 years 2.7% of the adolescents had some impairment of mandibular mobility (Table 2). No significant sex difference was found.

TMJ sounds were found in about one-fifth of the adolescents, and a significant sex difference with higher values in girls was found at the ages of 18 years ($p < 0.01$) and 19 years ($p < 0.05$) (Table 2). Clicking sounds from the TMJs were the only recorded sound; crepitation never appeared.

TMJ pain on palpation of grade II was seldom found but increased with time ($p < 0.05$), as did pain on TMJ movements ($p < 0.05$). At the age of 19 years 2.7% had pain on palpation laterally and 0.8% posteriorly; 1.1% had pain on one movement and 0.8% on two or more movements (Table 2). The prevalence of TMJ pain on palpation of grade I was recorded in 8.3–9.5% laterally and in 2.5–3.0% posteriorly at the annual examinations. No significant sex difference was found.

Muscle tenderness was significantly commoner among girls at the first ($p < 0.01$) and second examination ($p < 0.001$), whereas no difference between sexes was found at the third examination. Boys had a significant reduction in muscle tenderness between the first and second examination ($p < 0.001$) and a significant increase between the second and the third examination ($p < 0.001$), reaching a prevalence close to what was found at the first recording. The prevalence of muscle tenderness varied between 30% and 41%; the commonest site for both boys and girls was the lateral pterygoid muscle (27–38%), and the second commonest site was the insertion of the temporal tendon (15–25%). The prevalence of other tender sites of recorded muscles varied between 1% and 7%.

The prevalence of signs of mandibular dysfunction in accordance with the clinical dysfunction index (Di) of Helkimo (11) was for the total sample 56% at the first examination, 48% at the second, and 50% at the third. The percentage distribution for boys and girls in accordance with the dysfunction index is shown in Fig. 1. Girls had statistically significantly higher values than boys for the dysfunction index at all examinations ($p < 0.01$, $p < 0.001$, and $p < 0.05$, respectively).

The individual longitudinal pattern of changes in the adolescents within the clinical dysfunction index is shown in Fig. 2. No

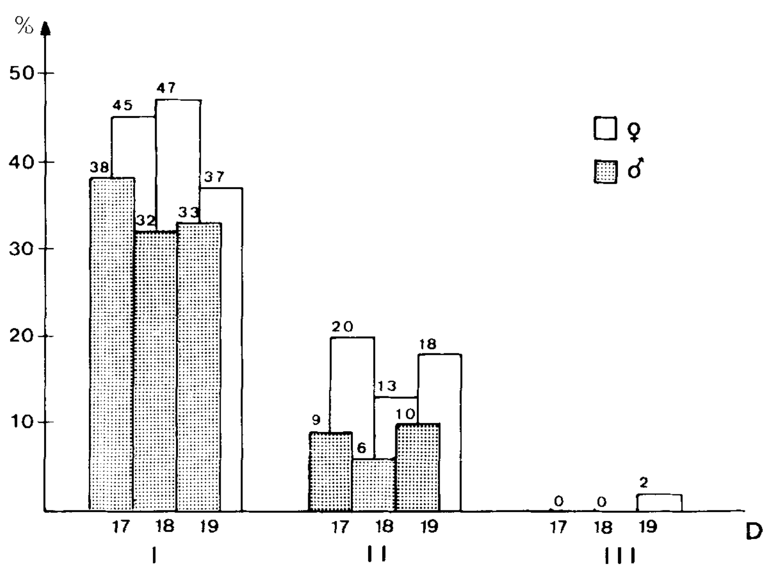

Fig. 1. Percentage distribution of clinical dysfunction index (Di) for boys and girls 17, 18, and 19 years of age.

