THE RESULTS OF TEN YEARS OF FLUORIDATION AT TOWNSVILLE,. AUSTRALIA

1. The effect on Caries experience of lifetime residents.

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ABSTRACT - An oral health survey was conducted in the sub-tropical city of Townsville ten years after its water supply was fluoridated to a level of 0.7 p.p.m. - The results of the calibration. of examiners prior to the survey are presented. Checks on the consistency and comparability of the results obtained by each examiner during the survey show that the results are reliable and reproducible. Dental caries experience of. both deciduous and permanent teeth was found to be significantly lower in Townsville than in 16 non-fluoridated towns and in some respects even in 4 naturally fluoridated towns.

INTRODUCTION

The reticulated water supply of the City of Townsville was fluoridated on 2nd August, 1965, by' the addition of sodium fluoride to bring the level of fluoride to 0.7 p.p.m.

A preliminary survey was undertaken in 1969 to determine the effect of five years experience of this public health measure on the oral health of children resident in Townsville since fluoridation . was introduced.

While optimal benefit will Only be received by those children who have been exposed to fluoridated water since birth, the examination of such children (aged four years in 1969) was not practical at that time. • Only the School child population was readily accessible for examination. This restriction was carefully considered before deciding on the ages of the population to be examined. Ten years have now elapsed since fluoridation was introduced so that children exposed to fluoridated - water since birth will now be aged 10 years or younger.

In order to make valid comparisons between the results of the two surveys the criteria for the assessment of the conditions recorded in 1975 were the same as in the Survey in the same city and in the survey of children in the country districts of Queensland.-[1]

The objectives of the Survey were —

I. To estimate, by clinical examination, the prevalence of dental caries in a representative sample of the school child population of To who were resident in Townsville since August 1965.

2. To obtain essential supplementary information from parents of the children examined as to their child's residency in Townsville, use of the reticulated water supply and exposure to alternative sources of fluoride.

DESIGN OF THE SURVEY

Selection of the Population to be surveyed

In order to determine the effect of fluoridation on the caries experience of Townsville children, comparisons are made with the results of two previous surveys conducted in Queensland country towns by Davies, Kruger and Homan (1969) and in Townsville by Phillips (1969 One of the examiners (W.V.) took part in the survey of children in country towns and Phillips received similar calibration training prior to his survey of Townsville in 1969. •

In the dental survey of children from 20 Queensland Country districts, children examined were aged 6, 8, 10, 12 and 14. years. the 1969 Townsville survey the children were aged 6, 8, 10 and 12. Children examined in 1975 survey were aged 6, 8, 10, 12 and 14 • years. This provided three age groups (6, 8 and 10 year olds) who were exposed to fluoridated water since birth, one group (12 year olds). who had been exposed to fluoridated water from about two years of age and a third group who had been exposed to fluoridated water from about four years of age.

Schools selected were in well—settled, geographically representative districts, while schools in suburbs which were growing rapidly or largely occupied by Service personnel were excluded. It was anticipated that many children at such schools would not have' been resident in Townsville for the complete period from 1965. The schools chosen for the examination of 6, 8, 10 and 12 year olds were the same as those included in the 1969 survey..

There were five selected primary schools and three selected high schools. It was realised that a shortage might occur in some of the four age groups so a reserve school was selected. Only a small number of examinees from this school were actually required.

Sample Size

The sample size was as follows:

	6	8	10	12	14	TOTAL
Male	90	90	90	90	90'	450
Female	90	90	90	90	90	450
TOTAL	180	180	180	180	180	900

Personnel

The survey was a joint undertaking of the Department of Dentistry, University of Queensland and the .Division of Dental • Services of the Queensland Department of Health.

The examination team comprised two dental surgeons and two dental assistants.

CALIBRATION TRAINING

Before the commencement of the survey, the examiners underwent a period of calibration training. A familiarisation trial was conducted at a School for the Deaf. This was followed by an inter-examiner and intra-examiner calibration trial at two schools.

At the first school 18 children aged 6 to 12 years were examined twice by each of the two examiners. This made it possible to assess both within-examiner consistency and between examiner comparability. The results were generally acceptable except that -

a) in the assessment of decayed deciduous teeth the second examiner obtained identical scores at the initial and duplicate examinations in only 67 per cent of cases; •

b) in the assessments of D and DTI' permanent teeth the second examiner obtained identical scores at the initial and duplicate examinations in only 44 per cent and 39 per cent of patients respectively;

c) the second examiner found only 78 per cent and 67 percent as many carious permanent teeth as did the first examiner at the initial and duplicate examinations respectively.

