



THE UNIVERSITY OF
SYDNEY

COPYRIGHT AND USE OF THIS THESIS

This thesis must be used in accordance with the provisions of the Copyright Act 1968.

Reproduction of material protected by copyright may be an infringement of copyright and copyright owners may be entitled to take legal action against persons who infringe their copyright.

Section 51 (2) of the Copyright Act permits an authorized officer of a university library or archives to provide a copy (by communication or otherwise) of an unpublished thesis kept in the library or archives, to a person who satisfies the authorized officer that he or she requires the reproduction for the purposes of research or study.

The Copyright Act grants the creator of a work a number of moral rights, specifically the right of attribution, the right against false attribution and the right of integrity.

You may infringe the author's moral rights if you:

- fail to acknowledge the author of this thesis if you quote sections from the work
- attribute this thesis to another author
- subject this thesis to derogatory treatment which may prejudice the author's reputation

For further information contact the University's Copyright Service.

sydney.edu.au/copyright

**A PRIMARY ORAL HEALTH PROGRAM
FOR SCHOOLCHILDREN OF THE ISLAMIC REPUBLIC OF IRAN**

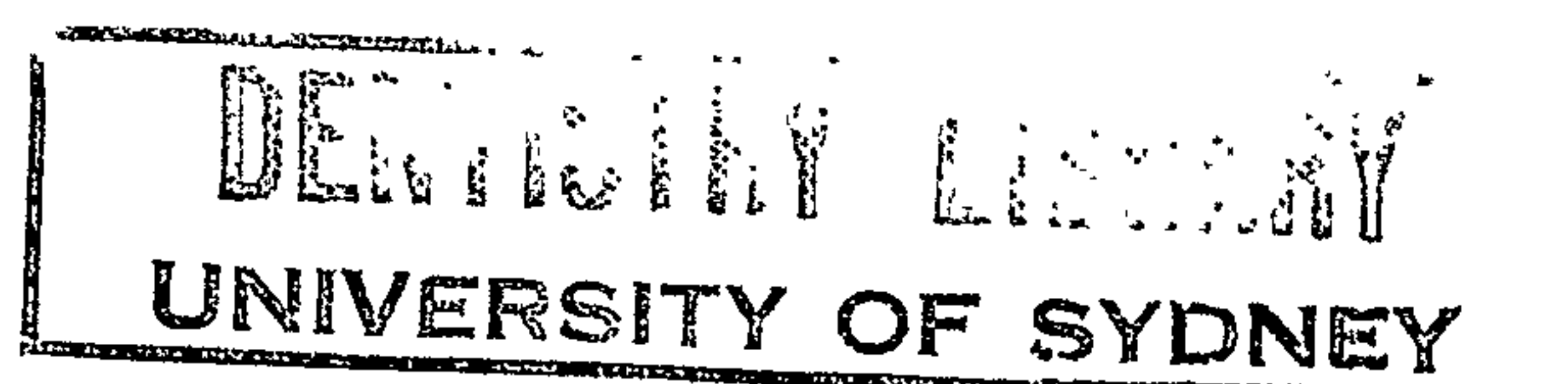
MOHAMMAD H. KHOSHNEVISAN
DDM (De Ocampo Memorial College, Manila)

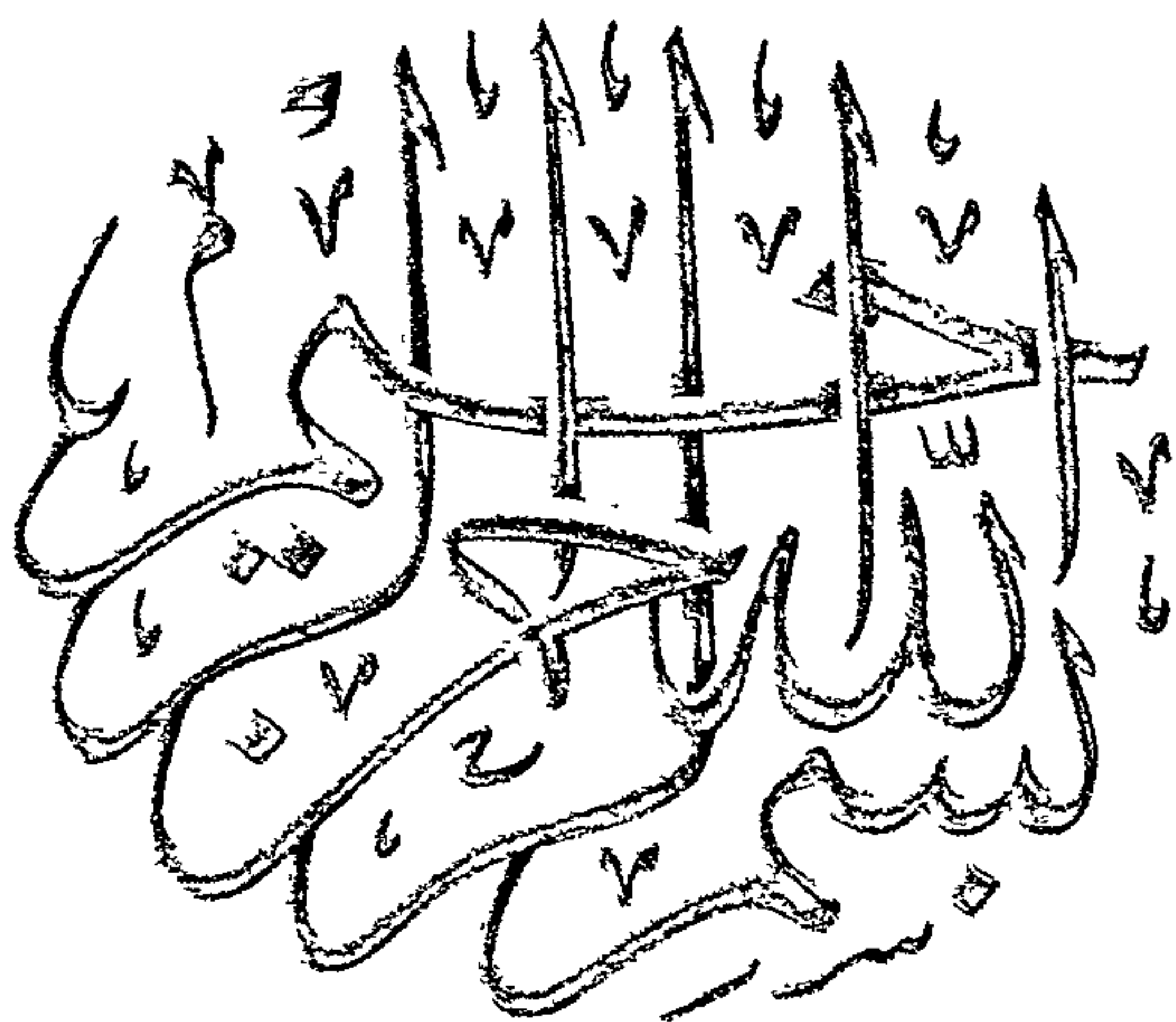

Dr. KHOSHNEVISAN

A thesis submitted in partial requirement
for the
DIPLOMA IN PUBLIC HEALTH DENTISTRY

Department of Preventive Dentistry
Faculty of Dentistry
University of Sydney

1990





SUMMARY

Children can not wait until our economic obstacles and other constraints have been rectified, it is now that their minds and bodies are being formed and it is now that they need adequate food, health care, and education (UNICEF 1990).

By nature the dentition is intended to last for a life time and the main oral diseases are eminently preventable or controllable.

The worldwide prevalence of dental caries and periodontal disease is well recognised. Both diseases may cause pain, infection, disfigurement, interference with function, and emotional problems.

There is a common factor presence in the initial stages of development of both dental caries and periodontal disease.

Standardised epidemiologic methods generally provide valuable data for comparison of prevalence and patterns of disease in any one population. Many epidemiologic reports show that oral health problems may be the most common disease throughout the world. Existing data on the prevalence and intensity of oral disease, show alarming trends, especially data obtained from developing countries.

In comparing dental caries prevalence it is necessary to focus on a similar age group. Most attention has been paid to 12-year-old, as they provide data on caries at exit from primary school.

The WHO goal for the year 2000 is that the DMFT at age 12 yrs should be 3.0 or less. Therefore school oral health programs with emphasis on prevention are a necessity. The availability of dental hygienists provides an effective and economical means to perform preventive procedures, screen school populations during the school year and to refer discerned pathology for definitive diagnosis and treatment.

Periodontal disease needs to be recognised and prevented. It is said to be one of the most widespread disease of mankind. Gingivitis affects over 80 per cent of young children and almost the entire adult population have experienced gingivitis, periodontitis, or both. Therefore, they comprise a world-wide health problem of major proportions. (WHO 1978)

Periodontal disease increases in prevalence and severity with increasing age. Improvements could best be achieved by means of primary prevention starting early at 7 years of age. (Ainamo, Ainamo 1981)

In the past decade there have been many changes in periodontal concepts. *Current concepts have been used to introduce a simple specific and realistic screening and monitoring examination. Data, based on CPITN, now accumulating at the WHO Global Oral Data Bank are just beginning to provide a global picture of periodontal disease patterns. (Renson et al. 1985)*

Existing data clearly indicate that periodontal treatment needs arise at an early age. *Improvements could best be achieved by means of primary preventive measures starting early at 7 years of age. (Ainamo, Ainamo 1981)*

There is a lack of an objective index for malocclusion and lack of comparability among reports on the prevalence of this anomaly. *Nonetheless, it has been estimated that about half of the school-age population in the U.S.A. needs some kind of treatment, and that one in five children suffers from malocclusion that could be considered severe.*

Reports agree that individuals with malocclusion showed higher caries rates than those with good occlusion. Disturbances in the direction of the occlusal force and the overloading of individual teeth caused by malocclusion have been considered an important factor in the ethology of periodontal disease. From clinical observations and from the findings of a few carefully conducted surveys, a highly significant correlation appears to exist between malocclusion and periodontal disease, emphasising the need for early treatment of malocclusion.

Overall review shows that, there is a major need for effective planning for oral health services in Iran. *The lack of resources, manpower and money, combined with their other needs and demands, emphasises the necessity for careful planning of the oral health services in developing countries, and for prevention and control rather than for a curative, restorative, and rehabilitative approach. (WHO 1980)*

All the Member States of WHO have adopted the goal of Health For All By The Year 2000, and all national oral health care systems must take their share of responsibility in efforts to meet this goal. (WHO 1987)

Much of the action required to meet the goals of Health for All falls within the responsibility of the government. Most of the underprivileged in health terms are women and children whose well-being requires special attention within primary health care.

The health sector has the important role of coordinating inter-sectoral efforts, by defining major problems, by suggesting preventive strategies, by proposing shifts in priorities and resource allocations, by encouraging positive action in other sectors, and by participating in advisory committees responsible for these efforts. (WHO 1988)

Community health policy should provide a major foundation for a National Preventive Health Care (WHO 1978). *In proposing a dental health policy for Iran it must be emphasised that the needs for prevention and control of dental disease are equally as important as the provision of other health care services.*

Why is dental disease so prevalent when a considerable amount is known already about how to prevent both dental caries and periodontal disease? Preventive dentistry can be highly successful. (Silverstone 1978)

By tradition, dentistry has been largely a reparative profession. While dental practice is concerned with the prevention and treatment of oral disease and their sequelae. (Burt 1983)

Dentists, whether they be in private practice or in government service, have a responsibility to provide dental care services to their patients and to uphold their professional aim of improving the oral health of the total community.

Strong and sustained efforts should be made to insure that there is no gap between the accepted goal that dental care should be available to all, regardless of income or geographic location, as rapidly as resources would be available and it is our professional responsibility to make real efforts to reach such an objective. Success requires a team effort, the dentist cannot do it alone - it requires both Ministerial and community level recognition to ensure optimal oral health.

It should be mentioned here that acceptance of the primary health care approach as a principle basis for planning health care in general, and dental services in particular, is the most recommended strategy. (Jacob 1989)

Primary health care services in the community should be comprehensive, multi-disciplinary and have an integrated management structure. All communities should have access to health educators who will work with them to identify and assess health problems, and develop solutions.

Political commitment is essential for the attainment of health for all. The seriousness of political commitment can really only be measured by the extent to which socially relevant development strategies such as primary health care actually being implemented. The concept of prevention inevitably finds its way into public health which is for the welfare of the group and of the individual at the same time. (Dunning 1962)

School health as an important public measure constitutes a major endeavour for any department of public health. Dental health is one of the large components of any school health program. (Dunning 1962)

One of the major objectives of health programs is the elimination or reduction of hazards to health. the effectiveness of the program is measurable in terms of reduction in occurrence of disease. The evaluation of the accomplishments of a dental program, therefore, is primarily concerned with a quantitative measurement in term of the prevention of dental disease or the reduction of its consequences.

The criteria for evaluating programs may be summarised as: *EFFECTIVENESS, EFFICIENCY, APPROPRIATENESS and ADEQUACY.*

The greatest challenge in the health field today is that of training and deploying the personnel required in a way that will make care less costly yet fully capable of meeting the stated goals (Mejia 1978). *In order to fulfil oral health services needs in developing countries, the current and future role of oral health personnel will have to be a public health and prevention oriented one.*

Children should receive first priority in the development of preventive services. Incremental dental care starts at the earliest available age (usually age six) when children enter the first grade of elementary school.

With ideal use of auxiliaries, comprehensive dental care could be supplied to the all schoolchildren of the country up to the age of 17 (end of high school) to cover the teenage period of most rapid tooth decay, on a national health insurance basis. *At this period of time in underdeveloped areas of the country, where dentists are often unavailable, oral health workers may best perform the job.*

A national health insurance policy that includes at the outset a dental component that gives priority to preventive and therapeutic services for children and emergency dental care for all (Dunning 1977) is recommended for Iran.

ALL children should be entitled to receive maximal primary preventive dental care. use of fluorides, pit and fissure sealants, sugar discipline, plaque control, and education.
(Harris 1987)

The dental treatment of children must be started at the age of 3 years.

ACKNOWLEDGMENTS

I deeply indebted to my supervisor, Professor PD BARNARD, Head of the Department of Preventive Dentistry, University of Sydney, for his untiring efforts and valuable assistance throughout the course and preparation of my thesis; his encouragement and support is highly appreciated and will be gratefully remembered.

