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Original article

Can oral health promotion help develop occlusion?

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Abstract: In an effort to promote adequate development of the masticatory system and prevent dental problems, the Oral Health Promotion Project (OHPP) was started in 1984. The study was carried out for 8 years, and then followed up for another 9, in a district with no regular dental service, on Miyako Island, Okinawa, Japan. The study evaluated the Project's effect on occlusion by means of 163 longitudinal data on complete deciduous dentition (II A) at 4 years of age and 112 data on permanent dentition (IVA) at 13-15 years. Each age group was divided into four sections according to their birth year. As a control study, 352 data were collected from a neighbouring district.

The presence of normal occlusion significantly increased and that of discrepancy type occlusion decreased among subjects born after 1984. This applied both to deciduous and permanent dentitions. An example would be the discrepancy in permanent dentition fell from 88.9% of children born in 1979-1980 (n=9), to 37.0% in those born in 1984-1985 (n=27) and to 27.8% for children born in 1986-1987 (n=18, $p<0.05$), while no significant changes were found in the control district. The majority of discrepancies (73.6%) seen at 4 years of age was still evident in the permanent dentition ($p<0.001$). Based on these results, the authors suggest that incidence of discrepant malocclusion can be reduced, but that it would be crucial to begin intervention soon after birth.

Key words: health promotion, malocclusion, tooth-to-denture base discrepancy, longitudinal study
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Introduction

There is considerable evidence to suggest that genes play a significant part in the aetiology of malocclusion[1~3]. This applies to malocclusion in both Class II division 1[4], Class II division 2[5,6], and Class III[7,8]. Thus, prevention of malocclusion through active promotion of normal occlusion would hardly seem possible except in the cases where malocclusion is the result of habits such as thumb sucking, or the pulling at a pipe stem. However, our study series of tooth-to-denture base discrepancy ("Discrepancy"), based on material ranging from 10,000 years old to modern, living humans has shown that the frequency of Discrepancy has increased with a change in dietary practices to soft and concentratedly nutritious food. The change seen ranged from 0 to 63%, with some fluctuations[9~14]. The frequency of malocclusion rose in essentially the same manner because the number of Discrepancies rose.

Experiments undertaken on mice demonstrated that a diet of pureed food significantly reduced the weight of the masseter muscle and the size of the mandible[15]. Liquidised food reduced the height of the mandibular ramus, the length of the body of the mandible and the condylar width, and widened the gonial angle[16,17]. It also reduced the size of the masseter and temporal muscles[18] as well as that of the salivary glands, and affected the chewing pattern[19,20].

Soft and nutritious food appears to result in much dental disease, such as caries and periodontitis. In addition, Discrepancy would make the risk of dental disease higher, especially in the neck of the tooth[21].

If diet can be a cause of not only dental disease but also of some types of malocclusion, it follows that a healthy oral condition can be brought about by a change in dietary regime. In the hope that we would be able to redress the insufficient development of the masticatory system, and prevent dental problems through health education focusing on diet, we set up the Oral Health Promotion Project (OHPP) and a longitudinal study in a selected district on Miyako Island in 1984[22]. The OHPP lasted eight years with another nine years of follow-up and finished in 2000. In this paper we discuss the change of occlusion taking place over the period studied, and the effect of the OHPP on occlusion.

Subjects and method

The Oral Health Promotion Project

The Project was begun in April 1984, to coincide with the school year, which runs from April to the following March. During the first eight years the OHPP focused mainly on health education with special emphasis on diet and on thrice-yearly dental examination and treatment such as the filling of cavities and tooth extraction[23].

Breast feeding and natural weaning were recommended for the infancy period. For the period after weaning, the two main points of dietary instructions were: 1) No drinking of large amounts of high-calorie drinks like juice or soda, especially before meals; and 2) Provide fibre-rich food such as vegetables at all meals. Where this is not done, we see the following pattern developing: An unceasing consumption of high-calorie drinks results in continually high blood sugar levels,

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and it becomes impossible for the child to eat adequate meals at breakfast, lunch, and dinner because of not feeling hungry. As a result of inadequate meals, infants soon become hungry again and more juice and snack foods are given. In order to break this vicious circle mothers must control their infants' and children's intake so that their stomachs are empty at mealtime, and then provide enough fibrous food such as vegetables. This promotes the development of the chewing system, chewing ability, and secretion of saliva.