Since the reliable assessment of dental caries is the critical factor in an evaluation of the effectiveness of fluoridation these results were regarded as unsatisfactory so further discussions were held on the interpretation of the criteria. This was followed by a second calibration trial at another school at which the process was repeated for 16 children aged 6 to 12 years. •

The results of the second trial which are set out in Tables 1 and 2 •showed satisfactory thin-examiner consistency and between-examiner comparability for all assessments of the caries-status of both deciduous and permanent teeth. . For Examiner V identical results for the assessment of df teeth and DM- teeth were obtained at both initial and duplicate examinations in 94 per cent and 88 per cent of cases respectively. For Examiner S identical results for the assessment of df teeth and Di teeth were obtained at both initial and duplicate examinations in 100 per cent and 81 per cent of cases respectively. For both examiners df scores at the duplicate examination were within plus or minus one tooth per child in all cases.

In the case of DO scores the results from the second examination were within plus .or minus one tooth per child in 94 per cent and 100 per cent of cases for Examiners V and S respectively.

The extent of between-examiner variation in the assessment of the caries status of deciduous teeth is shown in Table 3. At the initial examinations Examiner S obtained df and DMF scores which were 105 per cent and 104 per cent respectively of those .obtained by. Examiner V. At the duplicate examinations both examiners obtained the same scores for each assessment.

EQUIPMENT:

All dental examinations were carried out in the schools using standard equipment provided by the Queensland School Dental Service.

Specifically, this was -

Collapsible dental chair;

Planet dental light;

Caries probes - Sickle - Ash No. 14,

Briault -.Ash No. 11;

Plane mirror No. 4;

Chip syringe;

Hot water sterilizer.

The probes used were Sharpened in a uniform manner and each probe was used no more than twelve times.

METHOD 0TT' COLLECTING DAM:

examination

The examination for dental caries was conducted with a plane mouth mirror and sharp, sickle-shaped explorer, with the subject seated under good artificial light. Radiographs were not used.

A tooth was considered present in the mouth when any part of it was visible or could be touched with the tip of an explorer,

without unduly displacing soft tissues. If a permanent and a deciduous tooth occupied the same tooth space, only the status of the permanent tooth was recorded.

The notation used on the Survey form for the numbering of individual teeth followed the recommended system of the International Dental Federation (FDI) made in 1970.

A numerical coding system was used for permanent teeth and an alphabetical coding system for deciduous teeth to record the status of each tooth.

Criteria

Sound tooth (A or 1). A tooth was recorded as sound if it showed no evidence of treated or untreated caries.

Decayed tooth (B or 2). Caries was recorded as being present when a cavity had a detectably softened fiber, undermined enamel or a softened wall. On an interproximal surface the explorer point must enter the lesion with certainty.

Where any doubt existed caries was not recorded as present.

Filled tooth with no decay (0 or 3). Teeth were considered to be filled with no decay whenever one or more permanent restorations were present and there was no recurrent caries or other area of the tooth with primary caries.

Filled tooth With other primary decay (D or 4). A tooth was scored as filled with other primary decay when it contained one or more permanent restoration• and there were also one or more other areas of the tooth that Were decayed bat which had no physical association with the restoration(s).

Filled tooth with recurrent deco. (E or 5). A tooth was scored as filled with recurrent decay when it contained one or more permanent restorations but there was recurrent decay (in physical contact with

the restoration(s). If a tooth was filled and contained both primary and. recurrent decay, it was recorded in this category (E or 5).

Extracted tooth due to caries (6). This score was used only for permanent teeth.

Unerupted tooth (a). This score Was restricted to permanent teeth and was only used for a tooth space with an unerupted permanent tooth and no deciduous tooth present.

Excluded tooth (X or 9). .A or deciduous tooth was ,excluded from any calculations concerning dental caries if it had been restored for reasons other than caries.

Questionnaire:

A questionnaire was sent to parents to gain additional information on the following —

-(a) Residency of child.

(b) Use of the' reticulated water supply.

'(e). Use of fluoride tablets.

(d) Use of fluoride dentifrice.

(e) Applications of topical fluoride.

(f) Toothbrushing habits.

