The Hastings Fluoridation Experiment: Science or Swindle?

By John Colquhoun and Robert Mann

Those in favour of fluoridation have hailed the Hastings Fluoridation Scheme in New Zealand as valuable evidence of the benefits on children's teeth of fluoride. However, studies of the Scheme, such as by the authors, show it to be seriously flawed from a scientific point of view. In fact, the data reveal no positive advantage to children's health as a result of being exposed to fluoride in water.

The controversy over fluoridation of public water supplies is normally seen as a weighing of costs against benefit. The costs, apart from financial inputs, are claimed to be various illnesses which have proved difficult to quantify or even to attribute to fluoridation. The benefit is taken to be causation of major decreases in tooth decay. One of the surveys usually cited as showing this benefit has now been found to show no such thing.

The Hastings fluoridation study in New Zealand, 1954-1970 (*New Zealand Dental Journal* vols 54, 55, 58, 59, 61, 67) is listed in textbooks throughout the world as an important study confirming the effectiveness of water fluoridation (e.g. J.J. Murray *Fluorides in Caries Prevention.* Wright, Bristol, 1982). Data from the study were used by O. Backer Dirks, the distinguished European researcher and advocate of fluoridation, in one of his better known and oft-cited published papers (*Caries Research,* vol. 8 suppl. p2). Professor Murray's book, after reviewing the famous United States' trials, saying of the Backer Dirks and Hastings studies that they reinforced the European finding because "free smooth-surface caries was reduced by 87 per cent . . . approximal caries by 73 per cent . . . and occlusal surface caries by 39 per cent . . ." The greatest reductions were among 6-year-olds—74 per cent by 1961 and 87 per cent by 1964—but the greatest part of these had occurred in the first few years of the project: 42 per cent by 1957 and 61 per cent by 1959. These spectacular reductions, following a Commission of Inquiry report in favour of fluoridation, (Government Printer, Wellington, 1957), led to acceptance of widespread fluoridation in New Zealand.

Hastings was chosen for such an experiment because its Council had already decided to fluoridate its water supply, the first to do so in New Zealand, following an approach from the local branch of the Dental Association. It was considered to be a 'typical' New Zealand population, and therefore ideally suitable. At first described as an 'experiment' with a neighbouring town, Napier, using essentially the same groundwater unfluoridated (0.15 ppm), as "an ideal control" (Cabinet decision, March 1952, National Archives), the project was later changed to a before-and-after 'demonstration' (*NZ Dental J,* vol. 58 p219).

The study's initial dental surveys of children in the two towns were not carried out until late 1954, almost two years after Hastings was first fluoridated. The follow-up survey in 1957 was reported to show a dramatic reduction in dental decay in Hastings after only 27 months of 'continuous fluoridation'. However, both the first and follow-up surveys had shown that the younger (under 10-year-old) control children had significantly less decay than the children of the same age in Hastings. It was said that a special protective factor—the trace element molybdenum in recent marine soil—had caused Napier decay rates to be below the average for the country. Because of that difference, the decision was made to discontinue the use of Napier as a control. Child dental decay rates being very high in New Zealand, it was reasoned that further continuous and marked reduction of dental decay among Hastings children would establish the effectiveness of fluoridation.

The Hastings study was carried out by Mr (later Dr) T.G. Ludwig, who replaced Dr R.E.T. Hewat as Dental Research Officer of the New Zealand Medical Research Council. Both have since died. Ludwig worked under the direction of the Fluoridation Committee of the Department of Health in Wellington. Most members of that Committee were officers of that Department. Co-opted on to it was a representative of the New Zealand Dental Association, Colonel (now Brigadier) J. Ferris Fuller. The latter became its chairman, and soon assumed a major role in direction of the Hastings operation. Ludwig's work also required the approval of the Dental Research Committee of the

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Medical Research Council, centred in Dunedin with the University of Otago's Dental Faculty, which followed the project closely. Colonel Fuller later became chairman of that Committee as well.