Following a dental examination, mother and child had a 15 to 30 minute consultation about their dietary life. We held meetings more than ten times with not only parents but also with grandparents involved in caring for their grandchildren.

Two small communities, Ikema and Karimata, Miyako Island, Okinawa were selected as model venues for OHPP. There is no regular dentist serving these communities, and public health nurses requested our help in improving the poor oral condition of the population. Also, in such small communities the likelihood of extensive population movement is low, enabling long-term continued investigation. In the first eight-year period the OHPP was run in co-operation with Miyako Public Health Centre and the local community's Women's Society. They contributed greatly to promote OHPP using community bond. It was partly supported by the Japanese Ministry of Health and Welfare.

Subjects

Miyako Island is situated at lat. 24 degr. 37 min. −24 degr. 57 min. N and long. 124 degr. 40 min. −125 degr. 30 min. E, 303 km south-west of Okinawa main island. Ikema (population about 850) is a small solitary island located 3 km north of Miyako main island, with a 15 minute ride on a small ferry between the two. In 1992 it was connected to Miyako by bridge. Karimata (population about 760) lies at the northernmost end of Miyako main island, facing Ikema. The main industry for both communities is sugar cane culture, and there is a ready supply of fish and shell fish along the coast. During the time of the study of the populations, neither community had a dentist.

All children born between April 1979 and March 1992 were eligible for enrolment in the OHHP. Informed consent was obtained with the help of public health nurses from Miyako Public Health Centre, and the number of participants during the first eight years was 250.

For the purposes of the investigating the effect on occlusion of the project, data was taken on completed deciduous dentition (II A) and completed permanent dentition (IVA). Records for 163 subjects at age 4 and 112 subjects of age 13-15 were collected and used in the study (Table 1). 51 subjects could not be followed up as 48 had moved too far away and 3 were absent at the examination. No subjects were enrolled in orthodontic treatment.

To evaluate the data, control data from the neighbouring district on Miyako Island were collected. Records were used for 105 5-year-olds (born in the 1980 school year), 49 4-year-olds (born in the 1995 school year), 127 13-15 year-olds (1972 school year) and 71 born during 1986 and 1987 school years.

Table 1 Number of subjects, by birth year and sex.

Birth year	Age 4 yrs.			Age 13-15		
	Male	Female	Total	Male	Female	Total
Model district						
1979-1980	12	9	21	6	3	9
1981-1983	31	41	72	22	36	58
1984-1985	14	21	35	9	18	27
1986-1987	16	19	35	9	9	18
Total	73	90	163	46	66	112
Control district						
1980*	48	57	105			
1995	31	18	49			
1972				61	66	127
1986-1987				26	45	71

*these children were 5 years old

Dental examination

Occlusion was examined in living subjects, where participants opened and closed the mouth and bit during observation of the complete cranio-facial structure followed by a rechecking of the dental cast. Each child's occlusion was examined and classified into one of six categories following our criteria[24,25]. Cases of maxillary protrusion, anterior crossbite or open-bite which showed Discrepancy were also classified in their respective groups, but counted as having the discrepancy factor.

The following definitions of maxillary protrusion, anterior crossbite, crowding, and open-bite were used for both deciduous and permanent dentitions. Pseudo-normal occlusion was the category of the deciduous dentition.

1) Normal occlusion: In the case of deciduous dentition, only occlusion with sufficient (0.5 mm or more) developmental space at least two site was classified as normal.

In the case of permanent dentition, only occlusion without the abnormalities listed below were classified as normal.

2) Discrepancy type:

a) Pseudo-normal occlusion: deciduous normal occlusion with closed dental arches. i.e. occlusion with sufficient (0.5 mm or more) developmental space at less than two sites.

b) Crowding: crowded arrangement of the teeth (2 mm or more overlapped).