Duplicate examinations -

•As a check on the maintenance of between•examiner comparability during the survey duplicate examinations were conducted for a 9 per cent random sample of all examinees. In addition each examiner . examined a further 4-5 per cent of subjects in duplicate to check his ability to maintain a consistent standard of examination.

Additional data

In addition to assessing the dental caries experience of the - children, data were collected on the following: fluorosis idiopathic enamel opacities, enamel hypoplasia, tetracycline staining, traumatic

injuries to teeth, oral mucosal disease, pathology of bone, dentofacial anomalies, periodontal status (soft deposits, Calculus, intense gingivitis), need for periodontal treatment, prosthetic status, denture requirements, conditions needing immediate attention and fillings and extractions required for 'individual teeth.

These data will be reported in a subsequent publication.

RESULTS

Within examiner consistency

The results of the evaluation are displayed in Table 4. Each examiner was able to maintain a satisfactory consistency in his assessment of decayed, extracted and filled deciduous and .Permanent teeth. When scores at the duplicate examination were expressed as a percentage of those obtained at the initial examination, the results for Examiner S were .110 per cent for df teeth and 95 per cent for DIF teeth.- ,For Examiner B the *results* were 98 per cent and 102 per cent respectively.

Between-examiner comparability

82 children were examined in duplicate by each examiner. The results, which are set out in Table 5, show that the scores obtained by Examiner S were 101 per cent of those obtained by Examiner V in the case of df teeth and 98 per cent in the case of DMF teeth.

Taken together these findings confirm that the results of the examination for dental caries are reliable and reproducible.

Effect of fluoridation on dental caries in lifetime residents of Townsville

a. Deciduous teeth with no caries experience

The outstanding feature of the data in Table 6 is the significantly higher proportion of children aged six and eight years with no df teeth in Townsville (1975) compared with 16 Low fluoride towns in Queensland ($P<0.01$),

4 Naturally-fluoridated towns (P 0.05 for 6 year olds, < 0.01 for 8 year olds) and Townsville (1969) (P 0.01).

However, at ages 10 and 12 years the differences between lifetime residents of Townsville (1975) 4 Naturally fluoridated towns and 16 Low fluoride towns are not significant.-

b. Permanent teeth with no caries experience

These data are set out in Table 7. For six-year-olds there was a significantly higher proportion of. children with no DMT teeth at Townsville (1975) Than at the 16 Low fluoride towns and even at the 4 Naturally fluoridated towns. For children aged eight-years there was 4 significantly higher proportion of children with no DMF teeth at Townsville (1975) than at the other three .areas. However, at 10 and 12.years of age the only significant difference was between Townsville (1975) and the 16 low fluoride towns.

c. Caries experience in deciduous teeth

These data are set but in Tables 8 and 10. At six years of age the mean number of df teeth per child was significantly higher in children from the 16 low fluoride towns (5.3 df teeth) than in .lifetime residents at Townsville, 1975 (2.6), 4 Naturally fluoridated towns (2.6) and lifetime residents at Townsville, 1969 (3.4). The percentage differences were 51 per cent, 51 per cent and 36 per cent respectively.

At eight years of age the mean number of df teeth per child was significantly higher in children from the 16 low fluoride towns (4.2) than in children from the 4 Naturally fluoridated towns (3.2) and Townsville, 1975 (1.9). At ages 10 an 12 the Children from the low fluoride towns had more df teeth per child (2.2 and 0.4) than did children from Townsville, 1975 (1 .8 and Percentage differences were 18 per cent and 50 per cent respectively.

d. Caries experience in permanent teeth

From the data displayed in Tables 9 and 10 and Fig will be seen that at all ages the moan number of D1.° teeth per child is consistently higher in children from the 16 low-fluoride towns than in the children from all other. areas. The. mean numbersof Da? teeth per child in Townsville, 1975, are lower than in Children from the 16 low fluoride towns by 0.8 (73 Per cent) at age six, 1.9 (65 per 'ent) at age eight, 2.5 (52 per cent) at age ten, 3.9 (49 per cent) at age 12, and 5.7 (49 per cent) at age 14. Six and eight year-old children at Townsville, 1975, had fewer Dial teeth per child (0.3 and 1.0) than Children of the same age from the four naturally fluoridated towns (0.7 and 1.7) but at ages 10, 12 and 14 the mean numbers of DI teeth per Child in the two areas are virtually identical and range from 2.3 at age 10' to 6.1 at age 14.