Special thanks are extended to The Ministry of Health and Medical Education of The Islamic Republic of Iran and the World Health Organization-The Oral Health Unit, for their financial support and the opportunity that was granted to me for the completion of this course.

My warmest gratitude goes to my wife for her understanding, sacrifices and moral support especially during the period of my stay and study in Sydney.

TABLE OF CONTENTS

	Page
1 INTRODUCTION	1
1.1 Geography and demography of Iran	5
1.2 Health and oral health status in Iran	6
1.3 Oral health care delivery problems in Iran	8
1.4 Definitions	9
1.5 Aims of school based prevention	10
2 EPIDEMIOLOGY	11
2.1 Epidemiology of Dental Caries	11
2.1.1 Onset of dental caries	20
2.1.2 Progression of dental caries	20
2.1.3 Age, sex, race and dental caries	21
2.1.4 Heredity and dental caries	22
2.1.5 Dentition of males and females	23
2.1.6 Dental caries and geographical variations	23
2.1.7 Localisation of caries on various teeth and tooth surfaces	24
2.1.8 Caries prevalence on upper and lower dentition	25
2.1.9 Symmetry of dental caries	26
2.1.10 Circular caries	26
2.1.11 Dental caries in primary dentition	26
2.1.12 Dental caries in permanent dentition	29
2.1.13 Primary and permanent tooth indices	33
2.1.14 Dental examination techniques	34
2.1.15 Identification of caries risk groups	38
2.1.16 Global changes in the oral health status and treatment needs of schoolchildren	42
2.2 Epidemiology of Periodontal diseases	48
2.2.1 Predisposing factors	55
2.2.2 Classification of periodontal diseases	56
2.2.3 Periodontal plaque and dental calculus	58
2.2.4 Gingivitis	61
2.2.5 Periodontitis	64
- Adult periodontitis	65
- Rapidly progressing periodontitis	65
- Juvenile periodontitis	65
- Prepubertal periodontitis	66
2.2.6 Periodontosis	67
2.2.7 Tooth loss	68
2.2.8 Community periodontal index of treatment needs	70
2.2.9 Global trends of periodontal disease	85
2.3 Epidemiology of dento-facial deformities	90
Malocclusion	90
2.3.1 Ethological factors	91
2.3.2 Classifications	92
2.3.3 Prevalence of malocclusion	93
2.3.4 Malocclusion and dental caries	95
2.3.5 Malocclusion and periodontal disease	97

2.3 Epidemiology of dento-facial deformities	99
Cleft Lip and Palate	99
2.3.6 Classification	100
2.3.7 Ethology	104
2.3.8 Incidence and distribution	104
2.4 Epidemiology of Oral Cancer	107
2.4.1 Histopathological classification	107
2.4.2 Incidence: world-wide distribution and trends	109
2.4.3 Treatment and survival	113
2.4.4 Risk factors	114
- Tobacco	114
- Alcohol	115
- Diet and nutrition	116
- Ultraviolet light	116
- Trauma	116
2.4.5 Pre cancer	116
2.4.6 Prevention	116
- Primary	116
- Secondary	118
3 PREVENTION METHODS AND PROGRAMS FOR ORAL DISEASE	119
Program Outline for IR Iran	120
3.1 Situation Analysis	121
3.2 Measurable Goals for Prevention	122
3.3 Primary Preventive Measures	123
3.3.1 Oral health education/promotion	123
3.3.2 Aims of oral health education	125
3.3.3 Principles and methods of oral health education	126
3.3.4 Oral health education and communication	127
3.3.5 Curriculum adjustment	131
3.3.6 Oral health teaching-teacher or parents responsibility	134
3.3.7 Parents participation	135
3.4 Oral Hygiene Instruction	137
3.4.1 Tooth brushing programs	137
3.5 School Based Fluoride Program	139
3.5.1 Fluoride mouth rinsing and fluoride tablets	141
3.6 Control of Cariogenic Diet	147
3.6.1 Factors increasing cariogenicity of foods	147
3.7 Use of Fissure Sealants	148
3.8 Preventive Programs	150

3.8.1	Early identification and treatment	151
3.8.2	Professional topical application of fluoride	155
3.8.3	Advantages of a comprehensive school-based program	156
3.9	Systematic Dental Care	158
3.10	Target Groups	158
3.11	Manpower	159
3.11.1	Manpower and oral health services	159
3.11.2	Manpower and prevention of dental disease	160
3.11.3	Manpower development in Iran	162
3.11.4	The future role of oral health personnel	164
3.12	Economic and financing for dental care services	165
3.12.1	Government responsibility	165
3.12.2	Priority for government-supported dental care	168
3.12.3	Dental insurance system	173
3.12.4	Individual and family responsibility	177
3.12.5	Role of the private sector	178
3.12.6	Community responsibility	179
3.12.7	Non governmental organisations	180
3.12.8	International cooperation	181
3.12.9	Cost of dental care and mechanisms of payment	182
3.12.10	Cost of preventive programs	186
3.13	Quality of care and evaluation	196
3.13.1	Quality assurance in dentistry	196
3.13.2	Objectives of checking quality of care	197
3.13.3	Review by government agencies	197
3.13.4	Peer review	198
3.13.5	Evaluation	200
3.13.6	Process evaluation	202
3.13.7	Product evaluation	203
3.13.8	Monitoring and evaluation in Iran	205
4	DEVELOPMENT OF DENTAL HEALTH POLICIES	207
4.1	Definition	207
4.2	Types of public health policies	209
4.3	Policy cycles	210
4.4	Policy analysis	213
4.5	Health-policy-making process	215
4.6	Principles of policy development	220
4.7	Dental health policy suggestions for Iran	224
4.7.1	Pre-requisites	224
4.7.2	Provision of dental care in the community	225
4.7.3	Planning coordination and implementation of policy	226
5	Conclusions	228
6	References	242

LIST OF TABLES

		Page
1	Demographic indicators. Source: UNICEF (1990)	5
2	Health indicators for Iran. Source: UNICEF (1990)	6
3	Nutrition indicators for Iran. Source: UNICEF (1990)	7
4	Education indicators for Iran. Source: UNICEF (1990)	7
5	The rate of progress in Iran. Source: UNICEF (1990)	7
6	Dental caries trends (DMFT) of 12-year old children in Iran. Source: Nevitt (1959) Semsaryazdi (1974) Hamy (1976) Khamesi (1976) Rahmathulla (1977) Makarem (1987) Navabi (1987) Sadaghiani (1988) Leous et al. (1990)	7
7	Caries prevalence 1986 (Jönköping, Sweden). Source: Koch (1987)	40
8	Dental caries levels at 12 years. Source: FDI/WHO (1985)	43
9	Increase in caries prevalence (DMFT) in 12-year-old children in some developing countries. Source: Newbrun (1987)	44
10	Community periodontal index of treatment needs survey data 1982-1985. Source: Barmes, Leous (1986)	86
11	Periodontal conditions measured by CPITN, and estimated national percentages of edentulousness at age 35-44 years: WHO Global Oral Data Bank, 1987. Source: Barmes, Leous (1986)	87
12	Prevalence of malocclusion in the deciduous dentition (Angle's classification). Source: Moller (1969)	94
13	Prevalence of malocclusion in the mixed and permanent dentitions. Source: Moller (1969)	94
14	Classification of cleft lip and palate. Source: Davis & Ritchie (1922)	101
15	Classification of cleft lip and palate. Source: Davis & Ritchie (1922)	101
16	Veau's classification of clefts (1931). Source: Edwards & Watson (1980)	102
17	Kernahan & Starks's classification of clefts (1958). Source: Edwards & Watson (1980)	103

18	American Cleft Palate Association's classification of clefts (1962). Source: Edwards & Watson (1980)	103
19	Distribution of clefts by groups. Source: Moller (1969)	105
20	Incidence by cleft groups. Source: Moller (1969)	106
21	Number of new cases and of deaths in the United Kingdom. Source: FDI (1990)	108
22	Five-year relative survival rates England and Wales 1981. Source: FDI (1990)	113
23	Methods for the prevention of dental caries. Source: WHO Global Oral Health Data Bank (1984)	139
24	Dental manpower development in Iran. Source: Oral health office - Iran (1989)	163
25	Direct cost of community water fluoridation in the US, 1988 based on the capital cost of existing equipment (in US\$). Source: Garcia (1989)	186
26	Direct cost of community water fluoridation in the US, 1988 based on equipment replacement costs (in US\$). Source: Garcia (1989)	187
27	Direct cost of school water fluoridation programs in the US, 1988 based on equipment replacement costs (in US\$). Source: Garcia (1989)	188
28	Direct annual personnel costs for school water fluoridation programs in the US, 1988 (in US\$). Source: Garcia (1989)	188
29	Direct annual costs of sealant programs in the US, 1988 (in US\$). Source: J Pub Health Dent (1989)	189
30	Direct personnel costs of sealant programs in the US, 1988 (in US\$). Source: Garcia (1989)	190
31	Direct annual costs of supplement programs in the US, 1988 (in US\$). Source: Garcia (1989)	191
32	Direct annual costs of fluoride mouthrinse (0.2% weekly NaF) programs in the US, 1988 (in US\$). Source: Garcia (1989)	192
33	Direct annual personnel costs for fluoride mouthrinse programs in the US, 1988 (in US\$). Source: Garcia (1989)	192
34	Direct costs of prevention programs in the US 1988, (in US\$). Source: Garcia (1989)	195
35	The policy process - a framework for analysis. Source: Jones (1977)	214

LIST OF FIGURES

		Page
1	Dental caries prevalence at 12 years of age, 1990. Source: WHO (1990)	17
2	The four factors in the aetiology of dental caries. Source: Larmas (1985)	19
3	Comparison of caries prevalence in the maxillary and mandibular primary teeth. Source: Toth (1970)	28
4	The percentage of children with caries experience of the permanent teeth, by age. Source: Finn (1982)	30
5	DMF teeth and DMF tooth surfaces in the permanent teeth of 6-12 year old children. Source: Finn (1982)	30
6	Contribution of homologous tooth pairs to the total caries experience in the permanent dentition. (N = 15 children) Source: Finn (1982)	31
7	Comparison of proximal caries lesions detected by direct observation and by radiography. Source: Finn (1982)	37
8	Worldwide prevalence of deep periodontal pockets at 35-44 years, 1989. Source: WHO (1990)	49
9	Degeneration of collagen. Source: Shapiro & Stallard (1982)	51
10	Prevalence of dental calculus at 15-19 years, 1989. Source: WHO (1990)	60
11	Tooth loss with age. Source: Burt (1983)	68
12	The WHO CPITN Periodontal probe. Source: Cutress et al. (1987)	77
13	CPITN probing of the gingival crevice. Source: Ainamo et al. (1982)	79
14	Number of new cases and ranking in developed and developing countries. Source: FDI (1990)	109
15a,b	Age specific incidence rates for males and females 1982-84 England and Wales. Source: FDI (1990)	110
16	Age-standardised death rates:males England and Wales 1911-1985. Source: FDI (1990)	111

17	Death rates by birth cohort: Cancer of the tongue males, England and Wales 1871-1951. Source: FDI (1990)	112
18	Total annual sales of tobacco products 1890-1919 UK. Source: FDI (1990)	114
19	Relative risks of oral cavity cancer by daily consumption of alcohol and cigarettes males. Source: FDI (1990)	115
20	Cost benefit analysis of oral cancer control in Sri Lanka. Source: FDI (1990)	117
21a,b	Conceptual model for patient motivation and education. Source: Jones (1982)	129
22	Decrease in dental caries - DMFT, Tamworth dental survey 1963-1988. Source: Barnard & Sivaneswaran (1990)	140
23	Decrease in dental caries - DMFS, Tamworth dental survey 1963-1988. Source: Barnard & Sivaneswaran (1990)	144
24	Increase in caries free - DMFT=0, Tamworth dental survey 1963-1988. Source: Barnard & Sivaneswaran (1990)	146
25	Increase in caries free - dmft=0, Tamworth dental survey 1963-1988. Source: Barnard & Sivaneswaran (1990)	146
26	The importance of the "critical" year. Source: Toth (1970)	152
27	Oral health personnel model. Source: Renson (1984)	161
28	Proportion of medicaid expenditures going to various services in USA. Source: Burt (1983)	182
29	Institutional relationships among different policies. Source: Randall, Ripley & Franklin (1976)	208
30a	The policy process. Source: Gardner (1989)	210
30b	The policy process. Source: Gardner (1989)	210
30c	The policy process. Source: Gardner (1989)	211
31	A 'systems' model of the policy-making process. Source: Adapted from Easton (1965a)	215
32	Key stages in the health-policy-making process. Source: Palmer, Short (1989)	217
33	The policy process. Source: Gardner (1989)	218

1 INTRODUCTION

Health tends to be appreciated only when it is impaired (WHO 1970). The modern concept of **Health** is well stated by the World Health Organisation (WHO 1970) in its constitution as *"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"*. This definition applies to the whole individual and therefore encompasses such specific parts of the organism as the oral cavity.

Dental health is concerned with the functional efficiency not only of the teeth and supporting structures but also of the surrounding parts of the oral cavity and of the various structures related to mastication and the maxillo-facial complex (WHO 1970).

