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Dental Fluorosis in Primary School Children in Lithgow, NSW

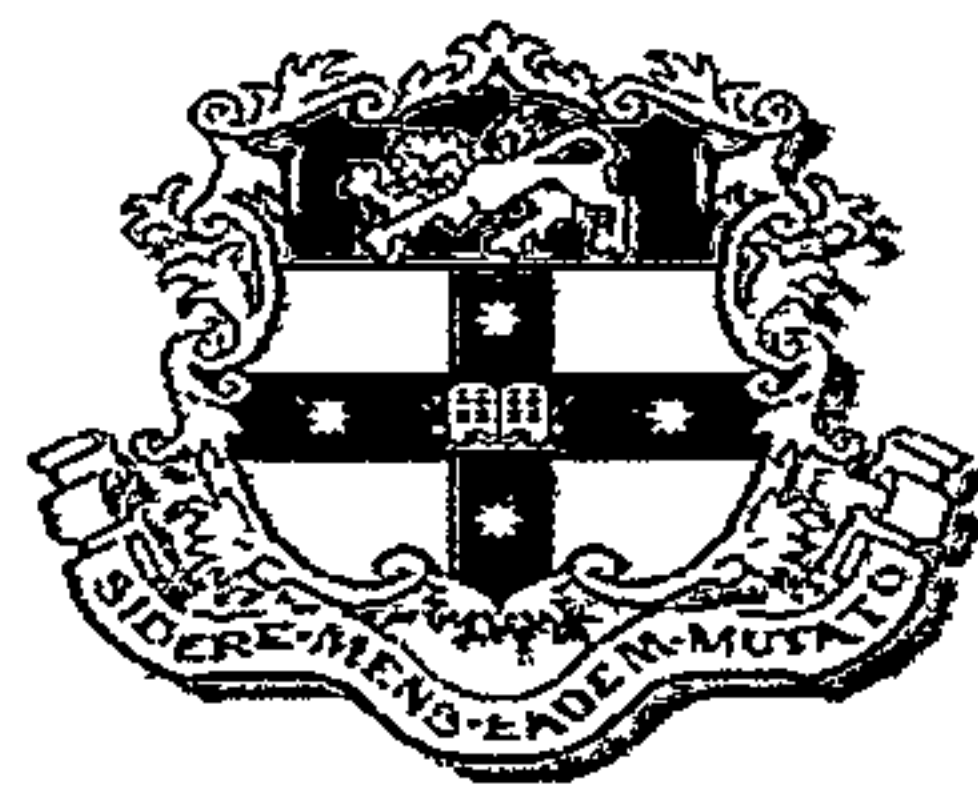
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A treatise submitted in partial fulfilment of the requirements for the degree of

MASTER OF DENTAL SCIENCE

Community Oral Health and Epidemiology



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Dedication

*This treatise is dedicated to my parents,
Mrs. Savitha Narayan Sujeer and
Dr. Narayan Nayak Sujeer
for encouraging me and giving all their support
in my pursuit of higher education.*

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- It is a great pleasure to express my deepest gratitude to my supervisor, Associate Professor Wendell Evans for introducing me to the inspiring field of research, and for his support and guidance throughout the studies.
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Summary and Recommendations

Exposure to fluoride from all sources including fluoridated water carries a risk of occurring dental fluorosis. With the advent of fluoride toothpaste, fluoride supplements like fluoride mouth rinse and gel, and the availability of commercially prepared beverages using fluoridated water, the incidence of dental fluorosis is increasing.

The purpose of this study was to obtain baseline data on dental fluorosis and dental caries and evaluating the risk factors for dental fluorosis in Lithgow LGA against which future changes can be measured following a likely commitment by the Lithgow City Council to implement water fluoridation in the near future.

The survey was conducted on primary school children in Grades 1-6 (aged 5 to 13 years) residing in the Lithgow Local Government Area (LGA), New South Wales. The sampling frame was the school roll of primary schools in the Lithgow LGA. Seven schools that received the water supply from the Lithgow Council were included in the study. Of these seven, four were located within Lithgow city and the other three from the nearby towns of Wallerawang, Cullen Bullen, and Hampton. A total of 502 children with permanent maxillary central incisors were examined. The overall prevalence of dental fluorosis was found to be 0.45.

The major findings from this study were

1. The Community Fluorosis Index in Lithgow was 0.45. At this level, dental fluorosis is not considered to pose a public health concern.

2. Children who commenced tooth brushing with toothpaste when aged 18 -24 months had higher odds of fluorosis than children who commenced brushing at earlier or later ages.
3. Exposure to fluoridated water was a fluorosis risk factor.
4. Children who consumed carbon-filtered water had higher odds of fluorosis than children who consumed tank rain water during the period of tooth development.
5. Sixty-five percent of the responding parents favoured the addition of fluoride to the water supply for the benefit of preventing dental decay in both children and adults.
6. The largest group of the responding parents (nearly 40 percent) thought that health authorities, as opposed to other agencies, should take responsibility for the decision to fluoridate the water supply.

It is recommended that

1. Further research should be carried out to determine the ideal concentration of fluoride for drinking water in NSW in view of the fact that a fluorosis risk already exists in NSW populations served with non-fluoridated water sources.
2. Because of the risk of fluorosis, oral health education should be directed at parents to ensure that they understand that fluoride toothpaste should not be used before the age of 2 years
3. Because of confronting results a recommendation for a new research project for assessing the age associated fluorosis
4. In future oral health surveys, photographs of the central incisors should always be taken for the purposes of:
 - Aiding historical comparisons
 - Diagnostic standardisation
 - Calibration
 - Confirmation of clinical diagnosis.

Table of Contents

Dedication	ii
Acknowledgements	iii
Summary and Recommendations	iv
Table of Contents	vi
List of Tables	ix
List of Figures	xi
List of Abbreviations	xii
PART 1 REVIEW OF LITERATURE	1
Chapter 1 Fluoride	2
1.1 What is fluoride?	2
1.2 Sources of fluoride	2
1.2.2 Topical Fluorides	3
1.3 Human exposure to fluoride	4
1.3.1 Fluoride content in other living organisms	4
1.3.2 Fluoride content in human tissue	4
1.4 Fluoride levels in Australia	5
1.5 The metabolism of fluoride	6
1.6 Toxicity of fluoride	9
1.6.1 Acute toxicity	9
1.6.2 Chronic toxicity	10
CHAPTER 2 Dental Fluorosis	12
2.1 Definitions of dental fluorosis	12
2.2 The assessment of dental fluorosis	13
2.2.1 The Community Fluorosis Index, CFI	13
2.2.1.1 Limitations of Deans Index	14
2.2.1.2 Advantages of Deans Index	15
2.2.1.3 Assessment of examiner reliability	15
2.2.2 The Tooth Surface Index of Fluorosis (TSIF)	15
2.2.3 The Thylstrup-Fejerskov Index, (TFI)	16
2.2.4 The Fluorosis Risk Index, (FRI)	17
2.2.5 Other systems of assessing enamel opacities	18
2.3 Differential diagnosis of dental fluorosis:	18
2.3.1 Normal enamel	19
2.3.2 Non fluoride opacities	19
2.3.3 Idiopathic fluorosis	19
2.3.4 Clinical differential diagnosis of enamel opacities	20
2.4 Risk factors for dental fluorosis	20
2.4.1 Exposure to fluoride toothpaste	23

2.4.2	Exposure to infant formula.....	26
2.4.3	Exposure to fluoridated water.....	27
2.5.	Prevalence of dental fluorosis in Australia.....	28
2.5.1	Central Australia.....	28
2.5.2	Canberra.....	28
2.5.3	Queensland.....	29
2.5.4	Northern Territory.....	29
2.5.5	New South Wales.....	29
2.5.6	Victoria.....	31
2.5.7	Western Australia.....	31
2.5.8	Prevalence of dental fluorosis internationally.....	33
2.6	Perceptions to dental fluorosis.....	35
2.7.	Public knowledge and attitudes towards dental fluorosis.....	39
2.8	Comparison of clinical and photographic scoring.....	40
Part 2	Dental Fluorosis in the Lithgow LGA.....	41
Chapter 3	Introduction.....	42
3.2	Lithgow fluoridation status.....	45
3.3	Aims of the study.....	45
3.4	Ethics review.....	45
Chapter 4	Materials and Methods.....	46
4.1	Target population.....	46
4.2	Sampling.....	46
4.2.1	Sampling frame.....	46
4.2.2	Method of sampling.....	47
4.2.3	Recruitment of the sample.....	47
4.3	Fluoride history.....	48
4.4	Survey team.....	48
4.5	Measurement of fluorosis.....	48
4.6	Clinical examination.....	49
4.7	Photographic assessment.....	49
4.8	Electronic data entry.....	50
4.9	Analysis.....	50
Chapter 5	Result 1.....	52
5.1	Prevalence of dental fluorosis scores and Community Fluorosis Index Values.....	52
5.2	Age specific distribution of fluorosis scores and CFI values.....	52
5.3	Bivariate associations of fluorosis experience in potential explanatory variables.....	57
5.3.1.	Dental fluorosis and age of the child.....	57
5.3.2	Dental fluorosis and toothbrushing factors.....	57
5.3.3	Dental fluorosis and exposure to fluoridated water.....	64
5.3.4	Dental fluorosis and main source of drinking water during tooth development.....	64
5.3.5	Dental fluorosis and other potential explanatory variable.....	65
5.4	Equivalence of clinical and photographic assessment of fluorosis.....	65

Chapter 6 Result 2	68
6.1. Odds of any fluorosis.....	68
6.2 Odds of very mild or more severe fluorosis	70
6.3 Odds of mild or more severe fluorosis.....	70
6.4 Best fitting multiple logistic regression model for predicting fluorosis in Lithgow	71
Chapter 7 Discussion.....	75
7.1 Prevalence and severity of dental fluorosis	75
7.2 Dental fluorosis and age of child	76
7.3 Dental fluorosis and toothbrushing factors	76
7.4 Dental fluorosis and type of toothpaste used.....	77
7.5 Dental fluorosis and other fluoride exposure	77
7.6 Dental fluorosis and water source	78
7.7 Comparison of the clinical and photographic scoring	79
7.8 Limitations of the Study	79
7.9 Major findings	80
7.10 Recommendations.....	81
References.....	82
Appendices	90
Appendix A: Map of Lithgow LGA	91
Appendix B: Ethics Approval.....	93
Appendix C: Letter for school principals.....	100
Appendix D: Information package for parents	101
Appendix E: Questionnaire	110
Appendix F: ABS Classification of Occupation.....	121
Appendix G: Kappa value calculation tables.....	124
Appendix H: Fluorosis photographs of school children (CD).....	128

List of Tables

Table 2.1: Summary of the studies comparing the esthetic perceptions of parents, dentists and children.....37

Table 5.1: The participant consent rate for children taking part in the Lithgow LGA survey.....53

Table 5.2: Distribution of children with erupted maxillary central incisors based on sex.....54

Table 5.3: Prevalence of dental fluorosis scores and CFI values among schools in Lithgow LGA.....55

Table 5.4: Age specific Community Fluorosis Index (CFI) values and dental fluorosis scores according to the Dean's Index.....56

Table 5.5: Mean fluorosis scores and related statistics by potential explanatory variable.....58

Table 5.6: Equivalence between clinical and photographic scores of dental fluorosis using Dean's Index.....67

Table 6.1: Univariate logistic regression analysis of the effect of potential explanatory variables on dental fluorosis.....69

Table 6.2: Best fitting multiple logistic regression analysis for predicting any fluorosis in Lithgow children. Model 1 (includes exposure to fluoridated water as predictor).....72

Table 6.3: Best fitting multiple logistic regression analysis for predicting any fluorosis in Lithgow children. Model 2(includes water sources as predictor).....73

List of Figures

Figure 1.1: Shows the typical plasma fluoride concentration curve after ingestion of a small amount of fluoride.....7

Figure 2.1: Shows a flowchart on the general metabolism of fluoride.....8

Figure 2.2: Flow chart showing the sequence recommended for the differential diagnosis of dental fluorosis.....21

List of Abbreviations

AHS	Area Health Service
ARCPOH	Australian Research Centre for Population Oral Health
AIHW	Australian Institute of Health and Welfare
C.I	Confidence Intervals
CFI	Community Fluorosis Index
ECF	Extra cellular fluid
F	Fluoride
G	gram
ICF	Intra cellular fluid
Kg	Kilogram
L	Litre
LGA	Local Government Area
mg	milligram
NHMRC	National Health and Medical Research Council
NSW	New South Wales
OR	Odds Ratio
ppm	parts per million (1ppmF= 1mg/LF)
TF	Thylstrup and Fejerskov Index.
WHO	World Health Organisation
µg	microgram

PART 1

REVIEW OF LITERATURE

Chapter 1

Fluoride

1.1 What is fluoride?

Fluorine is the thirteenth most abundant element found in the earth's crust. Fluorine is the first member of the halogen family and the most reactive of all chemical elements. Fluorine rarely occurs in element form but is normally found as fluoride ion or as a variety of inorganic and organic fluorides. Generally colourless, the different fluoride compounds are more or less soluble in water and can take the form of a solid, liquid, or gas. Fluorides are important industrial chemicals with a number of uses but the largest uses are in aluminium production, drinking water fluoridation, and the production of fluoridated dental products.

1.2 Sources of fluoride

Fluoride occurs in varying concentrations in rocks, soil, water, air, plants and animals both naturally and as a consequence of human activity such as agricultural or industrial processes. Fluorides are released into the environment naturally through the weathering and dissolution of minerals, from emissions from volcanoes and in marine aerosols. Fluorides are also released into the environment via: coal combustion, waste from various industrial processes, including steel manufacture, primary aluminium, copper and nickel production, phosphate ore processing, phosphate fertilizer production and use, from glass, brick and ceramic manufacturing, and glue and adhesive production. Human exposure may be through any or all of these sources (NHMRC, 1999).

1.2.1 Water

In Australia, the natural fluoride content of water from natural sources is less than 0.1 ppm but can range from 0.05 ppm to 1.5 ppm. Two-thirds of the Australian population is fluoridated and have concentrations ranging from 0.6 ppm to 1 ppm (NHMRC, 1999). Fluoride in drinking-water accounts for approximately one-quarter of the average daily intake in young children and approximately half of the total intake in adults (NHMRC, 1991)

1.2.2 Topical Fluorides

Fluoridated toothpastes provide another major source of fluoride intake. In Australia, fluoridated dentifrices contribute to more than 90 percent of toothpastes purchased (NHMRC, 1999). The concentration of fluoride in most toothpaste brands is 0.1 percent or 1000 ppm, although low-fluoride toothpastes, 400-526 ppm, targeted at children are available. Fluoride mouth rinses contain fluoride at a concentration of 230 ppm. Topical applications of fluoride gels are used by dentists as an anti caries product and have fluoride content in excess of 10,000 ppm. Fluoride tablets and topical gels represent additional sources of fluoride exposures. The amount of fluoride consumed following professional topical application of a fluoride gel is about 12,300 ppm.

1.2.3 Soil

The fluoride content in soil can be as high as 300 ppm. Fluoride tends to absorb more strongly to soil particles when the soil is slightly acidic.

1.2.4 Air

Fluoride can be present as gases or particulates. The distribution and deposition of airborne fluoride are dependent upon emission strength; meteorological conditions, particulate size and chemical reactivity (Low and Bloom, 1988). Fluorides are transported by wind over large distances before being deposited on the earth's surface or dissolved in water. Fluoride compound in the air rank third among the air pollutants. The most prevalent form of fluoride is hydrogen fluoride, which is rapidly absorbed by the lungs. However (NHMRC, 1999) states that fluoride exposure from the atmosphere makes only a small contribution to the daily intake of persons.

1.2.5 Food

Seafood has high levels of fluoride (eg, the bones of tinned fish may have 500 ppm fluoride), but this may not be very well absorbed in the body (Murray *et. al*, 1991). Only about one-seventh of the fluoride in food is derived from fluoridated water used in food preparation and cooking. The rest of the fluoride intake is from dietary sources, especially from tea, which contains fluoride in the range of 1 ppm to 3 ppm. Some heavy tea drinkers may even have intakes of 8 mg/day to 10 mg/day. Soft drinks contain fluoride at 0.3 to 0.5 mg per 12-ounce serving. Increasing consumption of beverages as a replacement for water have made fluoride content in beverages an important issue (Murray *et.al*, 1991). The fluoride content in juices vary according to the type of juice, white grape juice has a fluoride concentration of 1.45 ppm. In addition cranberry, cherry, apple, grape, pear have an average of 0.6 ppm. However, the fluoride concentration in juices depends on the type of water used for its preparation. The fluoride content also depends on the method of preparation of the food. For example Teflon-coated ware, the concentration of fluoride ion is nearly 3 ppm. Cow's milk and milk based formulas is of interest because it's the main source of nutrition in the first year of life. Cow's milk contains very low fluoride in concentrations of 0.05 ppm. A phenomenon described as 'Halo effect or Diffusion Effect' is when the non fluoridated communities ingest fluoridated beverages or foods that have been produced elsewhere.

1.3 Human exposure to fluoride

1.3.1 Fluoride content in other living organisms

Fluorides tend to accumulate in the bone tissue of aquatic animals. Mean fluoride concentrations of >2000 mg/kg have been measured in the bones of krill; mean bone fluoride concentrations in aquatic mammals, such as seals and whales, ranges from 135 to 18, 600 mg/kg dry weight.

1.3.2 Fluoride content in human tissue

In humans the concentration of fluoride is highest in the periosteal region, and decreases gradually towards the interior of the tissue. Pattern of fluoride

distribution changes with age and sex. It was found that females have less fluoride levels than males. Human breast milk has a very negligible level of fluoride. Approximately 99 percent of the body burden of fluoride is concentrated in calcified tissues (Whitford, 1994). Tooth dentin and bone appear to have similar fluoride concentrations (estimated at 1000 times than that of plasma) which increase with age, while that of enamel is markedly lower.

1.4 Fluoride levels in Australia

Australia is a highly urbanised country, with most of the people living in the urban and coastal areas. Australia celebrated 50 years of water fluoridation in 2003 when it was first implemented in Beaconsfield, Tasmania (Barnard, 1969). In only a few water supplies there is fluoride naturally present at the optimal level. All capital cities in Australia except Brisbane have implemented water fluoridation. However, the level of fluoride ranges between 0.6 ppm to 1.1 ppm due to difference in temperatures (Spencer *et.al*, 1996). Optimum fluoride concentrations are set above or below 1 ppm according to climatic conditions (Fejerskov *et.al*, 1977). In a sub-tropical climate fluoride concentration is less than 1 ppm because more amount of fluoride is consumed due to more fluid intake. However, in temperate climatic conditions due to less amount of fluid consumption the fluoride concentration is above 1ppm.

The optimum level of fluoride added to the water supplies of major cities of Australia are as follows:

CITY	FLUORIDE LEVEL
Adelaide	0.9 ppm
Brisbane	Not fluoridated
Canberra	0.8 ppm
Darwin	0.6 ppm
Hobart	1.1 ppm
Melbourne	1.0 ppm
Perth	0.8 ppm
Sydney	1.0 ppm
Townsville	1.0 ppm

Levels of fluoride in artificially fluoridated water vary according to the climate. In tropical Darwin 0.6 parts per million (ppm) fluoride is satisfactory but in temperate Hobart, 1.1 ppm is required (NHMRC, 1999).

Among Australian states, Tasmania has the best population coverage of fluoridated water, with 94.7 percent of the population living in areas with satisfactory water fluoridation levels. In contrast, only 4.7 percent of the Queensland population live in areas with satisfactory water fluoridation levels. Queensland has the lowest fluoridation levels and the highest level of caries. Overall, 69.1 percent of Australians receive more than 0.7 ppm fluoride in their water supply, indicating a satisfactory level of water fluoridation.

Temperature and climatic conditions have an important aspect in the inclusion of fluoride levels in a community, because an increase in temperature will cause increase in water consumption. Children living in warmer climate develop more fluorosis than children living in colder climate exposed to similar concentration of fluoride in the drinking water (NHMRC, 1999). Water consumption is defined as the "amount of drinking water, soups, home prepared beverages consumed per day per pound of body weight". Other factors such as diet and dietary preparation, work load and levels of consumption can cause a change in the consumption of fluoride

1.5 The metabolism of fluoride

Fluorides in water and dissolved forms are readily absorbed and they reach peak plasma concentrations within 60 minutes of consumption. The most common way fluorides are absorbed in the body fluids is through lungs or gastro intestinal tract. Within minutes after ingestion increased plasma levels can be seen indicating that fluoride ion is rapidly absorbed by the stomach. Fluorides not absorbed by stomach are absorbed by small intestine. Peak levels are reached usually during the following first hour after ingestion after which plasma levels shows a rapid decline due to the continuing uptake by bone and urine excretion. A typical plasma fluoride concentration curve after

the ingestion of a small amount of the ion is represented in (Fig 1.1). Approximately 99 percent of the fluoride associated with calcified tissues is not irreversibly bound. It is known that in the absence of high concentration of calcium and other dietary components that may form insoluble compounds with fluoride, about 75 to 90 percent of ingested fluoride is absorbed from the gastrointestinal tract. Fluoride is not bound to proteins or any other components in plasma or any subcellular structures (Whitford, 1999).