DISCUSSION

The results from this study confirm What is already known about the beneficial effect of fluoride in reducing the prevalence of dental Caries. The improvement noted in the teeth of six year old children in Townsville in 1969, five years after fluoridation began, has now - extended to include all children up to and including children aged 14 years. The percentage reductions in caries experience of both deciduous and permanent teeth are greatest in 6 and 8 year olds but even in 14 year olds the reduction of 49 per cent in the number of DMF teeth is substantial particularly when it is noted that the absolute reduction is of the Order of almost six teeth per child. It should also be noted that the 14 year olds of 1975 would not have had the full benefit of fluoridation since they would have,

on average been four years, old when the public health measure was instituted in. 1965.

Of particular interest is the observation that the teeth of children at Townsville in 1975 are generally in better condition than children from the four naturally fluoridated towns. The level of fluoride in the water supply at Townsville has been adjusted to 0.7 p.p.m. The four naturally fluoridated towns Cunnamulla Quilpie, Barcaldine and Aramac obtain their drinking water from artesian bores. At Cunnamulla the water comes from two deep bores and has a fluoride content of 0.4 p.p.m. The Quilpie water supply also comes from a deep bore with a fluoride content of 1.6 p.p.m.

Barcaldine is served by two bores. A 'Duty Bore' the fluoride content of which has ranged from 0.77 - 0.97 p.p.m. and a "Standby Bore" the fluoride content of which has ranged from 0.24 - 1.6 p.p.m. The extent to which each bore is used varies. Aramac is served by a single .bore the fluoride content of Which was recorded as 0.45 p.p.m. in July 1974 and 0.56 p.p.m. in April 1975. A further complicating factor is that in the four fluoride towns all residents do not depend entirely on the town supply for all drinking and cooking purposes. Unfortunately, it was not possible to determine the extent of this variable from the .results of this survey.

It would appear that the generally lower and fluctuating levels of fluoride in the naturally-fluoridated town water supplies are less desirable than the more constant optimal level in the Townsville supply. However, it would be desirable to monitor the fluoride levels at Cunnamulla, Quilpie, Barcaldine and Aramac to determine the levels in actual daily use.

Another feature of Townsville is the mobility of the population. This is reflected by the fact that although 900 children were examined only 317 or 35 per cent could be classified as lifetime residents. Data on the remaining non-lifetime residents will be reported in a separate paper.

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REFERENCES

Davies, G.N., Kruger, B.J. and Homan, B.T.: Dental survey 'of Children in country districts of Queensland. lust. dent. J. 1969: 14: 153-161i

Phillips, D. Townsville Post-Fluoridation Survey. Report to Director of Dental Services. Cyclostyled. 1969.