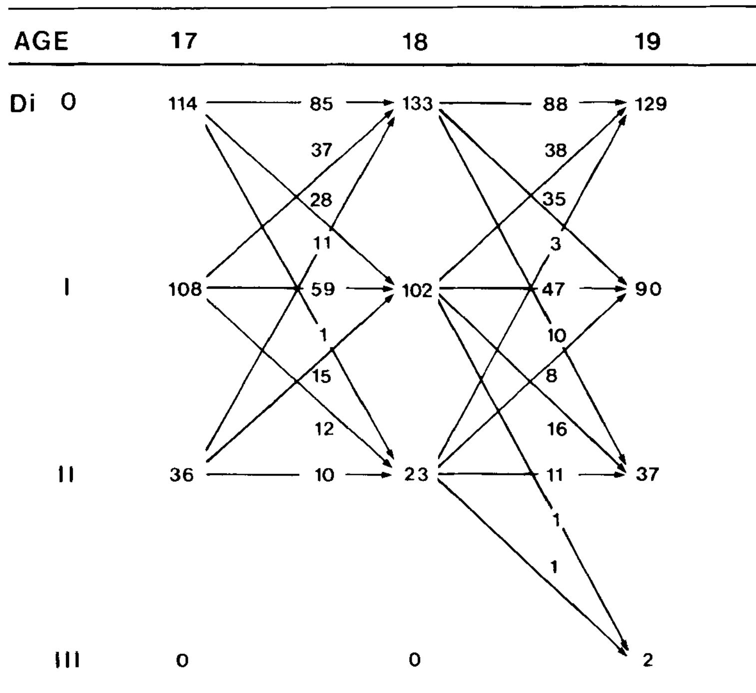

Fig. 2. Distribution of the longitudinal pattern of changes in the subjects in accordance with the clinical dysfunction index (Di) during the subsequent, following years (n = 258).

change was noted between the recordings in approximately 60% of the individuals, and impairment and improvement had occurred about equally often.

The cumulative percentage of the individuals that at least once during the 3-year period had some or multiple signs of mandibular dysfunction was 76% (Table 3). The variations of clinical signs and the index within the studied period is shown in Fig. 3. About one-third of the total variance of Di

Table 3. Percentage distribution of the cumulative prevalence of signs of mandibular dysfunction (Di) during 3 years in 258 adolescents from the age of 17 to 19 years. The p value denotes the level of significant difference between sexes

	Di			
	0	I	II	p
Total	24	50	26	
Boys	31	50	19	*** (Boys vs Girls)
Girls	17	50	33	

depended on one occasional recording. Totally, in 29% (75 subjects) signs were recorded all 3 years; about half of these had constant signs within the same level of the dysfunction index, whereas the rest fluctuated within the index.

The incidence of signs of mandibular dysfunction in accordance with the index varied, and the number of individuals in whom signs originally had been recorded was at the second examination 29 (11%) and at the third 45 (18%), as presented in Fig. 2. Of the former group signs were still recorded in eight subjects at the third examination, whereas the rest had improved. Of the latter group signs were recorded in half of them at the first examination, giving 22 individuals (8%) as purely 'new cases' with signs of mandibular dysfunction at the third examination. Of those 48 individuals who at the second examination had improved from signs to no signs, nearly half were worse at the third examination.