Oral health is an inseparable part of total health but has often been treated as if it were not, and left to develop rather independently. This attitude has led to the common experience of initial neglect of the oral health sector because too low a priority was allocated to it, followed by inordinate expenditure, private or public, on curative, restorative and rehabilitative services demanded by a public allowed to regress from low to high prevalence of oral disease. Yet, the main oral disease are eminently preventable or controllable. (Mahler 1985)

By nature the dentition is intended to last for a life time. Primitive man seldom lost his teeth. The teeth could become worn with advancing age, to the point where only the roots were left in the jaws, but dentitions still functioned. Such heavy attrition was still common in the Middle Ages. (Ainamo, Ainamo 1984)

In medieval times conservative treatment was non-existent and prevention was unknown, yet perfect teeth can be seen in medieval skulls. In historical terms edentulousness seems to be a rather recent phenomenon. (Ainamo, Ainamo 1984)

The growth of oral health services and oral health manpower in the twentieth century in highly industrialised countries has been of massive proportions. It came about in response to a demand created primarily by a tremendous increase in the prevalence of dental caries, which probably started in the nineteenth century and accelerated in the early decades of the twentieth century. The effect of this increase, superimposed on an already high prevalence of periodontal disease, was that a growing proportion of the population suffered from repeated episodes of acute pain from early childhood to the third or fourth decade of life and from premature loss of teeth; in some industrialised societies this became a normal state of affairs. Pain produced an immediate demand for services, which were aimed primarily at relieving the acute episodes and in themselves contributed greatly to the premature loss of teeth. It was also recognised that adults were often edentulous at an early age and dependent on prostheses that were often functionally inadequate, whereas in former times they had reached that state mainly in the fifth and later decades. Recognition of this situation brought about an increased awareness of oral health needs and of the need for more balanced and comprehensive oral health services to provide regular preventive, curative, restorative and rehabilitative services. As part of this evolution rather than as a result of comprehensive integrated planning, various systems for providing oral health services and different manpower structures developed. (WHO 1980)

As people become more and more concerned with health problems of all types and the search for appropriate solutions, therefore, the need to develop programmes that are directed to overcoming the most significant health problems in most efficient and effective manner is important. So because of social, economical and health-based reasons, the need for planning oral health services and manpower structures to meet carefully defined measurable goals and in harmony with overall health sector plans is receiving recognition to prevent caries and pain where possible and make services more relevant and available. (Hansen 1981)

In the USA Dunning (1962) stated that a century earlier dentistry consisted only of careful restorative work for those individuals afflicted with dental disease and able to pay for treatment in private offices, and that no preventive method existed of any type to justify community dental health programs. He (Dunning 1962) said that oral hygiene, diet, water fluoridation, and topical fluoride application are all practical enough to form good bases for community-wide programs to prevent dental caries.

Whatever the theoretical priority of oral health services, public demand has resulted in a considerable percentage of total national health expenditure being devoted to these services. (WHO 1980)

In 1980's the situation in developing countries, is relevant to highly industrialised countries because there is clear evidence that their populations are now experiencing the increase in caries that highly industrialised countries have had over the past century. (WHO 1980)

The lack of resources, manpower and money, combined with their other needs and demands, emphasises the necessity for careful planning of the oral health services in developing countries, and for prevention and control rather than for a curative, restorative, and rehabilitative approach. (WHO 1980)

The emphasis is placed on the high priority that should be given to preventive or control programmes in order to minimise the need for curative, restorative, and therapeutic treatment of oral diseases. (WHO 1984)

Emphasis on curative care has been adopted by some developing countries, but considering the increasing disease prevalence levels, low resources and scarcity of personnel, there is an even more pressing need to emphasise the preventive approach in those countries. (WHO 1987)

By tradition, dentistry has been largely a reparative profession. However, reparative dentistry alone cannot bring about the control of dental disease which has now reached epidemic proportions in some countries. The result of basic research, applied research and clinical trials from many parts of the world have shown that preventive dentistry can be highly successful. (Silverstone 1978)

It should be mentioned that acceptance of the primary health care approach as a basis for planning health care in general, and dental services in particular, is the most recommended strategy. (Jacob 1989)

The concept of prevention inevitably finds its way into public health which is for the welfare of the group and of the individual at the same time. (Dunning 1962)

The first six years of life are most important for the development and maintenance of the health of our children's teeth. During this period the first and most of the second dentition are already formed or in the process of forming prior to eruption into the oral cavity. Loss of even a single tooth as a result of dental decay or an accident during this period may have a permanent harmful effect on the development of the secondary dentition, their function and appearance. If necessary preventive measures are followed the children's teeth will have a good chance of lasting for their life. (Brown 1983)

School health as an important public measure constitutes a major endeavour for any department of public health. The gathering of children in a school not only imposes upon government a peculiar responsibility for the prevention of communicable disease, but gives government an unusual opportunity for health appraisal and the prevention of disease. In a quantitative sense, dental health is one of the large components of any school health program. (Dunning 1962)

1.1 GEOGRAPHY AND DEMOGRAPHY OF IRAN

The Islamic Republic of Iran, or the old Persia, is one of the large countries in the Middle East, covering an area of 1,648,000 square kilometres. The borders and neighbouring countries are: Soviet Union to the North; Persian Gulf and Oman sea to the South; Afghanistan and Pakistan to the East; and to the West lie Turkey and Iraq. The Alborze and Zagross mountain ranges divide this country into three regions, namely: North, Central and Southern Plateau.

Iran has a total population of about 55 million people, 53 per cent of whom are living in Urban and 47 per cent living in Rural areas; from the latter around 5 per cent are a moving (tribal) population (Table 1, UNICEF 1990). The average density of population per square kilometre is about 31 and varies considerably, being as high as 42 in Tehran (the capital) and as low as 6 in Yazd, Kerman and Sistan-va-Balochestan provinces.

Table 1
Demographic indicators.
Source: UNICEF (1990).

	Population under 16/under 5 (millions) 1988	Population annual growth rate (%)		Crude death rate		Crude birth rate		Life expectancy		Total fertility rate 1988	% population urbanized 1988	Average annual growth rate of urban population (%)	
		1965-80	1980-87	1960	1988	1960	1988	1960	1988			1965-80	1980-87
Middle USMR countries (31-94) Median	706T/232T	2.6	2.3	15	7	44	29	53	66	3.6	53	4.5	3.7
Iran, Islamic Rep. of	24.2/9.5	3.2	3.9	21	8	47	42	50	66	5.6	54	5.5	5.0

There are 24 provinces, 195 cities, and almost 70,000 villages in Iran. The culture, customs, life-style and dietary habits often vary in different regions of the country. There are 4 seasons and the climate varies considerably ranging from freezing temperatures in cool seasons to the heat of desert temperatures (about 45°C) in hot seasons. The weather is very mild and pleasant in the spring and autumn seasons.

1.2 HEALTH AND ORAL HEALTH STATUS IN IRAN

Through the various national plans, health services have been extended to most parts of the country. Basic medical and dental services, once not easily obtainable in the more rural areas, are now accessible to a larger segment of the population through the expansion of the Health Network System and the establishment of new district hospitals and health centers which include dental clinics and health houses. Preventive health programmes to control or eradicate debilitating disease endemic to Iran have also been intensified especially during the last decade.

The rapid development of medical and dental health services has brought about a significant increase of facilities throughout the country. To maintain efficient and effective operation of this infrastructure, the administrative and manpower components of the health services have likewise expanded. The objective of the government health services has always been to provide the population with the highest attainable standard of health, medical and dental care, with special emphasis given to the rural population so as to enable these people to participate fully in the economic development of the country.

Tables 2 to 6 show some of the basic indicators for Iran in the areas of health, nutrition, education, progress and dental caries.

On the other hand prevalence trends of dental disease are showing an increasing rates which it may be considered as a constant reminder of the urgent need for implementation of effective dental health programmes.

Table 2 Health indicators for Iran.

Source: UNICEF (1990).

	% of population with access to safe water 1985-87	% of population with access to health services 1985-87	Percentage fully immunized 1981/1987-88					ORS use rate 1986-87
			one-year-old children				pregnant women Tetanus	
			TB	DPT	Polio	Measles		
Total/urban/rural	Total/urban/rural	Total/urban/rural						
Middle USMR countries (31-94) Median	76/ 90/52	80/ 96/67	60/85	47/78	47/80	43/69	18/40	25.0
Iran, Islamic Rep of	76/ 95/55	78/ 95/60	6/73	29/80	47/80	48/90	2/50	15.0

Table 3. Nutrition indicators for Iran.
Source: UNICEF (1990).

	% of infants with low birth-weight 1982-88	% of mothers breast-feeding 1980-87			% of children (1980-87) suffering from			Average index of food production per capita (1979-81 100) 1988	Daily per capita calorie supply as % of requirements 1984-86	% of household income spent on all food/cereals 1980-85
		3 months	6 months	12 months	moderate & severe/underweight (0-4 years)	moderate & severe wasting (12-23 months)	moderate & severe stunting (24-59 months)			
Middle USMR countries (31-94) Median	9	80	70	48	22/3	7	34	97	113	35/10
Iran, Islamic Rep of	5				43*/.	23*	55*	89	138	/

Table 4. Education indicators for Iran.
Source: UNICEF (1990).

	Adult literacy rate		No. of radio/television sets per 1,000 population 1986/7	Primary-school enrolment ratio			% of grade 1 enrolment completing primary school 1985-1987	Secondary-school enrolment ratio 1986-1988 (gross) male/female
	1970 male/female	1985 male/female		1960 (gross) male/female	1986-88 (gross) male/female	1986-88 (net) male/female		
Middle USMR countries (31-94) Median	75/65	86/77	226/82	95/85	105/104	90/89	76	56/55
Iran, Islamic Rep of	40/17	62/39	236/53	56/27	122/105	98/89	83	57/39

Table 5. The rate of progress in Iran.
Source: UNICEF (1990).

	Under 5 mortality rate						GNP per capita average annual growth rate (%)	Total fertility rate					
				average annual rate of reduction (%)							average annual rate of reduction (%)		
	1960	1980	1988	1960-80	1980-88	required ** 1988-2000		1965-80	1980-87	1960	1980	1988	1960-80
Middle USMR countries (31-94) Median	155	79	63	3.5	3.3	3.5	4.0	-1.3	6.5	4.4	3.7	1.6	1.7
Iran, Islamic Rep of	254	130	90	3.4	4.6	2.7	2.9		7.2	5.8	5.6	1.1	0.4

Table 6 Dental caries trends (DMFT) of 12-year old children in Iran.
Source: Nevitt (1959) Semsaryazdi (1974) Hamy (1976) Khamesi (1976) Rahmathulla (1977) Makarem (1987) Navabi (1987) Sadaghiani (1988) Leous et al (1990).

Region	DMFT			Tentative trends
	1954	1974-76	1978-89	
North	2.2	2.5	2.8	Increasing
Central	1.9	4.2	5.8	Increasing
South	1.4	2.6	3.4	Increasing
All	1.8	3.1	4.0	Increasing

1.3 ORAL HEALTH CARE DELIVERY PROBLEMS IN IRAN

At the present time, a considerable number of the scattered population (mostly in rural areas) are deprived of all dental health services.

The rapidly expanding population and increasing urbanisation may yet result in higher dental disease levels and greater demand for dental services.

Those constraints which affect the efficient delivery of dental care in Iran, might be summarised as follows:

- a) Low priority status of dental health services.
- b) Insufficient resource allocation.
- c) Lack of manpower and its disproportional distribution.
- d) Logistical difficulties due to insufficient supply of dental instruments, materials and equipment.
- e) Regular maintenance and repair facilities are inaccessible for most dental clinics in rural areas.
- f) Lack of epidemiological data at the national level (base line data).
- g) National Dental Health Program of any kind is not available.
- h) The oral health services are very expensive and yet inaccessible for majority of the population.
- i) Lack of necessary regulations, policy and proper legislation.

Children can not wait until our economic obstacles and other constraints have been rectified, it is now that their minds and bodies are being formed and it is now that they need adequate food, health care, and education (UNICEF 1990).

1.4 DEFINITIONS

Winslow gave an excellent definition of public health, as *"the art and science of preventing disease, prolonging life, and promoting physical and mental efficiency through organised community effort."* The important concept in this sentence is contained in the last words, through organised community effort. (Dunning 1962)

Since *"public"* means *"of or pertaining to the people of a community, state, or nation,"* the simplest yet comprehensive definition of public health might be the literal one - public health is people's health. Therefore public health, in accordance with this broad definition, is not limited to the health of poor folks, or by methods of rendering health services, or by the nature of health problems. Nor is it defined by the method of payment for health services, nor by type of agency responsible for supplying those services. It is simply concern for, and activity directed toward, the improvement and protection of the health of a population group in the aggregate. (Knutson 1949)

No longer is the individual patient the sole objective of study, it is the aggregate health of a group, a community, a state, or a nation. This includes not only the sufferers from disease in all degrees of severity, from the sub clinical to the fatal, and those persons who have been left disabled in the wake of disease, but also *"Well"* persons, both resistant and susceptible to disease. (Dunning 1961)

A somewhat more accurate use of the word *"prevention"* involves primary focus on those measures taken in the period before any sign of frank disease has appeared, ie primary prevention (Dunning 1962). In other word prevention is considered to mean a procedure or course of action that prevents the onset of disease, whereas *"control"* implied reversing or stabilising disease conditions. (WHO 1984)

These definitions make several important points for our purposes and each would be used and/or discussed respectively in future sections.

1.5 AIMS OF SCHOOL BASED PREVENTION

The aims of school based oral health preventive programs should be:

- 1) To help every child appreciate the importance of healthy mouth.
- 2) To help every school child appreciate the relationship of oral health to general health and appearance.
- 3) To encourage the observances of dental health practices, including personal care, professional care, proper diet, and oral habits.
- 4) To enlist the aid of all groups and agencies interested in the promotion of school health.
- 5) To correlate dental health activities with the total school health program.
- 6) To stimulate the development of resources to make dental care available to all children and youths.
- 7) To stimulate dentists to perform adequate health services for children, in general and school age children in particular, as a major priority area.

(Dunning 1962)

Preventive methods are very well supported and documented for controlling oral diseases throughout the world and there is a big interest in the Ministry of Health and Medical Education of the IR Iran in this regard as well.

Hence the aim of this thesis is to prepare a scientific document based on available literature, to assist administrators and planners to facilitate their programming.

Hopping them to find between these covers a series of useful and practical procedures that will be of direct use to their oral health preventive programmes for schoolchildren.

2 EPIDEMIOLOGY

2.1 EPIDEMIOLOGY OF DENTAL CARIES

Epidemiology is a term derived from the greek language (epi=upon; demos=people; logos=science). It is a science concerned with health events in human populations.

In practical terms, it is the study of how various states of health are distributed in the population and what environmental conditions, life-styles, or other circumstances are associated with the presence or absence of disease. Epidemiologists are essentially medical detectives concerned with the who, what, where, when, and how of disease causation. By searching to find who does, and who does not, get sick with a particular disease and determining where the illness is and is not found, under what particular circumstances. When an agent is finally identified, public health officials can take steps to prevent or control the occurrence of the disease. (Valanis 1986)

The process of investigating the disease generates other information that is useful to public health officials and to medical clinicians. Epidemiological investigations may provide measures of disease frequency that are useful in assessing the need for specific community health services. (Valanis 1986)

The methods of epidemiology are not complicated. Broadly, three types of study may be identified - *descriptive, analytic and intervention*.