3) Maxillary protrusion: maxillary anterior teeth are protruded 3 mm or more.

4) Anterior crossbite: one or more mandibular teeth biting in front of the maxillary teeth.

5) Open-bite: a partial gap 2 mm or more between anterior maxillary and mandibular teeth when in occlu-

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sion.

Four main causative factors were seen in the cases of malocclusion, and these were used in combination to describe each case (e. g. anterior crossbite with skeletal and discrepancy factors):

1) Skeletal factor: skeletal imbalance in size and/or shape of the maxilla and/or mandible. Where such a condition is present, (1) in the case of maxillary protrusion or anterior crossbite, despite the factor of guidance of anterior teeth to the wrong biting position, maxillary or mandibular was still protruded, (2) asymmetric shape of left and right jaw when the mouth is open.

2) Functional factor: functional interference in occlusion, e. g. abnormal movement of the mandible.

3) Discrepancy factor: tooth-to-denture base discrepancy, with insufficient space in the dental arch compared to the total length of all the teeth. Where such a condition is present, (1) a tooth erupts on either the buccal or the lingual side of its normal space and overlapped other teeth 2 mm or more, which results in crowding; (2) teeth which erupt later, such as the third molars, do not have the space to erupt completely.

4) Habitual factor: thumb sucking or other habit.

Method of analysis

As there were no significant differences based on sex, both sets of data were analysed together.

Changes and coincidence rates between 4-year-olds and 13-15-year-old were evaluated using $\chi 2$ test or Fisher's exact test when number of samples per cell was less than 5.

Results

Changes in occlusion in the longitudinal study (Table 2)

At 4 years old, the percentages of normal occlusion were significantly increased from 23.8% in children born in 1979-1980 ($n=21$), to 57.1% in those born in 1984-1985 ($n=35$, $p<0.05$) and to 54.3% in those born in 1986-1987 ($n=35$, $p<0.05$). In the control district, they were slightly changed from 30.5% in children born in 1980 ($n=105$) to 40.8% in those born in 1995 ($n=49$) although not to a significant degree. The percentages of pseudo-normal occlusion (deciduous normal occlusion without developmental space) were fell from 42.9% of children born in 1979-1980, to 20.0% in those born after 1984 ($p<0.05$), while no significant changes were found in the control district. No significant differences were found between the percentages relating to other types of malocclusion.

At 13-15 years old, the percentages of normal occlusion were significantly increased from 11.1% of children born in 1979-1980 ($n=9$), to over 50.0% in those born in 1984-1985 ($n=27$, $p<0.05$) and in 1986-1987 ($n=18$, $p<0.05$), while no significant changes were found in the control district. The percentages of crowding fell from 66.7% of children born in 1979-1980 ($n=9$), to 37.9% in those born in 1981-1983 ($P<0.001$), to 7.4% in those born in 1984-1985 ($n=27$, $p<0.01$) and to 16.7% for children born in 1986-1987 ($n=18$, $p<0.01$), while no significant changes were found in the control district. No significant differences between the percentages of other malocclusion in the model district study.

Comparing the data for 13-15-year-olds between model and control districts, we found fewer cases of normal occlusion among model district children born in 1979-1980 than among control district children born in 1986-1987 ($p<0.05$). On the other hand, more cases of normal occlusion were found among model district children born in 1984-1985 than among control district children born in 1972 ($p<0.05$). More crowding was found in the model district group born in 1979-1980 than in the control groups born in 1986-1987 and in 1972, and less crowding in the model district group born in 1984-1985 ($p<0.05$).

Changes in causative factors (Table 3)

Discrepancy percentages for the 4-year-olds fell from 61.9% of children born in 1979-1980 ($n=21$), to 28.6% in those born in 1984-1985 ($n=35$, $p<0.05$) and to 31.4% for children born in 1986-1987 ($n=35$, $p<0.05$). In the control district, no significant change was found. No other significant differences were found between the model district groups.

