Original Article

Malocclusion and orthodontic treatment need evaluated among subjects with Down syndrome using the Dental Aesthetic Index (DAI)

Farah S. Abdul Rahim[a]; Alizae M. Mohamed[b]; Murshida Marizan Nor[c]; Roslan Saub[d]

ABSTRACT

Objective: To determine the prevalence of malocclusion and need for orthodontic treatment among persons with Down Syndrome (DS).

Materials and Methods: Study participants were 113 persons with DS from the selected community-based rehabilitation center who fulfilled the inclusion and exclusion criteria. Ten occlusal characteristics of the Dental Aesthetic Index (DAI) were measured on study models to determine the degree of malocclusion. A single score represented the dentofacial anomalies, determined the level of severity, and determined the need for orthodontic treatment.

Results: Crowding in the anterior maxillary and mandibular arch was the main malocclusion problems among the subjects with DS. Comparison between age group and genders revealed no significant differences in four categories of orthodontic treatment need ($P > .05$).

Conclusion: Most of the subjects with DS (94; 83.2%) had severe and very severe malocclusion, which indicated a desirable and mandatory need for orthodontic treatment. (*Angle Orthod.* 2014;84:600–606.)

KEY WORDS: Malocclusion; Dental Aesthetic Index; Orthodontics treatment need; Down syndrome

INTRODUCTION

Down syndrome (DS) is a well-known chromosomal abnormality characterized by the presence of an extra copy of genetic material on the 21st chromosome.[1,2] Down syndrome is diagnosed in 1 in 732 infants in United States, whereas the prevalence rate is 1.08 per 1000 live births in the United Kingdom.[3,4]

In Malaysia, the incidence of DS in 1989 was reported as 1 in 950 births with variation among the three largest ethnic groups: Malay, 1 in 981; Chinese, 1 in 940; and Indian, 1 in 860.[2] Regardless of ethnicity, the unique combination of facial features typical of DS is usually identified by a characteristic pattern of dysmorphic features such as small cranium, midface, and nasal bone depression; flat facial profile; hypotonia; slanted palpebral fissures; and strabismus.[5]

Malocclusion is characterized by deviations from the norm in size, shape, or position of maxilla and mandible. Studies have reported that the prevalence of malocclusion is higher among persons with DS.[6,7] Crowding, openbite, unilateral and bilateral crossbite, and Class III malocclusion are the malocclusion types among this group. Malocclusion not only affects such functions as mastication, speech and esthetics but also has psychosocial consequences because of the unacceptable dental esthetics.[8] The main aims of orthodontic care for persons with DS are to produce a healthy functional bite, create greater resistance to disease, and improve personal appearance. This contributes to the person's mental and physical well-being.

The Dental Aesthetic Index (DAI) is an occlusal index designed to categorize malocclusion into groups according to the level and priority of orthodontic

[a] Postgraduate student, Department of Orthodontics, Faculty of Dentistry, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.

[b] Orthodontic Specialist and Head, Department of Orthodontics, Faculty of Dentistry, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.

[c] Orthodontic Specialist and Lecturer, Department of Orthodontics, Faculty of Dentistry, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.

[d] Associate Professor and Head, Department of Preventive Dentistry, Faculty of Dentistry, Universiti Malaya, Kuala Lumpur, Malaysia.

Corresponding author: Dr Alizae Marny Mohamed, Department of Orthodontics, Faculty of Dentistry, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abd Aziz, 50300 Kuala Lumpur, Malaysia
(e-mail: alizaemarny@gmail.com)

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Table 1. Orthodontic Treatment Need According to the Dental Aesthetic Index (DAI)

DAI Score	Severity Level	Treatment Priority
≤25	Normal/minor malocclusion	No treatment needed/slight need for treatment
26–30	Definite malocclusion	Treatment elective
31–35	Severe malocclusion	Treatment highly desirable
>35	Very severe handicapping malocclusion	Treatment mandatory

treatment need.[9] The DAI relates the clinical and esthetic components to mathematically calculate a single score that reflects the malocclusion severity. By using cutoff points, the score was used to determine the need for orthodontic treatment. The DAI has been demonstrated to be simple, valid, reliable, and easy to use.[10–12] It may be used globally for diverse ethnic groups and cross-culturally without modification.[13–15] In addition, several previous studies have determined the prevalence of malocclusion and need for orthodontic treatment among persons with disabilities using DAI.[6,16–18]

The main objective of this study was to determine the prevalence of malocclusion and need for orthodontic treatment among persons with DS using the DAI.