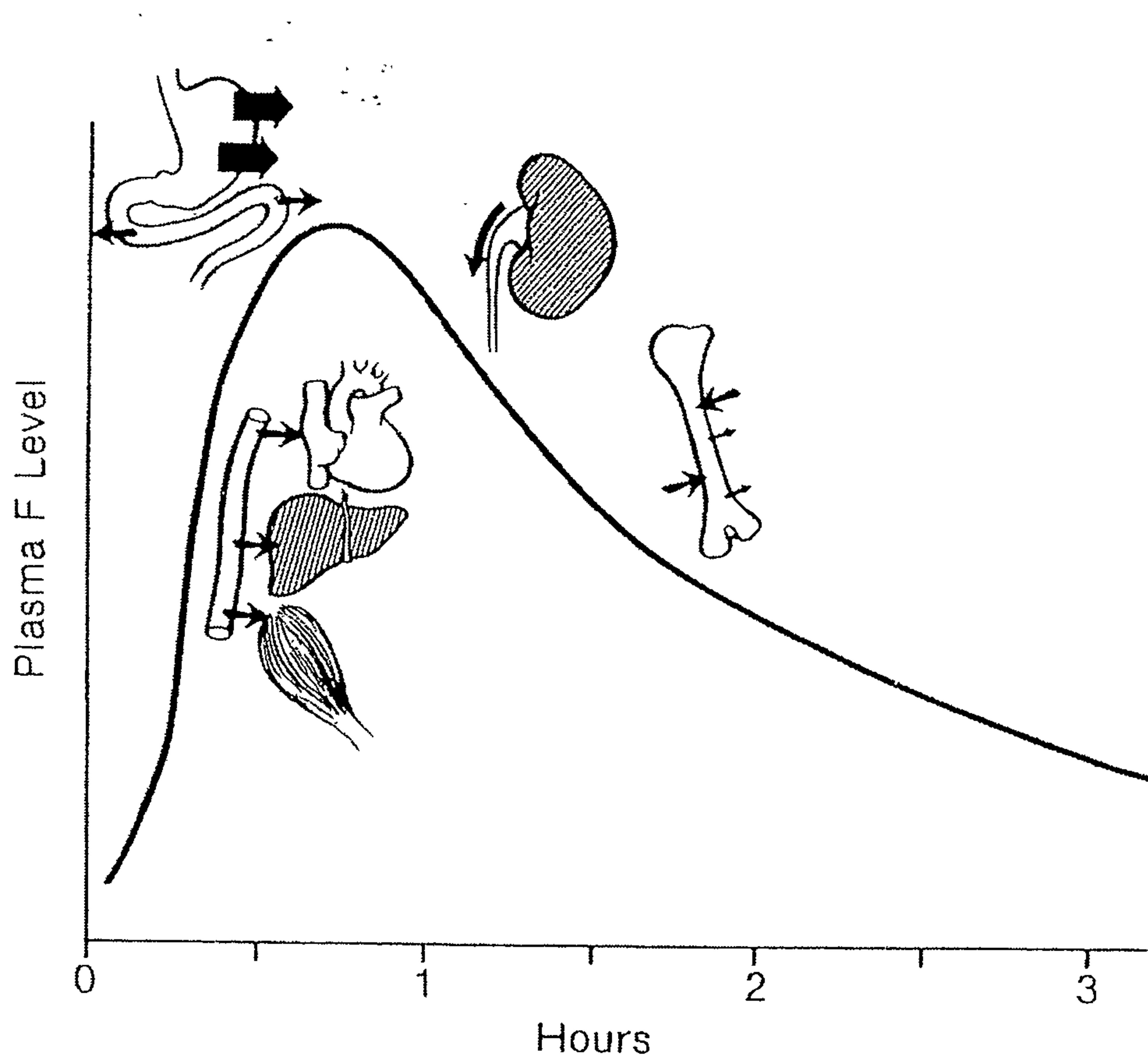


Figure 1.1: A typical plasma fluoride concentration curve after the ingestion of a small amount of the ion. The major determinants responsible for the shape of the curve are shown.

Source: Overview of Fluoride Metabolism and Intake (Whitford, 1996)

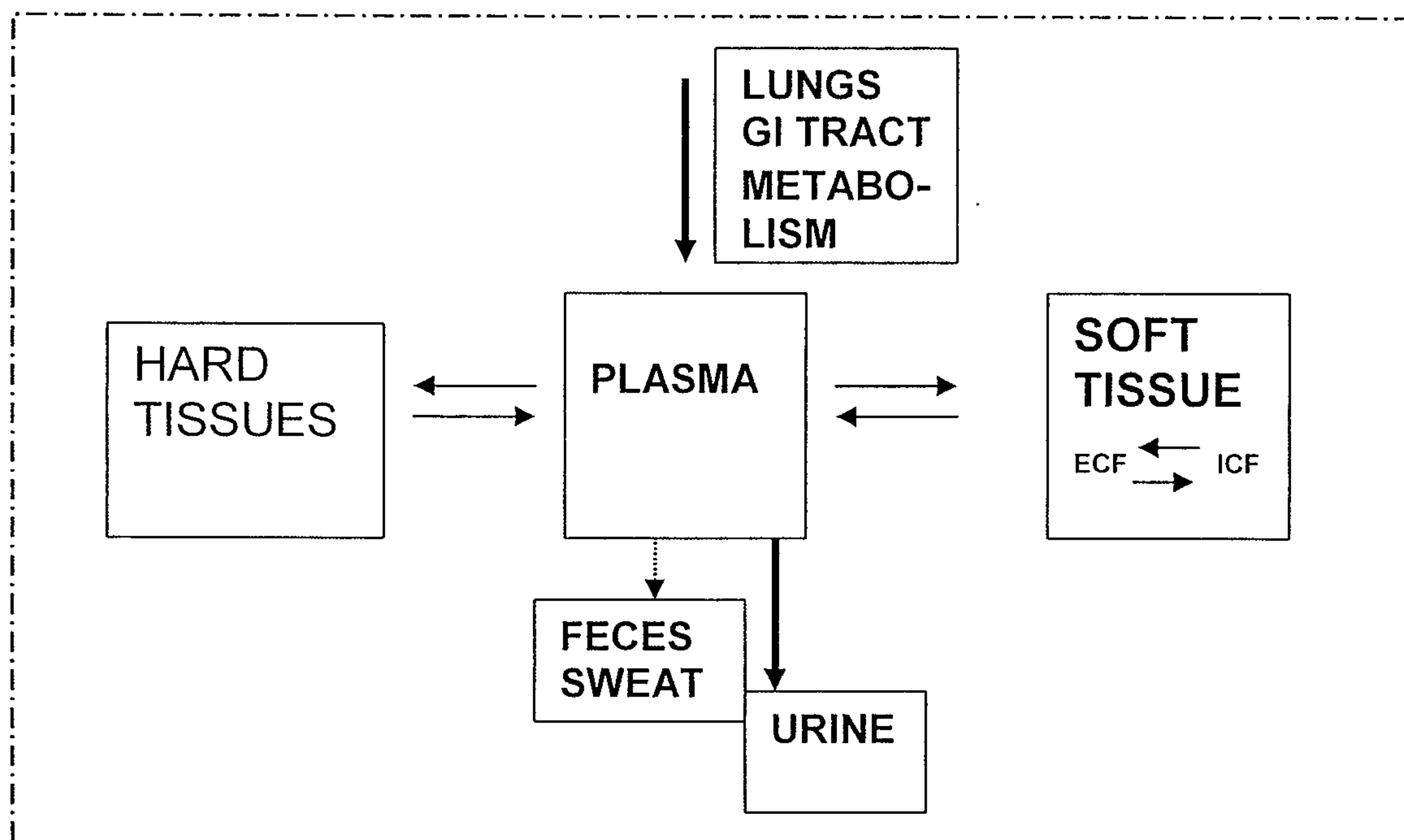


Figure 1.2: The General Metabolism of Fluoride.

Source: *Overview of Fluoride Metabolism and Intake* (Whitford, 1996)

1.6 Toxicity of fluoride

Fluoride toxicity is characterized by a variety of signs and symptoms. Poisoning most commonly occurs following ingestion (accidental or intentional) of fluoride-containing products. Symptom onset usually occurs within minutes of exposure.

Whitford (1996) stated that fluoride absorbed in the body binds with calcium ions leading to hypocalcaemia. Fluoride inhibits acetylcholinesterase, which may be partly responsible for hypersalivation, vomiting, and diarrhoea. Seizures may result from both hypomagnesemia and hypocalcemia. Severe fluoride toxicity will result in multi organ failure. Death usually results from respiratory paralysis, dysrhythmia, or cardiac failure

1.6.1 Acute toxicity

Death may result from ingesting as little as 2 g of fluoride in an adult and 16 mg/kg in children. However, symptoms may appear within 3-5 mg/kg of fluoride in children. Infants have accidental exposure and adults mostly have intentional exposure to fluoride (Whitford, 1992).

The Signs of acute fluoride toxicity are:

Gastrointestinal signs

- Hypersalivation
- Nausea
- Vomiting
- Diarrhoea
- Abdominal pain
- Dysphagia
- Mucosal injury

Electrolyte abnormalities

- Hypocalcemia
- Hypomagnesemia

- Hyperkalemia
- Hypoglycaemia

Neurologic effects

- Tremors
- Muscular spasm
- Tetanic contractions
- Hyperactive reflexes
- Seizures
- Muscle weakness
- Headache

Cardiovascular

- Various arrhythmias
- Shock
- Cardiac arrest

1.6.2 Chronic toxicity

The only known adverse effect associated with the ingestion of relatively low levels of fluoride (1-2 ppm in the drinking water) on a chronic basis is dental fluorosis. Signs of skeletal fluorosis may appear with higher levels of fluoride intake (8-10 ppm or more in the drinking water) for approximately 10 years or more (Whitford, 1992).

It was found that there was a relationship between water fluoride at concentrations of 8-10 ppm and the incidence of bone fractures. It was found that poverty, rural status, and the percent of the population served with fluoridated water were also associated with fracture incidence. The relationship with water fluoridation is weak, but was statistically significant. Possible confounding factors such as hormone use, body size, weight, age, and dietary intake of calcium were examined and were not found to be exerting any effects in the communities ([url.www.fluoridealert.org](http://www.fluoridealert.org)).

Whitford (1996) stated that, other than dental fluorosis, there are no known adverse effects of ingesting fluoride on a chronic basis at levels that are associated with drinking water concentrations of 4 ppm or less.

CHAPTER 2

Dental Fluorosis

Dean (1937) described the relationship between concentration of fluoride in drinking water and prevalence of dental fluorosis. In his study he found that the severity of fluorosis is directly proportional to the fluoride concentration in water and stated that fluoride concentrations not exceeding 1 ppm are of no public health significance.

2.1 Definitions of dental fluorosis

Various descriptions of dental fluorosis have been defined by different authors and they are:

“Dental Fluorosis is the hypo mineralisation of enamel characterized by greater surface and sub surface porosity than the normal enamel as a result of excess fluoride intake during the period of enamel formation”(Burt, Eklund, 1992).

“A specific disturbance of tooth formation caused by excessive intake of fluoride during the formation period of the dentition” (Murray, 1986)

“A specific disturbance of tooth formation caused by excessive intake of fluoride during the formation period of the dentition. The manifestations of this form of chronic fluoride toxicity depend upon the amount ingested, the duration of exposure, and the age of the subject” (Møller, 1982).

“Disturbance of tooth enamel formation caused by fluoride being present in the tissue fluid over a prolonged period of time during tooth development” (Fejerskov *et.al*, 1988).

“Dental fluorosis refers to the developmental defects of enamel induced by fluoride. Clinically, it is characterized by a pattern of white opacities affecting the teeth .The opacities can vary from minor white striations to small and extensive areas of opaque enamel; post eruptive staining or pitting .The severity and distribution of fluorosis depends on the fluoride concentration, duration of exposure, stage of ameloblast activity and individual variation in susceptibility” (Cutress *et.al*, 1990).

2.2 The assessment of dental fluorosis

A number of indices have been proposed over the years to measure dental fluorosis.

2.2.1 The Community Fluorosis Index, CFI

This epidemiological index was first developed by Dean (1934). According to this index each erupted permanent tooth is ranked according to the six-point ordinal scale. The community fluorosis index should be conducted using day light and not by using the dental light. During examination the teeth should not be dried and the best results are obtained when using the upper central incisors as the examination teeth.

The Classification for this index is as follows:

0-Normal: The enamel surface is smooth, glossy and usually a pale creamy-white colour.

1-Questionable: The enamel shows slight aberrations from the translucency of normal enamel, which may range from few white flecks to occasional white spots.

2-Very Mild: Small, Opaque, paper white areas scattered irregularly over the tooth but involving less than 25 percent of the labial tooth surface.

3-Mild: White opacity of the enamel is more extensive than for code 2, but covers less than 50 percent of the tooth surface.

4-Moderate: The enamel surface of the teeth shows marked wear and brown stain is frequently a disfiguring feature.

5-Severe: The enamel surfaces are badly affected and hypoplasia is marked to an extent that the general form of the tooth may be affected. There are pitted or worn areas and brown stains are widespread; the teeth often have corroded appearance.

The occurrence of dental fluorosis in population is expressed as the Community Fluorosis Index (CFI). The index is computed by weighting each of the six classifications is shown below as by Dean (1946).

Classification	Weight
Normal	0
Questionable	0.5
Very Mild	1
Mild	2
Moderate	3
Severe	4

The CFI can be calculated using the formula:

$$\text{CFI} = \frac{\text{Frequency of individual fluorosis classification} \times \text{statistical weight}}{\text{Total number of individuals examined}}$$

Dean (1946) stated that a “CFI value of 0.0 to 0.4 was of no public health concern, while values more than 0.4 to 0.6 were associated with borderline public health importance, values greater than 0.6 to 1.0 as slight, 1.0-2.0 as medium, 2.0- 3.0 marked, and 3.0- 4.0 as very marked.

2.2.1.1 Limitations of Deans Index

The Dean’s index has several shortcomings (Horowitz *et.al*, 1984). Firstly, a single score is given to a single tooth rather than a separate score to each tooth surface. The limitations of the Dean’s index is its inability to measure fluorosis in different tooth surfaces and the inability to specify the cosmetic importance of the severity of the fluorosis detected in the dentition. Therefore, any differences in the severity of dental fluorosis in different tooth surfaces cannot be ascertained. Secondly, the “questionable” category is difficult to diagnose and interpret precisely. The distinctions in the diagnostic categories using the Dean’s system are unclear and lacks sensitivity. Problems have also occurred during handling of the data because Dean’s scores are ordinal and

not interval scores, hence they cannot be averaged. In these areas, a large proportion of scores fall in “moderate” and “severe” categories. Dean’s Index has its unit of measure as the individual or community; therefore it cannot attempt to distinguish fluorosis based on histopathological association with age-related exposure.

2.2.1.2 Advantages of Deans Index

The most important advantage of Dean’s index is that it is reliable, simple to use and it has the ability to make comparisons with numerous studies.

2.2.1.3 Assessment of examiner reliability

Kumar (2000) reported on the inter examiner reliability using the Dean’s Index for dental fluorosis. Field examinations were conducted on 3,326 children from grades one to eight. Three examiners were trained in fluorosis evaluation by using colour transparencies and by discussing dental fluorosis cases at a study site. The unweighted kappa values ranged from 0.67 to 0.76, and the weighted kappa values exceeded 0.76, when the units of observations were subjects. When teeth were taken as the units of observations, the kappa values reduced and ranged from 0.52 to 0.65 for the unweighted kappa and 0.59 to 0.75 for the weighted kappa. The inter examiner reliability using Dean’s Index was found to be excellent when presence or absence of fluorosis was compared.

2.2.2 The Tooth Surface Index of Fluorosis (TSIF)

Horowitz *et.al.* (1984) proposed this index for assessment of dental fluorosis. This index ascribes a score on a scale of 0-7 to each tooth surface in the mouth. For anterior teeth the labial and lingual surfaces are scored; and for posterior teeth the buccal, lingual and occlusal surfaces are scored. Teeth that are fully erupted are only scored using this index. This index does not call for drying of teeth prior to scoring. Therefore, the very mildest forms of fluorosis are likely to be missed with TSIF. An increase in score indicates an increase in severity of dental fluorosis. In cases where more than one form of fluorosis is seen on the same tooth surface, the highest score is assigned.

The Tooth Surface Index of Fluorosis (TSIF) has a number of advantages. It is more sensitive than the Dean's index as it examines the different tooth surfaces. Two scores are assigned to anterior teeth and three for the posterior teeth. The other advantage of the Tooth Surface Index is that it was able to discriminate between the prevalence and severity of fluorosis in groups of community with different concentrations of fluoride in their drinking water (Horowitz, 1986).

The Tooth Surface Index does not use a questionable category. It permits a distinction between discreet pitting, advanced pitting and between staining alone and staining in conjugation with pitting. It has features designed to improve sensitivity when applied to population as a whole where more severe form of fluorosis prevail. TSIF is not an interval scale, they are arranged in various frequency distributions and the scores are not averaged. It is especially useful for determining the effect of fluorosis on health in a population.

2.2.3 The Thylstrup-Fejerskov Index, (TFI)

Thylstrup and Fejerskov proposed the TF index in 1978 to assess dental fluorosis. This index necessitates drying of the teeth with an air blast. It requires assessment of only one surface per tooth as fluorosis affects all tooth surfaces equally. It is the only index that attempts to correlate the clinical appearance with the pathological changes in the tissue. It is also a useful tool for evaluating the dental fluorosis severity in epidemiological studies.

The scores in the TF index are represented in an ordinal scale. The clinical appearance of dental fluorosis is classified in 10 scores ranging from 0 to 9, an increase in score referring to an increase in severity of dental fluorosis on buccal/lingual and occlusal surfaces. The scores in this index are designed to characterise macroscopic changes in enamel in terms of dental fluorosis and the correlation with the histological changes. The appearances of increase in degrees of dental fluorosis were directly proportional to the degree of subsurface porosity (Thylstrup, 1978).

The TF index is particularly useful in distinguishing variations in the clinical appearance of teeth with severe degree of dental fluorosis. The inter examiner reliability was found to be much better than the conventional Dean's Index (Mabelya, 1994).

2.2.4 The Fluorosis Risk Index, (FRI)

Pendrys *et.al.* (1990) designed this index to identify risk factors for dental fluorosis at specific stages of dentition development. It was designed to permit a more accurate identification of association between age specific exposure and development of enamel fluorosis. The index has a high reliability and validity. This index also identifies a strong association between mild-moderate enamel fluorosis and a history of exposure to fluoride supplement, which supports the validity of the Fluorosis Risk Index. The enamel surface zones of teeth, according to this index are categorized as:

- Classification I – enamel surface zones formed during first year of life.
- Classification II – enamel surface zones formed between third through sixth year of life.

The identification of fluorosed enamel is done using Dean's and Møller's criteria with an aesthetically relevant minimum severity of mild to moderate fluorosis to be determined as fluorosis. The enamel surface zones are scored as either negative for fluorosis, questionable for fluorosis, positive for mild-to-moderate fluorosis, or positive for severe fluorosis (scores 0 to 3). Any surface zone that has opacity that appears to be non-fluoride opacity should be scored as 7. A surface zone is categorized as excluded (with a score of 9) when any of the following conditions exist - incomplete eruption, gross plaque or debris, orthodontic appliances, or surfaces crowned or restored. The FRI Index is a useful tool for the identifications of risk associations and for also providing epidemiological insights into the underlying histopathology of enamel fluorosis (Pendry's, 1990).

2.2.5 Other systems of assessing enamel opacities

The enamel opacities of dental fluorosis have also been classified depending on the range of developmental enamel defects. Some of these indices are the Al-Alousi Index (1975) and that by the FDI Commission on Oral Health, Research, and Epidemiology the Developmental Defects of Enamel Index (DDE Index) Ainamo and Cutress (1982).

Evans (1995) reviewed these systems and stated "Because of generality inherent in these systems, it is inappropriate to use them for specific purpose of investigating the prevalence or severity of dental fluorosis. A specific drawback of the DDE index is that missing enamel and pits are classified as hypoplasia. Yet the pits which characterise severe dental fluorosis are not hypoplastic in origin – they develop post eruptively. Pits of hypoplastic origin are often more frequently found in non- endemic areas and may not therefore be differentiated from those of dental fluorosis by this index. When the FDI system is used in this way, the outcome will inevitably lack precision..."

2.3 Differential diagnosis of dental fluorosis:

Proper differentiation between fluorotic and non-fluorotic defects of dental enamel is an important diagnostic decision in epidemiology and public health dentistry. The commonly accepted diagnostic criteria for fluorosis are to differentiate between non discrete symmetrical and asymmetrical distributions of opacities of dental enamel. Studies have helped to diagnose between fluorotic and non-fluorotic defects of dental enamel for the purpose of diagnosis of dental fluorosis. However there is not a set pattern of occurrence or distribution of fluorosis. Misdiagnosis can be caused by metabolic, physiological, other trace elements. Malnutrition has been reported to induce bilateral symmetrical developmental enamel opacities (Cutress and Suckling, 1990)

2.3.1 Normal enamel

The concentration and distribution of fluoride varies in the enamel with age, environment and exposure to fluoride pre and post eruption. The level of fluoride is always higher in the outer than the deeper parts of the enamel. The fluoride content of the deeper part determines the fluoride availability during tooth development (Fejerskov, 1977)

In areas with low fluoride levels in drinking water the fluoride content of the surface enamel appears to be 900- 1000 ppm, about 1500ppm in areas with optimum fluoridated water and 2500ppm where the water fluorosis levels exceeds 3ppm. Fluoride levels in urine, saliva and plasma provide some indication of current and recent exposure to ingested fluoride. Age also has significant effect in fluoride retention and excretion (Den Besten, 1999)

2.3.2 Non fluoride opacities

These include all categories of opacities, which are not dental fluorosis. They are commonly characterized as discreet, demarcated white or coloured opacities often affecting a single tooth and less frequently multiple teeth with a symmetrical distribution. These opacities result from a wide variety of systemic and local causes during development of the tooth (FDI Tech Report, 1982).

2.3.3 Idiopathic fluorosis

Fejerskov *et.al* (1988) defined this condition as teeth, which exhibit the characteristics of dental fluorosis but with no apparent history of significant fluoride ingestion. The aetiology of such opacities has been attributed to idiopathic diseases or other trace elements like strontium. Malnutrition has been considered as a direct or contributing factor inducing generalised defective enamel. Diagnosis of dental fluorosis is primarily by appearance. However the appearance differs from the fluoride history of a population or person then a direct assessment of fluoride in body tissues may be helpful.

2.3.4 Clinical differential diagnosis of enamel opacities

Confidence in diagnosing dental fluorosis increases with increase in severity and prevalence. Flow chart showing the sequence recommended for the differential diagnosis of dental fluorosis can be seen in (Fig 2.1). Current recommended procedure for differential diagnosis of fluorosis confines them to discriminate between symmetrical and asymmetrical patterns of opaque defects (Fejerskov *et.al*, 1988). Diagnostic problems arise where there is mild form of fluorosis. Substantial variation in fluorosis with the same water fluoride intake can vary between and within populations which can be attributed to factors like diet, ingested fluoride, environmental fluoride, climate and individual physiological and metabolic factors.

2.4 Risk factors for dental fluorosis

The evidence suggests that excess fluoride intake causes dental fluorosis is well documented by Dean (1942), Thylstrup and Fejerskov (1978). The excessive fluoride intake must occur during the time of tooth formation, since the fluoride tends to affect the activity of ameloblasts.