Of the 19 subjects who at the age of 17 and/or 18 years were given treatment 25%

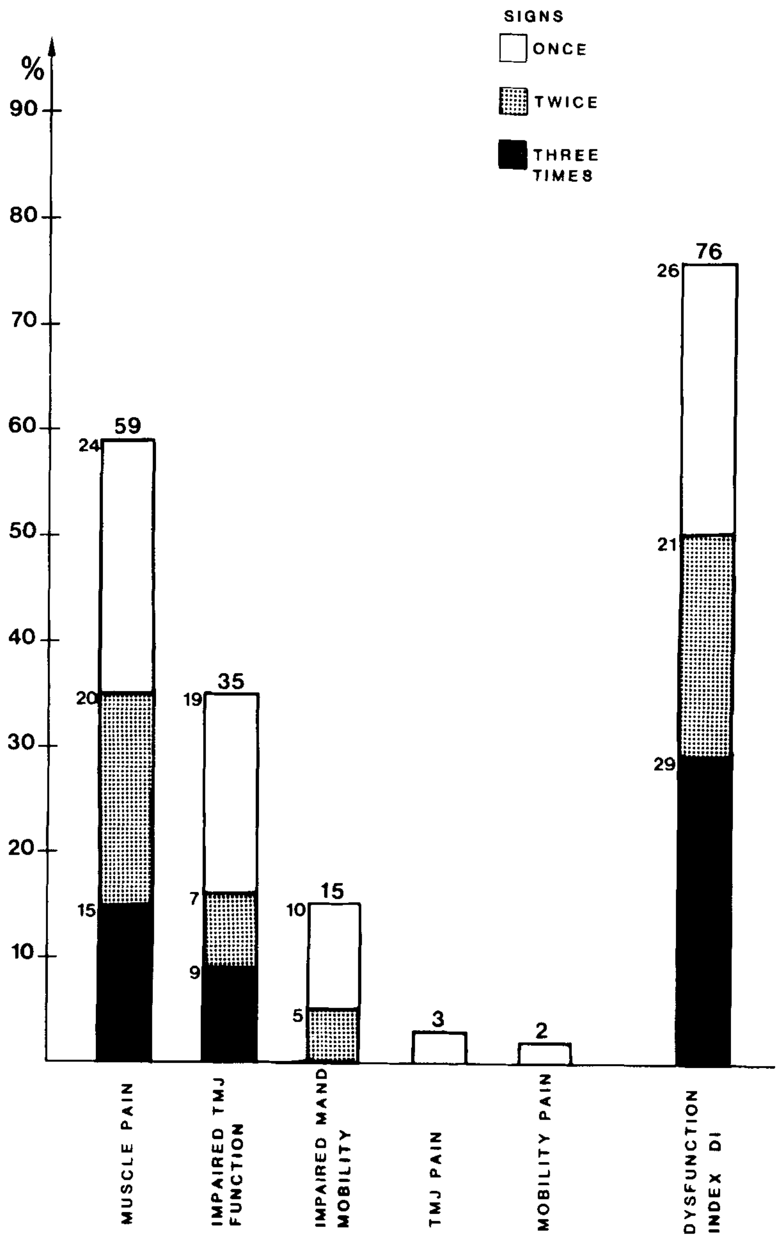

Fig. 3. Percentage distribution of the whole 3-year period prevalence of signs of mandibular dysfunction in 258 adolescents. The occurrence is given as Once = signs found only 1 year, Twice = 2 years, and Three times = all subsequent, following years.

had no signs of mandibular dysfunction at the follow-up study (Table 4). Most, however, still had signs, and two subjects were worse and two slightly improved.

Recordings of morphologic malocclusions were fairly constant throughout the studied years. At the first examination malocclusions were recorded in 35% of the sample and in 30% of the 19-year-olds.

The prevalence of recorded slides and

Table 4. Numerical distribution before (17- and 18-year-olds) and after treatment (19-year-olds) to signs of mandibular dysfunction in 19 adolescents subjected to stomatognathic treatment

Signs	Before	After
TMJ sounds	8	5
TMJ pain		
Laterally	0	0
Posteriorly	0	1
Muscle tenderness		
1–3 sites	5	5
≥4 sites	12	7
Impaired mandibular mobility		
Slightly	2	0
Severely	0	1
Pain on movement		
1 movement	0	0
≥2 movements	0	2
Dysfunction index		
0, no signs	1	5
I, mild	6	5
II, moderate	12	7
III, severe	0	2

occlusal interferences is shown in Table 5. On the average three-quarters of the sample had unilateral contact in retruded position (RP), and one-fifth had lateral slide (≥ 0.5 mm) from RP to intercuspal position (IP). The commonest contact in RP was recorded on the first maxillary premolar with frequencies of 37%, 40%, and 29%, respectively, for the three occasions.