MATERIALS AND METHODS

This study was undertaken after obtaining ethical clearance from the Research and Ethical Committee in Universiti Kebangsaan Malaysia Medical Centre (UKM1.5.3.5/244/DD/033[1]/2010). Approval was also obtained from the Social Welfare Department of Malaysia (Research and Development Unit) and the Malaysian Down Syndrome Association.

The DAI consists of 10 occlusal characteristics related to dentofacial anomalies according to three components: spacing, crowding, and occlusion. For subjects between 9.9 and 11.3 years old, the missing teeth component was omitted from the standard DAI.[19] The measurement was done directly on the study model using a digital caliper as it was difficult to gain cooperation among subject with DS if done intraorally. Each DAI component has a specific regression coefficient to yield the DAI score. The score for each component were multiplied by a weighting, and a constant was added to obtain a final DAI score for each subject. The final score represents the dentofacial anomalies by level of severity and need for orthodontic treatment (Table 1).

Sample size calculation was performed using an online sample-size calculator.[20] The parameters were determined using the probability proportional to population size method with a power of 80%, and the sampling error was set at 5%. The target sample size was estimated to be 124 (including 10% dropout), based on a 28,126 estimated population of persons with DS in Malaysia. In collaboration with the Social Welfare Department of Malaysia, 30 community-based rehabilitation centers (CBRCs) providing services to persons with DS in the states of Selangor, Negeri Sembilan, and Melaka were selected. All the persons with DS from the selected CBRCs who fulfilled the inclusion and exclusion criteria were invited to participate in the study. The following inclusion criteria were used: (1) diagnosed with DS at any level of intelligence quotient, (2) good cooperation during the clinical examination and impression-taking for study models, (3) no history of previous orthodontic therapy, and (4) absence of cerebral palsy and cleft lip and palate. In principle, all subjects with DS who had no written consent from a legal representative, were edentulous, or were uncooperative during impression taking were excluded.

At the center, each subject with DS was seated on an ordinary chair. The examiner performed a simple clinical examination, without the use of dental probe and mirror, to ensure that the subjects were not edentulous and confirm the absence of cleft lip and palate. Other persons with DS, if present, were allowed to monitor the procedure to gain their interaction, confidence, and cooperation. Impressions of the upper and lower arches were taken with fast-setting alginate and conducted under strict infection-control procedures. The study models were made once the impressions arrived at the laboratory.

The DAI measurements on the study models were done by the same examiner following the sequence of the DAI components. These DAI measurements were taken three times; the mean was used to ensure the precision of the measurement. Intraexaminer reliability was determined by remeasuring10 randomly selected DS study models at a 1-week interval. Kappa analysis showed good intraexaminer reliability with $r = 0.91$.

The demographic data and final DAI score were coded and analyzed using the Statistical Package for Social Science software for Windows version 20.0, (SPSS, Chicago, Ill). Data cleaning was done to ensure the accuracy of data transfer into the SPSS software. Descriptive statistics were performed, including frequencies and percentages for categoric variables, and means and standard deviations were calculated for quantitative variables (age and DAI score). The χ^2 test was used to test the association of

