IN BRIEF

- The island of Tristan da Cunha is one of the few remaining enclosed communities in the world.
- This paper reports the results of the first dental health survey to be carried out on the island since a fluoride supplementation programme was introduced in 1982.
- The dental health of 6–19-year-old children in Tristan da Cunha showed a significant improvement between 1966 and 1996.
- The number of caries-free individuals is suggestive of the efficacy of a school fluoride supplementation programme.
- The availability of longitudinal records makes this a good population for carrying out future studies of dental health and disease.

Fluoride supplements and changes in tooth decay on the Island of Tristan da Cunha: 1966–1996

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Background The island of Tristan Da Cunha is one of the few examples in the world of a remote enclosed community. The inhabitants of the island were transported to England in 1961 as a result of a volcanic eruption and during their time in England they received a detailed dental health examination. They were later examined back on the island in 1966 by Dr John Fisher and in 1982 a school fluoride supplementation programme was introduced.

Aim The present paper reports the results of the first dental health survey to be carried out on the island since the introduction of a regular school fluoride supplementation programme in 1982.

Subjects and methods A cohort of 6–19-year-old subjects on the island were examined in 1996 using a similar protocol to that which was used by Fisher in the 1966 examination.

Results Comparing the 6–12-year-olds who were caries free in 1966 with those caries free in 1996 using the Chi-squared statistic reveals a statistically significant greater number caries free in the more recent cohort ($\chi^2 = 6.0$, $P = 0.014$). For the older age group (13–19 years), a similar comparison reveals a highly statistically significant difference ($\chi^2 = 12.26$, $P = 0.005$).

Conclusions A significant increase in the number of caries free 6–19-year-old children in Tristan Da Cunha between 1966 and 1996 was noted: 1) This is a significant finding in the light of the school fluoride supplementation programme that was introduced on the island in 1982; and 2) Appropriate fluoride supplementation regimes may have

conferred a protective effect in a group of children with a cariogenic diet. The paper discusses the significance of this study in the support of fluoridation as a method of reducing the prevalence of dental caries and also discusses possibilities for future research on the island of Tristan Da Cunha.

Dental caries was often referred to in the past as 'a disease of civilization', this expression being used to describe the prevailing pattern of caries observed during most of the twentieth century; a high prevalence in the developed countries, low prevalence in the developing world. Although some of the ancient patterns of high attrition, little coronal caries and relatively high prevalence of root caries can still be found in remote places (Papua New Guinea and the Australian Aborigines) such populations are fast disappearing.

The main reasons are thought to be the increasing widespread cariogenic diet and lifestyle of the developed world, and the evolution and proliferation of cariogenic bacteria due to the selective pressure arising from changed diets. Despite these generalizations on the global distribution of dental caries, there are distinct differences in caries experience between countries, and from region to region within a country.

Remote non-mobile communities, which have limited contacts with the outside world such as the inhabitants of Tristan da Cunha, provide a unique opportunity for the long-term study of the effects of diet and other environmental factors on dental health. The indigenous population of the island has been of interest to medical and dental investigators, sociologists and other researchers over the years. Reports of dental health among the Tristan da Cunchans are recorded by Sampson¹ and by Sognnaes.^{2,3} Their dental status was examined in England in 1962⁴ when the islanders were temporarily evacuated due to a volcanic eruption, and again in 1966 after they had returned to the island in 1963.⁵

The present paper reports the results of the first dental health survey to have been carried out on the island since the introduction of a school fluoride supplementation programme which was initiated in 1982. There is evidence that the introduction of

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fluoridated toothpaste^{6,7} and fluoridation of public water supplies,⁸ has resulted in the reduction of dental decay, but there are often problems controlling for potentially confounding variables such as diet, lifestyle, oral hygiene and the level of dental care. There is evidence emerging through studies on human cariogenicity⁹ and monozygotic/dizygotic twin studies¹⁰ for a genetic influence in the susceptibility to dental caries. An isolated community provides a much more controlled background against which an investigation into the influence of genetic and environmental factors can be based.

DENTAL CARE ON TRISTAN DA CUNHA

Tristan da Cunha is an isolated volcanic island in the south Atlantic. It supports a community of some 300 people. The island's limited contacts with the outside world were gradually increasing when a volcanic eruption in 1961 led to the temporary evacuation of the entire community to England. They were dentally examined in England in 1962,⁴ and again after they had returned to the island in 1966.⁵ The two earlier studies by Sampson¹ and Sognnaes² show that the prevalence of caries in the first permanent molars of 6–19-year-olds was zero, but by 1962 had increased to 50%⁴ and to 80% in 1966.⁵

In the 1950s increased communication with the outside world and the establishment of fish processing provided work and income. The income enabled an alteration of the diet of the inhabitants from one in which refined fermentable carbohydrate was largely absent, to one which contained an abundance of these constituents. There was a dramatic increase in the prevalence of dental caries, thought to be the result of the alteration in diet, which accompanied these social changes. Tristan da Cunha is regarded as the best example of dental deterioration associated with the consumption of refined carbohydrates enjoyed by populations with an adjustment to their standard of living.