Mediotrusion interferences varied between 28% and 30% for the three recordings in these adolescents. These interferences were mainly situated on the first and second molars (21–25%) during the studied years. The third molars were found to interfere increasingly (2–6%) from 17-year-olds to 19-year-olds.

In the treated group 36% had lateral slides ≥0.5 mm between RP and IP, and 31% had mediotrusion interferences before treatment. At the follow-up study lateral slides were recorded in 10%, whereas 26% still had mediotrusion interferences.

Discussion

The adolescents constituted a well-defined sample selected by epidemiologically accepted principles as earlier presented (3). Everyone born in the area in 1964 who was referred to the clinic participated in the first examination.

A loss of participants is always a possible source of error in longitudinal studies. The number of dropouts was small (9%); they had moved from the town. Since an analysis of this group did not show any differences for symptoms, signs, or other variables in comparison with the total sample, it is not likely that they have influenced the results. Totally, only four individuals were examined just once—that is, on the first occasion. Only those examined all 3 subsequent years were included in the longitudinal intraindividual comparisons.

To avoid being influenced by the case histories, the examiner remained unaware of the answers to the questionnaire before the clinical evaluation. The methods used in the clinical examination in this investigation have long been used as standard procedures at departments or stomatognathic physiology and in clinical research (12–16). However, such clinical signs of dysfunction as

Table 5. Percentage distribution of occlusal recordings at 17, 18, and 19 years of age. n= number of individuals

	17 years (n = 285)	18 years (n = 275)	19 years (n = 264)
Unilateral contact in RP	76.5	84.4	64.8
Lateral slide RP to IP ≥0.5 mm	19.3	22.8	17.8
Anterior slide RP to IP >1 mm	7.9	7.6	8.3
Vertical slide RP to IP >1 mm	9.5	12.0	11.4
Mediotrusion interferences	29.8	28.7	28.0

tenderness to palpation in muscles and in the TMJs are criteria that might suffer from some interobserver differences, mostly because of the amount of pressure that is applied to the tissue. The intraobserver difference is, however, more constant (14). In this study all the adolescents were examined by the same person; comparisons of clinical signs within the material would thus be quite reliable. Only palpations that provoked a palpebral (II) or a protective (III) reflex were used as signs of tenderness in muscles and joints. The interobserver conformity is better when these objective signs (II and III) are used as criteria for palpation tenderness rather than only the subjective evaluation of the patient (I) (15).

The reason for the marked fluctuation in muscles tender to palpation for boys is obscure. Signs and symptoms of mandibular dysfunction are known to fluctuate with time (17), but palpation tenderness may also suffer from some longitudinal observer difference. However, since all observations were made by the same examiner, the finding may be relevant to actual changes in muscle tenderness, which may be related to environmental and/or psycho-emotional factors. In spite of the longitudinal variations in muscle pain a relationship to both signs and symptoms of mandibular dysfunction was found at 17 years of age (22).

Those 15% who had muscle pain all 3 years constitute a more constant and probable risk group for symptoms in the masticatory system. They will be analyzed in a separate paper.

TMJ sounds were, from the age of 18 years, a commoner finding in girls than in boys, which was also noted in the subjective reports for 19-year-olds in this sample (9). This sex difference has also been found in other samples (18, 19) and corroborates the increase also observed in earlier reports (5, 20). The preponderance of TMJ sounds in girls may be related to their significantly more often reported awareness of stress-related oral parafunctions (9) and differences in tissue response (21). The etiology of TMJ sounds is not clearly understood. However, at the age of 17 years a relationship was found between TMJ clicking and tenderness to palpation in the lateral pterygoid muscle (22), indicating an interaction between the components of the joint.