The New Zealand Official Information Act 1982 has made available for public perusal the archives of government departments. Department of Health Head Office files (nos 125/299, 125/299/1, 2 & 3 and 124/30/31 & 33) now held in National Archives, Wellington, and other official and professional sources reveal a considerable amount of information not in agreement with the currently accepted published version of the Hastings fluoridation study:

1) The claimed reductions in decay, which were greatest for the younger children, were brought about partly if not mainly by a local change in diagnostic procedure following the introduction of fluoridation.
2) Reductions over such short periods are, by today's statistical standards, beyond the "limit of credibility" for genuine decay reductions.
3) A reduction in dental decay occurred in other, non-fluoridated, places throughout New Zealand during the time of the study, making it difficult for public health officials to present convincing statistics showing that the claimed reductions were related to fluoridation. The reduction occurred in the control town as elsewhere.

Tables 1 and 2. Reproduced exactly from T.G. Ludwig's report to Fluoridation Committee: "Investigation of diagnostic standards of dental nurses in Hastings and Napier." The "diagnostic standards required" after the experiment's initial dental examinations called for a reduction in the number of cavities requiring filling to almost a quarter of the number found by the dental nurses using their earlier standards.

TABLE 1

Comparison of Diagnostic Standards of Hastings Dental Nurses, T.G. Ludwig and Principal Dental Officer (Gisborne).

	Hastings Nurses	T.G.L.	P.D.O.
No. of Patients Examined	51	51	51
No. of Lesions Diagnosed as Carious	77	20	22
Average Number of Lesions per Child	1.51	0.39	0.43

TABLE 2

Comparison of Diagnostic Standards of Napier Dental Nurses and Dental Research Officer

	Napier Dental Nurses	T.G.L.
No. of Patients Examined	32	32
No. of Teeth Diagnosed as Carious	75	23
Average No. of Teeth Carious per Child	2.34	0.72

Source: Department of Health file: Fluoridation, Hastings Study 1956-70, National Archives, Wellington.

Change in diagnostic Procedure

Most of the younger children involved in the experiment received their dental treatment regularly at school dental clinics, staffed by the then unique New Zealand grade of dentist called "school dental nurse". In a 1957 report to the Fluoridation Committee, entitled "Investigation of diagnostic standards of dental nurses in Hastings and Napier" Ludwig expressed concern that "the meticulous diagnostic standards of the dental nurses in Hastings might overshadow any improvement in the caries prevalence resulting from fluoridation". During the latter part of 1955, he wrote, he met each nurse and explained to her the diagnostic standards required by the study and illustrated these standards by examining a number of children in company with her. "While this procedure enabled one or two nurses to cooperate effectively by taking a more lenient view of possible very early carious lesions it did not seem to be successful generally . . ."

The report continued: "To determine the actual extent of the problem the following course was adopted. Each dental nurse operating in Hastings and Napier was asked to examine twenty children, record her findings and then to leave these children untreated until further notice. The nurses were not informed of the purpose of the examinations. The dental research officer and the Principal Dental Officer for Hawke's Bay then visited the Hastings and Napier clinics and examined suitable children previously examined by the nurses. The results of the three examiners were then compared and those for Hastings are given in Table 1. The results for Napier are given in Table 2 and include the results of the nurses and of the dental research officer only. The findings tabulated apply only to carious lesions upon the occlusal surfaces of molars . . ."

These tables summarised the results of the dental research officer for 7 Hastings and 4 Napier school dental nurses. They show that on average the dental nurses, even after two years of persuasion to alter their earlier standards which were still maintained in the rest of New Zealand, were still finding almost four times as many cavities requiring fillings as the new diagnostic standards required. Subsequently Ludwig reported to the Department on which dental nurses were and were not 'co-operating'. The problem was also discussed with private dental practitioners in the two towns.