FIG. Caries Experience in Permanent Teeth

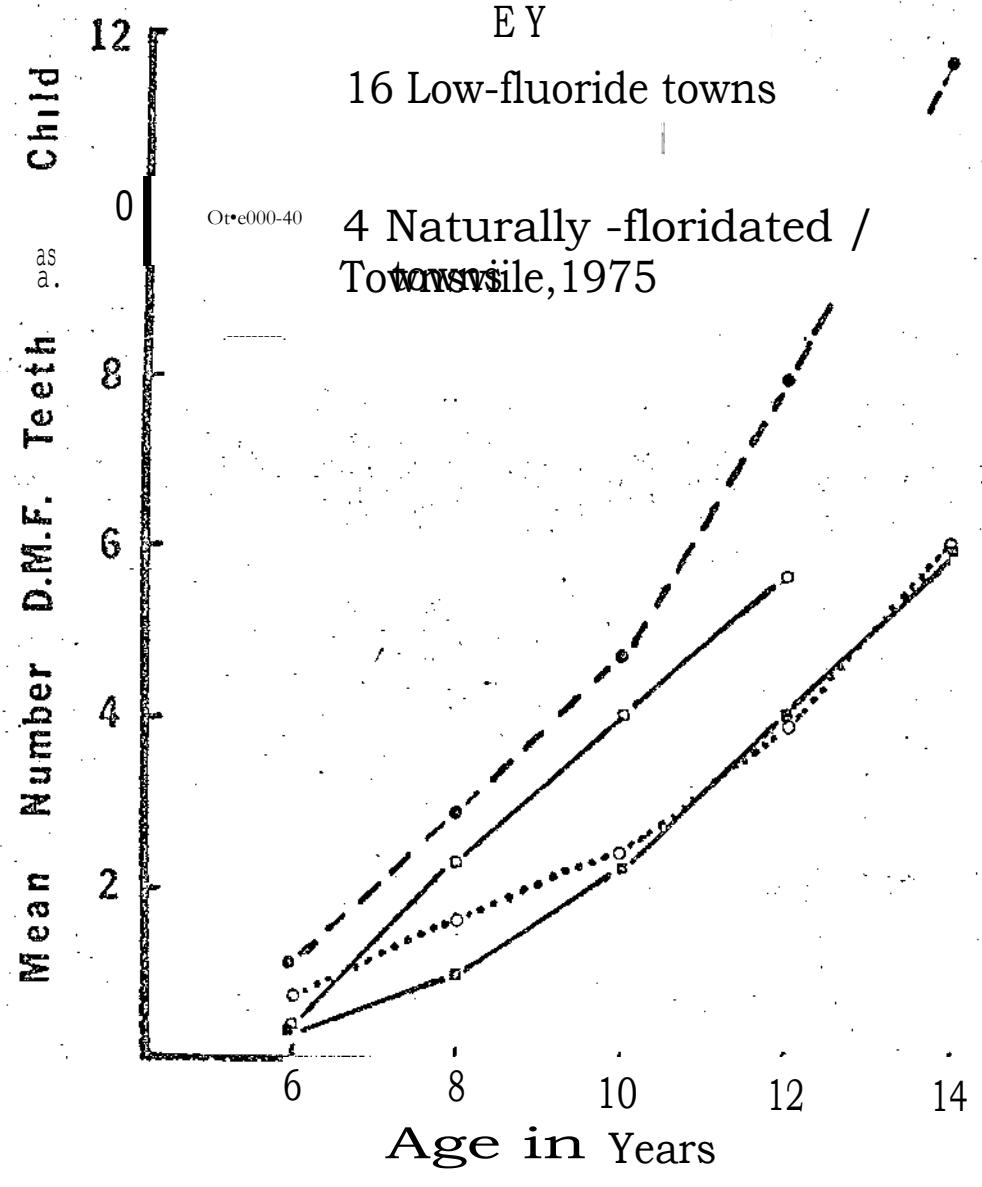

TABLE 1.

"PERCENTAGE OF CASES IN WHICH THE RESULTS FROM THE DUPLICATE EXAMINATION FOR THE AS OF THE CARIES STATUS OF DECIDUOUS TEETH WERE IDENTICAL WITH AND WITHIN PLUS OR MINUS ONE TOOTH PER CHILD OF THE RESULTS FROM THE INITIAL EXAMINATION

	EXAMINER V							S						
	CODE						df	CODE						df.
	A	B	C	D	F	X		A	B	C	D	E	X	
% results within ± 1 tooth/child	94	94	100	100	100	100	100	100	100	100	100	100	100	100
20 results identical at 1st & 2nd exam	94	94	100	100	100	100	94	100	100	100	100	100	100	100

TABLE 2

PERCENTAGE OF CASES IN ICH THE RESULTS FROM DUPLICATE EXAM INA TI ON FOP, THE *A* SSESS E NT OF TrIE CARIES STATUS OF PERMANENT TEETH WERE IDENTICAL WITH AND. WITHIN PLUS OR MINUS ONE

INITIAL EXAMINATION

	EXAMINER V										EXAMINER S									
	CODE										CODE									
	1	2	3	4	5	6	7	8	9		1	2	3	4	5	6	7	8	9	
suits In. + 3th	94	100	100	100	100	100	100	100	100	94	100	100	100	100	100	100	100	100	100	100
suits tical s t 8: exams	88	88	94	100	100	100	100	94	100	88	81	81-100.100			100	100	100	94	.100	81

TABLE 3

[illegible]

THE ASSESSMENT OF THE CARIES STATUS OF DECIDUOUS AND PEI AP TEETH BY EXAMINER S •EXPRESSED AS A PERCENTAGE OP THE SCORES

EXAMINATION	N	Scores obtained by Examiner S as a percentage of Scores obtained by Examiner V								
		Deciduous Codes								
		A	B	C	D	E				
Initial		98	108	100	100	100				105.
Duplicate		100	100	100	100	100				100
		Permanent Codes								
		1	2	3	4	5	6	8	9	DMF
Initial		100	107	104	100	100	100	99	100	104
Duplicate		100	100	100	100.	100	100	100	100	100

TABLE 4.