Potential sources of fluoride identified as risk factors to cause fluorosis include

- a) Community water supplies fluoridated above optimum
- b) Dilution of concentrated and powdered infant formula with fluoridated water
- c) Inappropriate use of fluoride and fluoride vitamin supplements.
- d) Inadvertent ingestion of fluoride toothpaste used in brushing
- e) Dietary factors like high consumption of fish and tea
- f) Inadvertent swallowing of topical fluoride-either professionally applied or self applied therapies

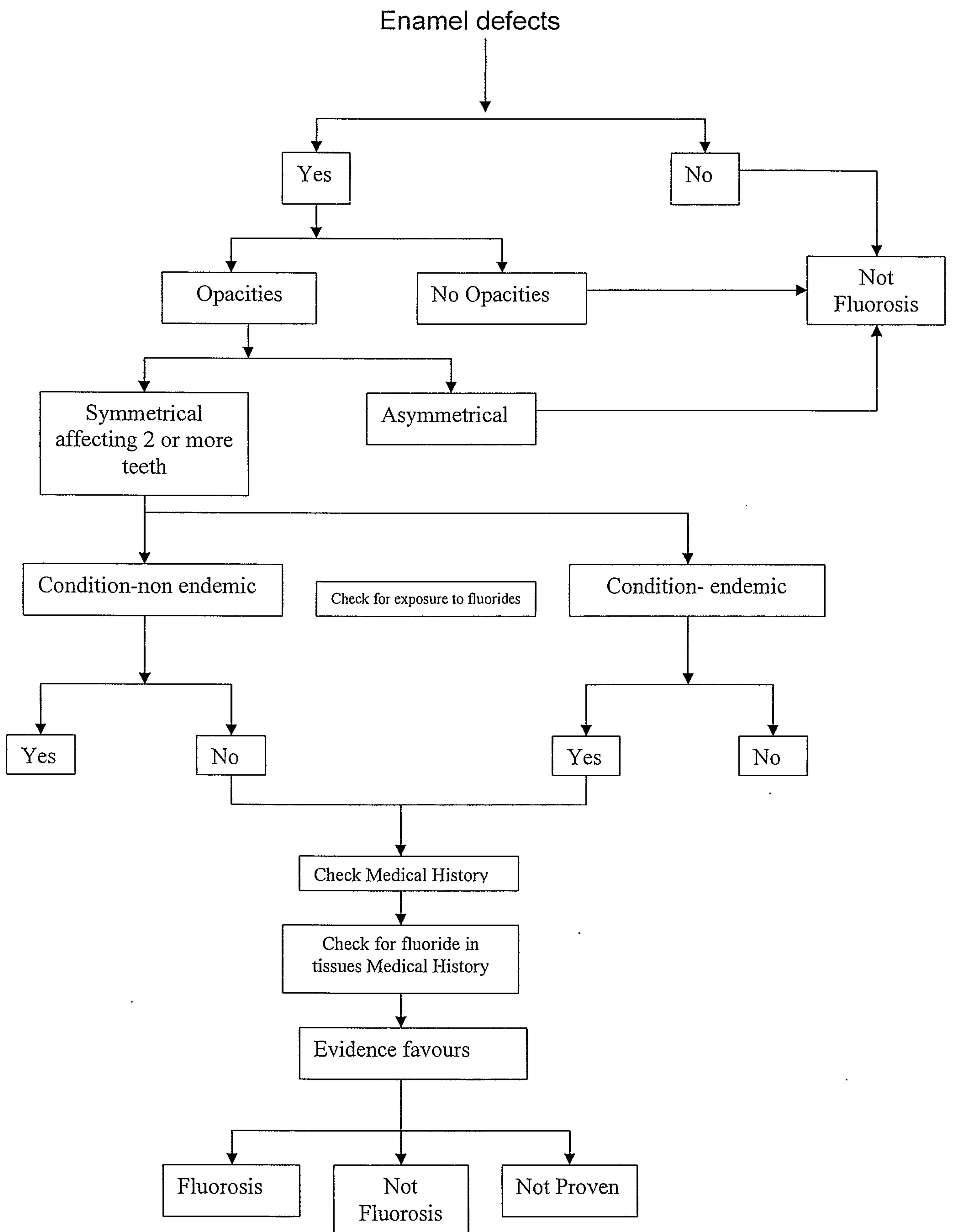


Fig 2.2: Flow chart showing the sequence recommended for the differential diagnosis of dental fluorosis (Cutress and Suckling, 1990)

Whitford (1996) reported that the amount of fluoride intake needed to induce a degree of dental fluorosis ranged from 0.75 to 1.0mg/day. If diet were the only source of fluoride then the intake of fluoride was estimated to be 0.5mg /day. Tooth brushing once a day with 1g of toothpaste would increase the daily intake of fluoride by 50 percent, and if the brushing of the teeth was carried out twice a day then the fluoride intake would be doubled. Similarly rinsing with 0.05 percent sodium fluoride solution or ingestion of 0.05 percent fluoride tablets would add 0.25 mg F/day if taken once a day and 0.5 mg F/day if taken twice a day. The levels of fluoride intake would thus add up to 2.0mg/day and produce more than the mild type of dental fluorosis. When taking these high levels of fluoride intake into consideration, the prevalence of dental fluorosis is more severe than can be predicted only on the basis of intake of fluoride from food and water.

In a review carried by National Health and Medical Research Council (NHMRC, 1991), the daily intake of fluoride for 2-year old children living in areas with 1.0 ppm, 0.5 ppm and 0.15 ppm of fluoridated water was calculated. Children aged 2 years were selected, as they were more likely at that age to have maximum intake of fluoride per kilogram of body weight. It was found that major part of the daily fluoride intake was from toothpaste.

Levy (1995) reported that beverages, juices, and baby foods constitute the majority of an infant's diet. Water by itself was consumed only in small proportions. The study was carried out in Iowa City. The total intake of water by infants was estimated to compare with the recommended optimal levels of fluoride intake. The estimates were derived from water alone and water added during food preparation, but did not consider other dietary and non-dietary sources of fluoride. Results showed that water by itself was not the primary source of fluoride for infants, as about 35 to 70 percent of the children aged between 6 weeks and 9 months did not ingest water by itself. The range of fluoride intake by all sources was 0-1.24mg/day at 6 weeks, 0-1.57mg/day at 3 months, 0-1.29mg/day at 6 months and 0-1.73 mg/day at 9 months. It was found that 10 percent of the infants in each age group exceeded the optional daily intake of fluoride considerably.

Suji (1988) did a study to determine the prevalence and severity of dental fluorosis, the sources of fluoride associated with fluorosis and risk of fluorosis with each source in a child population in a nearly optimally fluoridated community in Toronto. The study involved children aged 8, 9 and 10 in publicly supported schools. The children in this study had fully erupted anterior teeth. The children who gave consent were screened for presence and severity of fluorosis using the Thylstrup and Fejerskov index. The diagnostic criteria index and photographs of fluorosis were kept at the chair side for reference and confirmation by one examiner. The result of the study was that prevalence of fluorosis among 8, 9 and 10 year old was that only thirteen percent of children exhibited scores of 1 or 2 on the Thylstrup and Fejerskov index, thereby indicating that this is not a public health problem of any significance.

2.4.1 Exposure to fluoride toothpaste

A study to determine the risk factors for dental fluorosis was conducted a study in Goa by Mascarenhas and Burt (1998). A total of 1,250 students from 11 of the affluent schools were examined. The mean age of the children was 12 years. Questionnaire was given to the children to be completed by the parents. Dental fluorosis was recorded using the TF index. The water supplies of Goa have never been fluoridated and the level of fluoride in water ranges from 0.05 to 0.1 mg/LF. The prevalence of fluorosis was observed to be 12.9 percent. It was observed that among children who had fluorosis, the children who had started tooth brushing before the age of 2 years had significantly higher severity of fluorosis. The results of the study indicated that fluoride toothpaste use before 6 years of age was a risk factor for fluorosis.

In another study, the amount of fluoride ingested from toothpaste was determined by Bentley *et.al* (1999). A total of 50 children aged 30 months were selected randomly. The homes of the children were visited and the parents were asked about the brushing habits of the children. The children were weighed on household scales. The parents were provided with new

toothbrush and a weighed tube of toothpaste, and were then asked to brush the children's teeth in the usual manner. The amounts of fluoride retained on the toothpaste and in the rinsing fluids were measured. The mean amount of toothpaste used was 0.36 grams and the mean amount of toothpaste ingested per brushing was 0.27grams. The mean weight of children was 14.2 kg. The amount of fluoride ingested depended on the type of toothpaste ingested by the children. The mean daily dose of fluoride ingested using the family fluoride toothpaste was 0.06mg F/kg and for those using the children's toothpaste was 0.01 mg F/kg. It was observed, that on an average 72 percent of the toothpaste applied to the toothbrush was retained in the mouth and presumably ingested. It was found that the higher concentration of fluoride in the toothpaste of the children the greater the risk of the child to dental fluorosis.

Tabari (2000) conducted a study to determine the prevalence and severity of fluorosis in permanent incisor teeth in young children in a fluoridated and a fluoride-deficient community. The study also attempted to establish a relationship and association between the occurrence of dental fluorosis and the reported use of fluoride toothpaste in childhood. The study was conducted on children aged 8, 9 years who had been continuous residents in fluoridated Newcastle or fluoride deficient Northumberland. The permanent maxillary central incisor teeth were examined clinically and photographed by one examiner using the Thylstrup-Fejerskov index. The photographs were read blind to child identity and clinical score.

The study reported that the prevalence of fluorosis was 54 percent in the fluoridated area and 23 percent in the fluoride-deficient area when all grades of fluorosis were included. The percentage prevalence of mild to moderate fluorosis was 3 percent and 0.5 percent in the two areas, respectively. Multivariate analysis indicated that area of residence (OR = 4.5), and type of toothpaste (OR = 1.6) was statistically significantly related to presence or absence of fluorosis. The risk factors for fluorosis are fluoridated area and use of adult toothpaste.

Griffin (2002) estimated the prevalence and attributable risk of fluorosis in the entire dentition. Fluorosis prevalence estimates were obtained from the National Survey of Oral Health in U.S School Children (1986–87) for the 1,839 children aged 12 to 14 years who had fluorosis, who had never received fluoride drops or tablets, and had lived in only one home. For each child Dean's fluorosis index was calculated and an anterior fluorosis index (value of the highest scored maxillary anterior tooth assigned). The result of the study showed that prevalence of fluorosis, very mild or greater, was 26 percent with Dean's Index, which was significantly higher than the 18 percent figure calculated with the anterior index. Using the anterior index, fluoridation was a risk factor for very mild and mild fluorosis. Risk of fluorosis (very mild or greater) concerning fluoridation was significantly higher with the estimates using Dean's Index (24 percent) than estimates calculated with the anterior index (18 percent). The findings further suggest that both estimates of fluorosis prevalence and risk of fluorosis attributable to fluoridation will be higher when calculated with an anterior index than applied to the entire dentition. Data were unavailable for fluoridated toothpaste and diluted formula consumption.

Pendrys (1996) carried out a case-control investigation to investigate the possible association between mild to moderate enamel fluorosis and exposure during early childhood to fluoride supplements, fluoride toothpaste, and/or infant formula use in non-fluoridated communities. Analysis was performed on 460, 10 to 13 year-old children, who were residents of six non-fluoridated communities in Massachusetts and Connecticut. The fluorosis status of the subjects was determined on the basis of a clinical dental examination using the Fluorosis Risk Index (FRI). Logistic regression analysis revealed a moderate association between mild to moderate enamel fluorosis on enamel surfaces and both fluoride supplement use (OR= 2.25, 95% CI 1.08, 4.69) and early tooth-brushing habits (OR = 2.56, 95% CI 1.34, 4.88). There was a strong association between mild to moderate fluorosis on later formed enamel surfaces and both supplement use (OR = 7.97, 95% CI 2.98, 21.33) and early tooth-brushing habits (OR = 4.23, 95% CI 1.72, 10.41).

2.4.2 Exposure to infant formula

Fluoride in infant formula has been implicated as a risk factor for dental fluorosis in a number of studies. Silva and Reynolds conducted a study on the fluoride content of the commonly used infant formulae in Australia. The major source of fluoride in infancy is considered to be infant formulae. The eleven most commonly used infant formulae were selected and analysed using the micro diffusion method. In milk-based formula, the fluoride content was found to range from 0.23 µg F/g powder to 3.71 µg F/g. The known addition of fluoride recovered from each sample was 92 to 100 percent. The infant formula was analysed again after being reconstituted, according to manufacturer's instructions, using water containing 0, 0.1 and 1.0 ppm of fluoride. It was observed that infant formula consumption alone was not unlikely to be a risk factor for dental fluorosis, but made a significant contribution to the daily fluoride intake of an infant. Therefore it suggested that, prolonged consumption of infant formula reconstituted with optimally fluoridated water might be a risk factor for the development of dental fluorosis of the anterior permanent teeth.

In a similar study in Brazil, Buzalaf *et.al* (2001) investigated the fluoride content of reconstituted infant formula using fluoridated, deionised and bottled mineral water. Ten samples of infant formula available commercially in Brazil were used in the study. The infant formulas were reconstituted according to the manufactures instructions. The fluoride concentration of the fluoridated water was 0.9 ppm and for the bottled water it ranged from 0.02 -0.69 ppm. The powdered infant formula had fluoride content ranging from 0.01 to 1.65 ppm. The fluoride concentrations of reconstituted infant formula ranged from 0.01 to 0.75 ppm with deionised water, from 0.91 ppm to 1.65 ppm with fluoridated water and from 0.02 ppm to 1.37 ppm with bottled mineral water. The infant formula samples were found to exceed the optimal daily intake of fluoride and almost all the samples provided a daily intake of fluoride above the suggested threshold of 0.1mgF/kg for fluorosis. The study concluded that in order to limit fluoride intake to <0.1 mg/kg/day the use of fluoridated water to reconstitute infant formula was to be avoided.

Karina (2000) suggested certain recommendations, which would reduce the risk of fluorosis

1. Before fluoride supplements are prescribed the clinicians should initially assess the fluoride concentration of the water and caries risk of the child.
2. Fluoride rinse should not be prescribed to children below 6 years of age.
3. Parents should be encouraged to use ready to use formulas.
4. Only parents should dispense toothpaste, a pea size amount on the toothbrush.
5. Parents should supervise tooth brushing to see if children expectorate and rinse during tooth brushing.

2.4.3 Exposure to fluoridated water

The National Health Service (UK) Centre for Reviews and Dissemination at the University of York (CRD) carried out a review of studies pertaining to water fluoridation (Treasure, 2002). The objectives of the review indicated that the only negative effect of water fluoridation was fluorosis, and the fluoridated drinking water was the main factor associated with this risk to dental fluorosis. Hawley (1996) estimated that at levels of 1.0 ppm F, the prevalence of fluorosis was 0.48. At levels of 0.1 ppm F, the prevalence of fluorosis was estimated to be 0.15. Therefore it was concluded that dental fluorosis was associated with fluoridated drinking water supplies.

2.5. Prevalence of dental fluorosis in Australia

2.5.1 Central Australia

Barrett (1956) investigated the relationship between fluoride in water supplies and the relationship of fluorosis on an Aboriginal population in the Yuendumu Native Settlement of Central Australia. The mean temperature of Yuendumu was 69 degrees Fahrenheit. The fluoride content in the water ranged from 1.3-1.8 ppm. Deans Index was used to determine the fluoride status and approximately 30 percent of the children and adults aged 6 to 28 years had fluorosis. Of the 158 people examined, 36 had very mild, 8 mild and a few moderate fluorosis. Barrett (1956) predicted that there would be more occurrence of fluorosed enamel in the future.

2.5.2 Canberra

Canberra's domestic water supply was fluoridated on September 9; 1964. The study of the effects of water fluoridation was done in children living in Canberra. Before the study took place a pre-fluoridation survey was carried out in 1964 to study the prevalence of mottling of teeth and gross hypoplasia of enamel. This investigation was divided into four main sections dealing with opacities, hypoplasia of enamel, dental caries and occlusion. The children involved in the survey from aged 5 to 12 years. The presence and degree of enamel fluorosis was recorded on the permanent teeth.

The results of the study indicated that 28.1 percent of 6- year- old, 34.5 percent of 9- year- old and 27.2 percent of 12- year- old had white mottling. Brown mottling was observed in 2.4 percent of the 6- year- old, 7.6 percent of 9- year- old and 14.6 percent of 12- year- old. Hypoplasia was observed in 1.8 percent of the 6- year- old, 4.1 percent of the 9- year-old and 9.6 percent of the 12- year- olds (Carr LM, 1966).

2.5.3 Queensland

Davies (1969) surveyed a total of 3,251 children in 20 towns that were selected to be representative of the country districts of Queensland. The children were aged 6 to 14 years and approximately equal number of girls and boys in each age group were examined. Dean's Index was used and it was reported that 419 children had questionable to very mild fluorosis and 19 children showed mild, moderate or severe fluorosis.

2.5.4 Northern Territory

In 1970 a study to investigate the prevalence of clinically observable dental fluorosis in Australian Aborigines in Yuendumu in the Northern Territory was conducted by Williamson and Barrett (1972). A total of 163 males and 146 females were examined; their ages ranged from about four to twenty-four years. Deans Index was used to record the dental fluorosis prevalence and CFI was calculated for each of the groups. The results indicated that more than 50 percent of the subjects had a fluorosis score of mild or more severe, but less than 35 percent had a fluorosis score of moderate or severe. This indicates that this is a minor public health problem. Also more than 90 percent of the 1970 study subjects showed a fluorosis score of 'very mild' or 'more severe' compared to only 30 percent of the subjects in the 1956 study. The water supplies between 1955 and 1965 had a fluoride content ranging from 1.3 ppm to 1.8 ppm. It was concluded from the results that aboriginal children drank more water than European children.

2.5.5 New South Wales

A baseline dental examination was carried out in Tamworth, NSW in 1963 before the introduction of water fluoridation in October 1963 (Barnard, 1995). Follow up surveys were continued annually to 1973, then in 1979 and in 1988 to evaluate the changes in the dental health of school children in Tamworth and to assess whether fluorosis had occurred.

All schools in Tamworth were included in the dental survey and all children who returned the parental consent forms were examined. A total of 62,908 children were examined during the 13 surveys and oral data was summarised for children aged 5, 6, 9, 12 and 15 years. Fluorosis of deciduous and permanent teeth was recorded using Dean's classification. Fluoride histories were obtained and included: the length of residence in Tamworth; water sources used for cooking and drinking, and usage of fluoride supplements. In 1967, of 480 subjects examined, none had dental fluorosis and it was concluded that fluorosis was not of public health concern. However, in 1973 it was observed that of the 532 subjects; 0.2 percent had questionable and 2.9 percent had very mild fluorosis. In 1979, out of a total of 493 subjects examined, 1.3 percent had questionable, 5.8 percent had very mild fluorosis and 0.7 percent had mild fluorosis. In 1988 out of 259 subjects examined, 1.8 percent had questionable, 1.5 percent had very mild, and 0.4 percent had mild and moderate fluorosis respectively. In 1979, it was reported that out of the 480 subjects 1.3 percent had questionable, 5.8 percent very mild and 0.7 had mild fluorosis. Also within this age group, 4 percent had fluorosis in 1979 and 5 percent in 1988. In 1963, 20 percent of children living in Tamworth used fluoride supplements (Barnard PD, 1995). Fluoridated toothpaste use was reported to have increased dramatically after Colgate introduced fluoride toothpaste in 1972.

Dental fluorosis prevalence in The Blue Mountains and in Hawkesbury was investigated by Bal (2004). The water supply of Blue Mountains and Hawkesbury were fluoridated in 1993 and 1969 respectively. A total of 1,963 children were examined in both Blue Mountains and Hawkesbury. The study was conducted using the Deans Index and examination of the children was done in normal daylight. Photographs of the upper and lower front teeth were also taken. Results of the study indicated that 19.6 percent of children examined had normal teeth in the Blue Mountains. Some 41.3 percent had questionable, 31.3 percent had very mild, 5.7 percent had mild, 1.4 percent had moderate and 0.7 percent had severe fluorosis. In Hawkesbury 28.9 percent had questionable, 31.7 percent had very mild, 6.5 percent had mild, 0.6 percent had moderate, and 0.4 percent had severe fluorosis. It was also

reported that CFI for the combined Blue Mountains and Hawkesbury was 0.66, which according to Dean's Index could be a public health problem. In that study seventy percent of the children started brushing their teeth with toothpaste before the age of 2 years. Seventy percent of children had lifelong exposure to fluoridated water. Children using tank water as the domestic source were 50 percent less likely to have fluorosis. Whereas, children using fluoride mouth rinse were three times more likely to have fluorosis.

2.5.6 Victoria

Evans *et.al* (1998) carried out a study to determine the fluorosis prevalence in Melbourne amongst 12 year olds. The water supplies of Melbourne were fluoridated since 1977 at an optimum fluoride concentration of 1.0 ppm. The study was conducted on 644 children aged 12 year. The children were scored for fluorosis on the basis of the Deans Index. Seventy percent of the sample was classified as having normal enamel, 15 percent had questionable signs of fluorosis and remaining 15 percent had very mild or mild fluorosis.

It was found that 18 percent of the life long residents had definite signs of fluorosis. It was found that fluorosis risk has not increased in Melbourne since the introduction of water fluoridation and the degree of risk was found to be of no public health concern.

2.5.7 Western Australia

Kailis and Silva (1967) conducted a study on Caucasian children aged 6 to 16 years in Carnarvon, Western Australia. Carnarvon has a mean maximum annual temperature of 80.2 degrees Fahrenheit and humidity of 63 percent. Dental fluorosis was observed in the permanent teeth of 225 children. Of the total children examined, 17 children exhibited questionable fluorosis, 92 exhibited very mild fluorosis, 95 and 21 exhibited mild and moderate respectively. The fluorosis assessment was done using the Deans Index. The CFI was found to be 0.71. Kailis reported that these climatic conditions were

conducive to an increased liquid intake and would increase the amount of fluoride ingested per child.

Medcalf (1975) did a study in Goldfields where the water fluoridation was implemented for six years. Goldfields water supply was fluoridated at 0.7 ppm during the summer months and 0.9 ppm from April to September. Dean's Index was used to assess the effects of six years of water fluoridation of the Goldfields water supply on dental health of selected age groups of children. Results of the study indicated that less than 3 percent of children examined had either questionable or very mild fluorosis.

In 1991 Riordan and Banks investigated dental fluorosis and fluoride exposure in Western Australia. The aim of the study was to measure the dental fluorosis in 12 year olds in fluoridated and non fluoridated areas of Western Australia. The labial surface of each upper left central incisor was scored according to the TF index. In Perth 338 children were examined. The mean age of the children examined was 11 years and 7 months. The overall dental fluorosis was found to be 0.37. In Perth it was 0.40 and in Bunbury 0.33. This study demonstrated a strong relationship between fluoride exposure and TF score. The prevalence of fluorosis was recorded at 0.45 for participants exposed to fluoridated water from birth to 4 years of age. Riordan (1993) reported on dental fluorosis, caries, and fluoride exposure among 7 year olds. The aim of this study was to record the weaning age and also the exposure to fluoride from water, toothpaste and supplements. Information regarding weaning and exposure to fluoride were obtained from a questionnaire. The majority of children examined had lived at least 2.5 years in a fluoridated area between birth and 4 years of age. Most of these children had been breast-fed and their mean age of weaning was 7 months. The prevalence of dental fluorosis was found to be 0.48 and was higher in those who had lived for a longer period in fluoridated area between birth and 4 years. Fluorosis was found to be statistically significant with fluoride exposure, weaning, swallowing toothpaste and licking toothpaste.