Most of the permanent tooth fillings for 6- and 7-year-old children were in the "occlusal surfaces of molars" mentioned above. This change in diagnostic procedure followed much discussion within the Fluoridation Committee. In 1954, it had been agreed to instruct school dental nurses in Hastings and Napier to cease inserting 'prophyl-

actic fillings'—that is, small fillings placed, as a preventive measure, in pre-carious (not decayed but considered likely to decay) fissures on the occlusal (biting) surfaces of permanent molar teeth—and also to discontinue applying fluoride solution topically. In a report sent to the Committee in 1957 entitled "Effect of prophylactic fillings and examination criteria on the results to be expected from fluoridation" a Dental Faculty member recommended "a re-evaluation of the criteria now used in deciding when a cavity should be filled" and "that no cavity should be filled until the lesion has penetrated the enamel." It was originally intended to record changing decay rates in both Hastings and Napier, so that the difference between them would show the fluoride effect.

There can be no doubt that Ludwig and the Committee members sincerely believed, in the authors' view correctly, that dental nurses and private dentists were filling many teeth which should not definitely be classed as 'carious'. They also believed that such a meticulous filling practice could prevent a fair test of fluoridation in Hastings. But the change in diagnostic standard which they implemented must have contributed substantially to the reductions reported. Ludwig measured caries prevalence using the 'DMF' measure (average number of decayed, missing and filled teeth). Because the children examined, like all children in New Zealand at that time, had been receiving regular six-monthly dental treatments, the measure was largely of the number of fillings. Thus the first recorded DMF scores consisted largely of a count of fillings which had been inserted using the earlier criteria for finding cavities.

It is clear that the results eventually published, for Hastings only, claiming to show the effect of water fluoridation, were partly if not mainly the result of the change in diagnostic procedure. The 6- and 7-year-olds, whose occlusal surfaces of molars were in 1954 filled much earlier and more often, would be the most affected by the change and showed the greatest reductions. Also smooth tooth-surface cavities ('approximal' or between-teeth and 'gingival' or near-the-gum) reported by Ludwig and later by Backer Dirks to be the most reduced by fluoridation, were similarly in 1954 filled much earlier than the stage of "penetration of the enamel" described above. In none of the published papers on the Hastings study was the change in diagnostic standards reported. No explanation has been offered for that omission.

Limit of Credibility

The claimed large reductions in Hastings are beyond what is today regarded as the "limit of credibility" for genuine reductions in decay prevalence. According to Alman (*Journal of Dental Research* vol. 61 special p1361) an annualised reduction rate of 10 to 12 per cent becomes an "upper limit of credibility" and rates well above ten per cent suggest that we may be looking at a data-set-dependency, where the high level of change may combine true changes in caries prevalence with factors relating to changes in the population sampled or with inadvertent changes in diagnostic standards". The annualised rate is not the percentage over a period divided by the number of years, but is the rate for each single year which would result, when calculated like compound interest, in the percentage reduction over that period. In the Hastings study the spectacular reductions, for 5- to 7-year-olds, were mostly beyond the limit of credibility, annualised rates varying between 13 per cent and 20 per cent.

Ludwig reported, in each published part of his study, the total reduction since 1954 for each age group, which was very impressive expressed as a percentage. Thus in each later report it was not clear that many reductions since the previous report were quite small, after the first big ones (Figure 1). These large reductions carried through to some extent as the children grew older. The effect is shown in Figure 2. (In Figure 1 the 6- to 8-year-olds in the first stage became the 8- to 10-year-olds in the next stage, 2+ years later.) A part of the carried-through difference must have been due to a real decay decline, now known to be occurring everywhere. The change in diagnosis, rather than