Among the 13-15-year-olds, the Discrepancy percentages fell from 88.9% of children born in 1979-1980 ($n=9$), to 37.0% in those born in 1984-1985 ($n=27$, $p<0.05$) and to 27.8% for children born in 1986-1987 ($n=18$, $p<0.05$), while no significant changes were found in the control district.

Comparing the data for 4-year-olds between model and control districts, we found fewer cases of Discrepancy among model district children born in 1984-1985 ($p<0.05$) and 1986-1987 ($p<0.05$) than among control district children born in 1980. Skeletal factors were present more frequently among those born in 1980 in the control district, compared to the other groups, with the exception of the group born in 1979-1980 ($p<0.05$). Comparing the data for 13-15-year-olds, we found more cases of Discrepancy among model district children born in 1979-1980 than in the control district group from 1986-1987 ($p<0.05$) than among control district children born in 1980. Skeletal factors were present less frequently in the control district among those born in 1986-1987.

Longitudinal study of developmental change (Tables 4 and 5)

Normal occlusion, anterior crossbite and crowding, when found in the deciduous dentition, tended to remain the same, or similar, in the permanent dentition (Table 4). Only 23.8% of pseudo-normal deciduous occlusion ($n=42$) became normal permanent occlusion, while 30 of these cases (71.4%) retained the discrepancy factor in the permanent dentition.

Most of the cases involving a skeletal factor (100.0%) and the Discrepancy factor (72.2%) retained the same

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Table 2 Distribution of cases by type of occlusion and age

	Birth year		Normal	Discrepancy type		Maxillary protrusion	Anterior crossbite	Open-bite	Total
				Pseudo-normal	Crowding				
Age 4 years	Model district								
	M1:1979-1980	n	5	9	2	1	4	0	21
		%	23.8	42.9	9.5	4.8	19.1	0.0	100.0
	M2:1981-1983	n	25	32	2	3	8	2	72
		%	34.7	44.4	2.8	4.2	11.1	2.8	100.0
	M3:1984-1985	n	20	7	2	1	5	0	35
		%	57.1	20.0	5.7	2.9	14.3	0.0	100.0
	M4:1986-1987	n	19	7	2	2	2	3	35
		%	54.3	20.0	5.7	5.7	5.7	8.6	100.0
	Control district								
	C1:1980	n	32	32	9	10	19	3	105
		%	30.5	30.5	8.6	9.5	18.1	2.9	100.0
	C2:1995	n	20	18	0	5	5	1	49
		%	40.8	36.7	0.0	10.2	10.2	2.0	100.0
	Significant difference	All	*	*					
	betw. groups		M1<M3	M1>M3					
			M1<M4	M2>M3					
			M2<M3	M2>M4					
			M2<M4						
			C1<M3						
			C1<M4						
Age 13-15	Model district								
	M1:1979-1980	n	1		6	1	1	0	9
		%	11.1		66.7	11.1	11.1	0.0	100.0
	M2:1981-1983	n	20		22	3	12	1	58
		%	34.5		37.9	5.2	20.7	1.7	100.0
	M3:1984-1985	n	15		2	4	6	0	27
		%	55.6		7.4	14.8	22.2	0.0	100.0
	M4:1986-1987	n	9		3	2	4	0	18
		%	50.0		16.7	11.1	22.2	0.0	100.0
	Control district								
	C3:1972	n	41		36	22	25	3	127
		%	32.3		28.3	17.3	19.7	2.4	100.0
	C4:1986-1987	n	33		22	10	4	2	71
		%	46.5		31.0	14.1	5.6	2.8	100.0
	Significant difference	All	*		**				
	betw. groups		M1<M3		M1>>>M3				
			M1<M4		M1>>M4				
			M1<C4		M1>C3				
					M1>>C4				
					M2>>M3				
					C3>M3				
					C4>M3				

*:p<0.05, **:p<0.01, </>:p<0.05, <</>>:p<0.01, <<</>>>:P<0.001

condition in both deciduous and permanent dentition (p <0.001) (Table 5).