2.5.8 Prevalence of dental fluorosis internationally

Singapore was the first country in Asia to institute water fluoridation (Loh, 1996). The fluoride level in the Singapore water supply was adjusted to 0.7ppm. A study was conducted in 1958 on 2,090 children aged 11 to 13 to evaluate the extent of developmental defects in dental enamel. Of these, 50.3 percent children had no fluorosis, 11.6 percent questionable fluorosis, 26.6 percent very mild, 10.5 percent mild fluorosis, 0.9 percent moderate and 0.1 percent severe fluorosis. The Community Fluorosis Index was 0.56. The results from this study prompted the Ministry of Health in Singapore to lower the fluoride levels in the water supplies to 0.6 ppm.

In another study in the United States, Griffin (2002) obtained prevalence of enamel fluorosis from the National Survey of Oral Health in U.S School children from 1986-1987. The recording of fluorosis on fully erupted teeth was done, using the Dean's criteria. The CFI was found to be 0.26 with relevance to mild or greater fluorosis. It was found that posterior teeth were most likely to be affected than anterior teeth. The study reported that 33 percent of the children in the optimally fluoridated group and 9 percent in the low fluoridation group were found to have very mild or greater enamel fluorosis.

A study was conducted by Whelton (2004) to determine the prevalence and severity of dental fluorosis. A total of 17,851 children aged 5, 8, 12 and 15 years were selected randomly. Dental fluorosis was recorded using Deans Index in natural day light. The difference of distribution of dental fluorosis between the fluoridated and non fluoridated populations in the two regions were found to be statistically significant ($p < 0.0001$). In 1984, 95 percent of the 8 and 15 year old were normal. An increase in the prevalence of dental fluorosis was noted for the 8 year old and 15 year olds between 1984 and 2002 and the difference was found to be statistically significant ($p < 0.0001$ for both groups). It was concluded that prevalence of fluorosis was higher for children having fluoridated water supplies.

Pendrys (2000) conducted a study in United States to determine the prevalence of fluorosis and attributed risk percent estimated of enamel fluorosis. The subjects examined were aged 10 to 14 years. Students were divided into two groups one which is fluoridated and other is non fluoridated. The examination was carried out using the Fluorosis Risk Index (FRI). The prevalence of mild to moderate enamel fluorosis was found to be 0.39 and 0.34 for optimally fluoridated areas. A significant association of fluorosis was found with the age of starting toothbrushing and frequency of toothbrushing. The study concluded that the prevalence of mild to moderate enamel fluorosis in non fluoridated and optimally fluoridated areas were associated with early toothbrushing habits.

Bardsen (1999) conducted a study in Norway to determine the prevalence of fluorosis and attributed risk. Subjects aged 8 to 15 years were selected and Thylstrup and Fejerskov index was used for the study. A questionnaire was used to obtain information on fluoride exposure and other relevant factors. . It reported that the consumers of low fluoride water demonstrated prevalence of 14.3 percent fluorosis as compared with 79 percent in the group that consumed mild to high fluoride water. In the study it was found that the subjects were exposed to multiple fluoride sources and uncontrolled groundwater with moderate to high fluoride content was the most important factor in the development of dental fluorosis.

Villa (1998) did a case control study to determine the association between very mild to moderate enamel fluorosis and exposure during early childhood to fluoridated water mainly through ingestion of powdered milk. Study was done on 136 residents and Dean Fluorosis index was used. It was found that subjects born after 1986 were 20 times more likely to develop fluorosis and subjects born between 16 and 24 months were 4.5 times more likely to develop fluorosis. Results obtained suggests that the current fluoride concentration in drinking water may have contributed to fluorosis and also recommend the need for future studies to establish the most appropriate water fluoridation level in Chile.

2.6 Perceptions to dental fluorosis

Studies on perceptions of dental fluorosis have found that even mild fluorosis and staining of the teeth can produce significant dissatisfaction and psycho behavioural impacts over the teeth's appearance. It is estimated that the occurrence of "aesthetically objectionable" dental fluorosis in fluoridated communities ranges from 2 to 12 percent of the childhood population. The moderate and severe forms of fluorosis can result in profound embarrassment and psychological stress on the child, especially during the adolescent years. The resulting impact on self-esteem can have long-lasting effects on an individual's emotional and mental health. It was also found that girls were more critical to their tooth colour than boys and younger subjects were more critical than older subjects (Shulman 2004). Clark (1994) found that parents, children and dentists were able to distinguish between teeth with and without fluorosis. However dentists rated the teeth better than did the parents, parents better than the children. The study also reported that parents are more worried about the colour of the teeth than the child. Lalumandier and Rozier (1993) found that parents whose children who had a tooth surface fluorosis index score greater than 0 had more than twice the odds of reporting dissatisfaction with their children aesthetics than did the children with parents of children with TSIF of score 0.

Studies on people's perception on the aesthetics of dental fluorosis are summarised in (Table 2.2). Assessment of dental fluorosis is assessed by size, shape, colour, contour and gingival status. Fluorosis indices fail to address the issue of perceived aesthetics, in spite of the fact that aesthetics concerns are a significant consequence of dental fluorosis. Ripa (1991) found that the patient's appearance should be the primary measure of significance, rather than just the mere presence or absence of dental fluorosis.

Riordan and Banks (1991) conducted a study on aesthetic perceptions of dental fluorosis on dental students. In his study he used three groups- students, parents, and dentists. The students group comprised of 37 nutrition students, 28 preclinical dental students and 17 non-dental administrative staff.

Fluorosis was scored using the TF index. The index teeth were dried in air blast and their appearance was categorized on a 10-point scale according to the criteria. Subjects that were selected for the study were had no crowding and no non-fluoride related opacities in the upper incisors. In this study subjects sat upright in normal dental chair with proper daylight, artificial light and also normal clinical lights. Observers were requested to examine each subject's teeth from a normal conversational distance. No cheek retractors were used and teeth were not dried. Chi squared analysis did not show significant difference among responses across the subgroups.

Twenty eight children participated in a study by Horowitz (1990) had their central incisors observed by 110 observers for fluorosis. The observers were university students, parents and public servants. The results based on the responses showed, that lay and dental observers could

Table 2.1 : Summary of the studies comparing the esthetic perceptions of parents, dentists and children (Shulman, 2004).

Author	Year	Study focus	Expectation Parent Vs Child	Expectation Parent Vs Dentist	Expectation Child Vs Dentist	Other
<i>Brisman</i>	1980	Shape and symmetry of maxillary central's incisors.			Dentists more critical than patients	No difference in opinion
<i>Shaw</i>	1981	Malocclusion	Parents more critical than children	Parents and orthodontists assessments similar.	Orthodontists more critical than children	
<i>Evans & Shaw</i>	1987		Parents more critical than children	Parents and orthodontists assessments similar.	Orthodontists more critical than children	
<i>Kerr and O'Donnell</i>	1990	Malocclusion		Parents less critical than orthodontists.		
<i>Clark and Colleagues</i>	1993	Fluorosis/ tooth colour	Parents more critical than children			
<i>Pietila and Pietila</i>	1994	Dental appearance and function		Agreement on need for orthodontic treatment.		
<i>Clark</i>	1995	Fluorosis	Children critical than parents	Parents more critical than dentists.	Children more critical than dentists.	
<i>Clark and Berkowitz</i>	1997	Fluorosis	Children critical than parents	Parents more critical than dentists.	Children more critical than dentists.	
<i>Beyer and Lindauer</i>	1998	Midline Position	Parents more critical than children	Parents less critical than orthodontists.	Orthodontists more critical than children	No difference in opinion
<i>Bikerland and Colleagues</i>	2000	Malocclusion			Orthodontists more critical than children	No difference in opinion

distinguish between different fluorosis levels. The dentists responded that most fluorosis did not require any treatment, but when the TF score was 3 the majority of the dentists felt that aesthetics treatment would be required. The results suggest that fluorosis score of TF 2 means it is greatly noticed and when TF score was 3 arouse concern in most observers. Of the 28 children, six subjects had TF score 0, seven had TF score 1, nine had TF score 2 and six had TF score 3. The finding of this study indicates that lay and professional observers can identify dental fluorosis under normal lighting conditions, and their concern about appearance increases with the TF score. The findings also indicate that the TF index has validity as a measure of the cosmetic importance of fluorosis. Most observers also felt that low TF scores would not be a source of embarrassment. Most observers felt that the enamel appearance was a disadvantage suffered by girls and boys. Horowitz (1991) expressed that "Although mild fluorosis is generally interpreted by investigators as having minimal cosmetic importance, it may be considered an aesthetic problem to person affected". He recommended that attempts should be made to eliminate fluorosis with TF score 3 and to reduce significantly the prevalence of fluorosis with score TF 2. The strategies include a reduction in tooth paste ingestion or widespread use of low fluoride toothpaste for infants (Horowitz, 1992), fluoride free infant formula (Pendry's and Stamm, 1990) and reduce fluoride supplements (Riordan, 1993).

Riordan (1993) conducted a study among registered orthodontists practising in Western Australia to determine specialist's clinician's perceptions to dental fluorosis. An interview method was used to access the knowledge of the orthodontist in relation to prevalence of enamel mottling, understanding the relationship of mottling and fluoride intake and whether or not the dentists were aware of the mottling of enamel as a problem to the clients and clients children. Of the 34 orthodontists, 32 were from Perth and had a mean period of 22.5 years of experience. Only one interviewer conducted the interviews. The majority of orthodontists felt that prevalence of fluorosis was increasing and virtually all of them had noted a defect in the enamel. It was perceived that patients and /or parents were more concerned about enamel defects than were the orthodontists.

2.7. Public knowledge and attitudes towards dental fluorosis

The debate on the role of fluoride as a caries preventive agent must take into account the risks of dental fluorosis as a potential drawback and importance of public perceptions on fluorosis. Evidence suggests that dentists and epidemiologists are more sensitive to aesthetic impact of fluorosis than lay people.

The views of the public on the impact of fluorosis in informing the merits of fluoride as a caries preventive agent are important. A study conducted by Williams (2006) on attitudes towards dental fluorosis using images of dental fluorosis rated by 40 volunteers, aged between 18 to 34 years. The study reported that there was minimal difference between normal enamel and mild fluorosis; a different form of response was given to severe fluorosis and dental caries. The logistic regression showed that normal enamel and mild fluorosis had a very similar percentage of 'yes' responses to positive characteristics 88 percent and 85 percent respectively and 45 percent showed that severe fluorosis was most likely to be attributed with negative characteristics.

Logistic regression was also conducted on participant's judgements on attributes like attractiveness, carefulness, cleanliness, intelligence and reliability and sociability. These findings provide evidence that participant made social judgments that extend beyond the aesthetic when viewing images of fluorosis and untreated dental caries. The judgements made about mild fluorosis were not different to those made about the same individual with normal dental enamel. However, severe dental fluorosis and dental caries had significant negative impact on social judgements.

A study by Levallois (1998) evaluated the knowledge, perception and behaviour regarding the addition of fluoride in drinking water amongst people living in fluoridated and non-fluoridated areas in the Quebec City region. The study involved four municipalities of the Quebec City region which was the focus of the study. Two municipalities' added fluoride to drinking water and

other two supplied non fluoridated water. Random samples of subjects, aged 18 years and older, were selected by using the telephone list of the four communities. A final sample of 2,009 residents participated in the study. Interviews were carried out under the supervision of a coordinator. The results of this study found that residents of municipalities who had fluoridated water systems do not react very differently from people living in non-fluoridated areas in regard to the use of fluoride. The benefits of use of fluoridated drinking water are slightly more known in fluoridated areas, but awareness is still low in this population. Use of fluoridated toothpaste is widespread in all communities. It was found that of forty-five families with children living in fluoridated areas, 8 percent of the people who believed that their tap water was fluoridated said that they gave supplements to children more carefully. It was hypothesised that people drinking fluoridated water are more aware of its risk and benefits, and therefore they reduce the exposure of their children to other source of fluoride and are less opposed to fluoridation.

Fluoridation of drinking water is still a recommended practice by public health practitioners. It is striking to note that globally the knowledge of its use is not high and knowledge of its risks and benefits is not very different between residents of fluoridated and non-fluoridated communities. However it is not clear that raising the level of knowledge on actual fluoridation status will change the attitude.

2.8 Comparison of clinical and photographic scoring

Sabieha (1998) conducted a study to compare the results of clinical and photographic recording enamel of opacities using the TF and modified DDE indices. Enamel opacities on the maxillary central incisors were recorded two weeks apart. On the first occasion scoring was according to the criteria of the TF index and on the second occasion the modified DDE index was used. An intraoral colour slide photograph was taken of the teeth of each subject and these were scored on two occasions in random order. Three hundred and twenty-five 9-year-old children who were life time residents in an area where the domestic water was fluoridated at one part per million were included in the

study. Agreement between clinical and photograph scoring was good for both TF and modified DDE indices, Spearman's Rank Correlation Coefficients being 0.77 and 0.69 respectively. There was also good agreement between the distribution of scores for the two indices as indicated by Coefficients of 0.75 for clinical scores and 0.76 for photographic scores.

Tabari (2000) did a study to determine if clinical and photographic results agreed closely and had high reproducibility. Subjects with both photographic and clinical fluorosis data of varying severity were recorded on the maxillary central incisors in two places. 312 (38 percent) children were examined by clinically and 298 (37 percent) from photographs. In New Castle 54 percent were assessed clinically and 52 percent photographically, while for Northumberland these figures were 23 percent and 21 percent respectively. Because of the close agreement between clinical and photographic scores (Cohen's kappa = 0.7) it suggests that clinical scores and photographic scores based on TF criteria were highly reproducible.

Part 2

Dental Fluorosis in the Lithgow LGA

Chapter 3

Introduction

Although dental diseases are preventable, yet many people across the world suffer from the pain and discomfort associated with oral disease (Watt, 2005). In 1999, dental caries was estimated to be the most prevalent health problem in Australia (Mather's *et.al*, 1999). Community Water fluoridation (fluoride in water) prevents tooth decay in two ways: primarily through direct contact with teeth throughout life, and when consumed by children during the tooth forming years (Williams, 1972).

Water fluoridation proves to be the most economical method to prevent dental caries (Griffin *et.al*, 2001). Community Water fluoridation is an effective, safe, and inexpensive way to prevent tooth decay. This method of fluoride delivery benefits people of all ages and socioeconomic status. Community water fluoridation is one of the greatest public health achievements of the 20th century (Centre for disease Control and Prevention, 1999) Beaconsfield in Tasmania was the first community in Australia to receive fluoridated water in 1953 (Barnard, 1969). Water fluoridation was introduced in NSW in Yass in 1956 (Williams, 1972). Sydney commenced the fluoridation of its water supplies in 1968 (Anon, 1968).

Children in non-fluoridated areas of NSW have significantly higher decay rates compared with fluoridated areas (Armfield, 2005). Therefore, NSW Health targets these areas for water fluoridation as it substantially reduces tooth decay incidence and prevalence. However, the adoption of water fluoridation in currently non-fluoridated communities is hindered due to community reluctance (Spencer *et.al*, 1996). This is due to the misinformation provided by anti-fluoridationists. Moreover, due to the so called "halo effect" whereby

fluoride is consumed in non-fluoridated areas via the food chain, and the use of fluoridated toothpaste, the disparities between fluoridated and non-fluoridated areas has been reduced, thus leading to a wrong conclusion that water fluoridation programs are ineffective.

Formerly, community surveys in Australia indicated a decrease in support for fluoridated water (Spencer *et.al*, 1996). Public knowledge on the importance of fluoride was reported to be poor (NHMRC, 1991). However, the recent Report of the Chief Health Officer, 2006 showed that about 86 percent of the people now support water fluoridation.

The major side effect of water fluoridation, however, is the occurrence of mild levels of dental fluorosis. Water from all naturally occurring sources contains fluoride ions that range in concentration from trace amounts up to 20 parts per million (ppm). In sea water, the fluoride concentration is around 1.3 ppm. At fluoride concentrations above 6 ppm in the USA, it was shown that most individuals developed severe fluorosis, which is unacceptable from an aesthetical view point. In most cases, the naturally occurring fluoride concentration in water is less than 1 ppm. This is the case in Australia.

In his investigations to determine the fluoride concentration in drinking water that is compatible with normal tooth development, Dean (1942) found that individuals, who were born and raised in environments where the drinking water fluoride concentration was about 1 ppm, had teeth of normal appearance but that up to 20 percent had evidence of the mildest form of fluorosis. At this level, fluorosed teeth show small paper white flecks that cover up to 25 percent of the tooth surface. In general, this appearance is not noted by laypersons and is not considered to be aesthetically unpleasing (Riordan, 1993).

By the late 1930s, Dean (1942) had demonstrated that fluoride in drinking water at a concentration of around 1 ppm was associated with low caries experience. He demonstrated a strong dose response in that caries experience decreased markedly as the fluoride in drinking water increased

from near zero to around 1 ppm. At this concentration, the reduction in caries experience levelled off and that higher fluoride concentrations were not associated with further decreases in caries experience. On the other hand, he demonstrated that the occurrence and severity of dental fluorosis increased as the fluoride concentration increased above 1 ppm. The concentration of 1 ppm was, therefore, referred to as the optimal concentration, since at that concentration the side effect of dental fluorosis was negligible and caries experience was minimal. From then onwards, water fluoridation has been promoted. It has been confirmed in Australia and elsewhere that the controlled fluoridation of water supplies is associated with minimal levels of fluorosis.

The prevalence of dental fluorosis in Australia has increased over the past few years (NHMRC, 1999). Fluorosis results from the intake of a higher than desirable amount of fluoride during the period of tooth development. The possible source of fluoride is the diet, fluoridated water, fluoridated toothpaste, fluoride supplements, and fluoride mouth rinses.

The most recent guidelines for fluoride use in Australia recommend (1) that fluoride supplements should not be used, (2) that fluoride mouth rinsing should not occur in pre-school children, and (3) that the use of fluoride toothpaste should be controlled by parents (ARCPOH, 2006). It was shown in Western Australia that a reduction in fluoride exposure during childhood was achieved through public health policy initiatives, and that the prevalence of fluorosis was reduced accordingly (Riordan, 1993).

3.1 The Lithgow Local Government Area:

Lithgow is nestled in a valley to the west of the Blue Mountains and covers an area of 3500 square kilometres. It extends from Hartley Valley in the south east to the Capertee valley in the northwest. The eastern area reaches Dargan while Meadow Flat defines the western border. In 2001, the Lithgow LGA had a population of approximately 20,314 of which 4416 were in the 0 – 14 years age group (ABS, 2001). Lithgow is classified as a low socio-

economic area (SEIFA Index – 927). (*Map of the Lithgow Local Government Area – Appendix A*)

3.2 Lithgow fluoridation status

The water supply in Lithgow is not fluoridated. The NSW Government has a policy to promote the fluoridation of community water supplies. As part of this initiative, a project entitled "Teeth for Health" was established and one of the roles of the project manager is to communicate with NSW LGA for the purpose of encouraging water fluoridation. The Government will subsidise by 100 percent the capital development required to install fluoridation facilities in local government areas. An outcome of the Teeth for Health project is that a proposal to fluoridate the water supply is being considered by the Lithgow City Council.

3.3 Aims of the study

The purpose of this study was to obtain baseline data on dental fluorosis in Lithgow against which future changes can be measured following a likely commitment by the Lithgow City Council to implement water fluoridation in the near future.

The aims of the study were:

1. To estimate the prevalence and severity of dental fluorosis among school children aged 5 to 13 years in the Lithgow LGA.
2. To evaluate risk factors for dental fluorosis.
3. To determine if fluorosis scores derived from digital photographs of teeth are equivalent to results obtained from clinical scoring.

3.4 Ethics review

The research proposal for this study was approved by the Human Research Ethics Committees of the following organisations (1) the University of Sydney, (2) the Sydney West Area Health Service, (3) the New South Wales Department of Education and Training, and (4) Catholic Education diocese in Bathurst. (*Ethics approval – Appendix B*)

Chapter 4

Materials and Methods

4.1 Target population

The population studied was primary school children in Grades 1-6 (aged 5 to 13 years) residing in the Lithgow Local Government Area. Communication with the New South Wales Water Authority established that no areas within the Lithgow LGA were supplied with fluoridated water.

4.2 Sampling

4.2.1 Sampling frame

The sampling frame was the school roll of primary schools in the Lithgow LGA. Seven schools that received the water supply from the Lithgow Council were included in the study. Of these seven, four were located within Lithgow city and the other three from the nearby towns of Wallerawang, Cullen Bullen, and Hampton.

In fact, due to communication problems, some misinformation was received. Hampton did not receive reticulated water from Lithgow, and two schools in nearby Portland were omitted from the list of schools provided. The total number of consent forms sent was 1592 and out of it 711 gave consent thereby received a poor consent rate of 45 percent.

The selected schools are listed below:

1. Coerwull Public school
2. Lithgow Public school

3. Wallerawang Public school
4. Hampton Public school
5. Cullen Bullen Public school
6. St. Patrick's Catholic school
7. Zig Zag Public school

4.2.2 Method of sampling

All children listed on the school rolls were selected to be included in this survey. This method is referred to as total enumeration.

4.2.3 Recruitment of the sample

The principals of the selected schools were sent letters of invitation (see *Appendix C*) to include their schools in the survey. Then each principal was visited when the purpose of the study was explained to him/her more fully. All school principals agreed to include their school in the survey provided a formal letter of consent. They were also asked about: the best days to conduct the survey; the lunch time; and any school activities which might affect the survey on a certain day. The principals provided class lists of the children and their home addresses. On this basis, information packs were addressed to the parents of the children and were distributed to them with the help of the class teachers. Each information packs contained: a Participant Information Statement (see *Appendix D*); a Consent Form (see *Appendix D*); and Questionnaire (see *Appendix E*).

The Participant Information Statement explained the purpose of the study and assured parents that information supplied by them would be kept confidential. Parents were requested to return the completed questionnaire and the consent form to the school before the date set for examining the children. A reminder notice (see *Appendix D*) was sent to the parents via the school news letters one week after the information packages has been distributed.

Only children, whose parents/guardians had given consent for inclusion in the survey, were examined.