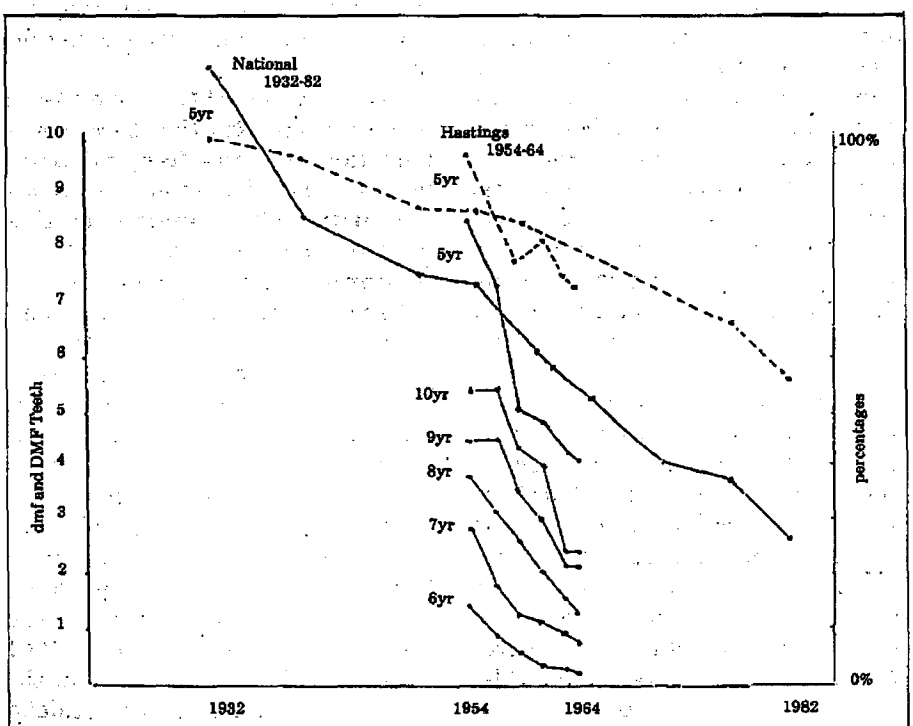


Figure 1: Graph compiled from published results of reductions in dmf and DMF teeth, and in percentages with decay, of younger Hastings children between 1954 and 1964. The national reduction in 5-year-old dental decay (dmf and percent with decay) is also shown. Early steep declines, after the changed method of diagnosing for fillings, were followed by declines of similar steepness to that occurring for 5-year-olds throughout New Zealand without water fluoridation.

Dotted lines: the percentage of 5-year-olds with decayed teeth (100-percentage caries-free)
Solid lines: the average number of decayed, missing and filled teeth ('dmf' primary teeth of 5-year-olds, and 'DMF' permanent teeth of 6- to 10-year-olds.

fluoridation, explains the big early reductions.

Those big reductions were rather deceptive. Obviously, delaying one filling in a 6- or 7-year-old, whose DMF has reached only 2 or 3, can result in a 30 to 50 per cent reduction. But by the time the child is 15 or 16, with a much higher DMF, the reduction carried through was a much smaller percentage. Thus the difference between the 6-year-old DMFs in Figure 2 is 74 per cent, while the carried-through reduction in the two DMFs by the time the children reached 15 is only 13 per cent for the 6½ year period—an annualised decline of 2 per cent.

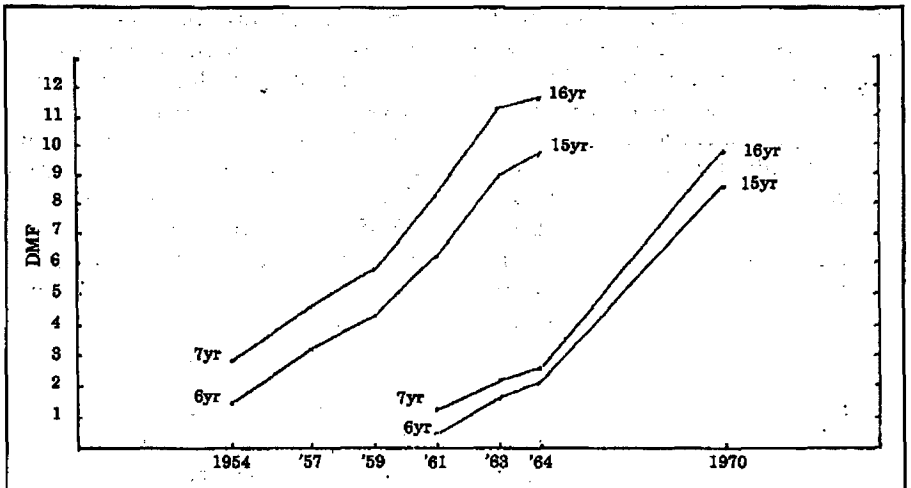


Figure 2: The increase in mean DMFT (decayed, missing and filled permanent teeth) of groups of children as they grew older after their first examination in the study. The suddenly lowered DMFT carried through and 9 or 10 years later was similar to the gradual 5-year-old decline everywhere.