Table 2. Distribution of Dental Aesthetic Index (DAI) Components

DAI Component	Age (y) and Gender	Scores												n	Significance
Missing teeth		0	1	2	3	4	5	6	7	8	9	10	11		
	<20 y	29	15	7	2	4	1	1	1	0	0	1	0	61	.372
	≥20 y	15	11	7	4	6	3	2	0	0	2	1	1	52	
	Male	25	13	4	3	7	3	2	1	0	2	0	0	60	.289
	Female	19	13	10	3	3	1	1	0	0	0	2	1	53	
	Total	44	26	14	6	10	4	3	1	0	2	2	1	113	
	%	38.9	23.0	12.4	5.3	8.8	3.5	2.7	0.9	0	1.8	1.8	0.9	100	
Crowded incisal segments		0	1	2											
	<20 y	10	21	30										61	.793
	≥20 y	11	16	25										52	
	Male	15	17	28										60	.157
	Female	6	20	27										53	
	Total	21	37	55										113	
	%	18.6	32.7	48.7										100	
Spaced incisal segments		0	1	2											
	<20 y	38	17	6										61	.957
	≥20 y	32	14	6										52	
	Male	36	15	9										60	.264
	Female	34	16	3										53	
	Total	70	31	12										113	
	%	62.0	27.4	10.6										100	
Midline diastema (mm)		0	1	2	3	4	5	6							
	<20 y	53	3	3	2	0	0	0						61	.369
	≥20 y	46	0	4	1	0	0	1						52	
	Male	49	3	4	3	0	0	1						60	.150
	Female	50	0	3	0	0	0	0						53	
	Total	99	3	7	3	0	0	1						113	
	%	87.6	2.7	6.2	2.6	0	0	0.9						100	
Anterior maxillary irregularity (mm)		0	1	2	3	4	5	6	7	8	9	10	11		
	<20 y	16	0	5	4	13	11	7	1	1	3	0	0	61	.087
	≥20 y	20	0	2	10	7	3	6	0	2	0	1	1	52	
	Male	23	0	2	7	10	3	9	1	2	2	1	0	60	.180
	Female	13	0	5	7	10	11	4	0	1	1	0	1	53	
	Total	36	0	7	14	20	14	13	1	3	3	1	1	113	
	%	31.9	0	6.2	12.4	11.5	0.9	2.6	0.9	2.6	2.6	0.9	0.9	100	
Anterior mandibular irregularity (mm)		0	1	2	3	4	5	6	7	8	9	10	11		
	<20 y	24	0	7	12	7	3	4	1	1	0	1	1	61	.412
	≥20 y	18	1	13	7	8	4	1	0	0	0	0	0	52	
	Male	23	0	12	6	10	2	4	1	0	0	1	1	60	.217
	Female	19	1	8	13	5	5	1	0	1	0	0	0	53	
	Total	42	1	20	19	15	7	5	1	1	0	1	1	113	
	%	37.1	0.9	17.7	16.8	13.3	6.2	4.4	0.9	0.9		0.9	0.9	100	
Maxillary overjet (mm)		0	1	2	3	4	5	6	7	8					
	<20 y	27	6	11	11	4	2	0	0	0				61	.829
	≥20 y	20	5	13	7	3	3	0	0	1				52	
	Male	25	6	14	8	4	3	0	0	0				60	.911
	Female	22	5	10	10	3	2	0	0	1				53	
	Total	47	11	24	18	7	5	0	0	1				113	
	%	41.6	9.7	21.3	15.9	6.2	4.4	0	0	0.9				100	
Mandibular overjet (mm)		0	1	2	3										
	<20 y	50	6	4	1									61	.626
	≥20 y	42	5	2	3									52	
	Male	46	7	5	2									60	.382
	Female	46	4	1	2									53	
	Total	92	11	6	4									113	
	%	81.4	9.7	5.3	3.6									100	

Table 2. Continued

DAI Component	Age (y) and Gender	Scores						n	Significance
Open bite (mm)		0	1	2	3	4	5		
	<20 y	48	1	7	2	2	1	61	.538
	≥20 y	35	3	8	4	2	0	52	
	Male	42	2	9	3	3	1	60	.823
	Female	41	2	6	3	1	0	53	
	Total	83	4	15	6	4	1	113	
	%	73.5	3.5	13.3	5.3	3.5	0.9	100	
Molar relationship		0	1	2					
	<20 y	9	24	28				61	.814
	≥20 y	7	18	27				52	
	Male	9	20	31				60	.668
	Female	7	22	24				53	
	Total	16	42	55				113	
	%	14.1	37.2	48.7				100	

each components and DAI scores in relation to the age group and gender.