Except for TMJ sounds and muscle tenderness signs of mandibular dysfunction were quite rare in the total sample, which is in line with cross-sectional studies of young populations (2, 18). Recordings of TMJ pain and pain on movements were thus infrequent, but these signs are of importance because both increased longitudinally and may indicate development of more severe signs and symptoms of dysfunction, possibly related to a TMJ disease in progress.

The interobserver differences with regard to maximal movement capacity are of an acceptable level of constancy, and these recordings were made by the same operator, which minimizes the method error (14–16). In our sample the maximal mandibular opening capacity increased significantly up to the age of 19 years; at this age significantly greater values were found for boys. These figures for maximal opening capacity correlate well and are a continuation of the findings by Agerberg in 13- to 16-year-olds (23) and just slightly higher than his findings in 20-year-olds (24), in whom a sex difference was also found. The increasing opening capacity up to the age of 19 can be seen in relation to the growth of the mandible and TMJ, which is considered to be completed at about the end of the teenage period.

In this study the number of those with impaired mandibular mobility, mostly in the horizontal plane, was reduced longitudinally. Only one subject had an impaired opening capacity (<40 mm). It can be questioned whether the limits suggested in the Helkimo index are valid in adolescents. In an earlier analysis of our sample (22) and in another study on adolescents (5) a relationship between signs and symptoms and slightly impaired mandibular mobility was found. The relative size of changes between recordings may be of importance and indicate dysfunction, which is supported by the fact that both short- and long-term changes of maximal mandibular mobility are small in individuals without signs and symptoms of dysfunction (25).

The longitudinal pattern of changes in the adolescents within the clinical dysfunction index showed fluctuations, although the prevalence was quite constant each year. The separate findings in each age group corroborate those of earlier cross-sectional studies (4). Even though the period prevalence for the 3 years was 76%, and 29% had signs at all the examinations, most of the individuals (60%) were stable within the same group of dysfunction when comparing the two examinations. These findings are in line with a previous 5-year longitudinal study on 15- to 20-year-olds (5). In two younger samples the clinical dysfunction index increased significantly during a period of 4 years (20).

The incidence of new cases with signs was generally mild in character (DiI). No predictable pattern of changes was found, and for most of the individuals signs of mandibular dysfunction fluctuated longitudinally. This may be seen in relation to the fluctuations in symptoms reported by these adolescents (9) and to the fact that most children and adolescents report occasional symptoms (2, 5, 20), but it may also support the view that the stomatognathic system is sensitive to psycho-emotional factors (26), which Perry et al. (27) were among the first to demonstrate. However, it has not been possible to estimate the effects of physical and/or psychological/emotional changes or the individual adaptability of the studied subjects.

The relative smallness of the treated sample (5%) and their fluctuation in signs do not seem to have influenced the longitudinal findings of the whole sample to any major extent.

The small reduction in the prevalence of morphological malocclusions can be explained by orthodontic treatments during the period. The functional malocclusions with interferences in RP were mainly dependent on the contacts on the first premolars, as earlier presented (3, 28).

The prevalence of balancing (mediotrusion) interferences was almost constant and comparable to previous findings on asymptomatic 15- and 22-year-olds (28).

Since the occlusal state of the treated cases did not differ significantly from that of the untreated group, this variable can hardly be of any significant importance in the etiology of mandibular dysfunction, which has also been postulated in some recent papers (28, 29). At the age of 17 neither symptoms nor the dysfunction index was found to be related to any of the occlusal variables (22).

It is obvious from the prevalence figures that signs of mandibular dysfunction are common in adolescents and young adults, although generally of mild character. No predictable general pattern in the development of signs of mandibular dysfunction was found. The longitudinal analysis has identified a minor group with more constant signs, who may be at greater risk of developing more severe dysfunction; additional longitudinal research is needed. Thus, a stomatognathic examination should be included in the routine dental check-up, to identify individuals who need treatment or need to be observed more closely.

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