Subjects for the study were all available Hastings schoolchildren of European extraction aged 5 to 16 years (except in 1970) who had lived in the city and consumed fluoridated water throughout life. Number in each age group varied from 259 (5-year) to 24 (16-year). The groups were thus approximately the same children between 1954 and 1970, though reducing in number with some overlapping of content of the groups in intervening years. Figure 2 is compiled from the published results for those children who were examined at age 6 or 7 years and again at 15 or 16 years.

Source: Ludwig, op cit.

Decay reduction in non-fluoridated Places

A reduction in dental decay of primary teeth at an annualised rate around 4 per cent, shown by continuously collected statistics for 5-year-olds (*Health Department Annual Reports* 1956-1971 and *NZ Dental Journal* vol. 48 p160, vol. 80 p14), has occurred throughout New Zealand over the past 50 years (see Figure 1). An equally steep though less continuously recorded decline in 12-13-year-olds' permanent tooth decay has also occurred, in recent years slightly steeper in non-fluoridated areas (Fulton, WHO monograph no. 4, 1951. *Health Department Annual Report* 1984).

In 1962 the Director of the Dental Division of the Health Department, Dr Leslie, in response to a request for dental clinic statistics showing the reported spectacular effects of fluoridation, wrote to the Fluoridation Committee. From dental records of the entire primary school population of New Zealand, he was unable to produce convincing figures showing and advantage from Hastings fluoridation. The 'simple method' he hoped for seems to have been devised. Population dental figures which would have shown relative effects of fluoridation, like those for 5-year-olds, were not collected, and were discontinued for 5-year-olds; ever since, only selected sample statistics have been presented to defend fluoridation.

For Hastings, two articles compared the filling rates in Hastings with other patient groups without fluoridation experience (*NZ School Dental Service Gazette* vol. 24 p55, *NZ Dental Journal* vol 62 p32). In these studies there was no consideration of socio-economic or ethnic differences between the Hastings and the other groups, nor of differences in decay prevalences between the groups before Hastings was fluoridated.

In explanation of Dr Leslie's letter it is now conceded that there was a reduction in dental decay occurring in New Zealand, over and above the fluoridation effect, during the time of the Hastings study, although treatment records cannot be considered a satisfactory epidemiological tool (D.J. Beck letter to J.C.). However, one would have expected a dental decay reduction of 74 per cent claimed to have resulted from Hastings fluoridation by 1961, to be reflected in treatment requirements.

The Department's dental research officer found the same difficulty for Havelock North which was fluoridated along with Hastings, and stated of the years 1955 to 1961 "There has been a reduction in the caries incidence for all New Zealand in this period". He concluded "It is recommended that an investigation into the effect of fluoridation in Havelock North not be carried out." (File 124/30/33 May 21, 1965.)

No 'before and after' studies, using controls, have ever been carried out to demonstrate the effectiveness of water fluoridation under New Zealand conditions.

Napier Reduction

According to Fuller, (Letter to J.C.), surveys by Ludwig of Napier children in 1957 and 1961 showed that the change in diagnostic criteria had reduced filling rates only slightly there, indicating that the Hastings reductions were due mainly to fluoridation. Only the 1957 results of those surveys seem to have been published (*Soil Science* vol. 92 p359). Abandonment of Napier as a control after 1957, and consequent lifting of pressure on school dental operators to delay fillings, would have resulted in the national reduction being less evident in Napier between 1957 and 1961. Dental clinic records examined by one author (National collection of School Dental Service patient history charts, Department of Health, Wellington) suggest that the overall Napier reduction, over a longer period than the brief one observed by Ludwig, was comparable to the national one (see Figure 3).

Who was Right?