RESULT

The final sample consisted of 113 persons with DS from 30 CRBCs. The persons with DS showed similar gender distribution (males, 53.1%; females, 46.9%), and the mean age was 20.8 ± 6.8 years old.

Cross-tabulations between the subjects' occlusal components of the DAI, age group, and gender are given in Table 2. Most of the subjects with DS (92; 81.4%) had crowding, and 36 (31.9%) had anterior maxillary irregularity ≥5 mm. However, only 16 (14.2%) had anterior mandibular irregularity ≥5 mm. Nevertheless, 69 (61.1%) subjects had at least one permanent tooth missing, and spacing in at least one incisor segment was observed in 43 (38.1%) subjects. However, only 14 (12.3%) subjects had a midline diastema ≥1 mm. In occlusion, only 6 (5.3%) subjects had a positive overjet ≥5 mm, whereas 21 (18.6%) had a reverse overjet ≥1 mm. Almost one third (30; 26.5%) of the subjects had vertical anterior open bite, and only 16 (14.2%) had an Angle Class I molar relationship. Nevertheless, no significant differences were found between age group and gender in each of the DAI components.

The distribution of age group and gender by treatment-need category are given in Table 3, which demonstrates that the number of subjects for both age group and gender increased with the severity of malocclusion. Most subjects (94; 83.2%) had severe and very severe malocclusions. Only 3 (2.7%) subjects had normal or minor malocclusion requiring no treatment. However, there was no significant difference in the distributions by age group ($P > .05$). Similarly, there was no significant difference in the distributions of gender in the four categories of treatment need ($P > .05$).

DISCUSSION

The DAI index is a well-known epidemiologic tool that combines a single mathematic score of esthetic and physical aspects of malocclusion. Its assessment of the 10 occlusal traits provides more clinical information than indices based on a single worst

Table 3. Distribution of Treatment Need Category

	Dental Aesthetics Index (DAI)					
Demographic Data	Normal/Minor (DAI ≤ 25) n (%)	Definite (DAI = 26–30) n (%)	Severe (DAI = 31–35) n (%)	Very Severe (DAI > 35) n (%)	Total n (%)	Significance
Age (y)						
<20	2(1.8)	12(10.6)	16(14.2)	31(27.4)	61(54.0)	.065
≥20	1(0.9)	4(3.5)	8(7.1)	39(34.5)	52(46.0)	
Gender						
Male	2(1.8)	6(5.3)	15(13.3)	37(32.7)	60(53.1)	.451
Female	1(0.9)	10(8.8)	9(8.0)	33(29.2)	53(46.9)	
Total	3(2.7)	16(14.1)	24(21.3)	70(61.9)	113(100.0)	

feature. It is also less likely to underestimate the severity of a malocclusion. However, the performance of the DAI with mixed dentition was shown to be slightly lower than in permanent dentition.[21] In a mixed dentition clinical examination, missing permanent teeth are more likely to be unerupted than missing.[21,22] Hence, it was recommended that the missing teeth component be omitted in calculating the DAI in the mixed dentition. In the present study, this understanding was applied to 8 (7.1%) of the subjects.

Measurements were performed on study models instead of examining directly because of the short attention span of persons with DS, which often results in noncompliance, impulsive behavior, and poor judgment.[23,24] This is a widely accepted challenge faced by health care professionals and researchers. As convenience sampling was planned in consideration of the subjects' cooperation, no age range was determined before this study. Hence, the wide age range of the subjects. Nevertheless, the distribution of subjects for age group (61 subjects $<$20 years; 52 subjects $>$20 years) and gender (males, 60; females, 53) was almost equal.