These methods are now used in the investigation of the causes and natural history of all types of disease and medical conditions, as well as in the development and evaluation of preventive programs, the assessment of treatments and the planning of health services. (Miller 1983)

Epidemiologists may identify new clinical syndromes, refine disease classifications, or identify factors that are associated with a high risk of developing a particular condition. (Valanis 1986)

Epidemiologists also generate information about the natural history of a disease - how disease occurs and progresses in the human host; they identify the various signs and symptoms of the condition and the usual patterns of presentation. They may identify physiological changes, clinical signs and symptoms of the disease, early case-finding so that, where effective treatment is available, it can be instituted to arrest the progression of the disease. (Valanis 1986)

When a specific causative agent is identified, programs to eliminate the agent from the environment or to protect the human population from the agent can be instituted. Since epidemiology provides these basic data needed for decision-making in public health, it is considered one of the basic sciences of public health. (Valanis 1986)

For thousands of years people have been trying to explain what causes disease. Supernatural events are often used to explain the occurrence of illness. Hippocrates (460 to 377 BC) attempted to explain disease occurrence on a rational rather than a supernatural basis. (Valanis 1986)

The investigative observations of John Snow in England in the 1850s led him to suspect contaminated water as the source of cholera outbreaks. The advent of quantitative measures of disease frequency, called rates, enabled him to determine that rates of cholera were much higher among those persons drinking the water than among those who did not. This was well before the actual isolation of the cholera vibrio by Koch in 1883. (Valanis 1986)

The use of rates to measure the frequency of disease occurrence provided a scientific basis for the growth of systematic methods to study disease. (Valanis 1986)

Investigations based on these methods have, over the years, provided a substantial amount of data about human health and disease. This accumulation of data provides an epidemiological body of knowledge about what factors are associated with the occurrence

and progression of diseases. The scope of this body of epidemiological knowledge is broadening with time, and it enhances the practice of medicine by increasing understanding of how disease arises and how it may be managed both in the individual and in society. (Miller 1983)

Further, epidemiology today is not limited to the study of diseases or patterns of ill health. It can also focus on other health-related characteristics of populations. By extending its scope to include mental and social conditions in addition to disease, epidemiology has helped behavioral scientists, social workers, community health planners and, in general, all those concerned with the health and well-being of human populations.

This recognition has led in recent years to a wider spectrum of professionals who participate in epidemiological research. (Valanis 1986)

Research into the etiology, prevention, and treatment of oral disease has provided a sound basis for control. If public awareness of present-day knowledge were increased, the prevalence of the disease and the severity of its sequelae could be considerably reduced. The generally accepted principle that "*prevention is better than cure*" (mentioned by Imam Ali(a) 14 centuries ago) is particularly apt, because oral disease is one of the few chronic diseases for which evidence is available on effective methods of prevention. (WHO 1978)

Dental practice is concerned with the prevention and treatment of oral disease and their sequelae. Practitioners, therefore, should be familiar with the epidemiology of the conditions they treat, because the type of treatment and services provided obviously relate to the diseases prevalent in the community. Practitioners can apply the epidemiological methods in their own practices to provide a *third dimension* to help them evaluate the impact of their services. (Burt 1983)

Epidemiology provides the assessment of the two most prevalent oral disease (dental caries and gingival or periodontal disease), and a standard system for the examination,

identification and recording of a wider range of oral conditions, a systematic approach to the collection and reporting of comparable data on the most common oral diseases for use in planning and evaluating oral health programmes and in identifying important research potentials. (Ainamo et al. 1987)

Dental health personnel should be encouraged to perform systematic epidemiological assessment of oral diseases as a basis for planning and evaluating oral health programmes, especially for the prevention and earlier diagnosis of oral lesions either benign or malignant ones. (Ainamo et al. 1987)

Hugoson et al.(1981) made the statement, "*...One of the aims of epidemiological recording of caries and gingivitis-periodontitis is to use the results for planning dental care and the different resources needed for its realisation.*"

Standardised epidemiological methods generally provide valuable data for comparing prevalence and patterns of disease in one population with those of another, in the same population at different times, and between several subgroups within a population. Many epidemiological reports show that oral health problems may be the most common disease throughout the world. (Truin et al. 1981)

In fact most doctors from time to time find themselves involved with the subject in one way or another, either as participants in epidemiological investigations or through the use they make of the results of epidemiological studies. It is, therefore, important that all doctors and others involved in health care, should have an understanding of the subject so that they can both take advantage of opportunities for using the method for investigating disease and be able to evaluate other people's contributions before accepting their conclusions. (Miller 1983)

Throughout his evolutionary advancement, man has been subject to a constantly changing environment. Some of these alterations have proved beneficial, others detrimental to his well-being. Among those environmental problems with which man has been unable to cope completely is an increased susceptibility to dental caries. Billions of carious teeth are in need of being filled that cannot be cared professionally for various reasons, such as economy, high prevalence of the disease and a lack of complete preventive and corrective measures. In view of this situation, dental caries assumes the enormity of a major national disaster. Man, because of present living habits, is the only species susceptible to this disease in his normal environment, and present attempts at preventing its ravages fall short of approximating the caries freedom enjoyed by other animals that are subsisting on their natural diet in a wild habit. (Finn 1982)

Primitive man probably ate his food unwashed. The food combined with the grit from the soft sandstone mortars used in grinding his grain abraded the occlusal surfaces of the teeth and obliterated the pits and fissures. By this means the surfaces were rendered free of dental caries, but the destruction of the normal spillways allowed for the interproximal impaction of food and development of proximal lesions. (Finn 1982)

The skulls of prehistoric human beings evidenced a slight susceptibility to dental caries and its sequelae. When man first learned to eat various tubers, grains, and berries and to enjoy the sweet taste of honey and other natural sugars, dental caries increased. Skulls found in France dating back 2,500 years indicate that even at this early period, one per cent of the teeth were carious. (Finn 1982)

The lesions of caries that have been found in skulls dated 1,500 AD are most commonly cervical or root caries; coronal caries was relatively uncommon. The disease seems to have been uncommon in the primary dentition, although some lesions in younger persons seem to have begun in the occlusal fissures but developed no further because the rate of attrition was faster than the rate of progression of the lesion. The modern pattern of caries

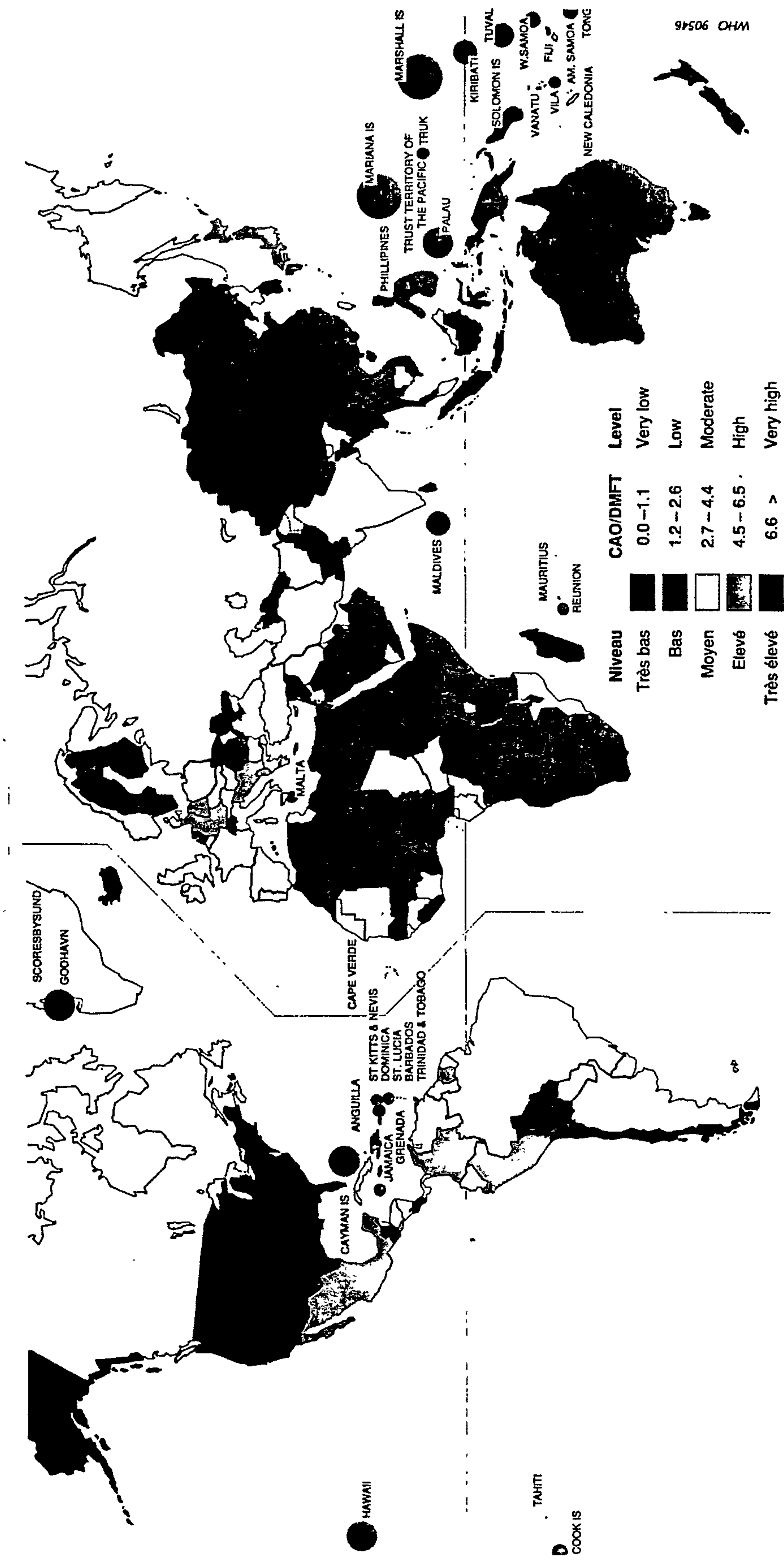
in which the disease usually begins in pit and fissure surfaces and later on proximal surfaces, developed around the sixteenth century. Changes in dietary habits during the seventeenth century - principally increased refinement of the diet and greater use of sugar as it became more available - are considered chiefly responsible for the development of the modern pattern of caries, which is characterised by relatively high caries susceptibility on all tooth surfaces (Burt 1983). Present civilisation is characterised by a relatively high caries susceptibility on all tooth surfaces. (Finn 1982)

Investigation on the prevalence and distribution of dental caries in a given population is one of the indirect methods of research into the aetiology of dental caries. (Toth 1970)

Today the occurrence of dental caries has become universal, affecting all ages and all races from all geographic areas of the world. **Figure 1** depicts the broad distribution of this disease.

Caries prevalence will have important implications for the planning of dental services in terms of the number and type of dental personnel required, the content of their professional training, the provision of facilities, and the way in which dental care is provided. From the point of view of the scientific community, a detailed consideration of changes in the pattern of caries may provide further insight into the nature of the disease and its prevention.

Figure 1.
Dental caries prevalence at 12 years of age, 1990.
Source: WHO (1990)



The *causes of dental caries* can be grouped into four major categories: *microbial agent(s); host and teeth; time; and general and local environment*. In addition, numerous interrelationships exist among the various factors within and between these ethologic categories. In order for caries lesion to occur in human beings, four conditions representing these major categories must be met simultaneously:

1. caries-producing microorganisms must be present in the mouth and colonise on the teeth surface in sufficient numbers;
2. the host and the teeth must be prone to develop carious lesions;
3. foods with caries-producing potential must be consumed in a caries- conducive way; and
4. is the time, since dental caries is a chronic disease, these conditions must prevail for weeks, months, or years in order for tooth substance to be destroyed sufficiently for carious lesions to be evident clinically.

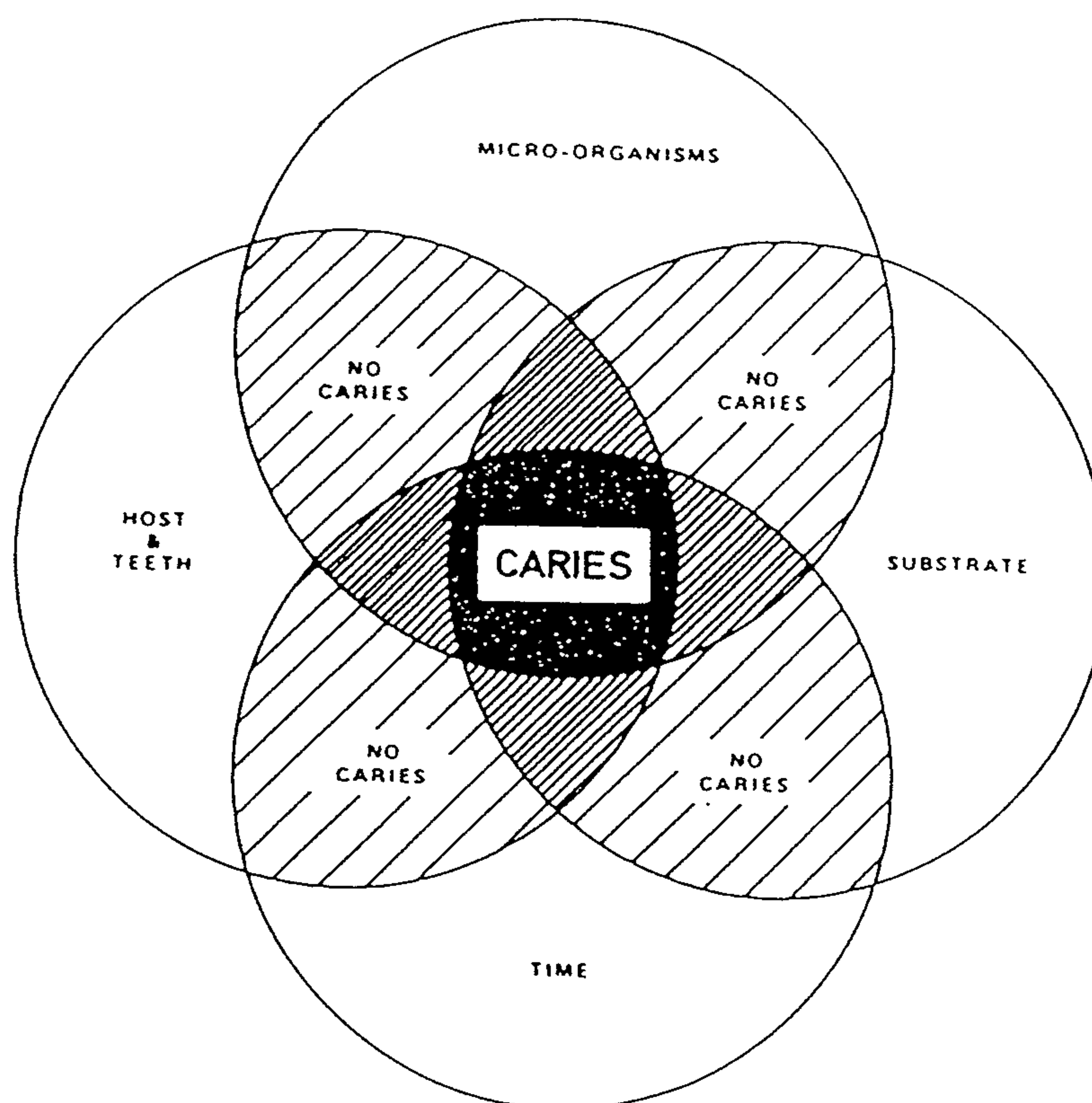
Unless all these 4 parameters are fulfilled simultaneously (as indicated at the center of **Figure 2**. where the four circles interlock) carious lesions cannot occur. Progression of the carious process is intermittent and there is active metabolism of the caries-producing microorganisms while food is available to them and relative or complete lack of metabolism in the absence of food. (Shaw 1982)