4.3 Fluoride history

The fluoride history (exposure to fluoridated water and use of fluoride toothpaste, fluoride supplements, fluoride mouth rinse) of each child was obtained from the questionnaire survey. The structured questionnaire used in this survey was obtained from the Australian Research Centre of Population oral Health (ARCPOH). It had been used previously in the survey of children in the Blue Mountains and Hawkesbury LGA's in 2003. Further, this questionnaire has been used elsewhere in Australia, and hence its use ensures that standardised data is obtained and can, therefore, be use for comparative purposes. The original form of the questionnaire is complex and some questions were simplified.

The questionnaire also sought demographic information, including date of birth and gender, and other information on the social circumstances of the children. Other questions were included that related to another aspect of the study, not dealt with in this thesis.

4.4 Survey team

The survey team consisted of one examiner (dental surgeon) who also directed the taking of clinical photographs, one recorder (dental surgeon) and other support researchers (dental surgeons) and one supervisor. The role of the recorder kept interchanging among the team members in order that each member gained experience.

4.5 Measurement of fluorosis

Fluorosis was measured in accordance with the Dean Index, as recommended by the World Health Organisation (WHO, 1997). The codes and criteria are as follows:

- 0- *Normal*. The enamel surface is smooth, glossy and usually a pale creamy-white colour.
- 1- *Questionable*. The enamel shows slight aberrations from the translucency of normal enamel, which may range from few white flecks to occasional white spots.

- 2- *Very Mild*. Small, Opaque, paper white areas scattered irregularly over the tooth but involving less than 25 percent of the labial tooth surface.
- 3- *Mild*: White opacity of the enamel is more extensive than for code 2, but covers less than 50 percent of the tooth surface.
- 4- *Moderate*. The enamel surface of the teeth shows marked wear and brown stain is frequently a disfiguring feature.
- 5- *Severe*. The enamel surfaces are badly affected and hypoplasia is marked to an extent that the general form of the tooth may be affected. There are pitted or worn areas and brown stains are widespread; the teeth often have corroded appearance.

The photographs of different degrees of fluorosis are illustrated (see *Appendix H*).

4.6 Clinical examination

All children were examined within the campus of the schools visited. In this study dental fluorosis was assessed in relation to the permanent maxillary central incisors alone. The permanent maxillary incisors were selected for the following reasons:

1. Ease of accessibility
2. The aesthetic aspect of fluorosis is mainly relevant to maxillary anterior teeth.

A single examiner was calibrated regarding the fluorosis diagnosis. Both intra-examiner calibration and inter-examiner calibration was periodically carried out during the survey. Examinations were carried out in shaded natural daylight, mostly indoors beside a window or if outdoors, under an awning. The teeth were examined wet. Following each assessment, the fluorosis score was entered beside the subject's name on a class list obtained from the school.

4.7 Photographic assessment

Clinical photographs of erupted permanent central incisors were taken for each child. Only the teeth and surrounding gums and lips were included in the

field of view. A Canon EOS 10 D digital camera, fixed with lens and a macro ring-flash light was used. The camera was directed at the tooth surface at an angle of 45 degrees facing downwards. Photographs were taken with the children seated on a chair. An assistant helped to retract the child's lips and to position the teeth edge to edge. During focusing, illumination was provided by a standard lamp. The photograph numbers, together with the child ID numbers, were recorded for future analysis.

An advantage of using a digital camera was that it enabled an immediate inspection to determine the quality of the photographs. It was, therefore, possible to ensure that high quality photographs were obtained before proceeding to the next child.

The images were processed using Adobe Photoshop 5. They were viewed using Microsoft Power Point software on a flat screen LCD monitor. The image size, at the standard setting, was 270 by 185 mm. At this setting, the width of a central incisor was about 70 to 80 mm.

The images were scored without knowledge of the clinical scores. The Power Point presentation was set automatically to select a new image at 5 second intervals. They were read when seated in front of the monitor where the distance from the image to the eye was about 200 mm.

4.8 Electronic data entry

The fluorosis scores and photograph numbers (linked to the subjects ID numbers) were later entered into an electronic database for subsequent statistical analysis. Similarly, data obtained from the questionnaires were entered.

The answers to questions that were left blank were coded as missing values.

4.9 Analysis

Following the entry of the completed questionnaires into an electronic database, it was checked for inconsistencies and abnormal values through

inspections of the variable values. When discrepancies were found, the questionnaires were re-checked and the database was amended as necessary.

The age of the child at the date of examination was calculated using the SAS statistical software.

The estimate of the prevalence and severity of fluorosis and the risk factors among school children was estimated using Epi Info. The steps are described as follows:

1. The variables of the questionnaire were compared with the fluorosis scores to derive the variables which provide the explanation to the fluorosis severity
2. Later a univariate logistic regression was carried out to find out the effect of potential explanatory variables on dental fluorosis
3. Finally a multiple logistic regression was carried out using the backward step wise method for predicting fluorosis in Lithgow LGA.

To determine if fluorosis scores derived from digital photographs of teeth are equivalent to results obtained from clinical scoring were carried out by comparing the fluorosis scores by both clinical and photographic method using the SAS Statistical Software.

Chapter 5

Result 1

A total of 1,592 children aged between 5 to 13 years were selected to take part in the survey. Of these 711 children were given consent for clinical examination. The overall response rate was 44.7percent (Table 5.1). The overall sample included 243 males and 259 females with erupted permanent maxillary incisors in the age groups 6 – 13 years (Table 5.2)

5.1 Prevalence of dental fluorosis scores and Community Fluorosis Index Values.

Table 5.3 shows the fluorosis scores and its prevalence among schools in Lithgow LGA. It was found that nearly 47 percent of the school children were normal. Of the 148 children examined in Coerwull Public school, nearly 70 percent of the children had fluorosis which was either questionable, very mild and severe fluorosis. More than 50 percent of the children were normal in Cullen Bullen and Hampton. The highest CFI of 0.51 was observed in Wallerawang School and the lowest CFI of 0.35 was in Zig Zag Public. The overall CFI of all the schools in the Lithgow LGA was found to be 0.45.

5.2 Age specific distribution of fluorosis scores and CFI values

The Table 5.4 represents the comparison of different ages with the different levels of Dean's Fluorosis scores. The ages compared to the Dean's fluorosis scores were from 6 to12. Dean's fluorosis scores were categorised into Normal, Questionable, Very Mild, Mild, and Moderate and Severe fluorosis.

Table 5.1 : Participant consent rate for children taking part in Lithgow LGA survey.

	n	%
Consent form and Questionnaires sent	1592	100
Consent given	711	44.66
Consent not given	881	55.34

Table 5.2 :Distribution of children by age and gender with erupted
maxillary central incisor

Age (years)	Male	Female	Both
6	8	9	17
7	22	24	46
8	48	40	88
9	38	49	87
10	40	47	87
11	41	55	96
12	46	35	82
Total	243	259	502

Table 5.3: Prevalence of a dental fluorosis scores and Community Fluorosis Index (CFI) values among schools in Lithgow LGA.

Fluorosis Grades	Coerwull		Cullen Bullen		Hampton		Lithgow Public		St.Patricks		Wallerawang		Zig Zag		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Normal	66	44.6	8	61.5	3	42.9	59	49.6	50	44.6	33	45.2	18	60	237	47.20
Questionable	45	30.4	1	7.7	1	14.3	27	22.7	36	32.1	15	20.5	9	30	134	26.70
Very mild	32	21.6	3	23.1	2	28.6	27	22.7	20	17.9	20	27.4	3	10	107	21.30
Mild	4	2.7	1	7.7	1	14.3	5	4.2	6	5.4	5	6.8	0	0	22	4.40
Moderate	0	0	0	0	0	0	1	0.8	0	0	0	0	0	0	1	0.00
Severe	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
Total	148		13		7		119		112		73		30		502	100.0
CFI	0.45		0.42		0.42		0.44		0.44		0.51		0.35		0.45	

Table 5.4: Age-specific Community Fluorosis Index (CFI) values and dental fluorosis scores according to the Dean Index.

Fluorosis Score	Age (years)												Total			
	6		7		8		9		10		11			12		
	n	%	n	%	n	%	n	%	n	%	n	%		n	%	
Normal	12	71	17	38	32	36	34	39	48	55	50	52	44	53	237	47.20
Questionable	2	11	19	42	28	31	26	30	22	25	19	20	18	22	134	26.70
Very mild	2	11	9	20	25	29	22	25	12	13	19	19	18	22	107	21.30
Mild	1	6	0	0	3	3	4	4	5	5	8	8	1	1	22	4.40
Moderate	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.00
Severe	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.00
Total	17		45		88		87		87		96		82		502	99.60
CFI	0.35		0.41		0.51		0.54		0.38		0.46		0.39		0.45	

The table showed that less than 50 percent of the children were normal and of it more than 70 percent of the children of age six were normal. More than 40 percent of children age 7 had questionable fluorosis. One fifth of the children of age 7, 11, 12 had very mild fluorosis. Nearly 30 percent of the children of age 8 had very mild fluorosis. Less than 5 percent of the children examined had mild fluorosis. There was only one child each who had moderate and severe fluorosis. The total CFI according to Deans Index was 0.45.

5.3 Bivariate associations of fluorosis experience in potential explanatory variables.

Table 5.5 represents the bivariate analysis between the fluorosis experience of children aged 5 to 13 years and potential explanatory variables. The potential explanatory variables are classified under the following headings: demographic factors, socioeconomic factors, tooth brushing factors, other fluoride exposure, dental history, and variables not classified elsewhere. Of the 34 potential explanatory variables, 5 were found to be significantly associated with the mean fluorosis scores. These were age of the child, age of the child when tooth brushing with toothpaste commenced, type of toothpaste used, and source of drinking water during the period of tooth development, and exposure to fluoridated water.

5.3.1. Dental fluorosis and age of the child

The low mean fluorosis scores was 0.53 for age 6 and the highest was the age 8 with the mean fluorosis score of 0.99. The p value was marginally significant in association of fluorosis scores with the age of the child.

5.3.2 Dental fluorosis and toothbrushing factors

Forty-one percent of the children had commenced tooth brushing before and including the age of 12 months. Most of the remainder commenced during

Table 5.5: Mean Fluorosis scores and related statistics stratified by potential explanatory variables

Potential explanatory variable	Variable Category	N	Mean	SD	Percent	Chi-square*	p value
Demographic factors	Age of child (years)	6	0.53	0.94	3.3	11.70	0.07
		7	0.82	0.75	8.9		
		8	0.99	0.89	17.5		
		9	0.98	0.94	17.3		
		10	0.70	0.91	17.5		
		11	0.84	1.02	19.1		
		12	0.73	0.89	16.1		
Sex of the child	Male	243	0.87	0.96	48.4	0.35	0.54
	Female	259	0.80	0.88	51.6		
Child of Aboriginal or Torres Strait Islander origin	No	480	0.84	0.93	95.6	0.28	0.60
	Aboriginal	22	0.68	0.72	4.3		
	Torres Strait Islander	0	0.00	0.00	0.0		
	Aboriginal and Torres Islander	0	0.00	0.00	0.0		
	Strait Islander						
Child in one-parent household?	Yes	112	0.79	0.95	22.3	0.53	0.47
	No	390	0.85	0.92	77.6		
Country of birth	Australia	497	0.84	0.93	99.0	1.95	0.58
	Overseas	5	0.33	0.58			
Birth place of mothers	Australia	457	0.83	0.92	91.0	0.13	0.90
	Overseas	39	0.82	0.85	7.7		
Birth place of fathers	Australia	357	0.84	0.91	71.1	0.12	0.73
	Overseas	24	0.88	0.85	4.7		

*Kruskal Wallis

continued over

Potential explanatory variable	Variable Category	N	Mean	SD	Percent	Chi-square*	p value
Is English the language spoken at home?	Yes	490	0.83	0.93	9.7	0.12	0.73
	No missing values	6	0.67	0.82	1.1		
Number of missing teeth of the mother	1-4 Missing teeth	187	0.86	0.89	37.2	2.56	0.27
	More than 5 missing teeth	77	0.75	0.89	15.3		
	Missing values	18	0.56	0.78			
Socioeconomic factors							
Do you have dental insurance?	Yes	187	0.84	0.90	37.2	0.09	0.70
	No	288	0.83	0.94	57.3		
	Missing values	27					
Education level of male parent/guardian	Some high school	75	0.84	0.89	14.9	3.28	0.66
	Completed high school	107	0.97	0.96	21.3		
	Some vocational training	62	0.76	0.88	12.3		
	Completed vocational training	82	0.78	0.93	16.3		
	Some university or college	17	0.82	0.88	3.3		
	Completed university or college.	40	0.93	0.92	7.9		
	Missing values	119					
Education level of female parent/guardian	Some high school	110	0.80	0.90	21.9	3.32	0.51
	Completed high school	188	0.85	0.92	37.4		
	Some vocational training	84	1.00	1.05	16.7		
	Completed vocational training	0	0.00	0.00	0.0		
	Some university or college	45	0.82	0.94	8.9		
	Completed university or college.	71	0.68	0.79	14.1		
	Missing values	4					
Number of missing teeth of the father	1-4 Missing teeth	132	0.83	0.90	26.3	0.25	0.87
	More than 5 missing teeth	74	0.77	0.88	14.7		
	Missing values	132	0.82	0.96			

*Kruskal Wallis

continued over

Potential explanatory variable	Variable Category	N	Mean	SD	Percent	Chi-square*	p value
Occupation of the female parent/ guardian	Manager and Administrators	48	0.90	0.97	9.5	12.40	0.14
	Professionals	40	0.75	0.87	7.9		
	Associate Professionals	21	0.71	0.90	4.2		
	Trade and Clerical Workers	56	0.91	0.90	11.1		
	Advanced Clerical & Service Workers	66	0.80	0.85	13.1		
	Inermediate clerical,sales and	33	1.21	1.02	6.5		
	Intermedate production and	29	0.72	1.00	5.7		
	Elementary clerical sales and service	21	0.38	0.67	4.2		
	Labourers and related workers	173	0.85	0.93	34.4		
Occupation of the male parent/ guardian	Manager and Administrators	60	1.08	0.96	11.9	13.60	0.13
	Professionals	33	1.15	0.97	6.5		
	Associate Professionals	42	0.83	0.88	8.3		
	Trade and Clerical Workers	19	0.79	1.03	3.7		
	Advanced Clerical & Service Workers	13	0.46	0.78	2.5		
	Inermediate clerical,sales and	40	0.68	0.80	7.9		
	Intermedate production and	78	0.87	0.94	15.5		
	Elementary clerical sales and service	74	0.72	0.88	14.7		
	Labourers and related workers	51	0.73	0.80	10.1		
Total household income	Up to \$20,000	78	0.64	0.87	15.5	7.20	0.29
	\$20,001 to \$40,000	79	0.94	0.92	15.7		
	\$40,001 to \$60,000	59	0.98	0.99	11.7		
	\$60,001 to \$80,000	62	0.92	0.89	12.3		
	\$80,000 to \$100,000	49	0.84	1.01	9.7		
	Over \$100,000	45	0.76	0.85	8.9		
Tooth brushing factors							
Type of toothpaste used	Standard fluoride toothpaste	374	0.79	0.93	74.5	6.61	0.07
	Children's toothpaste	119	0.94	0.90	23.7		
	Missing values	7					

*Kruskal Wallis

continued over

Potential explanatory variable	Variable Category	N	Mean	SD	Percent	Chi-square*	p value
How much toothpaste did/does your child (or do you) put on his/her toothbrush	Full brush	174	0.84	0.93	34.6	0.10	0.95
	Half brush	270	0.83	0.91	53.7		
	Pea size	54	0.81	0.97	10.7		
	Missing values	4					
When did/does your child usually brush his/her teeth ?	Before breakfast	162	0.84	0.90	32.2	0.06	0.97
	After Lunch	312	0.84	0.94	62.1		
	After dinner	27	0.81	0.96	5.3		
	Missing values	1					
How often does your child brush his/her teeth with toothpaste ?	Less than once daily	23	0.87	0.97	4.6	0.61	0.89
	Once daily	158	0.87	0.89	31.4		
	Twice daily	306	0.82	0.94	60.9		
	More than twice daily	14	0.86	1.03	2.7		
After tooth brushing does your child usually....	Rinse and swallow	25	0.92	1.00	4.9	0.44	0.80
	Rinse and spit	419	0.83	0.92	83.4		
	Just swallow	0	0.00	0.00	0.0		
	Just spit	53	0.89	0.91	10.5		
	Other	0	0.00	0.00	0.0		
	Don't know	0	0.00	0.00	0.0		
	Missing values	5					
Age (months) when toothbrushing with toothpaste commenced	0 - 17	206	0.78	0.91	41.0	9.33	0.02
	18-24	176	0.95	0.93	35.0		
	25-36	78	0.65	0.91	15.5		
	37 +	42	0.98	0.92	8.3		
	Missing values	2					
Have you noticed your child licking or eating toothpaste	Often	0	0.00	0.00	0.0	0.76	0.38
	Sometimes	120	0.87	0.84	2.4		
	Never	382	0.83	0.95	76.1		

*Kruskal Wallis

continued over

Potential explanatory variable	Variable Category	N	Mean	SD	Percent	Chi-square*	p value
Other Fluoride Exposure							
Child ever fed on infant formula?	Yes	375	0.84	0.91	74.7	1.01	0.60
	No	126	0.84	0.98	25.1		
At what age did your child start taking fluoride tablets ?	Age group 1- 24 months	18	0.50	0.62	3.6	3.66	0.16
	Age group 25+	31	0.65	0.88	6.1		
	Not applicable	453	0.86	0.93	90.2		
Exposure to fluoridated water (months)	No exposure to fluoridated water	373	0.71	0.85	74.3	33.90	0.00
	1 and 24 months exposure	40	0.85	0.98	7.9		
	25 and 48 months exposure	34	1.12	1.01	6.7		
	More than 49 months	55	1.51	1.02	10.9		
Main source of drinking water during the period of tooth development	Carbon/charcoal filtered water	19	1.32	1.06	3.7	26.30	0.00
	Mains supply (fluoridated)	97	1.20	1.05	19.3		
	Mains supply (non-fluoridated)	297	0.69	0.84	59.1		
	Osmosis/distillation filtered water	43	1.00	0.90	8.5		
	Tank rain water	46	0.67	0.84	9.1		
Age started taking fluoride mouthrinse (months)	Age group 9 and 24 months	22	0.64	0.73	4.4	1.10	0.56
	Age group 25 months +	84	0.79	0.92	16.7		
	Not applicable	396	0.86	0.93	78.8		
Dental History							
Time been since the child's last dental visit ?	Less than 6 months	282	0.81	0.90	56.1	5.37	0.37
	Between 6 and 12 months	115	0.82	0.97	22.9		
	Between 1 and 2 year	69	0.96	0.93	13.7		
	More than 2 years	15	1.27	1.10	2.9		
	Never	16	0.63	0.81	3.1		
	Dont know	4	1.00	0.82			

continued over

*Kruskal Wallis

Potential explanatory variable	Variable Category	N	Mean	SD	Percent	Chi-square*	p value
Not classified elsewhere							
Who should take responsibility for a decision to fluoridate the public water supply ?	State government	52	0.69	0.90	10.3	3.80	0.79
	Health authorities	190	0.85	0.93	37.8		
	Dental associations	85	0.81	0.87	16.9		
	Water boards	3	0.33	0.58	0.0		
	Community	86	0.88	1.01	17.1		
	Others _____ specify	5	0.60	0.89	0.0		
	Don't know	71	0.86	0.90	14.1		
	Refused	5	1.40	1.34	0.0		
	Missing values	5					
Would you be favour in adding fluoride to the public water supply to prevent dental decay ?	In children?	27	0.74	0.81	5.3	1.90	0.75
	In adults?	0	0.00	0.00	0.0		
	Both children and adults	325	0.80	0.91	64.7		
	Neither	31	0.87	1.06	6.1		
	Don't know	98	0.91	0.93	19.5		
	Refused	14	1.14	1.23	2.7		
	Missing values						
Water used to constitute infant formula.	Mains supply	307	0.84	0.90	61.1	7.19	0.21
	Carbon/charcoal filtered water	2	2.50	0.71	0.0		
	Osmosis/distillation filtered water	12	0.92	0.90	2.3		
	Mineral/Spring water	24	0.83	0.96	4.8		
	Tank rain water	20	0.60	0.88	4.0		
	Missing values	5	1.20	1.10			

*Kruskal Wallis

their second year of life. The age at commencement of tooth brushing was significantly associated with fluorosis severity ($p < 0.02$). However, the pattern was not an increasing trend. Fluorosis scores were lower in those who commenced brushing when aged 0 -12 and 25-36 months and higher in the age groups of 13-24 and 37 or more months.

The majority of the children used standard fluoride toothpaste (normally 1000 ppm) followed by children's toothpaste which contains only 400 ppm fluoride. It was found that children using the low fluoride toothpaste had a mean fluorosis score of 0.94 which was higher than that for standard fluoride toothpaste use (0.79).

5.3.3 Dental fluorosis and exposure to fluoridated water

More than 63 percent of the children had no exposure to fluoridated water. The remaining 37 percent were exposed to fluoridated water prior to taking up residence in Lithgow. Fluorosis scores were directly proportional to the number of month's exposure to fluoridated water ($p < 0.001$). The mean fluorosis score of those not exposed was 0.71, whereas those that had been exposed for more than 49 months had a mean score of 1.51.

5.3.4 Dental fluorosis and main source of drinking water during tooth development

Most of the children were exposed to mains supply water, as their major source of drinking water, which was not fluoridated. These children had a low mean fluorosis score of 0.69, which was only slightly higher than that for children whose water source was tank rain water 0.67, whereas children who were exposed to a fluoridated mains supply had a mean fluorosis score of 1.20. The 19 children using water that had been treated using a carbon filter had the highest mean fluorosis score of 1.32.

5.3.5 Dental fluorosis and other potential explanatory variable

No other explanatory variable was significantly associated with fluorosis experience. However, more than 60 percent of children brushed twice daily. The most usual time for tooth brushing was after lunch. Most used a full or half brush load of toothpaste, but only 10 percent used the recommended Pea-sized amount on their toothbrush. It was also reported that 83 percent of children rinsed and spat after tooth brushing.

Another finding, which was interesting, was that children with the lowest observed mean fluorosis scores resided in households that had the highest and lowest incomes, whereas, children from the middle income households had the higher observed scores, but as already noted, not significantly higher

Regarding the question of fluoridation, 65 percent of the respondents favoured the addition of fluoride to the water supply for the benefit of preventing dental decay in both children and adults.

5.4 Equivalence of clinical and photographic assessment of fluorosis

The equivalence between the Dean Index fluorosis scores derived from the separate clinical and photographic assessments are shown in (Table 5.6).

A total of 479 subjects had erupted central incisors and digital photographs were taken of their teeth (*see Appendix H*).