The discovery revealed by Ludwig's initial dental surveys in the two towns—that younger children, the ones expected to show the

greatest benefit from fluoride, had up to 58 per cent less decay in the unfluoridated control town—caused considerable embarrassment. The explanation—a trace element in Napier soil, causing below average decay there (*Nature* vol 186 p695)—was simply not believed by the opponents of fluoridation. The discovery of the decay difference was not made until well after fluoridation had commenced. It was alleged by opponents that fluoride must have damaged Hastings children's teeth. The subsequently published figures on the dental status of virtually the entire 5-year-old population of New Zealand show that Ludwig's published figures for Napier 5-year-olds' dental health at that time (*Soil Science* vol 92 p359) were not below the national average. But the decay prevalence of Hastings 5-year-olds was well above average.

Early Doubts

The reason for the initial surveys being undertaken after fluoridation had commenced was the replacement of Hewat. The experiment had been commenced by him in 1952, when he carried out pre-fluoridation dental examinations of Hastings children. The results were not published. They are not in Department of Health files. Fuller, when he sought to examine them years later, found they had been destroyed in one of the Department's "periodical purges of records" (Letter to J.C.). The Medical Research Council, whose records at that period were held by the Department of Health, has none on the Hastings experiment. As well as the rather crude and subjectively influenced DMF measure, used in United States studies and later by Ludwig, Hewat used a more precise and complex 'caries index' and 'annual caries attack rate', based on the proportion of tooth surfaces diseased after allowing for their period of exposure since eruption (Hewat and Eastcott, *Dental Caries in New Zealand*, Medical Research Council of New Zealand, 1955). Following the replacement of Hewat, there was in 1954 a complete new start. According to Fuller, Ludwig "simply could not calibrate against Hewat".

Although willing to submit fluoride to a fair trial, Hewat had doubts. In private memoranda he pointed out to his colleagues that an earlier survey had shown that children residing in natural fluoride areas of New Zealand (0.2 or more parts per million) did not have significantly less dental decay, and sometimes had significantly more. He stated "In spite of the fact that there is a steady increase in the number of communities in USA which are adopting fluoridation (over 400 recently), there is still doubt in my mind whether the benefit claimed to result from this measure is fully supported by scientific evidence. In New Zealand we have found that many factors are interrelated with the caries rate, and I am not aware that any consideration has been given to such influences in the published data on caries and fluorine" (Memo. Mar. 14, 1953 on file 125/299).

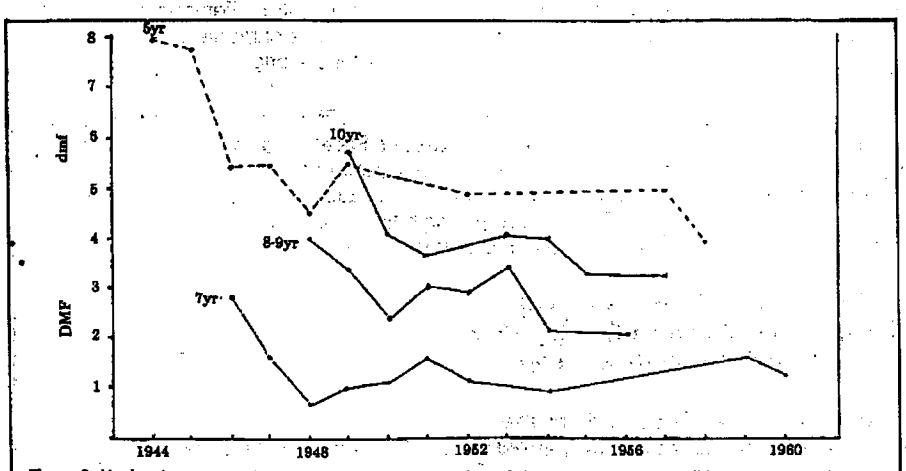


Figure 3: Napier decay reductions. Declines in mean number of decayed, missing and filled primary teeth (dmf 5-year-olds, broken line) and permanent teeth (DMF 7- to 10-year-olds; solid lines) between 1944 and 1960. The overall downward trends are similar to the national decline in dmf of 5-year-olds.
Source: 259 dental history charts from Napier school dental clinics. In later part of the period older children were treated by private dentists.