Plaque bacteria produce acid by fermenting ingested refined carbohydrates, especially sugars. This acid causes localised demineralisation of the enamel surface and if the process is not checked it will result in progressive destruction of the tooth. Dental caries is a widespread disease that eventually leads to pain and tooth loss if untreated.

The number of carious lesions and the rapidity of their progression are directly correlated to the composite pressure for caries initiation and development exerted by the various factors in the four categories. If the intensity of any one category is reduced materially, the carious process is reduced (**Figure 2**).

In the formulating of a program for optimal caries prevention, it is important to know the point in the ethologic relationships at which each preventive method acts and to combine methods that act at different points. Ideally, for a maximally effective preventive program, each of the major categories should be addressed simultaneously and continuously by preventive procedures in order that the intensity of the microbial attack is reduced, the resistance of the host and the teeth to decay is increased, and the use of food with caries-producing potential is decreased in amount and frequency by replacement with more desirable items. (Shaw 1982)

Figure 2.
The four factors in the aetiology of dental caries.
Source: Larman (1985).



2.1.1 Onset of Dental Caries

The investigations of Toth and Szabo (1960) extended to the youngest age group available, i.e. to babies 12 months old. In the age group of children having passed their first birthday caries frequency was found to be 5 per cent and the df count amounted to 0.15. No carious teeth were found by Fulton in children six months of age but by the time they had completed their first year, the number of carious teeth amounted to 0.02. In a similar age group, Savara and Suher (1954) found a df count of 0.67. Investigations conducted in Honolulu, Jones et al.(1930) found that one-third of children aged from six months to one year had carious teeth. Carious lesions of the deciduous dentition start very early, often not long after eruption of the teeth, this is the same as with the permanent teeth.

(Toth 1970)

Onset of dental caries:	Frequency:
6 months old babies	No caries teeth were found
12 months old babies	5% & df count amounted to 0.15
1-2 year old babies	df count amounted to 0.02

2.1.2 Progression of Dental Caries

The length of time required for the development of a carious lesion bears an important relation to preventive treatment. Investigators recognise that some lesions never progress beyond the incipient stage and that other identifiable lesions may become benign and progress very slowly. The time required for caries development is highly dependent upon the environment which exists at any particular period. Should this environment change to a less conducive one, because the surface becomes self-cleansing or for some other reasons, the caries process may be completely arrested or there is a possibility that incipient lesions may remineralize. (Finn 1982)

2.1.3 Age, Sex, Race, and Dental Caries

In susceptible communities, dental caries begins early. Studies from a number of countries, show that some 25 to 80 per cent of children between the ages of one to five have already suffered from caries. Caries begins in the permanent dentition soon after the first permanent molars erupt, usually in the pit and fissure surfaces of those teeth.

One age-related problem is root caries, found where gingival recession has led to exposure of the roots and to the accumulation of bacterial plaque around these exposed roots. The root caries is found both in Western and non-Western societies and is more prevalent in older persons.

Females generally appear to develop higher DMF scores than do males, although this finding is not universal. The difference is small enough to be explained by the earlier eruption of teeth in females; their teeth are at risk in the oral environment for a longer time.

That certain races enjoy an immunity or at least a high degree of resistance to dental caries have been evident in dentistry for a long time. They probably stemmed from the earlier observations that certain races, such as those in Africa and India, seemed to enjoy a much greater freedom from dental caries than others. These assertions have faded in recent years, as the evidence mounts that global differences in caries prevalence are more a result of environment than they are of inherited racial attributes. One convincing piece of evidence is the observation that certain racial groups, once thought to be resistant to caries, seemed to become more susceptible to the disease when they moved to more economically developed societies or to areas with different cultural and dietary patterns. (Burt 1983)

Familial tendencies ("good or bad teeth run in families") are seen by many dentists and have been demonstrated by dental research (Garn et al. 1977, Klein et al. 1938, 1954, Ringelberg 1974). However, whether such tendencies have any genetic basis or whether they only represent bacterial transmission or continuing familial dietary or behavioral traits is difficult to ascertain. Husband-wife similarities clearly have no genetic origin, and intra-familial transmission of cariogenic flora has also been shown to occur. (Burt 1983)

2.1.4 Heredity and Dental Caries

Investigators have recognised genetic variations in dental caries prevalence based on two sources of evidence in humans: *family studies*; and *twin studies*.

The data pertaining to family studies have been derived from information supplied by several investigators. In one study, parents with either low or high caries scores were compared with their siblings. The offspring had caries scores similar to their parents. If both parents had low caries scores, the offspring had low caries scores, and the reverse was equally true. If scores of the parents differed, the offspring had intermediate scores. Likewise, the caries-free children in another study had a close resemblance, in this respect, to their siblings.

In a number of twin studies, monozygotic twin pairs of like sex have been compared relative to caries experience. There was a greater concord between the monozygotic than between the dizygotic pairs and an even greater similarity between either type of twin pairs than between pairs of unrelated children of the same sex and age. The unrelated pairs of children, living in different households, may have received unlike diets. This may have accounted for the greater discrepancies that were noted between their caries experience and those of the pairs of twins who lived in the same home. At any given age there was a greater similarity between the number of teeth that were erupted in the monozygotic than in the dizygotic twin pairs, which may explain to some extent why there were greater differences between the dental caries experience in the dizygotic than in the monozygotic twin pairs.

No correlation has been established between the caries experience of individuals and the ages of his parents, the number of children in his family, or the relative position of the individual in his family. (Finn 1982)

2.1.5 Dentition of Males and Females

No essential difference in the caries experience of the deciduous teeth has been observed between boys and girls. In some age groups more carious teeth were noted in boys, and in others, in girls. No differences were found between the dentitions of the two sexes in the pertinent literature either, as stated by Toth, Csemi and Adler (1965). In populations susceptible to caries the permanent teeth of females are more subject to decay than those of males. (Burt 1983)

5.1.6 Dental Caries and Geographic Variations

The importance of geographic factors in the prevalence of caries was recognised by Hamar as early as in 1928 (Toth 1970). There are recognisable geographic variations in dental caries experience in different areas throughout the world. (Finn 1982)

People all over the world living under varying geographical circumstances are different as regards their culture and civilisation, and also their agricultural and industrial production. Consequently, their living standards, their way of life, and their dietary habits, all of which affect dental caries, are likewise different. (Toth 1970)

Investigators have pointed out the relationship between depleted soil areas and caries prevalence. Similar comparison have been made in respect to abundance of sunshine, higher temperatures, hardness of water and greater distance from the sea coast. These factors are correlated with lower caries scores. The trace elements selenium, molybdenum, vanadium, and fluorine have been studied for their effect on caries. Selenium shows some direct correlation with caries resistance, but fluorine is the only element associated with an unequivocal caries reduction. (Finn 1982)

The probable correlation between geographical location, the type of locality (large or small towns, villages, isolated farms) and dental caries. Considerable statistical data showed that the population living on small farms had better teeth than that living in towns. Sos (1936) noted that at the age of 6 years 41 per cent of children living on farms had sound teeth,

while only 22 per cent of children of the same age living in town had caries-free dentition. This was not, however, confirmed by Bruszt in 1949, who concluded that the teeth of children whether well- or under-nourished and whether in towns or in villages, are equally subject to decay. (Burt 1983)

2.1.7 Localisation of Caries on Various Teeth and Tooth Surfaces

Teeth vary in susceptibility to caries, though most teeth that develop the disease usually do so within two to four years after eruption. The pioneering Hagerstown studies of Klein and Palmer ranked the susceptibility of teeth to caries in the following order:

1. Mandibular first and second molars.
 2. Maxillary first and second molars.
 3. Mandibular second premolars, maxillary first and second premolars, maxillary central and lateral incisors.
 4. Maxillary canines and mandibular first premolars.
 5. Mandibular central and lateral incisors, mandibular canines.
- (Third molars had not erupted in the children studied)

Although the Hagerstown studies were carried out in 1937, this ranking of tooth vulnerability has probably not changed. (Burt 1983)

C type or central caries lesion start in the fissures of deciduous molars (about 40 per cent), P type or proximal (about 40 per cent), and C+P type or mixed group account for about 20 per cent of lesions. According to Toth "the teeth first attacked by caries are in 99.5 per cent of the cases are deciduous molars. Two-thirds of carious lesions are initiated on occlusal surfaces and one-third on the proximal ones. (Toth 1970)

2.1.8 Caries Prevalence in Upper and Lower Dentitions

Studies of caries prevalence in the upper and lower deciduous teeth disclose that the lower molars and the upper anterior teeth are more susceptible to decay than the other teeth. In children of 2 and 3 years of age no caries lesions were observed in lower incisors. Later, until the 7th year, lower incisors contribute about 10 per cent to the total caries experience of deciduous incisors. Lower canines are attacked by caries at a very early age, and in children of 3 years lower canines contribute about 10 per cent of the life long caries experience of all canines. In later years their condition, apart from the percentage of 13.3 observed at 4 years, is approximately 20 per cent. Thus, the lower canines not only become carious at an early age, but they are also most subject to decay among the deciduous lower anterior teeth. (Toth 1970)

Lower molars are attacked earlier by caries than are upper ones. At 3 years of age when the deciduous dentition can be regarded as complete, the lower deciduous molars account for 75 per cent and the upper molars only for 25 per cent of the total deciduous molar caries experience. This data was confirmed by the observations of Adler et al (1965) who have stated that the number of deciduous lower molars which are the first to become carious is about the double that of the upper molars. (Toth 1970)

Increased caries susceptibility of the lower deciduous molars may play a role in acquired malocclusions. The early decay and consequent loss of the lower deciduous molars will lead to mesial drift of the first lower permanent molars and this will happen more often than in the upper ones. Where there is a caries-free lower deciduous dentition, an intact upper dentition can be expected and if there is caries of the upper deciduous molars then even a more advanced decay is to be expected in the lower ones. (Toth 1970)

There is remarkable difference between the caries susceptibility of the lower canines in the deciduous and permanent dentitions. The cause, however, of the difference is unclear. (Toth 1970)

2.1.9 Symmetry of Dental Caries

As has been stated by Csemi, Adler and Toth there are only slight differences in the onset and progress of caries between the right and left side of the dentition. Thus, caries attack in the deciduous dentition has a symmetrical pattern. (Toth 1970)

2.1.10 Circular Caries

Circular caries is a particular type of decay of deciduous teeth. It appears at a very young age usually at the cemento-enamel junction or extending to the whole enamel. In certain cases some teeth are so severely attacked by caries that the entire crown is destroyed and only a blackish-brownish tooth or root remnants remain in the mouth. Circular caries seems to be the result of some deleterious oral habits such as sugar-filled comforters. In Oravec's (1935) opinion circular caries is frequent in undernourished children of the susceptible type. (Toth 1970)

2.1.11 Dental Caries in the Primary Dentition

Primary teeth is subject to attack at a very early age, may become carious prior to the eruption of the completed deciduous dentition. Dental caries attack in these teeth is progressive and, until all teeth are exfoliated by 11 to 12 years of age, can create a serious problem in the proper functioning of the masticatory apparatus. (Finn 1982)

Since exfoliation of the primary teeth commences at five years of age, surveys of the complete primary dentition must be done on infants and preschool children. There is difficulty in assembling large population groups of preschool children. Therefore, the number of surveys made with this group has been limited and the number of individuals in each study relatively small. This may account for some of the wide variation in reported findings. (Finn 1982)