Of the 228 subjects whose incisors were scored as normal, according to the clinical method, 215 of their photographic images were also rated as normal. The equivalence, therefore, was 94 percent. With regard to the category of questionable fluorosis, of the 128 subjects for whom this clinical score was recorded, the agreement with the photographic image score was 85 percent. There was complete agreement on the one case of severe fluorosis. The equivalence for very mild and mild fluorosis was 78 and 67 percent,

respectively. The non-zero numbers to the left of the shaded numbers in (Table 5.6) indicated that, compared with the clinical rating, the photographic scores were under-rated. Overall, more scores derived from the photographic images were under- rather than over-rated. The related simple and weighted Cohen's kappa values, that are measures of agreement between the two systems, were 0.80 and 0.85, respectively (see *Appendix G*).

Table 5.6: Equivalence between clinical and photographic scores of dental fluorosis using Dean Index.

Clinical score	Photographic score								Clinical Total		
	Normal		Questionable		Very mild		Mild			Severe	
	N	[%]	N	[%]	N	[%]	N	[%]		N	[%]
Normal	215	94	13		0		0		0		228
Questionable	14		108	85	6		0		0		128
Very mild	1		15		79	78	6		0		101
Mild	0		0		7		14	67	0		21
Severe	0		0		0		0		1	100	1
Photographic Total	230		136		92		20		1		479

Number and percent cases showing complete agreement between the clinical and photographic scores.

Cohen's Kappa: 0.80 (Simple), 0.86 (Weighted)

Chapter 6

Result 2

Table 6.1 contains the results of the univariate logistic regression analysis of the effect of potential explanatory variables on dental fluorosis among children aged 5 to 13 years of age. The five variables explored were those that showed significant associations with fluorosis they were: the age of the child; type of toothpaste used; exposure to fluoridated water; age in months when the child started tooth brushing; and main source of drinking water during the period of tooth development. Three models were investigated; the odds of: any fluorosis (fluorosis was dichotomised as 0 = score 0, 1 = scores 1 and above) very mild or more severe fluorosis (dichotomised 0 = score 0 + 1, 1 = scores 2 and above), and mild fluorosis or more severe fluorosis (dichotomised 0 = scores 0 + 1 + 2, 1 = scores 3 and above),

6.1. Odds of any fluorosis

The age of the child was associated with fluorosis. Odds of any fluorosis decreased by 10 percent; per year increase in age (OR = 0.90; 95% CI = 0.81, 1.00).

It was found that children using standard fluoride toothpaste had decreased odds of developing any fluorosis (OR = 0.63; 95%CI = 0.41, 0.95) compared with users of toothpaste for children that contain a low fluoride concentration.

Table 6.1: Univariate logistic regression analysis of the effect of potential explanatory variables on dental fluorosis.
Categories shown in bold are reference categories in relation to odds ratio estimates.

Potential explanatory variable	Variable category	N	Normal versus Questionable and above				Normal + Questionable versus Very Mild and above				Normal + Quest. + Very Mild versus Mild and above			
			OR	95% C.I	p value		OR	95% C.I	p value		OR	95% C.I	p value	
Age of child (years)	Continuous	502	0.90	0.81	1.00	0.05	1.00	0.89	1.12	0.94	1.11	0.87	1.42	0.40
Type of toothpaste used ?	Standard fluoride toothpaste	374	0.62	0.41	0.95	0.03	0.83	0.52	1.31	0.42	1.15	0.42	3.17	0.78
	Low fluoride formulation toothpaste	119												
Exposure to fluoridated water	1 to 24 months	373	1.21	0.63	2.33	0.57	1.24	0.58	2.65	0.57	3.70	0.94	14.55	0.06
	25 to 48 months	40	2.29	1.09	4.83	0.03	1.78	0.83	3.81	0.13	6.08	1.73	21.37	0.04
	More than 49 months	34	3.93	2.01	7.68	0.00	4.81	2.67	8.65	0.00	8.93	3.28	24.28	0.00
	No exposure	55												
Age in months when child started toothbrush with toothpaste	18- 24 months	502	1.61	1.07	2.42	0.02	1.21	0.76	1.90	0.42	1.65	0.65	4.20	0.29
	25-36 months		0.69	0.43	1.16	0.16	0.84	0.45	1.54	0.60	0.99	0.25	3.83	1.00
	37+ months		1.68	0.85	3.33	0.13	1.36	0.65	2.81	0.40	1.23	0.25	6.04	0.79
	0-17 months													
Main source of drinking water during the period of tooth development	Carbon/charcoal filtered water	19	3.33	1.03	10.78	0.04	2.99	0.93	9.60	0.06	8.44	0.82	87.06	0.07
	Mains supply (fluoridated)	97	2.31	1.13	4.73	0.02	2.89	1.25	6.64	0.01	6.35	0.80	50.43	0.08
	Mains supply (non-fluoridated)	297	1.05	0.56	1.95	0.88	1.02	0.47	2.23	0.90	1.09	0.13	9.04	0.90
	Osmosis/distillation filtered water	43	2.01	0.86	4.69	0.10	2.20	0.84	5.76	0.10	1.07	0.06	17.68	96.00
	Tank rain water	46												

In comparison with children who commenced toothbrushing with toothpaste during the period from birth to 17 months, children who commenced started toothbrushing between the ages of 18 months and 2 years were 61 percent more likely to experience any fluorosis (OR = 1.61, 95%CI = 1.07, 2.42).

Compared with children who were not exposed to fluoridated water, those who had been exposed to fluoridated water for 25 to 48 months and more than 49 months, respectively, had increased odds of experiencing any fluorosis (OR=2.29, 95%CI=1.09-4.83; OR=3.93, 95%CI=2.01-7.68).

The effect of exposure to fluoridated water was also explored from a different angle. Those who had been exposed to fluoridated mains supply, and those who were exposed to a carbon-filtered supply, were 3 times and 2.5 times, respectively, more likely to experience any fluorosis than users of tank rain water (OR=3.33, 95%CI=1.03-10.8; OR=2.31; 95%CI=1.13-4.73).

6.2 Odds of very mild or more severe fluorosis

Only two variables were significant predictors of very mild or more severe fluorosis. In comparison with children who were not exposed to fluoridated water, those who had been exposed to fluoridated water for more than 49 months, had almost five times the odds of experiencing very mild or more severe fluorosis (OR=4.81, 95% CI=2.67,8.65).

In comparison with the users of tank rain water, those who had been exposed to fluoridated mains supply were nearly 3 times more likely to experience very mild or more severe fluorosis (OR=2.89, 95% CI=1.25,6.64).

6.3 Odds of mild or more severe fluorosis

Only one potential explanatory variable was associated with increased odds of fluorosis. Those who had been exposed to fluoridated water for more than 49 months had increased odds of experiencing fluorosis (OR=4.81, 95% CI=2.67, 8.65) in comparison with children who were not exposed to fluoridated water.

6.4 Best fitting multiple logistic regression model for predicting fluorosis in Lithgow

Tables 6.2 and 6.3 shows the results of the best fitting multiple logistic regression models for predicting fluorosis in Lithgow children.

All five variables showing a univariate association ($p < 0.05$) with the any fluorosis were considered in the multiple variable analysis. Two of these variables are concerned with exposure to fluoridated water, but from different perspectives. Therefore, two models were explored; each using only one of the two possible variables related to fluoridated water exposure, that is, four variables were entered into each model. Selection of the entered variables was according to the backward stepwise method.

In the model that included exposure to fluoridated grouped in 24 month categories, only three variables remained significant. These were exposure to fluoridated water, type of toothpaste used, age when toothbrush with toothpaste commenced. Exposure to fluoridated water for between 25 and 48 months, and more than 49 months was associated with increased odds of two and four times, respectively, of experiencing any fluorosis ($OR = 2.19$, 95% $CI = 1.03, 4.67$; $OR = 4.14$, 95% $CI = 2.09, 8.21$). The children who used a standard fluoride toothpaste had decreased odds of developing fluorosis ($OR = 0.54$; 95% $CI = 0.35, 0.84$) compared with the users of toothpaste that contained a low fluoride concentration. And also children who commenced toothbrushing with toothpaste during the period from birth to 17 months, children who commenced started toothbrushing between the ages of 18 months and 2 years were 53 percent more likely to experience any fluorosis ($OR = 0.63$, 95% $CI = 0.39, 1.01$).

In the second model, where exposure to fluoridated water was included as one of several other sources of drinking water during tooth development, only age when toothbrushing with toothpaste commenced remained significant.

Table 6.3. Best fitting multiple logistic regression* analysis for predicting any** fluorosis in Lithgow children. Model 2 (includes water source as a predictor).

Categories shown in bold are reference categories in relation to odds ratio estimates.

Explanatory Variable	Variable Category	OR	95% C.I	p value
Age of child (years)	Continuous	0.91	0.81 1.03	0.12
Type of toothpaste used	Standard fluoride toothpaste	0.70	0.44 1.13	0.14
	Low fluoride formulation toothpaste	1.00		
Age (months) when toothbrushing with toothpaste commenced	Age group 18 - 24	1.58	1.04 2.42	0.03
	Age group 25 - 36	0.71	0.41 1.23	0.22
	Age group 37+	1.49	0.73 3.05	0.27
	Age group 0 - 17	1.00		
Main source of drinking water during tooth development.	Carbon/charcoal filtered water	2.79	0.84 9.26	0.09
	Mains supply (fluoridated)	1.88	0.89 3.96	0.09
	Mains supply (non-fluoridated)	0.87	0.46 1.66	0.69
	Osmosis/distillation filtered water	1.76	0.74 4.19	0.19
	Tank rain water	1.00		

* Backward stepwise selection method

** Normal versus questionable and more severe fluorosis.

Table 6.3. Best fitting multiple logistic regression* analysis for predicting any** fluorosis in Lithgow children. Model 2 (includes water source as a predictor).

Categories shown in bold are reference categories in relation to odds ratio estimates.

Explanatory Variable	Variable Category	OR	95% C.I	p value
Age of child (years)	Continuous	0.91	0.81 1.03	0.12
Type of toothpaste used	Standard fluoride toothpaste	0.70	0.44 1.13	0.14
	Low fluoride formulation toothpaste	1.00		
Age (months) when toothbrushing with toothpaste commenced	Age group 18 - 24	1.58	1.04 2.42	0.03
	Age group 25 - 36	0.71	0.41 1.23	0.22
	Age group 37+	1.49	0.73 3.05	0.27
	Age group 0 - 17	1.00		
Main source of drinking water during tooth development.	Carbon/charcoal filtered water	2.79	0.84 9.26	0.09
	Mains supply (fluoridated)	1.88	0.89 3.96	0.09
	Mains supply (non-fluoridated)	0.87	0.46 1.66	0.69
	Osmosis/distillation filtered water	1.76	0.74 4.19	0.19
	Tank rain water	1.00		

* Backward stepwise selection method

** Normal versus questionable and more severe fluorosis.

Compared with those who commenced brushing during the period from birth till age 17 months, children who commenced started tooth brushing at the age group of 18 to 24 months, were 58 percent more likely to experience any fluorosis (OR = 1.58, 95% CI = 1.04,2.42).

Chapter 7

Discussion

The present survey provided an insight to the prevalence of dental fluorosis and the risk factors for dental fluorosis in the Lithgow LGA.

7.1 Prevalence and severity of dental fluorosis

In terms of dental fluorosis, the teeth of almost 50 percent of the children surveyed were scored as normal, and one quarter of them had borderline signs indicating possible fluorosis. Apart from two children, the remaining quarter had teeth that showed evidence of mild fluorosis. Two children had more severe dental fluorosis; one was rated as moderate fluorosis according to the Dean scale, and the other, severe. The overall CFI value was 0.45 which, according to Dean, does not indicate a public health problem. In the 1930s, when Dean was investigating dental fluorosis, the teeth of individuals who resided in low fluoride areas were non-fluorosed. However, the fluorosis prevalence among Lithgow children is similar to that found by Dean in the 1930s among children who resided in communities (in the USA) where the water source contained natural fluoride concentrations of around 1 ppm. Since the natural fluoride concentration in the Lithgow water supply is 0.1 ppm, the fluorosis observed is not due to fluoride in the drinking water and, therefore, must be due to an exposure from some another source.

The prevalence of fluorosis at any level in non-fluoridated Lithgow was 52.7 percent. This is in accordance with the findings of other studies in the recent past. Conway *et al.* (2005) reported that the prevalence of dental fluorosis in non-fluoridated Halmstad, Sweden, was 49 percent. In other studies, Pendry's (1990) and Clark (1994) reported that the prevalence of fluorosis in non-

fluoridated communities could range between 3 and 55 percent. This is higher than the expected levels of fluorosis among residents in a non-fluoridated and this led to a search to identify the cause of increased prevalence. Dean (1954) reported that the overall fluorosis prevalence in non-fluoridated communities would be expected to be 2 percent or less.

7.2 Dental fluorosis and age of child

In our study we found that age of the child was not significant with the fluorosis scores but when the values were analysed later using Univariate logistic regression age of the child was found to be significant with the fluorosis scores. In spite of an extensive literature review there were no reports on age related fluorosis.

7.3 Dental fluorosis and toothbrushing factors

It was assumed based on published studies that the earlier the child started toothbrushing, the more severe the fluorosis. In fact, the data tended to support the reverse situation. Children who started toothbrushing at an age less than 18 months had a mean fluorosis score of 0.78 (Table 5.5), whereas children who stated tooth brushing between the age of 18 months and 2 years, had mean fluorosis score of 0.95. It was observed that children who started toothbrushing between ages 18 months and 2 years were 53 percent more likely to get fluorosis compared with children who started toothbrushing before the age of 18 months (Table 6.2). This finding is not consistent with findings in other studies. Mascarenhas and Burt (1998) reported that children who started toothbrushing before the age 2 years had more severe fluorosis compared with children who started tooth-brushing after this age. In another study, Wang *et al.* (1997) reported that children who started toothbrushing at or before the age of 14 months were 2.4 times more risk at to dental fluorosis compared with children who started toothbrushing after the age of 14 months. In studies with environments similar to Australia, it was observed that the earlier the age at start of toothbrushing, the more severe the fluorosis (Lalumandier *et.al*, 1995).

7.4 Dental fluorosis and type of toothpaste used

It was assumed that compared with the use of toothpaste that had a low fluoride concentration; the use of standard fluoride toothpaste would be associated with an increased risk of dental fluorosis due to the higher concentration of fluoride. However, in the current study this was not the case. It was observed that children who used standard fluoride toothpaste were 38 percent less likely to have signs of fluorosis compared with children who used low fluoride formulation toothpaste (Table 6.2). A similar finding was observed by Evans and Darwell (1995) conducted a study to determine the critical period for susceptibility to fluorosis in human maxillary central incisors. They found that males aged 15-24 months and females aged 21-30 months, who were exposed to dietary fluorides, were more at risk of fluorosis development than children of other. However, recently a randomised controlled trial was conducted to assess the prevalence and severity of dental fluorosis among children who used 400 ppm fluoride toothpaste and children who used 1450 ppm fluoride toothpaste (Tavener *et.al*, 2006). Tavener *et.al*. (2006) reported that the prevalence of fluorosis among those who used standard fluoride toothpaste compared with a prevalence of who used low fluoride formulation toothpaste. Although the odds of fluorosis in the 1450-ppm fluoride toothpaste (OR=1.7) group were high compared with the odds in children using the 440 ppm fluoride toothpaste (OR=0.94) group, the prevalence and the attributable risk were low. Bentley *et al*. (1999) conducted a study in the United Kingdom on the amount of fluoride remaining in the mouth after brushing with either a 400 ppm fluoride toothpaste or 1450 ppm fluoride toothpaste. It was found that no child of average weight, who used the 400 ppm fluoride toothpaste twice daily, ingested more than 0.05mg F/Kg body weight (the considered threshold for fluorosis development), however, 14 average weight children would have exceed this amount if they had used the 1450 ppm fluoride toothpaste.

7.5 Dental fluorosis and other fluoride exposure

In our multivariate analysis, it was observed that children who had two to four years of exposure to fluoridated water were more than two times; and children

who had more than four years of exposure to fluoridated water were more than four times likely to get dental fluorosis (Table 6.2).

Griffin (2002) reported that in the United States 33 percent of the children living in an optimally fluoridated area had very mild or more severe fluorosis. On the other hand no children living in a non-fluoridation area presented with signs of fluorosis. He estimated that the risk of fluorosis attributable to fluoridated water was 24 percent.

In Western Australia, Riordan and Banks (1991) reported that children residing in a fluoridated area for one to 2.4 years were three times more likely to experience fluorosis (OR = 3.02) compared with children who had resided in a fluoridated area for less than one year. In the same study, it was also reported that children residing in a fluoridated area for 2.5 to four years had four times the odds (OR= 4.06) of experiencing fluorosis compared with children who had lived in a fluoridated area for less than one year.

Results from these two studies, and our Lithgow survey, confirms Dean's findings that exposure to water containing fluoride at a concentration of around 1 ppm is a risk factor for dental fluorosis.

7.6 Dental fluorosis and water source

It was interesting to find that though carbon filters are supposed to remove fluoride from water, children using carbon-filtered water their drinking water source were at risk of dental fluorosis. This finding questions the purpose of use of carbon filters. Studies conducted elsewhere have failed to establish that domestic water filters remove fluoride (Ong *et.al*, 1996; Buzalaf, 2003). In a recent study conducted in Blue Mountains, NSW, Bal (2003) reported that children who used carbon-filtered water to reconstitute infant formula were more likely to develop fluorosis (OR=6.0) compared with children who used tank rain water. It is possible that, somehow, these filters were concentrating the fluoride. On the contrary, Jobson (2000) reported that fluoride in drinking water is removed efficiently with the use of carbon filters.

From the above results it is evident in spite the water supply of the Lithgow LGA being not fluoridated there are findings of very mild and mild fluorosis which could be from other risk factors like previous exposure to fluoridated water, the type of toothpaste used and commencement of tooth brushing with toothpaste. As Lithgow Council is going implement water fluoridation in the near future, It would be interesting to find out the ideal amount of fluoride be introduced in the water supply taking consideration to the above findings.

7.7 Comparison of the clinical and photographic scoring

In our study it was observed that the clinical and the photographic score result agreed closely (Table 5.6). This finding is consistent with other studies. Tabari (2000) reported that clinical scores and photographic scores based on TF criteria were highly reproducible ($\kappa = 0.7$). In a similar study, in which the TF and modified DDE indices were used, Sabieha (1998) assessed the agreement between clinical and photographic scores. It was reported that agreement between the clinical and photographic scores was good for both the TF and modified DDE indices (Spearman rank correlation coefficients of 0.77 and 0.69, respectively).

7.8 Limitations of the Study

A limitation of the current study was the poor response rate. Although weekly reminder notices were sent to parents for four weeks with the school newsletters, the response rate was low. One of the reasons could be due to the lengthy questionnaire, participant information statement and the consent forms, or that parents may not have placed a high importance on dental health.

Many children that should have been screened were missed out in the survey. because

1) Due to the misinformation received concerning the schools located in the Lithgow LGA, the coverage of the survey was not complete. It was reported

personnel in the Lithgow Community Health Centre that children living in Portland had poorer oral health than elsewhere. Whether or not Portland children were likely to have signs of dental fluorosis is not known.

2) From the school principals it was found out that the response rate from parents related to school matters were very low, therefore a low response rate.

With regards to the questionnaire, the answers to several questions depended on the ability of the respondents to recall practices of their children that occurred about a decade ago. The responses to these questions, therefore, are subject to recall bias. In particular, questions concerning the detailed early history of: (1) toothbrushing, (2) use fluoride supplements, and (3) dietary habits, were likely to be incorrect.

7.9 Major findings

The major findings from this study were:

1. The Community Fluorosis Index in Lithgow was 0.45. At this level, dental fluorosis is not considered to pose a public health concern.
2. Children who commenced tooth brushing with toothpaste when aged 18 -24 months had higher odds of fluorosis than children who commenced brushing at earlier or later ages.
3. Exposure to fluoridated water was a fluorosis risk factor.
4. Children who consumed carbon-filtered water had higher odds of fluorosis than children who consumed tank rain water during the period of tooth development.
5. Sixty-five percent of the responding parents favoured the addition of fluoride to the water supply for the benefit of preventing dental decay in both children and adults.
6. Clinical and the photographic diagnoses of dental fluorosis are closely equivalent (Cohen's kappa=0.80).

7.10 Recommendations

It is recommended that:

- 1 Further research should be carried out to determine the ideal concentration of fluoride for drinking water in NSW in view of the fact that a fluorosis risk already exists in NSW populations served with non-fluoridated water sources.
- 2 Because of the risk of fluorosis, oral health education should be directed at parents to ensure that they understand that fluoride toothpaste should not be used before the age of 2 years
- 3 Because of confronting results a recommendation for a new research project for assessing the age associated fluorosis occurrence.
- 4 In future oral health surveys, photographs of the central incisors should always be taken for the purposes of:
 - Aiding historical comparisons
 - Diagnostic standardisation
 - Calibration
 - Confirmation of clinical diagnosis.