Four deciduous malocclusions of open-bite, which were caused by a thumb-sucking habit, disappeared in the permanent dentition, since the habit had been discontinued when the permanent teeth erupted. One permanent malocclusion of open-bite seems to be caused by a tongue habit which emerged after the OHPP had finished.

Discussion

Epidemiology of malocclusion

Among model district group, changes could be seen in the frequency of normal occlusion and of discrepant types. No significant differences were found between

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Table 3 Distribution of cases by causative factors†

	Birth Year		Normal	Causative factors†				Total number of subjects
				Skeletal	Functional	Discrepancy	Habitual	
Age 4 years	Model district							
	M1:1979-1980	n	5	0	5	13	0	21
		%	23.8	0.0	23.8	61.9	0.0	100.0
	M2:1981-1983	n	24	2	8	39	2	72
		%	33.3	2.8	11.1	54.2	2.8	100.0
	M3:1984-1985	n	20	1	5	10	1	35
		%	57.1	2.9	14.3	28.6	2.9	100.0
	M4:1986-1987	n	19	0	2	11	4	35
		%	54.3	0.0	5.7	31.4	11.4	100.0
	Control district							
	C1:1980	n	32	16	19	56	1	105
		%	30.5	15.2	18.1	53.3	1.0	100.0
	C2:1995	n	20	1	7	20	3	49
		%	40.8	2.0	14.3	40.8	6.1	100.0
	Significant difference	All	*	**		*		
	betw. groups		M1<M3	C2<M2		M1>M3		
			M1<M4	C2<M4		M1>M4		
			M2<M3	C2<C1		M2>M3		
			M2<M4			M2>>M4		
			C1<M3			C1>M3		
			C1<M4			C1>M4		
Age 13-15	Model district							
	M1:1979-1980	n	1	0	2	8	0	9
		%	11.1	0.0	22.2	88.9	0.0	100.0
	M2:1981-1983	n	20	8	8	30	1	58
		%	34.5	13.8	13.8	51.7	1.7	100.0
	M3:1984-1985	n	15	2	8	10	0	27
		%	55.6	7.4	29.6	37.0	0.0	100.0
	M4:1986-1987	n	9	2	5	5	0	18
		%	50	11.1	27.8	27.8	0.0	100.0
	Control district							
	C3:1972	n	43	21	39	65	0	127
		%	33.9	16.5	30.7	51.2	0.0	100.0
	C4:1986-87	n	33	2	16	30	1	71
		%	46.5	2.8	22.5	42.3	1.4	100.0
	Significant difference	All	*	*		*		
	betw. groups		M1<M3	C4<M2		M1>M2		
			M1<M4	C4<C3		M1>>M3		
			M1<N2			M1>>M4		
						M1>C3		
						M1>C4		

†: multiple response

*: $p<0.05$, **: $p<0.01$, </>: $p<0.05$, <</>>: $p<0.01$, <<</>>>: $P<0.001$

the percentages of maxillary protrusion, anterior crossbite and open-bite. Normal occlusion increased and discrepant types decreased particularly among those born after the establishment of the OHPP, while no similar changes were found in the control district, either among 4-year-olds or 13-15-year-olds. The OHPP was therefore believed to have effected a reduction in discrepant occlusion.

Among the various forms of malocclusion, the Discrepancy type would be expected to grow in severity as the economy progressed with resultant influence on dietary regimes, and consequently would be the most important factor in the reduction of normal occlusion[26,27]. In hunter-gatherer economies, such as that seen in the earlier Jomon period in Japan (10,000-5,000 BP), or in pre-European contact New Zealand Maori society (400-200 BP), the discrepancy prevalence was less than 10%. In agricultural economies, on the other hand, discrepant occlusion occurs at near to, or in excess of, 20%. Examples of such economies are the

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Table 4 Distribution of occlusion at 4 years old and 13-15 years old