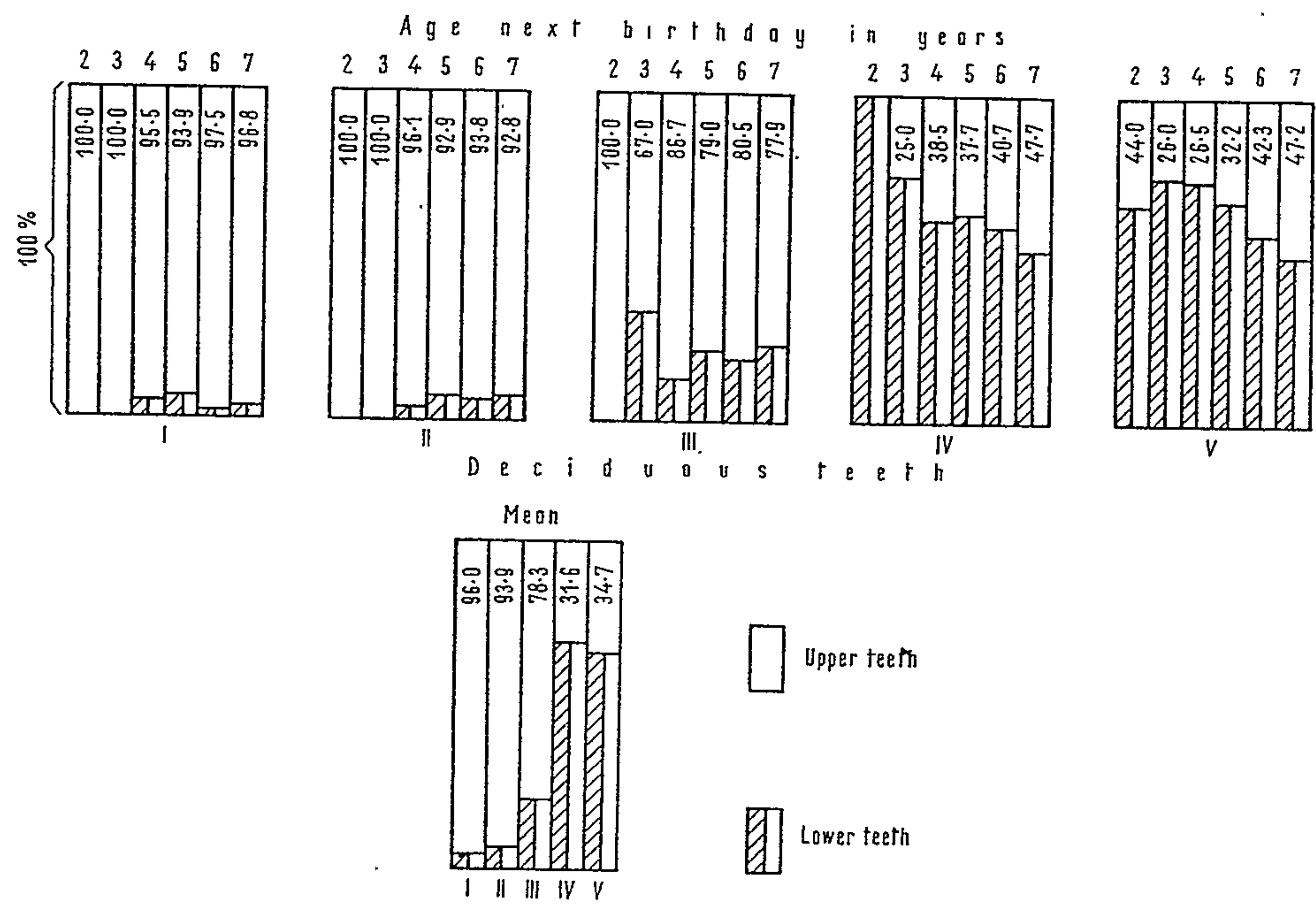
There appears to be no significant difference between sexes concerning caries in the primary dentition, although there is a definite variation between sexes at any specific age in caries experience in the permanent dentition. (Finn 1982)

Each tooth in both dentition has a caries susceptibility that is related to the other teeth of the complete dentition. There also seems some relationship between the caries susceptibility of specific tooth types. This only permits us to predict that a group having decayed deciduous teeth will have decayed permanent teeth. (Burt 1983)

On any individual tooth, there may be different reasons why a carious attack might favour one surface over another. Developmental pits and fissures may foretell the early development of occlusal caries, but other morphologic differences such as the size of the contact area between adjacent teeth or the amount of space between teeth might govern the rate of development of proximal caries. Because of the variation of interproximal contact, the surfaces of approximal teeth have a more similar caries experience than the mesial and distal surfaces of either tooth. Proximal surfaces, before there is a tooth in juxtaposition, usually have remained caries-free until the tooth approximating this surface erupts. The presence of an apposing tooth appears to have little effect on the development of occlusal caries. (Finn 1982)

The lower second molars are the most susceptible teeth in the primary dentition because of the length of the fissures and the broad extent of both proximal contacts. In general the lower incisors are the most resistant, accounting for only about 10 per cent of the total caries experience. The lower molars, being about twice as susceptible as the upper molars, account for about 52 per cent of the total caries experience. If an infant has a caries-free lower dentition, there is a strong implication that the upper dentition will also be decay-free. There are certain exceptions to this observation as exemplified by the early and rampant carious breakdown of the upper anterior teeth seen in nocturnal bottle-feeders given milk sweetened with sugar. **Figure 3** compares the relative susceptibility of the maxillary and mandibular primary teeth from two through to seven years of age. The lower anterior primary teeth at all ages have lower caries scores in contrast to the molar teeth. (Finn 1982)

Figure 3.
Comparison of caries prevalence in the maxillary and mandibular primary teeth.
Source: Toth (1970)



2.1.12 Dental Caries in the Permanent Dentition

Dental caries experience involving the mixed and permanent dentitions has been surveyed in numerous studies that have included individuals of all ages. The onset, progression and eventual fate of these teeth has been recognised as one of the major public health problems involving present-day man.

In 1982 Finn indicated that as early as 14 years of age, 97 per cent of children had evidence of caries in the permanent teeth in the USA, as indicated in **Figure 4**. (Finn 1982)

Since the first permanent molars erupt between five and six years of age, at which time 20 per cent of the children had experienced dental decay, this clearly demonstrates the vulnerability of these teeth to attack. (Finn 1982)

The number of DMF teeth rose sharply from 0.4 at six years of age to 8.33 at 14 years of age in the study of Finn (1982). The yearly increment, approximating 0.75 of a new tooth per year, involved approximately two surfaces per year. Despite the parallelism between the number of carious surfaces and that of DMF teeth for the chronological period indicated in **Figure 5**, there is an abrupt rise in the number of surfaces attacked. This situation is attributable to the development of new carious surfaces on previously decayed teeth and to increase in the size of some existing lesions, so that these lesions extend to other surfaces.

Although at six years of age there is an average of less than one DMF tooth per child, the rate rises to over five DMF teeth with nearly eight DMF surfaces at about 12 years of age. (Finn 1982)

Figure 4.
The percentage of children with caries experience of the permanent teeth, by age.
Source: Finn (1982).

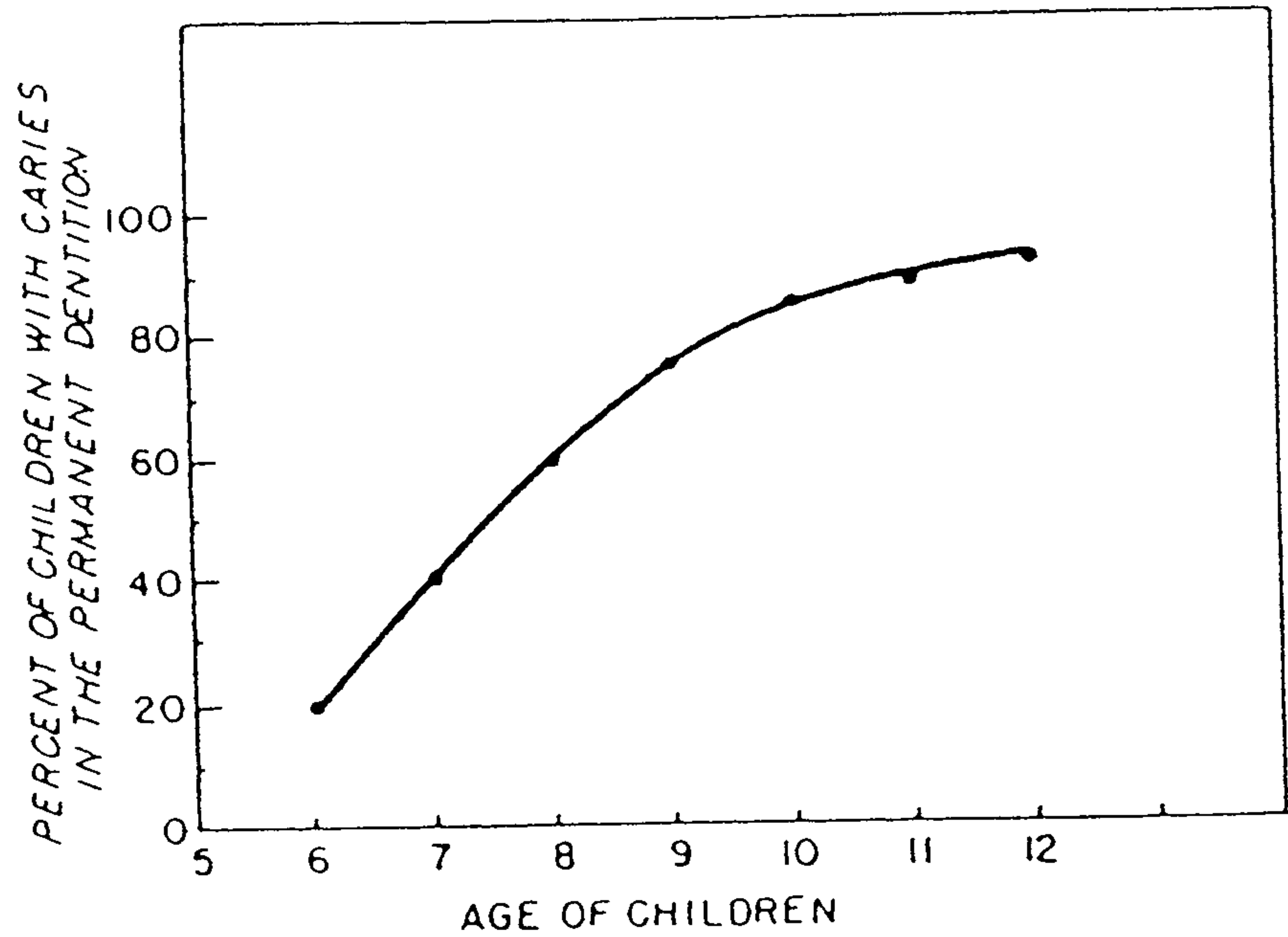
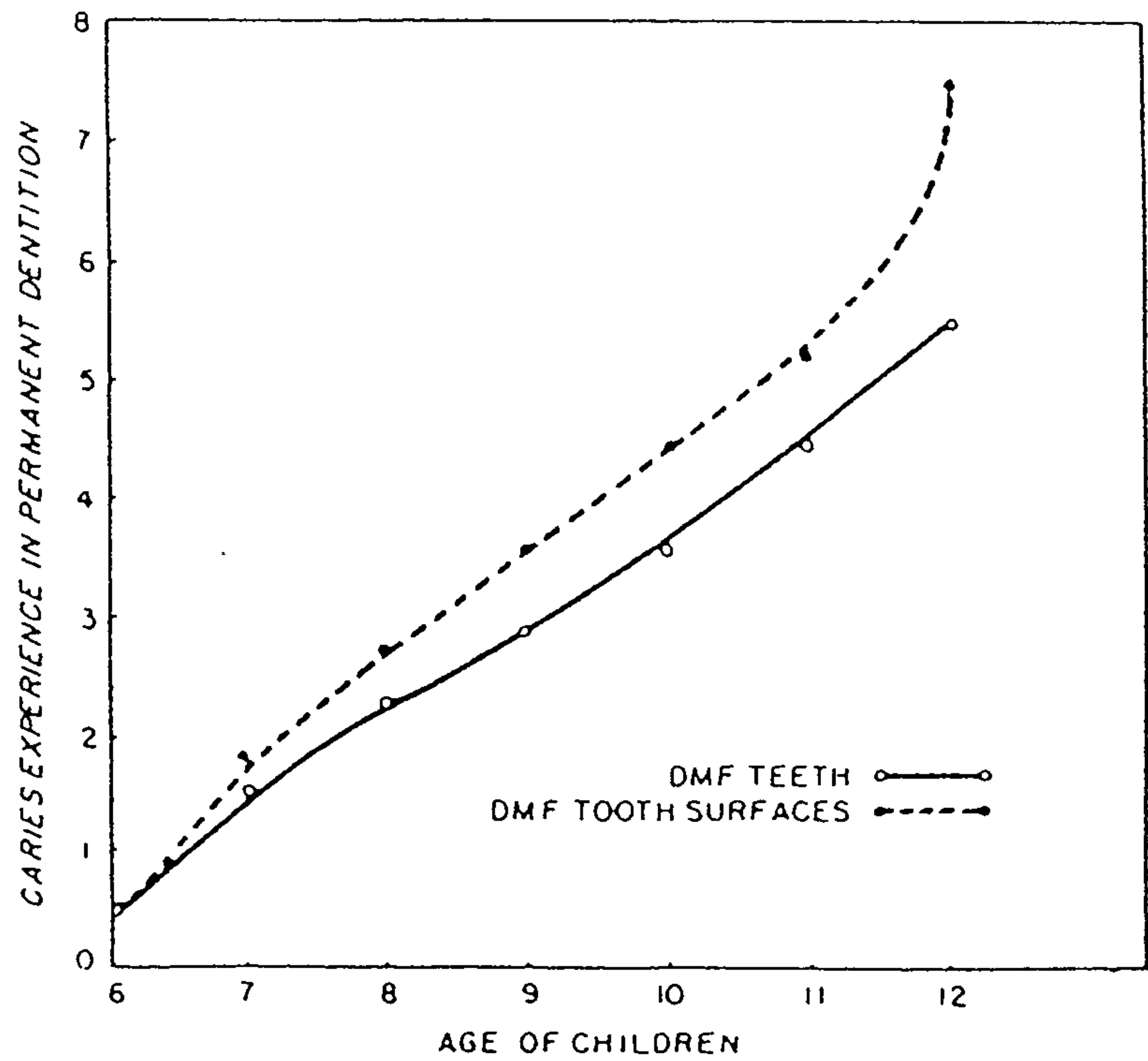
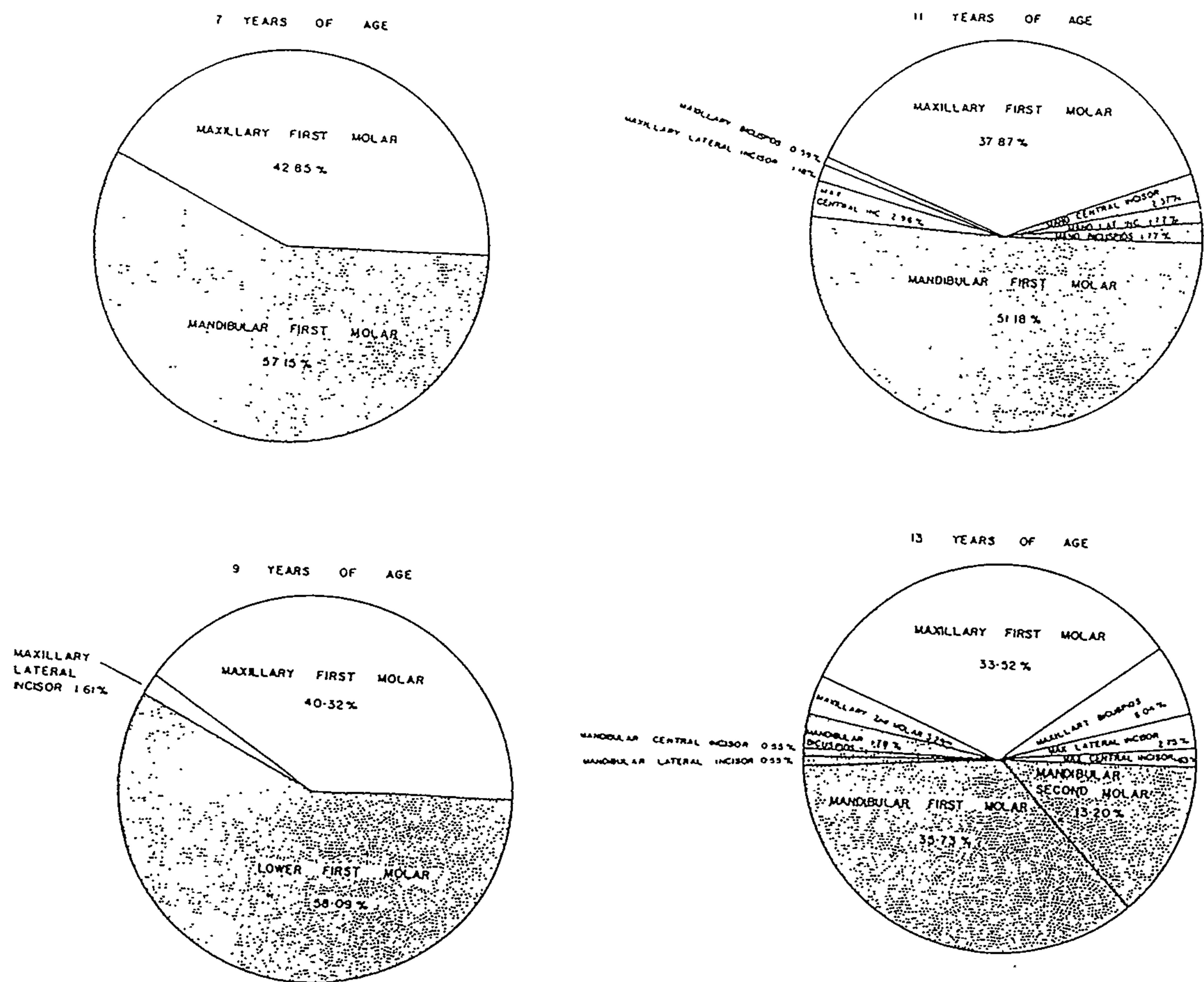