In addition, oral hygiene and preventive measures were not available, nor was regular dental treatment. There is no resident dentist and dental care for the islanders was provided by an occasional (now annual) visit from a dental team. In 1972, Dr Shibli, the general medical practitioner on the island from 1966 to 1972, whose remit included dealing with the consequences of dental decay among the inhabitants, advised on the introduction of a programme of fluoride supplementation to the island's school children (aged 3 to 15). Fluoride tablets (2.2 mg sodium fluoride containing 1 mg fluoride) were first introduced into the island's school from April 1975 but the distribution was spasmodic because of the nature and number of tablets that had to be dispersed. In 1982 the fluoride tablet dispensation was rationalized and restarted with a single tablet per day per school term. This has continued until the present time with no interruptions. From 1982 the adults were using fluoridated toothpaste and children's toothpaste was available but was not fluoridated. In 1982, the water supply had a naturally low fluoride content of 0.13 part per million (ppm) and recent CSIR analysis confirms that the current level remains low at 0.14 ppm.

All the indigenous inhabitants of the island aged under 30 at the time of the 1996 survey would therefore have participated, and the effects on tooth decay could be investigated. There is no suggestion of any effort to simultaneously modify the diet or reduce the consumption of refined carbohydrates.

AIM

The main aim of this study was to monitor the changes in the oral health of Tristan da Cunha islanders comparing parameters of dental health in 1996 with those reported in the same population in 1966.

SUBJECTS AND METHODS

During successive dental expeditions to the Island of Tristan da Cunha in August 1995 and September 1996, 32 children between the ages of 6 and 19 years were examined at the dental clinic at the Camogli Hospital. A full intra-oral examination was carried out by the visiting dentist, an experienced GDP who was not calibrated in epidemiological surveys methods, using a mirror and standard probe under good lighting conditions within a dental surgery setting. The teeth were charted as being missing, decayed or filled and the surfaces affected in the last two categories were recorded. Routine radiographs were not taken for all of the children examined and radiographs were not used in the detection of caries. The examination was carried out to the D3 caries diagnostic threshold; ie carious surfaces were recorded only if there was cavitation detectable on clinical examination.

Nineteen 6–12-year-olds and thirteen 13–19-year-olds were examined in this way which enabled the allocation of decayed, missing and filled permanent teeth (DMFT) scores to each child. The examiner followed the same protocol as that followed by Fisher (1968)¹¹ in his recording of caries experience with deciduous teeth being ignored in the recording of the caries experience of each individual. He was able to check dental records to verify which permanent teeth were missing due to extraction for orthodontic reasons and therefore to differentiate between those teeth which had been extracted because of caries.

RESULTS AND STATISTICAL ANALYSIS

This descriptive epidemiology records the differences between the caries experience in a cohort of children in 1966 as reported in the literature compared with figures for similar age groups in 1996. The amount of data available from 1966 imposes limitations on the type of analysis that can be carried out. This analysis is therefore a simple case control analysis of DMFT and of the number of caries-free individuals using the 1966 cohort as a historical control. Also the group DMFT as opposed to individual DMFT scores imposes limitations on the conclusions that can be drawn.

Prevalence of dental disease in 6–19 year olds

In Table 1 the dental caries experience in the permanent teeth of 6–19-year-olds on Tristan da Cunha in 1966 and 1996 is compared. The data is classified according to age and gender to facilitate comparison with Fisher's dental epidemiological survey of 1966.

Comparing the 6–12-year-olds who were caries free in 1966 with those caries free in 1996 using the Chi-squared (χ^2) statistic (Table 2a) reveals a statistically significant difference ($\chi^2 = 6.0$, $P = 0.014$). For the older age group (13–19 years), a similar comparison (Table 2b) also reveals statistically significantly more caries-free individuals in 1996 ($\chi^2 = 12.26$, $P = 0.005$).

Table 1 Comparison of dental caries experience in permanent teeth for 6–19 year age group on the island of Tristan da Cunha in 1966 and 1996

	1966		1996	
	Males	Females	Males	Females
Number of children examined	23	27	18	14
Number of teeth examined	477	596	365	308
Number of decayed teeth	84	111	5	11
Number of filled teeth	45	66	21	19
Number of extracted teeth	15	17	0	1
% DMF	29.3%	31.6%	7.1%	9.7%

Table 2a Number of caries free 6–12 year old children between 1966 and 1996

	Caries experience	Caries free
1966	20	2
1996	11	8

χ^2 statistic = 6.03 P = 0.014, significant

Table 2b Number of caries free 13–19 year old children between 1966 and 1996

	Caries experience	Caries free
1966	28	0
1996	8	5

χ^2 statistic = 12.26, P = 0.0007, significant

DISCUSSION

The most valid comparison of caries experience in this study is an examination of the number and proportion of children who are caries-free between these two groups. The results of this comparison are illustrated in Tables 2a and 2b and the fact that there are so few children in the sub-groups imposes limitations on the statistical power to detect differences between the groups. It was felt appropriate that for the purposes of analysis the children would be split into two age groups: a) 6–12 years and b) 13–19 years because of DMFT being cumulative over time with older children having teeth at risk of developing caries for a longer period of time than younger children.