Age 4 years		Age 13-15: Normal	Crowding	Maxillary protrusion	Anterior Crossbite	Open-bite	Total
Normal	n	25	9	3	6	0	43
	%	58.1	20.9	7.0	14.0	0.0	100.0
Pseudo normal	n	10	16	6	9	1	42
	%	23.8	38.1	14.3	21.4	2.4	100.0
Crowding	n	1	3	0	0	0	4
	%	25.0	75.0	0.0	0.0	0.0	100.0
Maxillary protrusion	n	3	1	1	0	0	5
	%	60.0	20.0	20.0	0.0	0.0	100.0
Anterior crossbite	n	2	4	0	8	0	14
	%	14.3	28.6	0.0	57.1	0.0	100.0
Open-bite	n	2	0	0	0	0	2
	%	100.0	0.0	0.0	0.0	0.0	100.0

$P<0.05$

Table 5 Distribution of causative factors at 4 years old and 13-15 years old

Age 4 years Factor		n	Age 13-15 Factor: Skeletal −	Skeletal +	Functional −	Functional +	Discrepancy −	Discrepancy +	Habitual −	Habitual +
Skeletal	−	107	98	9 F***						
		100%	91.6	8.4						
	+	3	0	3						
		100%	0.0	100.0						
Functional	−	97			77	20				
		100%			79.4	20.6				
	+	13			9	4				
		100%			69.2	30.8				
Discrepancy	−	56					42	14***		
		100%					75.0	25.0		
	+	54					15	39		
		100%					27.8	72.2		
Habitual	−	106							105	1
		100%							99.1	0.9
	+	4							4	0
		100%							100.0	0.0

F: Fisher's exact test ***: $p<0.001$

Yahoi and Kofun societies in Japan (4,000-2,000 BP), Iron Age economies (2,500 BP), Romano-British societies (2,000-1,700 BP), Anglo-Saxons in Britain (1,700-1,400 BP), and present-day Maori farmers in New Zealand or farmers in Kenya. In industrial economies, such as that developed among Victorian merchants in London and in Yedo society in Japan, the occurrence of Discrepancy is near to, or in excess of, 40%. Such a tendency can also be observed among current-day Japanese. In people born before WW II the frequency lay around 40%, whereas in those born after the war it had risen to 59.9%[11]. Fibre-rich food would be the effective, because it produces a greater load on the jaws in mastication.

The frequencies of maxillary protrusion and anterior crossbite vary among populations but few links to the economy can be seen[11]. Mossey (1999)[28] reviewed over one hundred contributions to the literature in the field of heritability study of malocclusion. He concluded that genetic factors underpin the development of Class II, division 2, malocclusion. He also found that while various other factors such as lip/tongue contact or hormonal disturbance may contribute to the aetiology of class II, division 1, malocclusions and class III malocclusion, these two types are influenced significantly by genetics. In the present study, it was found that skeletal factors

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(skeletal imbalance in size and/or shape of the maxilla and/or mandible) which contributed the presence of anterior crossbite, decreased in the control district. This might slightly increase the frequency of normal occlusion in the control district. Factors like extensive population movements, perhaps resulting in greater closeness to a town than that of the model district, may also have an influence. However, with insufficient data, further discussion is difficult.

In the present study, it was found that all open-bite in the deciduous dentition were caused by a thumb-sucking habit. Those open-bites were not present in the permanent dentition, since the habit of thumb-sucking had been discontinued when the permanent teeth erupted, following our instruction to those taking care of the children[22].

From these facts we may conclude that a change in diet may help reduce the occurrence of Discrepancy type and timely instruction may help reduce open-bite in the permanent dentition.