Figure 5.
DMF teeth and DMF tooth surfaces in the permanent teeth of 6-12 year old children.
Source: Finn (1982).



Dental caries appears to develop bilaterally; more cavities occur on homologous teeth and surfaces than occur unilaterally. As in the primary dentition, each tooth or each pair of homologous teeth has its specific susceptibility to dental caries. When dental caries is reduced by preventive measures, the teeth remaining caries-free are ranked in decreasing order based on original susceptibility; that is, the teeth that are more resistant to the caries attack are the first to remain caries-free. This may possibly explain the observation that currently used caries-preventive agents appear to be more effective on the proximal surfaces than on the occlusal surfaces. **Figure 6** shows the percentage of caries experience contributed by each tooth to the total for each child at 7, 9, 11, and 13 years of age. (Finn 1982)

Figure 6.
Contribution of homologous tooth pairs to the total caries experience in the permanent dentition. (N = 15 children)
Source: Finn (1982).



At seven, nine and eleven years of age the mandibular first molars contributed more than half of the total caries experience, with the maxillary molars contributing approximately 40 per cent. At 11 years of age all other teeth contributed approximately 10 per cent of the total caries experience. (Finn 1982)

Dental caries increases in a straight line progression through the teen ages and then levels off as the teeth mature and are consequently less susceptible to attack, and as the number of available susceptible surfaces is reduced by previous carious involvement. (Finn 1982)

On the molars, pit and fissure areas of the occlusal surfaces usually become carious earlier than the proximal and other smooth-surface areas. Cervical caries is generally the last to develop on the enamel. Root caries develops after gingival recession and is principally a disease of adulthood or old age. Occlusal caries is dependent upon the existence of pits and fissures (original faults of development) and to the steepness of the cusps. Where such faults are nonexistent, especially in the bicuspid, proximal lesions quite commonly occur earlier than those in the occlusal surfaces. (Finn 1982)

The most susceptible tooth surface in the permanent dentition is the occlusal surface of the mandibular first permanent molar, which may possess a fissure transversing practically the entire mesiodistal diameter of the tooth and by gravity invites impaction of food and debris. The maxillary molars possess a well-defined transverse ridge that divides this surface into two smaller pits. Pits are also present on the buccal surfaces of the lower molars and the lingual surfaces of the upper molars. Cavities appear earlier in these faults than in cervical areas on these same surfaces. (Finn 1982)

2.1.13 Primary and Permanent Tooth Indices

A comprehensible index to express dental caries experience either of an individual or a population needs to be developed so that all surveys and clinical trials can be universally understood and evaluated on a common basis. Progress is being made toward establishing comparable examination techniques and data compilations. (Finn 1982)

The index most widely accepted for compiling data for the permanent teeth is based on the number of decayed, missing and filled teeth (DMFT) or surfaces (DMFS) either per individual, per hundred erupted teeth or per thousand erupted surfaces. Another index is based on the number of (DMF) teeth or surfaces as calculated on the basis of a full complement of teeth and surfaces. An index of this type would compensate for age and sex differences (Finn 1982). There are other types of indices, which, because of their infrequent use, are not included.

During the period of changing dentition, it is not possible to make a reliable determination as to whether teeth have been lost because of exfoliation or through extraction. This makes it unsatisfactory to use the same indices that are used for the permanent teeth. Indices for the primary dentition generally employ the terms decayed, indicated for extraction, and filled (def)teeth and surfaces, or decayed and filled (df) teeth and surfaces. Because of the exfoliation factor, the def index is not completely reliable for children over five years of age. An index that counts only the primary cuspid and molar teeth would be reliable until approximately nine years of age, since these teeth are generally lost physiologically, beginning at this age. An index of only df teeth and surfaces ignores missing teeth and would be accurate only if the teeth were lost because of exfoliation and were known to have been caries-free. (Finn 1982)

The RID index, based on the caries experience of the individual, is calculated from the number of teeth and surfaces present in the mouth. Although not as widely used as the def index, it has several advantages in that the index can be used for the primary, mixed, and permanent dentition and considers only the teeth that are present in the oral cavity. As one gathers from the discussion, there is no perfect index but a few are adequate within expressed limits. (Finn 1982)

2.1.14 Dental Examination Techniques

The predominant diagnostic method employed in both clinical practice and epidemiology remains the clinical examination of the teeth.

Examination techniques vary depending upon the goals of the individual study. (Finn 1982)

The traditional clinical technique for diagnosing the disease (the tactile method) is to probe the suspected lesion with a sharp explorer (Horowitz et al 1974, Moller & Poulsen 1973).

The oral health survey method recommended by the World Health Organisation (1987) has this technique as its basis. A second technique (the visual method) is to clean and dry the site and examine it by eye in a good light (Marthaler 1966, Rugg-Gunn & Holloway 1974).

A predominantly visual method is widely used in dental surveys in the United Kingdom. (Todd & Dodd 1985, Dowell 1988)

Competent epidemiological surveys reporting dental caries prevalence should include the use of sharp explorers and mirrors under good light. For limited short-term studies, when testing the efficacy of a preventive agent is the objective, the importance of detecting all lesions as early as possible is critical. In this type of study, radiographs are desirable and perhaps essential, especially if the major inhibition occurs on the proximal surfaces. However, because of the harmful effect of radiation, caution must be employed to limit the amount of radiation received by the subjects, and the advantages to be gained must be weighed against the essentiality of the additional information.

Surveys concerned only with the number of missing teeth require less critical precision than those used in detecting caries, since there is only a need for tooth identification.

(Finn 1982)

For contacting approximal surfaces of posterior teeth caries detection may be aided by radiography or by fibre-optic transillumination. (Downer 1989)

The visual method of examining, which has been systematically validated in a number of studies, seems preferable to the tactile system using a sharp probe (Mitropoulos & Downer 1987). Thus the retention of the explorer points in a fissure, for example, is dependent on

a number of factors other than the presence of caries, including the physical characteristics of the point, the pressure exerted in applying it and the morphology of the fissure (Downer, 1975). Moreover, there is evidence that the tactile method is a less discriminating diagnostic technique than the visual method (Howat et al. 1981). Probing can also damage the integrity of partially demineralised surface enamel, compromising its capacity for remineralisation, and may transfer cariogenic micro-organisms to non-infected fissures. (Kay et al. 1988)

With regard to the adjunct to clinical diagnosis, Grondahl (1979) reviewed the results of four validation studies of bitewing radiography. These and other investigations (Downer, 1975) have indicated that radiological diagnosis produces a net underestimation of the severity of caries at individual sites. Also, depending upon the extent of radiolucency selected as a threshold for positive diagnosis, a relatively high rate of either false-positive or false-negative decision tends to be generated. In attempting to draw some conclusion about the validity of the method from the overall findings of these studies, the assumption that clinical cavitation has occurred when radiolucency has reached at least the amelodentinal junction appears to be the most tenable. Bille and Thylstrup (1982) noted that this criterion had often formed a basis when evaluating restorative treatment need. However, these investigators, and more recently Milemane et al. (1983) and Milemane et al (1986), have implied that, given the inherent shortcomings in validity of radiological diagnosis, the current low incidence and slow progression of approximal caries in many western populations, the perceptual inability of some examiners, and the adverse consequences of false-positive treatment decisions, unambiguous penetration of radiolucency into dentine might be a more appropriate threshold for a positive diagnosis of cavitation.

It has been suggested, on the basis of a retrospective examination of radiographs and clinical data obtained in 1974 and 1982 in two clinical trials, that the advent and widespread use of fluoride dentifrices has made occlusal caries more difficult to diagnose

and that bitewing radiography should therefore be used as an aid in detecting occlusal as well as approximal caries (Sawle, Andlaw 1988). From an epidemiological viewpoint the radiographic findings added only 2 per cent to the prevalence of caries diagnosed in occlusal surfaces in both trials (Anderson 1988). Moreover, the investigators used a tactile method of clinical examination the sensitivity and specificity of which is itself problematic. The results must therefore be regarded as inconclusive. (Downer 1989)

Although used extensively in clinical practice, radiological examination for caries is rarely used in descriptive epidemiology because of ethical, logistic and economic considerations and latterly because of the small amount of additional information it contributes. (Downer 1989)

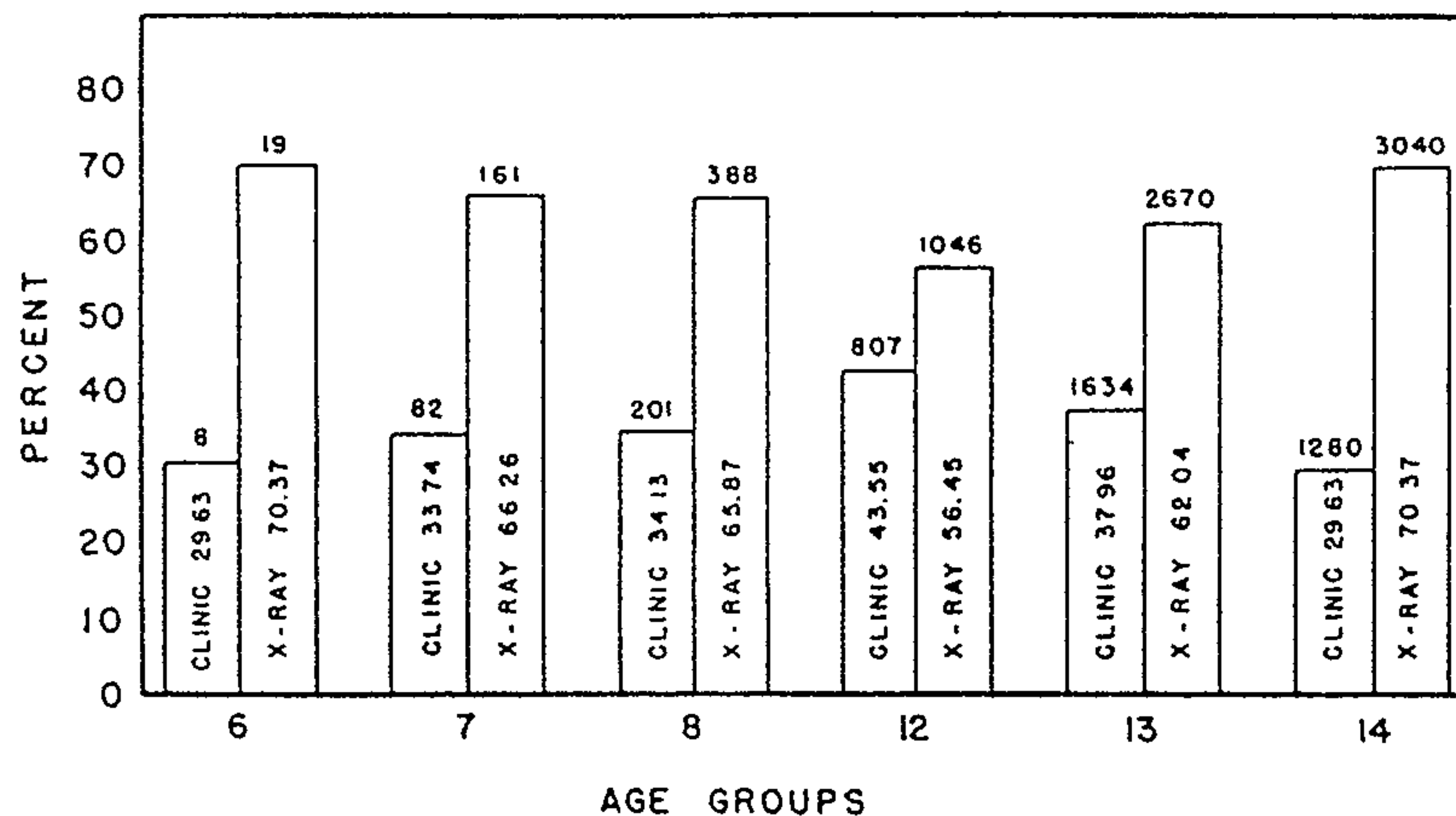
Fibre-optic transillumination (FOTI) has been used as an aid to the clinical diagnosis of approximal caries in posterior teeth and has some advantages over bitewing radiography (Mitropoulos 1985). Compared with conventional methods of illumination, FOTI detects more lesions (Mitropoulos, Worthington 1984). It can also identify lesions that are not revealed radiographically, though, conversely, other lesions disclosed by radiography are not detected by FOTI. Sidi and Naylor (1988) reviewed a number of recent studies comparing FOTI with radiography. The conflicting results of these and their own investigations demonstrated the difficulty of attempting to compare a new technique with a standard one which itself has imperfect validity. They concluded that the value of FOTI could not be adequately assessed until it had been more rigorously validated. (Downer 1989)

Figure 7 illustrates the number of proximal lesions detected in the Evanston Water Fluoridation Study by direct observation and by radiography. These figures indicate that over 64 per cent of the lesions were found by x-ray.