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[http: www.fluoride.org](http://www.fluoride.org)
[http: www.fluoridealert.org](http://www.fluoridealert.org)
[http: www.inchem.org](http://www.inchem.org)

Appendices

Appendix A: Map of Lithgow LGA

Appendix B: Ethics Approval

Appendix C: Letter for school principals

Appendix D: Information package for parents

Appendix E: Questionnaire

Appendix F: ABS Classification of Occupation

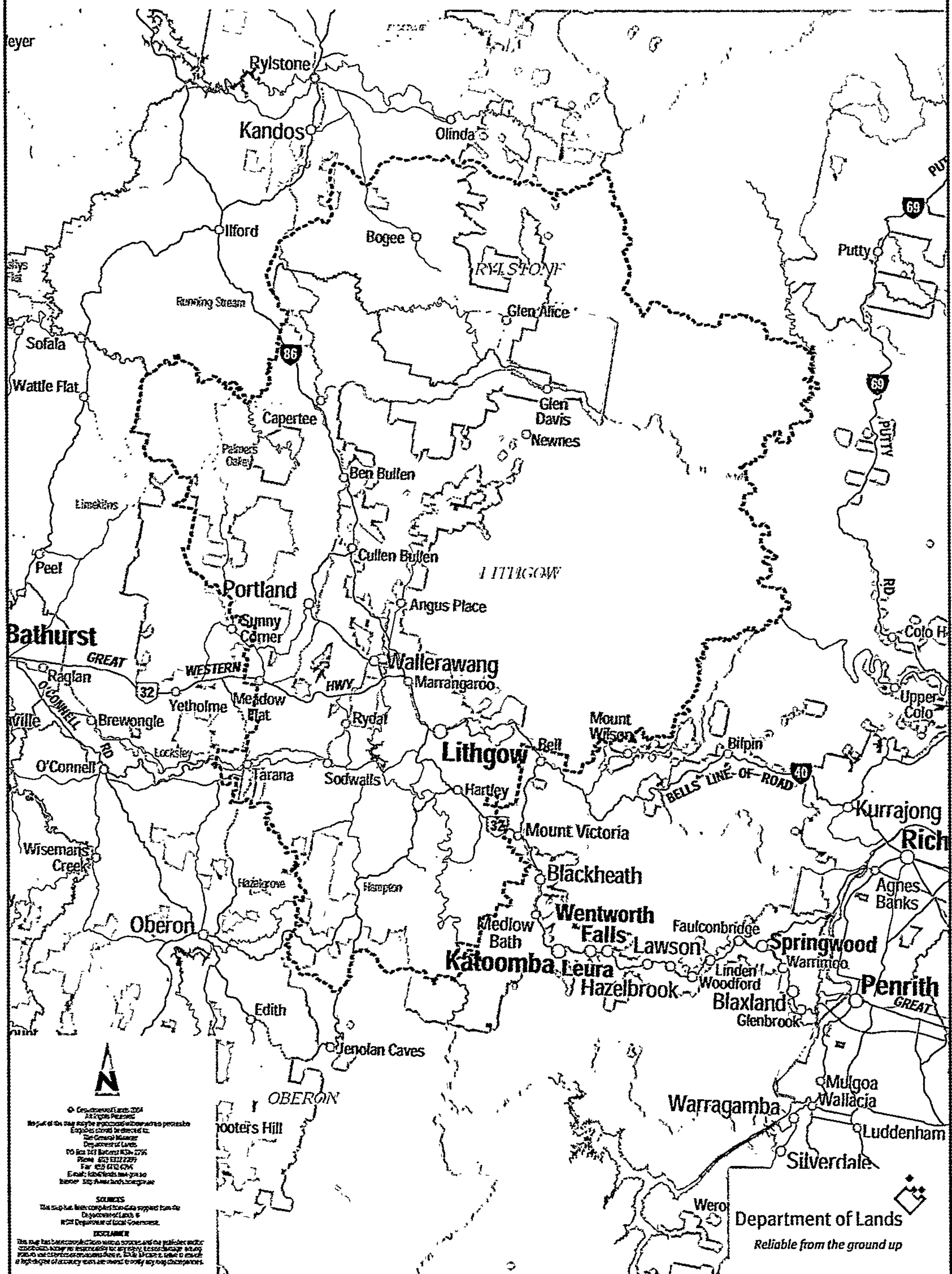
Appendix G: Kappa value calculation tables

Appendix H: Fluorosis photographs of school children(CD)

Appendix A: Map of Lithgow LGA

CITY OF LITHGOW LGA

----- New Boundary



Appendix B: Ethics Approval

SYDNEY WEST AREA HEALTH SERVICE (Westmead Campus)

HUMAN RESEARCH ETHICS COMMITTEE

Research Office, Clinical Sciences
Westmead Hospital Campus
Westmead NSW 2145

Telephone: 02 9845 8183
Facsimile: 02 9845 8352
Email: researchoffice@westgate.wh.usyd.edu.au

In reply please quote:

HS/pme HREC2006/5/4.16(2354)

4 August, 2006

A/Prof R.Wendell Evans
Community Oral Health & Epidemiology
Westmead Centre for Oral Health

Dear Professor Evans

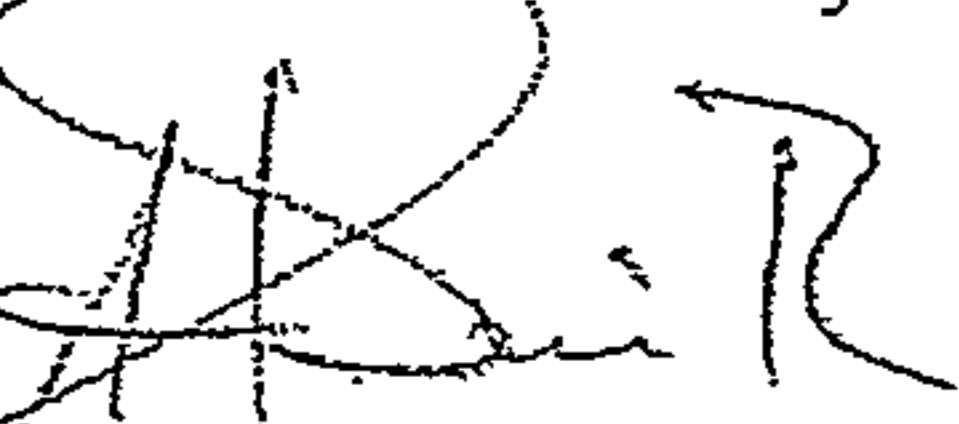
Research Proposal: Oral Health Survey of School Children in New South Wales

Thank you for your letter dated 3 August 2006 and for forwarding your revised Participant Information and Consent Forms Version 4 dated 19 July 2006 and amended Questionnaire Version 3 dated 19 July 2006, together with correspondence between yourself and the Department of Education as requested in the Human Research Ethics Committee letter dated 26 June 2006.

As the ethical concerns of the Department of Education have now been addressed, approval of the study is confirmed and it may now commence. A copy of the amended Participant Information and Consent Forms Version No.4 dated 19 July 2006 and Questionnaire Version 3 dated 19 July 2006 have been reviewed and approved, an approved copy of which is attached for your records.

The Committee wishes you well with the study.

Yours sincerely



Dr Howard Smith
Secretary
Sydney West Area Health Service
Human Research Ethics Committee

Committee Secretariat:

Professor Stephen Leeder AO
Chairman
Professor of Public Health &
Community Medicine

Dr Howard Smith
Secretary
Medical Graduate -
Endocrinologist

Committee Members:

Mr Leonard Burney
Layman

Dr Michael Cole
Medical Graduate - Neonatal
Paediatrician

Mrs Patricia Fa
Clinical Trials Pharmacist

A/Prof Lorraine Ferguson AM
Nursing Research Unit

Mr John Fisher
Lawyer

Ms Janet Fox
Law Graduate

Ms Jillian Gwynne Lewis
Patient Representative

Dr Anthony Harris
Medical Graduate -
Psychiatrist

Dr Jim Hazel
Medical Graduate -
Endocrinologist

Ms Vicki Hewson
Social Worker

Ms Jan Kang
Diversity Health Institute

A/Prof Ian Kerridge
Haematologist and Bioethicist

Ms Rada Kusic
Clinical Trials Manager

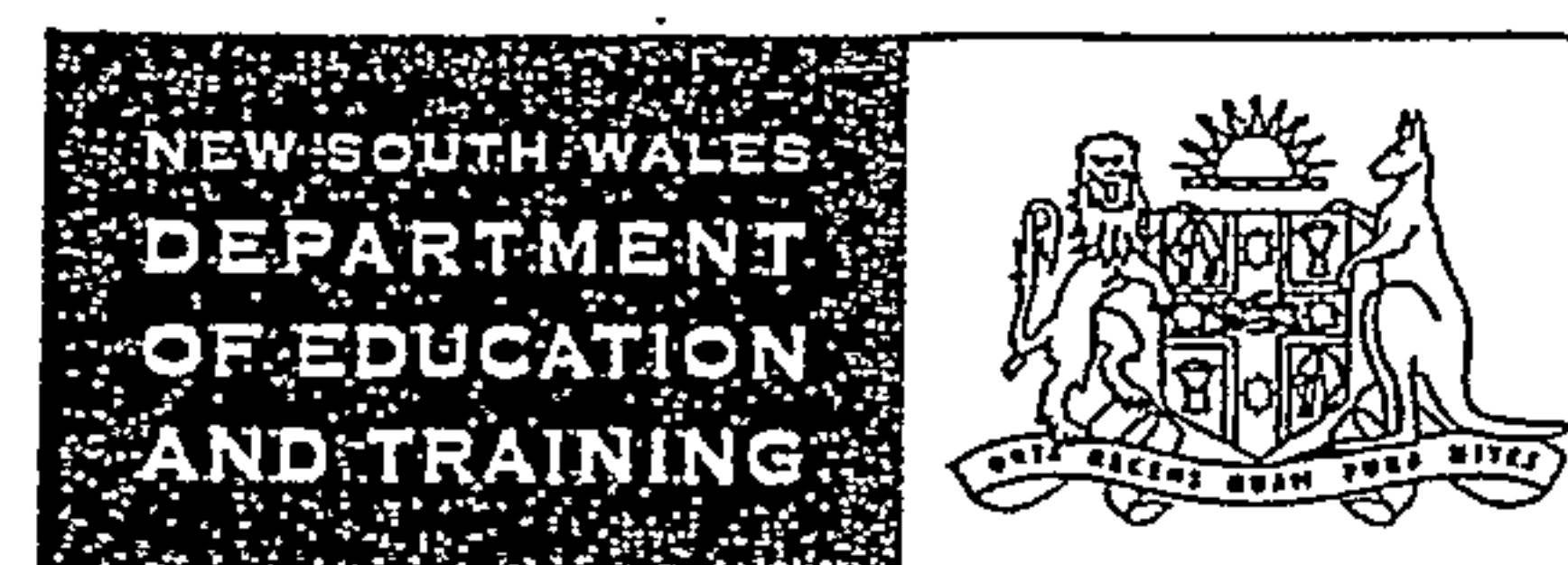
Rev Sarah Plummer
Minister of Religion

Mr John Shaw
Layman

Dr Geoff Shead
Medical Graduate - Surgeon

Mrs Carol Walsh
Laywoman

Ms Shane Waterton
Laywoman



Early Childhood and Primary Education
Secondary Education
Technical and Further Education
Vocational Education and Training
Higher Education
Adult and Community Education

Assoc. Prof. Wendell Evans
Community Oral Health and Epidemiology
The University of Sydney
C 24 Westmead Centre for Oral Health
Westmead NSW 2145

Dear Assoc. Prof. Evans

SERAP Number: 06.286

I refer to your application to conduct a research project in NSW government schools entitled *Oral Health Survey of School Children in New South Wales*. I am pleased to inform you that your application has been approved. You may now contact the Principals of the nominated schools to seek their participation.

This approval will remain valid until 26 June 2007.

This approval covers the following researchers and research assistants to enter schools for the purposes of this research:

Researcher's name	Valid until
Athin Narayan Sujeer	29 May 2007
Amit Arora	29 May 2007
Shanti Sivaneswaran	29 May 2007
Robin Wendell Evans	29 May 2007
Pathik Shailesh Mehta	04 July 2007
Priyanka Grover	06 July 2007
Vishal Chhabra	04 July 2007
Nannan Zhao	04 July 2007
Bassam Abdulamer	06 July 2007
Syed Mussamil Ali Shah	04 July 2007
Aman Deep Singh Badwal	04 July 2007
Mary Geethamma Varkey	04 July 2007
Bradley Christian	20 July 2007

You should include a copy of this letter with the documents you send to schools.

I draw your attention to the following requirements for all researchers in NSW government schools:

- School Principals have the right to withdraw the school from the study at any time. The approval of the Principal for the specific method of gathering information for the school must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school's convenience.

- Any proposal to publish the outcomes of the study should be discussed with the Research Approvals Officer before publication proceeds.

When your study is completed please forward your report marked to General Manager, Planning and Innovation, Department of Education and Training, GPO Box 33, Sydney, NSW 2001.

Yours sincerely

R. J. Mew

for

Dr Christine Ewan

General Manager, Planning and Innovation

25 July 06



The University of Sydney

NSW 2006 Australia

Human Research Ethics Committee

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18 September 2006

Associate Professor W Evans
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C24

Dear Professor Evans

Title: Oral Health Survey of school children in New South Wales

Reference: 9437

The Executive Committee at its meeting on **7 September 2006** considered your correspondence received on 11 August 2006.

The following documentation has been noted as approved by SWAHS (Westmead Campus) HREC & NSW Department of Education and Training:

- Participant Information Statement – version no. 4, dated 19 July 2006
- Consent Form – version no. 4, dated 19 July 2006
- Consent Form (Interpreter) – version no. 4, dated 19 July 2006
- Questionnaire – version 3, dated 19 July 2006
- Mr Bradley Christian – Masters Degree student

Yours sincerely

Associate Professor J D Watson
Chairman
Human Research Ethics Committee

The Diocese of Bathurst
Catholic Education Office



Gilmour Street, Kelso
P.O. Box 308, Bathurst 2795
P: (02) 6332 3077 F: (02) 6332 4284
ABN 73 470 086 952
Dubbo Office: P: (02) 6882 7355 F: (02) 6882 9337
REF:VMW

Associate Professor Wendell Evans
Westmead Centre for Oral Health
Westmead Hospital
WESTMEAD NSW 2145

Dear Associate Professor Wendell Evans,

Approval to conduct your research "Oral Health Survey of School Children in New South Wales" is readily given.

Thank you for the clearance details of the investigators/researchers.

Yours sincerely,

Don Ellem
Executive Director of Schools
BATHURST DIOCESE

8th August, 2006

Appendix C: Letter for school principals



Faculty of Dentistry

Wendell Evans, MDS DDSc
Community Oral Health and Epidemiology
Westmead Centre for Oral Health
Phone (02) 9845 7537
E-mail: w.evans@dentistry.usyd.edu.au

DATE

NAME AND ADDRESS OF SCHOOL HERE

DEAR PRINCIPAL

ORAL HEALTH SURVEY OF SCHOOL CHILDREN IN NEW SOUTH WALES

On behalf of the Faculty of Dentistry, University of Sydney, and the Sydney West Area Health Service we are writing about an oral health survey of school children. All Lithgow primary schools will be invited to participate.

The purpose of the survey is to obtain data on oral health of school children in NSW.

The survey, which will be conducted according to World Health Organisation guidelines, has been approved by the Human Ethics Committees of (a) the University of Sydney, (b) the Sydney West Area Health Service, and by (c) the Strategic Research Unit of the NSW Department of Education.

Please take a few minutes to read the material in the attached pack which is intended for parents of children at your school. The survey relies on the cooperation of the participating schools in two ways: -

1. To distribute a survey pack for each child at the school to parents and receive signed consent forms back in sealed labelled envelopes to maintain confidentiality.
2. To provide a suitable space for the survey for the short time that researchers are at the school. All equipment needed will be provided and meet OHS requirements.

If you have any questions about the survey, please do not hesitate to contact me on Ph 02-9845-7537. One of the researchers will contact you within the next week about this letter to discuss what is involved in more depth.

We look forward to working with you on this study, and acknowledge that before it can proceed your agreement in writing will be required.

Yours sincerely,

Dr Wendell Evans
Associate Professor and Principal Investigator

Dr Clive Wright
Chief Dental Officer, NSW Health

Appendix D: Information package for parents



The University of Sydney

**Faculty of Dentistry
College of Health Sciences**

Wendell Evans, MDS DDSc
Associate Professor
Community Oral Health and Epidemiology

Westmead Centre for Oral Health
Westmead Hospital
Australia NSW 2145

Tel: +61 2 9845 7537 Fax: +61 2 9845 8306
E-mail: w.evans@dentistry.usyd.edu.au

Date

Dear Parent/Guardian,

Oral Health Survey of School Children in New South Wales

Welcome to the Oral Health Survey of School Children in New South Wales. Your child's school is one of those selected to participate. Details of this survey are described in the Information Statement.

The purpose of this survey is to gather data on the oral health of school children in NSW.

The survey, which will be conducted under my direction according to World Health Organisation guidelines, has been approved by your School Principal, and the Ethics Committees of the NSW Department of Education, University of Sydney, and Sydney West Area Health Service.

Please take a few minutes to read the Information Statement, the enclosed questionnaire, and the consent forms.

I hope that you will consent to the dental health survey and fill out the attached questionnaire. If your child participates in the survey you will receive a report of your child's dental health needs.

If you have any questions about the survey, please do not hesitate to contact me on 02 9845 7537.

Yours sincerely,

Dr Wendell Evans
Associate Professor and Principal Investigator



PARTICIPANT INFORMATION

Study Title: Oral Health Survey of School Children in New South Wales

Short Title: Oral Health Survey

Chief Investigator: Dr Wendell Evans **Department of** Community Oral Health and Epidemiology.

What is the purpose of the study?

The purpose of the survey is to monitor the oral health of school children living in New South Wales. The main outcome is to compare the oral health of children in non-fluoridated and fluoridated areas of New South Wales. This will provide valuable information to assist the planning of a more effective oral health service and research into establishing effective ways of preventing oral diseases for children residing in these areas.

Who will be invited to enter the study?

Your child has been invited to enter the study because all children in his/her school have been invited to take part in this survey.

What will happen on the study?

With your permission, we will conduct an oral examination of your child at school according to World Health Organisation criteria. This oral examination, using a dental mirror and a non-sharp ball-ended tooth explorer, will identify any treatment need for tooth decay. We will also record tooth cleanliness, the number of fillings and missing teeth (if any). In addition, we will take a photograph of your child's front teeth as a record of tooth colour and shape (the photograph will not include your child's face). This photograph will be stored and used to compare tooth colour in future studies. No x-rays will be taken.

You are also asked to complete the enclosed questionnaire and return it to your child's school in the envelope provided.

Are there any risks?

There are no risks involved in the study. The participation in the survey will not physically harm to your child. The survey will not involve any psychological distress in the participants.

Are there any benefits?

The participants will be given a report of their dental treatment needs to alert parents to access dental care.



PARTICIPANT INFORMATION

Study Title: Oral Health Survey of School Children in New South Wales.

Confidentiality

Only the University dentists will have access to the oral examination and questionnaire information. This information will be put in a computer for analysis and the examination and questionnaire forms will be destroyed. Your name and your child's name **will not** be put in the computer.

What will happen at the conclusion of the study?

The survey results will be published and a report will be sent to your school. The report will not include names or other information that could identify you or your child. Finally, you will be advised of any need to arrange for dental care.

Do you have a choice?

The participation of your child in this study is entirely voluntary. Participation will make an important contribution to knowledge about oral health of school children in your region.

Consent to participate

You will need to consent for your child to take part in this survey by completing the accompanying consent form. You are free, after giving consent, to change your mind and withdraw your child from the survey. In this case, you will need to notify Dr Wendell Evans by phone or email (see details below).

Complaints

If you have any concerns about the conduct of the study, or the rights of your child as a study participant, you may contact

The Secretary, Human Research Ethics Committee.

Telephone No. 02- 9845 8183 or email – researchoffice@westgate.wh.usyd.edu.au

Contact details

If you have any problems while on the study, please contact

Dr Wendell Evans

Associate Professor, Faculty of Dentistry, The University of Sydney

Working hours Telephone No: (02) 9845 7537

After hours Telephone No: 0421 050 185

E-mail: w.evans@dentistry.usyd.edu.au



CONSENT TO PARTICIPATE IN RESEARCH

Study Title: Oral Health Survey of School Children in New South Wales

Name of Researcher: Dr Wendell Evans

1. I understand that the researcher will conduct this study in a manner conforming with ethical and scientific principles set out by the National Health and Medical Research Council of Australia and the Good Clinical Research Practice Guidelines of the Therapeutic Goods Administration.
2. I acknowledge that I have read, or have had read to me the Participant Information Sheet relating to this study. I acknowledge that I understand the Participant Information Sheet. I acknowledge that I understand the general purposes, methods, demands and possible risks and inconveniences which may occur to my child during the study and I, being over the age of 16 years acknowledge that I understand the general purposes, methods, demands and possible risks and inconveniences which may occur during the study.
3. I acknowledge that I have been given time to consider the information and to seek other advice.
4. I acknowledge that refusal to take part in this study will not affect the usual treatment of my child's condition.
5. I acknowledge that taking part in this study is voluntary and I may withdraw my child at any time.
6. I acknowledge that this research has been approved by the Sydney West Area Health Service Human Research Ethics Committee.
7. I acknowledge that I have received a copy of this form and the Participant Information Sheet, which I have signed.

Before signing, please read 'IMPORTANT NOTE' following.

Name of participant child _____ Date of Birth _____

Address of participant _____

Name of parent or person responsible _____

Address of parent or person responsible _____

Signature of participant _____ Date: _____

Signature of parent or person responsible (where applicable) _____ Date: _____

Signature of researcher _____ Date: _____

Signature of witness _____ Date: _____



Study Title: Oral Health Survey of School Children in New South Wales

IMPORTANT NOTE

This consent should only be signed as follows:

1. *Where a participant is over the age of 16 years, then by the participant personally.*
2. *Where the participant is between the age of 14 and 16 years, it should be signed by the participant and by a parent or person responsible.*
3. *Where the participant is under the age of 14 years, then the parent or person responsible only should sign the consent form.*
4. *Where a participant is under a legal or intellectual disability, eg unconscious, then particular consent should be sought from the Human Research Ethics Committee as to whether the person should take part in the research.*

WITNESS:

I, _____ (name of witness)

of _____ hereby certify as follows:

1. I was present when _____ ("the parent of the participant") appeared to read or had read to him / her a document entitled Participant Information Sheet; or
I was told by _____ ("the parent of the participant") that he/she had read a document entitled Participant Information Sheet (*Delete as applicable)
2. I was present when _____ ("the researcher") explained the general purposes, methods, demands and the possible risks and inconveniences of participating in the study to the participant. I asked the participant whether he/she had understood the Participant Information Sheet and understood what he/she had been told and he/she told me that he/she did understand.
3. I observed the participant sign the consent to participate in research and he/she appeared to me to be signing the document freely and without duress.
4. The parent of the participant showed me a form of identification which satisfied me as to his/her identity.
5. I am not involved in any way as a researcher in this project.
6. (Delete this clause if not applicable) I was present when _____ ("the interpreter") read the Participant Information sheet to the participant in the _____ (here insert appropriate language) language. I certify that when the researcher explained the general purposes, methods, demands and possible risks and inconveniences of participating in the study that what was said by both the researcher and the participant was translated by the interpreter from the English language into the above language and vice versa. When I spoke to the parent of the participant what I said and what the parent of the participant said was translated by the interpreter from the English language into the above language and vice versa.

Name of witness _____

Address _____

Signature of witness _____ Date: _____

Relationship to participant _____



CONSENT TO PARTICIPATE IN RESEARCH

Study Title: Oral Health Survey of School Children in New South Wales.

INTERPRETER:

If an interpreter is used, the following addition is necessary--

I _____ (name of interpreter)

of _____ certify as follows:

1. I am qualified to translate speech and writing from the English language into the _____ language and vice versa.
2. I read the Participant Information Sheet to the parent of the participant in the above language and he/she appeared to understand it.
3. I was present when the researcher explained the general purposes, methods, demands and possible risks and inconveniences of participating in the study to the parent of the participant and I translated all that was said by the researcher and by the parent of the participant from the English language into the above language and vice versa.
4. I was present when the independent witness spoke to the parent of the participant and I translated all that was said by the witness and by the participant from the English language into the above language and vice versa.