WITHIN EXAMINER CONSISTENCY IN

THE ASSESSMENT OF DENTAL CARIES '

EXAMINER	NUMBER CHILDREN EXAMINED IN DUPLICATE	EXAM.	DECIDUOUS TEETH						PERMANENT TEETH							
			d		f		df		D		M		P			
			N	*	N	%	N		N	%	N	%			N	
S	39	1st	37	—	15	—	52	—	25	—	1	—	40	—	66	
		2nd	42	113	15	100	57	110	22	88	1	100	40	100	63	95
V	42	1st	45	-	23	-	68	-	24	-	1	-	70	-	95	-
		2nd	44	98	23	100	67	98	26	108	1	100	70	100	97	102

Score obtained at the second examination
as a percentage of the score obtained at
the first examination.

TABLE

BETWEEN EXAMINER COMPARABILITY

IN THE ASSESSMENT OF DENTAL CARIES

NUMBER CHILDREN EXAMINED BY EACH EXAMINER	EXAMINER	DECIDUOUS TEETH						PERMANENT TEETH							
		A.		f		df		D		H		F		DM?	
		N	%*		e*		%*	N	c4B		2.*	N	%*	N	e* /0
82	V	114	-	•66	-	180		76	-	5	-	93	-	1'74	
		112	98	70	106	182	101	71	93	5	100	95	102	171	98

Score obtained by Examiner S as a percentage of the score obtained by Examiner V.

TABLE 6.

NUMBER AND PERCENTAGE OF CHILDREN WITH NO df TEETH

AGE	Lifetime Residents of Townsville 1975 with no df teeth —			Lifetime residents of Townsville 1969 with no df teeth				16 Low Fluoride Towns with no df teeth				4 Naturally Fluoridated towns' with no df teeth			
	Number Children	N		Number Children.	N		P	Number Children	N		P	Number Children	N	%	I
6	64	25	39.1i0,	115	27	23.5%	(**)	623	75	11.7;.:2	(**)	139	24	17.3	('
8	62	29	46.8.!¹ '	140	20	14.5;.¹	(**)	570	57	10.0;:'	(**).	144	29	20.1(Z	(*⁴
10	69	27	39.1	139	_			511	184	36.0A	(–)	120	47	39.27;	C⁻
12	60 .	54	90.05	79	-			602	486	80.7%		105	75	71.4:;	C⁻

Differences between each value and that for lifetime residents of Townsville (1975) are signified as follows:

(**)	highly significant	P <0.01
(*)	significant	P <0.05
(–)	not significant	

TABLE

NUMBER AND PERCENTAGE OF CHILDREN WITH NO D1-5 TEETH

AGE	Lifetime Residents of Townsville 1975 with no DMF teeth			Lifetime Residents of Townsville 1969 with no D117 teeth				16 Low Fluoride Towns with no DMF teeth				4 Naturally fluoridated towns with no D1-7 teeth			
	Number Children	N	%	Number Children	N	%	P	Number Children	N	%	P	Number Children	N	%	P
6	64	53	82.8;;	115	88	76.5;4	(–)	623	346	55.55	(**)	139	84	60.45	
8	62.	38	61.'0	140	26	18.6`4	(**)	570	81	14.2g	(**)	144	50	34.7d	
10	69	13	18.8 0	139	12	8.67;	(L)	511	26	5.1%	(*)	120	27	22.5,	(
12	60.	6	10.0%	79	4.	5.1%	(–)	602	7	1.2	(*.)	105	21	20.0;:)	(–)
14	62	• 3	4.81	–	–	–		425	3	0.1%	(–)	75	9	12.0,	‹ –›

Differences between each value and that for • Lifetime residents of Townsville (1975) are signified as follows:

**	highly 'significant	P c: 0.01
	significant	P C 0.05
	not significant	

TABLE 8.

CARIES EXPERIENCE IN DECIDUOUS TEETH

Age	Lifetime residents of Townsville 1975			Lifetime residents of Townsville 1969			16 Low fluoride Towns			4 Naturally Fluoridated Towns		
	Number Children	df teeth N	Mean	Number Children	df teeth N	Mean	Number Children	df teeth N	Mean	Number Children	df teeth N	Mean
6	64	165	2.6	115	393	3.4	623	3285	5.3	139	484	2.6
8	62	119	1.9	140	587	4.2	570	2418	4.2	144	464	3.2
10	69	122	1.8				511	1111	2.2	120	197	1.6
12	60	13	0.2				602	265	0.4	105	50	0.5