DMFT

The 1995 dental team (one dentist and support staff) saw all the children up to 12 years of age and in 1996 all those up to 19 years old with the same examiner involved on both occasions. However it is not possible to carry out a comparison with Fisher's 1966 figures (Table 1). These data indicate that there was an improvement in the DMF between 1966 and 1996. Both boys and girls show a marked improvement in dental health since the start of the supplementation programme and there was no statistically significant gender difference.

Gender effects

An interesting aspect of the pattern of carious teeth in the Tristan da Cunchans as previously reported is that for all sites, the females consistently have more lesions than the males, with the exception of cervical caries where the reverse is the case. The sex difference is especially marked in approximal lesions and anterior teeth amongst the under 40s, where the proportion of lesions amongst the females was found to be much higher than in the men.¹³ Holloway's earlier report from a survey in 1962 recorded an average DMFT of 8.8 in females up to 49 years of age, while that of a similarly aged male group was 6.3, and many of the later lesions were accounted for by root surface caries and were of the cemental rather than enamel type. According to Mansbridge,¹⁴ a higher prevalence of dental caries in females, both children and adults, is a common finding in both civilised societies and in more primitive groups, and during various historical periods. This suggests that constitutional elements, possibly an inheritance factor, may play a part in the development of dental caries.

The levels of dietary fluoride

In the context of this paper, a comment on the background of levels of fluoride ingested by the Tristan da Cunchans is relevant. Holloway⁴ reported that the level of fluoride in the water supply was 0.1 ppm. The content of fluoride in the fish – 0.65–1.15 ppm for cooked fish¹⁵ – represents a low fluoride intake overall, and the

quantity of fish consumed in recent times would be much lower than that consumed pre-1960. The average daily consumption of fish per head of population in 1937 when the staple diet was fish and potatoes, was about 300g.¹⁶ Holloway *et al.*¹⁷ also estimated the fluoride content of extracted Tristan teeth and showed that such teeth contained only slightly more fluoride than British teeth from low fluoride areas. Also, urine from some Tristan children was no higher in fluoride than that from London children.

Other sources of fluoride

The tiny British dependency of Tristan da Cunha did not have fluoride dentifrice available to them until 1982 when it was introduced by the visiting dentist and subsequently ordered by the island's shop. However, it was not widely used until the mid 1990s due to the expense of this item which was seen by the islanders as a cosmetic luxury. Fluoride mouthrinses are not available in the island shop. It is not likely therefore that differences in dental health between 1966 and 1995/96 are due in any great part to these other sources of fluoride.

CONCLUSIONS

1. The dental health of 6–19-year-old children in Tristan da Cunha shows a significant improvement between 1966 and 1996.
2. The reduction in caries and the increase in the numbers of caries-free individuals between these two cohorts are highly suggestive of the effectiveness of the introduction of a fluoride supplementation programme in addition to fluoride toothpaste use.

RECOMMENDATIONS FOR FUTURE RESEARCH

Due to the nature of the data collected in this study, the conclusions that can be drawn from the dietary study are limited. The frequency of eating sugar is only one of the factors involved in the prevalence of decay. The lower mean DMFT in the Tristan da Cunha 12–14-year-olds compared with the Tayside children, despite a similar frequency of eating sugared items is most likely to be due to the school administration of daily fluoride tablets in Tristan da Cunha. A suitably designed study to compare the nutrition of children in Tristan da Cunha and an area of Scotland should be planned for the future.

It is a recognised fact that in disorders of environmental aetiology or in polygenic multifactorial disorders where there is a genetic predisposition, there will be greatest benefit from environmental manipulation, in this case fluoride supplementation. There is some indirect evidence for a genetic influence on dental caries, and an enclosed genetically isolated community is the best possible site to investigate this further. Careful scrutiny of the pedigrees and the DMFT figures may reveal evidence for genetic susceptibility or resistance to dental decay on the island.

Similarly the influence of heredity in other dental diseases such as periodontal disease and malocclusion could be investigated on the island. In the study of periodontal disease, a unique opportunity is presented by the fact that a longitudinal study of periodontal disease is possible with the same individuals being available for comparison between 1961 and 1996. A study by Thomsen¹⁸ reported an increased prevalence of hypodontia among the Tristan Da Cunchans, and with the reduced incidence of caries and tooth loss in the present population this could be investigated more easily. Indeed, a dental survey (funded by the Oral and Dental Research Trust, Tattersall fund of the University of Dundee, Carnegie Trust and the Ethicon Foundation of the Royal College of Surgeons of Edinburgh) on Tristan da Cunha was carried out by a few of the authors in 1999 which included the recording of caries experience, periodontal disease experience and hypodontia. In addi-

tion to the phenotypic data that has been collected, DNA samples from the islanders may enable an investigation of genetic susceptibility to these disorders.

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