Signature of Interpreter _____ Date _____

PLEASE KEEP THIS COPY OF THE CONSENT FORM FOR YOUR RECORDS.



The University of Sydney

**Faculty of Dentistry
College of Health Sciences**

Wendell Evans, MDS DDSc
Associate Professor
Community Oral Health and Epidemiology

Westmead Centre for Oral Health
Westmead Hospital
Australia NSW 2145

Tel: +61 2 9845 7537 Fax: +61 2 9845 8306
E-mail: w.evans@dentistry.usyd.edu.au

Reminder Notice

Date

Dear Parent/Guardian,

Oral Health Survey of School Children in New South Wales

A short time ago you should have received a letter, information sheet, and questionnaire as part of an invitation to participate in an important oral health survey which will allow a better understanding of how to protect children's teeth against decay.

If you have already returned the consent form and questionnaire, please accept our thanks and ignore this notice. However, if you haven't done so, please fill and return the consent and questionnaire to your child's school today. Your cooperation will assist us to make this a useful one for the children of your region.

If by some chance, you did not receive the information package or it was misplaced, please contact the Research Team on 9845 7537.

Yours sincerely,

Associate Professor Wendell Evans
Principal Investigator

Appendix E: Questionnaire



The University of Sydney

Faculty of Dentistry
Faculties of Health

Wendell Evans, MDS DDSc
Associate Professor
Community Oral Health and Epidemiology

Westmead Centre for Oral Health
Westmead Hospital
Australia NSW 2145

Tel: +61 2 9845 7537 Fax: +61 2 9845 8306
E-mail: w.evans@dentistry.usyd.edu.au

ORAL HEALTH SURVEY OF SCHOOL CHILDREN IN NEW SOUTH WALES

Dear Parent/Guardian,

Thank you for agreeing to participate in the Oral Health Survey of the School Children in New South Wales .
Please fill in the forms below and the questionnaire. All information you provide will be strictly confidential.

CHILD'S FIRST NAME: CHILD'S SURNAME:
ADDRESS: TOWN/SUBURB:
STATE: POSTCODE: TELEPHONE: ()
(Area code) (Number)
SCHOOL: YEAR LEVEL:

CLINIC USE ONLY – All details must be completed

EXAMINATION
DATE

/ /
day month year

DATE OF
BIRTH

/ /
day month year

C ID

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PLEASE READ THIS BEFORE STARTING THE QUESTIONNAIRE

- All of the questions in the questionnaire that refer to 'your child' concern the child named on the Consent Form at the front of this booklet.
- All of your answers are valuable to us, so please complete all questions to the best of your knowledge. If you are uncertain about a question, please ring (02) 9845 7537 for advice.
- Please ignore the small numbers next to boxes; they are for office use only.

EXAMPLES OF QUESTIONS

- Some questions require you to tick only one box. For example:

How often does your child use fluoride mouthrinse? (*Tick one box only*)

- ☐₁ Never
- ☐₂ Every day
- ☐₃ A few times a week
- ☐₄ Once a week
- ☐₅ Infrequently
- ☐₆ Don't know

- Other questions may allow you to give multiple answers. For example:

When does your child usually brush his/her teeth? (*Tick as many boxes as applicable*)

- ☒₁ Before breakfast
- ☐₂ After breakfast
- ☒₃ After lunch
- ☒₄ After dinner
- ☐₅ Immediately before bed
- ☐₆ At other times

- There will always be instructions next to the question telling you how many boxes you can tick. These instructions will be written in *italic* writing.
- Some questions require a written answer, as in these examples:

At what age did your child start taking fluoride tablets?

8
Years

OR

What brand of infant formula did you use?

Enfamil

- The questions should take you around 20 minutes to complete. If you need help filling in the questionnaire, please don't hesitate to give us a call on (02) 9845 7537.

PLEASE START THE QUESTIONNAIRE ON THE FOLLOWING PAGE:

ORAL HEALTH SURVEY OF SCHOOL CHILDREN IN NSW

Dental Practices

1

At what age did he/she start brushing with toothpaste?

At age _____

☐ Does not brush his/her teeth → GO TO QUESTION 4

2

For the following questions, please tick one box only relevant to your child.

a) How often does your child brush his/her teeth with toothpaste?

- ☐₁ Less than once a day
- ☐₂ Once a day
- ☐₃ Twice a day
- ☐₄ More than twice a day

b) What type of toothpaste does your child use?

- ☐₁ Standard fluoride toothpaste
- ☐₂ Children's toothpaste
- ☐₃ Non-fluoridated paste
- ☐₄ Don't know/not sure

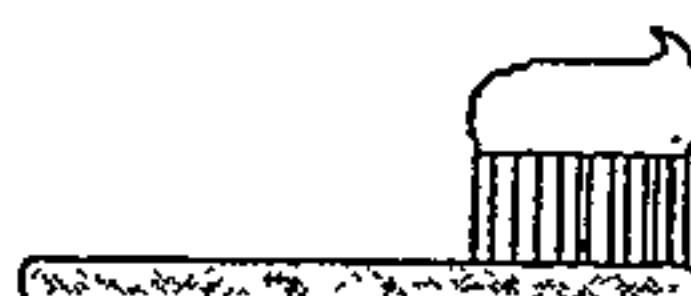
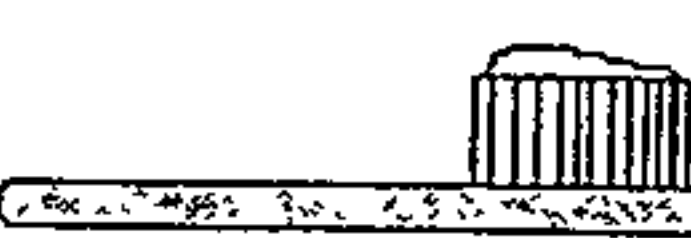
c) Have you noticed your child eating or licking toothpaste?

- ☐₁ Often
- ☐₂ Sometimes
- ☐₃ Never

d) After tooth brushing does your child usually...

- ☐₁ just swallow
- ☐₂ rinse and swallow
- ☐₃ rinse and spit
- ☐₄ just spit
- ☐₅ other
- ☐₆ don't know

e) How much toothpaste did/does your child (or do you) use on his/her toothbrush?

- ☐₁ 
- ☐₂ 
- ☐₃ 

f) What brand of toothpaste does your child use?

3 When did/does your child usually brush his/her teeth? *(Tick as many boxes as possible)*

- ☐₁ Before breakfast
- ☐₂ After breakfast
- ☐₃ After lunch
- ☐₄ After dinner
- ☐₅ Immediately before bed
- ☐₆ At other times

4 At what age did your child ...
start taking fluoride tablets?
(Write age or '0' if used since birth)

At age _____

☐₁ Does not take fluoride tablets



GO TO QUESTION 5

5 At what age did your child.
start using fluoride mouthrinse?
(Write age or '0' if used since birth)

At age _____

☐₁ Does not take fluoride mouthrinse



GO TO QUESTION 6

Birth Place and Residential Movements

Please read the example below and then complete the table on the next page.

Write the name of each suburb, town or location your child has lived in, and the years that he/she lived there.. Only include places where your child has lived for six months or more.

EXAMPLE:

- This is an example of a child who has lived at their current address in **Lithgow, NSW.**
- Prior to that she lived for **two months** in **Tamworth, NSW.** As she lived there for less than six months it is not included in the table.
- Prior to that she lived for **nine months** in **Bowral, NSW.**
- Prior to that she lived for **2 years** in **Gosford, NSW.**
- Her details would be filled in as follows:

Where does your child live now?

Name of place Lithgow Postcode 2790

Has this child always lived at this postcode ☐ Yes ☒ No

If no list places where your child has lived before

Place 1 Bowral State NSW Postcode 2576 Years lived there 9 months

Place 2 Gosford State NSW Postcode 2250 Years lived there 2 Years

Place 3 _____ State _____ Postcode _____ Years lived there _____

Place 4 _____ State _____ Postcode _____ Years lived there _____

If you have any trouble filling this table in, please don't hesitate to give us a call on the Associate Professor Wendell Evans on 02 9845 7537.
We would be more than happy to help you fill it in!

We have given you enough spaces for six residences/entries. If you run out of spaces please attach an extra sheet of paper following the same format as in our table.

You are able to list one residence more than once if your usual source of water has changed over time.

6

Where does your child live now?

Name of place _____ Postcode _____

Has this child always lived at this postcode ☐₁ Yes ☐₂ No

If no list places where your child has lived before

Place 1 _____ State _____ Postcode _____ Years lived there _____

Place 2 _____ State _____ Postcode _____ Years lived there _____

Place 3 _____ State _____ Postcode _____ Years lived there _____

Place 4 _____ State _____ Postcode _____ Years lived there _____

Place 5 _____ State _____ Postcode _____ Years lived there _____

Place 6 _____ State _____ Postcode _____ Years lived there _____

7

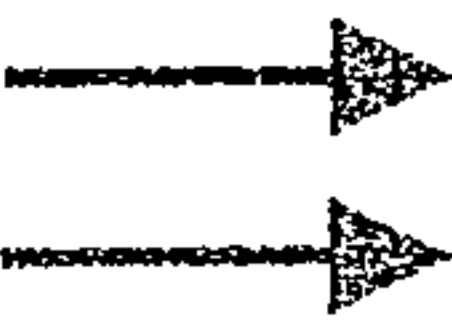
What is the source of your child’s drinking water?

- ☐₁ Tap/mains
- ☐₂ Carbon/charcoal filtered
- ☐₃ Osmosis/distillation filtered tap water
- ☐₄ Tank
- ☐₅ Spring or mineral
- ☐₆ Bore
- ☐₇ Don’t know

8

Was your child ever fed on infant formula? (Tick one box only)

- ☐₁ Yes
- ☐₂ No
- ☐₃ Don’t know



GO TO QUESTION 10
GO TO QUESTION 10

9

What did you usually add to the infant formula for your child? (Tick one box only)

- ☐₁ Tap water – mains supply
☐₂ Carbon/charcoal filtered tap water
☐₃ Osmosis/distillation filtered tap water
☐₄ Mineral/Spring water
☐₅ Tank water
☐₆ Unknown

10

In the table below, please write the number of serves of food your child eats in a usual day.

Enter the number of serves your child eats of each food or '0' if he/she does not usually eat the food	
Food	No. of serves in a usual day
EXAMPLE : FRUIT →	2
Fruit e.g., apples, oranges	
Pure fruit juices e.g., apple, orange	
Sweetened cordial drinks	
Fizzy drinks/ sports drinks e.g., Lemonade	
Cola drinks e.g., Coke, Pepsi	
Chocolate and sugary lollies	

Characteristics of the Household

The following questions are about your household. These questions will help to decide if different methods of preventing dental problems work equally well for all groups within the community and to ensure that the researchers obtain an accurate cross-section of households.

11 In which country was your child born?
(Write name of country)

OFFICE USE
ONLY

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12 Is your child of Aboriginal or Torres Strait Islander origin? (Tick one box only)

- ☐₁ No
☐₂ Yes, Aboriginal
☐₃ Yes, Torres Strait Islander
☐₄ Yes, Aboriginal and Torres Strait Islander

13 Does your child live in a one-parent household? (Tick one box only)

- ☐₁ Yes
☐₂ No

14 Please complete the table below.

If your child lives in a one-parent household, please fill in one column for yourself. If he/she lives in a two-parent household, please fill in both columns for yourself and your partner.

QUESTION	↓ Parent or Guardian (A)	↓ Parent or Guardian (B)
a) What is <u>your</u> age?	 Years	 Years
b) What is your sex?	☐ ₁ Male ☐ ₂ Female	☐ ₁ Male ☐ ₂ Female
c) In which country were you born? (Write country)		
d) Are you of Aboriginal or Torres Strait Islander origin? (Tick one box only)	☐ ₁ No ☐ ₂ Yes, Aboriginal ☐ ₃ Yes, Torres Strait Islander ☐ ₄ Yes, Aboriginal & Torres Strait Islander	☐ ₁ No ☐ ₂ Yes, Aboriginal ☐ ₃ Yes, Torres Strait Islander ☐ ₄ Yes, Aboriginal & Torres Strait Islander
e) What is the highest level of education you have? (Tick one box only)	☐ ₁ Some high school ☐ ₂ Completed high school ☐ ₃ Some vocational training (i.e. trade) ☐ ₄ Completed vocational training ☐ ₅ Some University or College ☐ ₆ Completed University or College	☐ ₁ Some high school ☐ ₂ Completed high school ☐ ₃ Some vocational training (i.e. trade) ☐ ₄ Completed vocational training ☐ ₅ Some University or College ☐ ₆ Completed University or College
f) What is your usual occupation? (Write description, e.g. clerk)		
g) How many teeth have you had pulled out due to tooth decay?	(Write number)	(Write number)

15

Is English the main language spoken at home?

☐₁ Yes☐₂ No

16

How long is it since your child had a dental visit?

(Tick one box only)☐₁ Less than 6 months☐₂ Between 6 and 12 months☐₃ Between 1 and 2 years☐₄ More than 2 years ago☐₅ Never☐₆ Don't know

17

Would you be in favour of adding fluoride to your water supply to try and prevent teeth decaying? *(Tick one box only)*☐₁ In children?☐₂ In adults?☐₃ Both children and adults☐₄ Neither☐₅ Don't know☐₆ Refused

18

Who should decide on the fluoridation of water supplies? *(Tick one box only)*☐₁ State government☐₂ Health authorities☐₃ Dental associations☐₄ Water boards☐₅ Community☐₆ Other _____ [specify]☐₇ Don't know☐₈ Refused

19

This question is voluntary.

Do you have private dental insurance?

☐₁ Yes☐₂ No

20

This question is voluntary.

Which category does your total household income (before tax) fall into? Include any salaries, pensions, allowances, benefits, etc from all persons in the household.

(Tick one box only)

Household income per year

☐₁ Up to \$20,000☐₂ \$20,001 to \$40,000☐₃ \$40,001 to \$60,000☐₄ \$60,001 to \$80,000☐₅ \$80,000 to \$100,000☐₆ Over \$100,000

Your Comments

Thank you. Your contribution to this study is greatly appreciated. Please take a moment to check that you have answered each question, have signed the consent form, and filled in the label on the front of the envelope provided. Then place the completed questionnaire and consent form inside the envelope, seal it, and return it to your child's school.

If you have any comments, please feel free to write them in the space below.

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Thank you for your support!

Appendix F: ABS Classification of Occupation

MAJOR GROUP 1 MANAGERS

SUB-MAJOR GROUP 11 Chief Executives, General Managers and Legislators

SUB-MAJOR GROUP 12 Farmers and Farm Managers

SUB-MAJOR GROUP 13 Specialist Managers

SUB-MAJOR GROUP 14 Hospitality, Retail and Service Managers

MAJOR GROUP 2 PROFESSIONALS

SUB-MAJOR GROUP 21 Arts and Media Professionals

SUB-MAJOR GROUP 22 Business, Human Resource and Marketing Professionals

SUB-MAJOR GROUP 23 Design, Engineering, Science and Transport Professionals

SUB-MAJOR GROUP 24 Education Professionals

SUB-MAJOR GROUP 25 Health Professionals

SUB-MAJOR GROUP 26 ICT Professionals

SUB-MAJOR GROUP 27 Legal, Social and Welfare Professionals

MAJOR GROUP 3 TECHNICIANS AND TRADES WORKERS

SUB-MAJOR GROUP 31 Engineering, ICT and Science Technicians

SUB-MAJOR GROUP 32 Automotive and Engineering Trades Workers

SUB-MAJOR GROUP 33 Construction Trades Workers

SUB-MAJOR GROUP 34 Electrotechnology and Telecommunications Trades Workers

SUB-MAJOR GROUP 35 Food Trades Workers

SUB-MAJOR GROUP 36 Skilled Animal and Horticultural Workers

SUB-MAJOR GROUP 39 Other Technicians and Trades Workers

MAJOR GROUP 4 COMMUNITY AND PERSONAL SERVICE WORKERS

SUB-MAJOR GROUP 41 Health and Welfare Support Workers

SUB-MAJOR GROUP 42 Carers and Aides

SUB-MAJOR GROUP 43 Hospitality Workers

SUB-MAJOR GROUP 44 Protective Service Workers

SUB-MAJOR GROUP 45 Sports and Personal Service Workers

MAJOR GROUP 5 CLERICAL AND ADMINISTRATIVE WORKERS

SUB-MAJOR GROUP 51 Office Managers and Program Administrators

SUB-MAJOR GROUP 52 Personal Assistants and Secretaries

SUB-MAJOR GROUP 53 General Clerical Workers

SUB-MAJOR GROUP 54 Inquiry Clerks and Receptionists

SUB-MAJOR GROUP 55 Numerical Clerks

SUB-MAJOR GROUP 56 Clerical and Office Support Workers

SUB-MAJOR GROUP 59 Other Clerical and Administrative Workers

MAJOR GROUP 6 SALES WORKERS

SUB-MAJOR GROUP 61 Sales Representatives and Agents

SUB-MAJOR GROUP 62 Sales Assistants and Salespersons

SUB-MAJOR GROUP 63 Sales Support Workers

MAJOR GROUP 7 MACHINERY OPERATORS AND DRIVERS

SUB-MAJOR GROUP 71 Machine and Stationary Plant Operators

SUB-MAJOR GROUP 72 Mobile Plant Operators

SUB-MAJOR GROUP 73 Road and Rail Drivers

SUB-MAJOR GROUP 74 Storepersons

MAJOR GROUP 8 LABOURERS

SUB-MAJOR GROUP 81 Cleaners and Laundry Workers

SUB-MAJOR GROUP 82 Construction and Mining Labourers

SUB-MAJOR GROUP 83 Factory Process Workers

SUB-MAJOR GROUP 84 Farm, Forestry and Garden Workers

SUB-MAJOR GROUP 85 Food Preparation Assistants

SUB-MAJOR GROUP 89 Other Labourers

Appendix G: Kappa value calculation tables

The FREQ Procedure
Table of Sujeer_Clinical by Photo

Sujeer_Clinical Score						
Frequency, Percent ROW Pct COL Pct	Score from Digital Photographs					Total
	0,	1,	2,	3,	5,	
0	215	13	0	0	0	228
	44.89	2.71	0.00	0.00	0.00	47.60
	94.30	5.70	0.00	0.00	0.00	
	93.48	9.56	0.00	0.00	0.00	
1	14	108	6	0	0	128
	2.92	22.55	1.25	0.00	0.00	26.72
	10.94	84.38	4.69	0.00	0.00	
	6.09	79.41	6.52	0.00	0.00	
2	1	15	79	6	0	101
	0.21	3.13	16.49	1.25	0.00	21.09
	0.99	14.85	78.22	5.94	0.00	
	0.43	11.03	85.87	30.00	0.00	
3	0	0	7	14	0	21
	0.00	0.00	1.46	2.92	0.00	4.38
	0.00	0.00	33.33	66.67	0.00	
	0.00	0.00	7.61	70.00	0.00	
5	0	0	0	0	1	1
	0.00	0.00	0.00	0.00	0.21	0.21
	0.00	0.00	0.00	0.00	100.00	
	0.00	0.00	0.00	0.00	100.00	
Total	230	136	92	20	1	479
	48.02	28.39	19.21	4.18	0.21	100.00

Frequency Missing = 1

The FREQ Procedure
Statistics for Table of Sujeer_Clinical by Photo

Test of Symmetry

Statistic (S)	4.9711
DF	10
Pr > S	0.8931

Kappa Statistics

Statistic	Value	ASE	95% Confidence Limits	
Simple Kappa	0.8019	0.0230	0.7568	0.8469
Weighted Kappa	0.8637	0.0163	0.8316	0.8957

Effective Sample Size = 479
Frequency Missing = 1

BETWEEN EXAMINER AGREEMENT - FIRST HALF OF DUPLICATE MEASUREMENTS

The SAS System 13:42 Monday, March 5, 2007 8

The FREQ Procedure
Table of Sujeer by Evans

Sujeer	Evans				
Frequency, Percent Row Pct Col Pct	0	1	2	3	Total
0	52	4	2	0	58
	43.70	3.36	1.68	0.00	48.74
	89.66	6.90	3.45	0.00	
	86.67	14.29	7.69	0.00	
1	4	21	3	0	28
	3.36	17.65	2.52	0.00	23.53
	14.29	75.00	10.71	0.00	
	6.67	75.00	11.54	0.00	
2	4	3	21	2	30
	3.36	2.52	17.65	1.68	25.21
	13.33	10.00	70.00	6.67	
	6.67	10.71	80.77	40.00	
3	0	0	0	3	3
	0.00	0.00	0.00	2.52	2.52
	0.00	0.00	0.00	100.00	
	0.00	0.00	0.00	60.00	
Total	60	28	26	5	119
	50.42	23.53	21.85	4.20	100.00

Statistics for Table of Sujeer by Evans

Test of Symmetry

Statistic (S) 2.6667
DF 6
Pr > S 0.8494

Kappa Statistics

Statistic	Value	ASE	95% Confidence Limits	
Simple Kappa	0.7124	0.0545	0.6056	0.8191
Weighted Kappa	0.7545	0.0512	0.6542	0.8548

Sample Size = 119

BETWEEN EXAMINER AGREEMENT - SECOND HALF OF DUPLICATE MEASUREMENTS

The SAS System 13:42 Monday, March 5, 2007 9

The FREQ Procedure
Table of Sujeer by Evans

Sujeer	Evans						
Frequency, Percent Row Pct Col Pct	0,	1,	2,	3,	4,	Total	
0	54 45.00 93.10 87.10	4 3.33 6.90 12.50	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	58 48.33	
1	6 5.00 18.18 9.68	26 21.67 78.79 81.25	1 0.83 3.03 5.56	0 0.00 0.00 0.00	0 0.00 0.00 0.00	33 27.50	
2	2 1.67 10.00 3.23	2 1.67 10.00 6.25	16 13.33 80.00 88.89	0 0.00 0.00 0.00	0 0.00 0.00 0.00	20 16.67	
3	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.83 12.50 5.56	7 5.83 87.50 100.00	0 0.00 0.00 0.00	8 6.67	
4	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.83 100.00 100.00	1 0.83	
Total	62 51.67	32 26.67	18 15.00	7 5.83	1 0.83	120 100.00	

The FREQ Procedure
Statistics for Table of Sujeer by Evans

Test of Symmetry

Statistic (S) 3.7333
DF 10
Pr > S 0.9586

Kappa Statistics

Statistic	Value	ASE	95% Confidence Limits	
Simple Kappa	0.7942	0.0481	0.6999	0.8885
Weighted Kappa	0.8504	0.0385	0.7749	0.9258

Sample Size = 120

Appendix H: Fluorosis photographs of school children.