Effect of fibre-rich diet through the OHPP

It has been argued that crowding may result from the early loss of primary teeth due to caries[29]. However, as Proffit pointed[29], the early loss of primary teeth does not appear to be a major cause of crowding as no significant change in crowding was observed after the introduction of fluoridation in U. S. community, which greatly reduced the incidence of caries. He suggested only a small percentages of all crowding problems is caused by early loss of primary teeth. Furthermore, there is evidence that Discrepancy, rather than early loss of primary teeth, has a strong effect on space closure. A study of space closure following premature loss of deciduous teeth, using longitudinal dental casts of 116 children[12], showed that the pattern of space closure and reopening after premature tooth loss is strongly influenced by Discrepancy in the earlier condition, with coefficient of correlation between the Tweed discrepancy and the score of space closure $(r) = -0.53$ for the maxillary arch and $r = -0.89$ for the mandibular arch ($p < 0.01$). The present authors also found that among Kenyans, who ritually extract both mandibular central incisors soon after eruption, the amount of space remaining is strongly influenced by the amount of tooth to denture base discrepancy on mandible ($r=0.73$ $p < 0.001$)[30].

The short-term effect of the OHPP was reported using the gingiva as an indicator, it being highly sensitive to pollution by sweet drink and food[23]. After enhancement of dietary education, sending a letter to each infant's home, gingival swelling diminished rapidly during the first year, but our tactics were not as effective in the next year[23]. One of the reasons for this change appeared to be that participants became polarized into two groups, one of which continued to put our dietary instructions into practice and retaining good gingival condition, while the other went back to former ways, with a resultant steady rise in the periodontal index[23]. In the healthy group, where the gingival score was low and developmental space was sufficient, both the frequency and amount of intake between meals and the quantity of sweet drinks remained low, and vegetable intake was high. Appetite at meal-times was good, meals were regular and there was less caries. In the unhealthy group, none of this was the case[23]. Thus, our dietary instructions to 1) Stop drinking large amounts of high-calorie drinks especially before meals; and 2) Eat fibre-rich food such as vegetables at all meals are correct. However, the problem of how to create habits of good dietary practice still remains unsolved.

In the present study, the frequency of discrepant dentition went down to less than 30%, which is a very low rate compared to those of Morioka, Tokyo and Kagoshima for the year 1986[31,32] where the frequency stood at 40-55%. Discrepancy type malocclusion could be reduced through promoting oral health, focusing on diet.

The timing of health promotion

Major improvement was only observed in children born after the OHPP started. There was less improvement in children born in 1979-1980, whose deciduous dentitions were already fully developed at the beginning of the project. Improvement seen among children born in 1981-1983 who were 0-2 years old when the OHPP began was slightly better than that of those born in 1979-1980. The same tendency could be seen in dental caries; children born after the start of the OHPP showed a remarkable decrease in carious teeth[33].

The study showed that three-quarters of the discrepant occlusion seen at 4 years of age still remained at 13-15 years. This may be an indication that it would be difficult to change the developmental "destiny". All subjects were enrolled in the project in the same manner, the underpinning "maternal character" is unlikely to have been different before and after the formation of the groups and many of the mothers had several children born both before and after the start of the OHPP.

A key period would be that of suckling and weaning. Experiments on mice have shown that the masticatory muscles and the jaw bone in breast-fed mice developed better than those in mice fed maternal milk through artificial teats. The masseter muscles and the jaw bones, such as the ascending ramus and the condylar head, all developed a greater size[34]. In human babies, the activity of the masticatory muscles is reduced in bottle-fed babies, compared to those of breast-fed babies[35,36]. Feeding rats or mice on soft or liquid food decreases the percentage of oxidative fibres in the ascending rami[17,37]. Therefore, we recommended breast feeding and natural weaning, through the OHPP. In the previous report, longitudinal study of nine subjects in the model district suggested that children who had family table food introduced as finger food, rather than pureed or liquid baby food, would have developmental space at 4-year-olds[38]. However, data of the weaning style did not form part of this study, as there was only recalled information of

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baby food among children born before 1984, which was not as reliable as the data of children born after 1984.

Conclusion

The occurrence of normal occlusion increased, and that of Discrepancy type occlusion decreased, especially among subjects who were born after the start of the OHPP. No corresponding significant changes were seen in the control district, neither at 4 years of age not at 13-15. We therefore suggest that it would be possible to reduce Discrepancy type malocclusion through dietary training and practice, but that it would be important to begin this approach soon after birth.

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