Overall, subjects with DS appeared to exhibit a high prevalence of malocclusion. This coincides with findings of other studies, where more than 80% of persons with DS presented with malocclusions.[25–27] Class III malocclusions were also the most common form of malocclusion in these persons, and these data were consistent with those of Vittek et al.[25] and Shyama et al.[26] The results were attributed to an altered cranial base relationship, reduced maxillary size, and decreased arch length.[26,28]

Almost a third of the subjects with DS had an anterior open bite, and this prevalence coincides with findings of studies by Vigild[27] and Oliviera et al.[29] Hypotonia and tongue thrust, which gives the impression of macroglossia in a relatively small oral cavity, and deficient maxilla have been reported as contributing factors in the anterior open bite.[29] On the other hand, deleterious oral habits, such as thumb sucking, may cause an unbalanced pressure to the teeth, which could also result in an anterior open bite and malocclusion.[29] According to Rao et al.,[6] the children with disabilities are sensitive and more vulnerable to stress.[6] This emotional insecurity forces the child to diversify into those oral habits. Correcting the harmful oral habit is crucial for the stability of orthodontic treatment if the habit was a causative factor in the malocclusion. This contributed to the higher DAI score and increased the priority for orthodontic treatment.

This study revealed that a large proportion (83.2%) of persons with DS had severe to very severe malocclusion with a DAI of more than 31. This indicates that the need for orthodontic treatment is highly desirable and mandatory for this group. The result was expected and is in agreement with previous studies establishing the frequent association between orofacial dysfunction, malocclusions, and DS.[6,30] Rao et.al.[6] who had a large number of subjects with DS, concluded that there was a higher prevalence of definite and severe malocclusion in persons with mental disabilities compared with other disabilities (ie, hearing, visual, and physical impairments). This finding is also supported by Winter et al.[16] Furthermore, in our study only 3 (2.7%) of the subjects presented with normal or minor malocclusion, again indicating the large proportion with malocclusion problems.

Keay et al.[21] stated that the DAI has high sensitivity and correctly predicts a high proportion of persons requiring orthodontic treatment.[21] Furthermore, the index also has high negative predicting power, where the no-treatment need recommended by the DAI is likely to be correct.[21] All this suggests that most persons with DS need orthodontic treatment. Therefore, it is the responsibility of the parents and health care providers to ensure that this is achieved. Nevertheless, there was no significant difference in prevalence of malocclusion with regards to the age.

Today there is an increasing trend toward deinstitutionalization of persons with special needs and subsequent resettlement in smaller home environments. Hence, there is an increase in the number of persons with DS who are working and living in the community. Those persons often lack the ability to recognize malocclusion problems, and when they do recognize the need for services, many environmental and individual barriers prevent them from receiving the necessary care.[30,31] It cannot be denied that a person with DS will face challenges and difficulties, but their needs for treatment and support are no difference than those of a person without DS. The treatment objectives for those persons with DS should be as comprehensive as possible but may need to be adapted to each individual's condition. Regardless of mental, behavioral, medical, and dental conditions, orthodontic treatment can be performed in patients with DS. Although several difficulties may appear, special care, facilities, and latest technology will support the orthodontic treatment. A multidisciplinary setting is essential in providing advanced dental care to patients with DS. This awareness has increased tremendously within the orthodontic specialty. Some management problems encountered in performing orthodontic treatment on persons with disabilities have been addressed in the literature.[32–34]

Most children with disabilities perceive dental treatment with exaggerated levels of apprehension, far more than other orthodontic patients. Hence, they must be approached with understanding and compassion to gain their trust.[35] This group cannot be expected to

perform most active cooperation responsibilities by themselves. The parents' cooperation becomes mandatory, particularly regarding care of the appliance.[35] Although some parents of children with disabilities do not think orthodontic treatment will make a difference, most presume that improving their child's appearance and/or oral functions will improve their future acceptance within society.[36]

Orthodontic treatment in patients with DS should be multidisciplinary and often presents a challenge for the clinician. Cooperation is the biggest challenge because of the presence of mental disabilities. Hence, it is hoped that the DAI will be a good guide for the orthodontist to identify those who really need orthodontic treatment and reassure the parents and the patient about the importance of the treatment. Nevertheless, mutual understanding of the goal, shared by both the clinician and patient's parents is crucial to obtain good and successful clinical results.

CONCLUSIONS

- Most persons with DS have very severe handicapping malocclusion, which indicates that orthodontic treatment needs of patients with DS are essential.
- Orthodontic treatment in patients with DS should be multidisciplinary, and to establish better treatment standards, both the clinician and the patient's parents must understand the treatment objective.

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