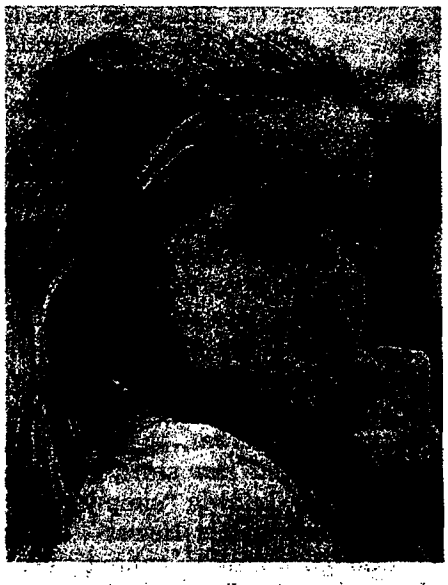
Professional Behaviour

The obvious possibility jumped at by opponents, that fluoride had actually damaged teeth of younger children, seems never to have been entertained by those conducting the experiment. They had faith in their theory that fluoridation would provide an immense benefit, based on their acceptance of evidence from the United States. The experiment was conducted in an atmosphere of intense public debate. Sir Dove Myer Robinson, for many years Mayor of Auckland and a prominent opponent of fluoridation, described the Hastings experiment as a 'swindle'. That view is understandable. But there is no doubt about the good intentions and sincere commitment of the professionals who conducted the experiment. Their ways of thinking and behaving are shared with other professions and have been the subject of sociological inquiry in other contexts (e.g. "Professional Networks and the Institutionalisation of a Single Mind Set" *American Sociological Review* vol. 50 p639). There was no conscious effort to deceive, because the first deception was of themselves. Some of their actions are difficult to explain or condone. One was the calling in of the police to investigate secretly the backgrounds and political affiliations of persons organising opposition to fluoridation. Apparently the professionals on the Fluoridation Committee were unable to understand that their opponents could have other than sinister motives. The result of their inquiry, in a letter from Head Office, no doubt left them mystified.

When the 1963 Hastings results were announced they drew comment from Hewat, then living in retirement (File 124/30/33, Apr. 27, 1965). He agreed, with the retired High School principal who had vigorously opposed Hastings fluoridation, that the results as presented could be interpreted differently, to show only a temporary delay in the onset of decay, with no reduction in the progress of the disease. Fuller and Ludwig, supported by the Government Statistician, rejected such an explanation (same File, May 19, 1965). The information now available, presented in this study, reinforces Hewat's assessment, which

could explain why by 1962 Hastings children, as Dr Leslie had discovered, were receiving as many fillings as in other places where overall prevalence of the disease was also declining.

At the time, Fuller commented "I think we all realise this is largely a question of point of view and unfortunately Dr Hewat does not see it from the viewpoint of a fluoridationist" (same File, Apr. 30, 1965). Those who are committed to strong belief in a theory can interpret data and arrive at conclusions quite opposite to the conclusions of those who are not so committed. The history of science has repeatedly demonstrated that more than one theoretical construction can usually be placed upon a given collection of data. It is apparent that belief in, and commitment to, the fluoridation paradigm strongly influenced New Zealand health professionals in their interpretation of the Hastings data. Many of the participants in the above events are still living. They have been invited to comment on this new information.



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Conclusion

From the above considerations it seems clear that the Hastings fluoridation study did not, as it was purported to do, demonstrate the effectiveness of water fluoridation in reducing dental decay in a typical New Zealand population. The reported reductions were at least partly, if not wholly, the result of factors other than fluoridation. Today proponents of fluoridation will concede that there were other factors operating to cause the reductions, over and above any fluoridation effect. But that fact, although known to those responsible for the study, was never mentioned in official and scientific published reports on it. The study was, it seems, more a public relations exercise than a scientific one. Nonetheless, it is still cited in dental scientific literature, and in textbooks like Professor Murray's, as being the latter. We suggest closer examination of past fluoridation studies in other countries, as begun by Diesendorf (*Nature* vol. 322 125-129, 10 July 1986).