Figure 7.

Comparison of proximal caries lesions detected by direct observation and by radiography.

Source: Finn (1982)



Because of marked variation in methods of examination and reporting, considerable caution must be exercised in interpreting the data (Finn 1982). Other factors such as the type of population from which the sample is drawn, the sample size, the elimination of bias and the statistical treatment of data are important to the relevance and reliability of any data presented.

Since the dental caries prevalence from community to community or from area to area may vary, it should be clearly understood that the information provided by a study applies specifically to that area studied and only relatively to all communities or areas throughout the world.

It is recommended that:

- The examination should be done by the same examiner using identical criteria (dynamic method).
- Dental examination should be conducted on the same age group.
- The examination should include all deciduous teeth and erupted permanent teeth present in the mouth. Since a single examination of a group of children with mixed dentition (static method), only permits the comparison of certain teeth, such as deciduous molars and first permanent molars.

2.1.15 Identification of Caries Risk Groups

A basic goal in medicine and dentistry is to prevent the initiation of disease and its further development. An ideal way to fulfil this goal would be to concentrate most of the available resources upon those individuals or groups of individuals who are most prone to develop a disease, i.e. those at risk. If this philosophy is to be applied to dental caries, which attacks most individuals worldwide, the situation is somewhat complicated. (Winter 1988)

The methods most likely to provide effective prediction of caries risk should be given high priority in future research. The factors that need to be considered in assessing the value of a method of predicting caries risk are the correlation coefficient between the predictions and the final caries scores and in particular an assessment of the ability of the method to recognise subjects who will develop caries (sensitivity) and to exclude those who will not (specificity). (FDI 1988)

The requirements of a good method of predicting dental caries are that the method should be simple, inexpensive and rapid, and should identify subjects who will become diseased and exclude subjects who will remain healthy. To date, a wide variety of factors have been considered in the search for an effective method of predicting caries risk, but only a few have had some success. Certain epidemiological methods have shown reasonable sensitivity but less specificity. Measures in this category include specific indicator surfaces and DMFT increment in the previous year. Among the more useful specific tests have been mutans streptococci and lactobacillus counts and measurement of saliva buffering capacity. Other methods that show some promise include the physical measurement of incipient carious lesion of enamel. (FDI 1988)

The information provided from a combination of tests can, however, be described in simple terms through the use of odds-ratios expressing the risk of disease. Also required is the development of simple, rapid microbiological counting methods for *S. mutans* and

lactobacillus. For the individual patient, however, the subjective clinical judgment of the dentist, based on a broad knowledge of the risk factors and of the patient, is likely to remain an important factor in the assessment of caries risk. (FDI 1988)

Different risk factors have been described by Hunter (1988):

Local risk factors

- Number of teeth
- Occlusion
- Fissure pattern
- Saliva
- Oral microflora
- Disease association
- Diet (sugar)
- Oral hygiene
- Trace elements

General risk factors

- Age
- Sex
- Race
- Social status
- Geographical location

Dental caries is a disease affecting most individuals. As long as the caries prevalence in a population is generally high, most of the effort has to be directed to the application of preventive measures to the whole population. Such activities have, in a number of areas of the world, resulted in general decreases in the prevalence of caries. (Winter 1988)

Despite the overall importance in dental health of children in the highly industrialised countries of the world associated with a continuing decrease in the prevalence of caries (Barnes 1986), there remains a minority with relatively high levels of disease. For 12-year-old Sydney children in 1982 approximately half the decayed, missed and filled permanent teeth (DMFT) were found in only 12 per cent of the subjects (Burton et al 1984) and one year later in the UK, 60 per cent of all DMFT were found in only 25 per cent of this age group (Picton 1986). Epidemiological evidence for these trends in dental disease patterns has stimulated considerable interest in methods for the prediction and preselection of individuals or groups in the child population with high caries risk. (Klock et al. 1979)

Table 7 shows that in the pre-school children and young adults a small proportion of individuals were responsible for a large proportion of the total caries in the two populations. In fact, 10 per cent of the populations in these age groups accounted about 50 per cent of total restorative dental treatment required. (Winter 1988)

At risk individuals and their early detection, before they ruin their teeth, must be of the utmost importance to the individual, to the dental team, to the dental administrators and to society. The gain can be expressed both in terms of oral health and economy. If, for example, the caries incidence were to be reduced by half in the above mentioned 10 per cent of the population studied, the restorative treatment need for the total population would be reduced by 25 per cent. This underlines the importance of finding accurate predictive methods that with reasonable certainty can identify an individual with a high caries risk. (Winter 1988)

Table 7.

Caries prevalence 1986 (Jönköping, Sweden).

Source: Koch (1987).

<i>Age (years)</i>	<i>No. of subjects</i>	<i>Diagnostic criteria</i>	<i>Per cent individuals with the following numbers of decayed surfaces</i>			
			<i>0</i>	<i>1-4</i>	<i>5-8</i>	<i>9-</i>
6	3511	defs	50	28	12	10
19	4157	DFS-prox	39	37	14	10

Analysis of caries predictive factors in a group of 3,000, 5-year-old children conducted by Birkhed et al. 1987. First examination of these children was performed in 1981-82 when they were 1.5-2.5-year old. They were divided into breast-and non breast-feeding groups, and re-examination was performed four years later, for the evaluation of caries, gingivitis and plaque. Also bacteriological analyse of saliva were performed and the parents were interviewed about the child's oral hygiene habits, fluoride supplementation and dietary habits. (Winter 1988)

The results of this unpublished study showed, the mean defs for the original breast-feeding group without caries was 6.0, for the breast-feeding group with caries 13.5, for the caries group without breast-feeding 14.5 and the control group 4.5 respectively. The caries increments in defs between the two examinations were 6.0, 8.5, 9.6 and 4.6 respectively. The breast-feeding group and the caries groups had statistically significant higher caries increments compared with the control group. No statistically significant differences were found between the groups at the age of 5, in dietary habits, plaque index, gingivitis or numbers of *S. Mutans* in saliva.

Of special interest was the prediction of caries in the original control group. It was found that children who at Examination I had *S. Mutans* counts in saliva lower than 100,000/ml developed significantly fewer caries lesions, compared with those with counts in saliva of 100,000/ml or more. However, only 5 per cent of the children had more than 100,000 *S. Mutans* per ml. When mean defs scores in children with no *S. Mutans* were compared with the scores of those with the organism in saliva or when dietary scores were compared, no statistically significant differences were found. (Winter 1988)

In terms of the prediction of caries development in the primary dentition at the age of 22 months the study showed that more than 100,000 *S. Mutans* per ml of saliva, existing carious lesions and ongoing breast feeding all pointed to a high risk of developing caries. This pattern may differ between geographical areas and between cultures. However, the study does indicate that through prospective research the value of different predictive factors may be analysed and early preventive programmes instituted for individuals exposed to high caries risk. (Winter 1988)

All individuals are susceptible if they do not practise adequate oral hygiene and do not refrain from diets rich in fermentable carbohydrate. Rather they should be regarded as a range of disease towards which different individuals will have different degrees of risk. Both high-risk and low-risk groups and individuals are existing and much scientific progress is being made towards being able to identify such people. The ability to do this would allow a rational treatment and preventive strategy, targeted on those most in need, and therefore less interventionist and more cost effective. (Johnson 1988)

2.1.16 Global Changes in the Oral Health Status and Treatment Needs of Schoolchildren

To study oral health epidemiology on a global level, the reviewer confronts many problems. It is not clear where to start and where to end. Unfortunately not all surveys conform to the rigorous criteria of representative sampling that are required for comparison between countries at any one time. Even fewer data exist by which one can determine comparative trends in oral health status over an extended period of time.

Despite all the imperfections of data comparisons from country to country, involving multiple uncalibrated examiners and different collection dates, the evidence is overwhelming that a number of highly industrialised countries, in which a variety of community programmes for prevention of dental caries are in operation, have experienced large decreases in the prevalence and severity of dental caries in children. That experience suggests that other countries having, or about to establish such programmes are either experiencing, or are about to experience, such trends. It also suggests that developing countries will be able to use similar approaches to halt the increase in dental caries prevalence which some are presently experiencing and, eventually, to reverse the trends.

For caries epidemiology in school age children the most available data is about coronal caries. A measure of caries prevalence is the percentage of the population with caries, or its converse, the percentage of the population that is caries free. The former is of limited usefulness when most of the population is affected. The most widely used measures of caries experience are the sum of decayed, missing, and filled teeth (DMFT) or tooth surfaces (DMFS).

Literature review reveals that the distribution of dental caries depends upon demographic, ethnic and socioeconomic factors, all of which must be considered in order to obtain data that accurately represent the entire population of schoolchildren age groups. In comparing caries prevalence it is necessary to focus on a group of similar age. Most attention has been paid to 12-year-olds, as they provide data on caries at exit from primary school. At this age a DMFT range of 0.0 to 1.1 is very low, 1.2 to 2.6 is low, 2.7 to 4.4 is moderate, 4.5 to 6.5 is high and 6.6 or greater is very high.

The WHO goal for the year 2000 is that DMFT at this age (12-year-old) should be 3.0 or less. Yearly increments from school health services records makes it possible to predict increasing and decreasing caries trends and the rate of progression of these trends. Study of the figures presented in this section strongly indicate changes and a dramatic decrease in caries prevalence in school age children of those developed countries.

Findings of dental caries prevalence at 12-year-old age group for the period of 1973-1983 are summarised in Table 8. (FDI/WHO 1985) In table 8 the data is tabulated in ascending order of the latest available DMFT figure (column 2).

Table 8.
Dental caries levels at 12 years.
Source: FDI/WHO (1985)

Country (1)							% Decrease (-) Increase (+) col 4-col 2 col 6-col 4		
	DMFT DATE		DMFT DATE		DMFT DATE		col 4 (8)	col 6 (9)	
	(2)	(3)	(4)	(5)	(6)	(7)			
Hong Kong	1.8*	80	2.0	68	4.3	60	-10.0	-53.5	(Medical & Health Dept., Hong Kong, 1960; Wong, 1980; Law, 1982)
Thailand	2.7	77	0.9	60			+200.0	—	(Harris, 1961; National Pathfinder Survey, 1977)
USA	2.6	80	3.8	74			-31.6	—	(US Dept. Health & Human Services, 1981)
Australia	2.8	83	4.8	75	9.3	56	-41.7	-48.4	(Barnard, 1956; Carr, 1982)
Singapore	2.8	79	3.0	70	5.4	64	-6.7	-44.4	(Cadell, 1965; Goh et al., 1972; Min. of Health Singapore, 1984)
Nigeria	2.9	73	1.2	65			+141.7	—	(Henshaw, 1975; Nutrition Survey, ICNND, 1965)
United Kingdom	3.0	83	4.7	73			-36.2	—	(Todd, 1973; Todd & Dodd, 1983)
New Zealand	3.3	83	9.0	73			-63.3	—	(Information from NZ Dept. of Health, 1973; de Liefde & Ritchie, 1984)
France	3.4	82	3.5	75			no change	—	(Sitbon, 1976; Cahen et al., 1982)
Sweden	3.4	82	4.8	72	6.2	67	-29.2	-22.5	(Pettersson, 1967; Faharsman, 1972; Bohlin, 1982)
Netherlands	3.9	82	7.5	73			-48.0	—	(Kalsbeek, 1982)
Ireland	3.9	80	8.0	61			-51.2	—	(O'Mullane, 1982)
Finland	4.1	82	6.9	75	10.0	56	-40.6	-31.0	(Haataja et al., 1956-7; Tala, 1983)
Norway	4.4	82	7.4	78	10.1	71	-40.5	-26.7	(Directorate of Health Norway, 1982; Von der Fe 1982; Rotaland, 1978)
Denmark	4.7	81	6.3	78			-25.4	—	(National Board of Health, Denmark, 1979; 1982)
Colombia	4.8	80	7.1	65			-32.4	—	(Mejia Villa et al., 1971, Moncado & Herazo, 1983)
Japan	5.9	80	5.9	75	2.8	57	no change	+110.7	(Ministry of Health Japan, 1957; 1975; 1981)
Brazil	7.2	80	7.2	75			no change	—	(Moreira, 1977; Pinto, 1982)

* Preliminary, unofficial data for year 1980.
N.B. The percentage change shown in column 9 is only the change between the dates given in columns 7 and 5, whereas the data in column 8 are for the changes between the dates given in column 3 and 5. Care must be taken not to compare these two changes as if they were calculated on the same basis for the overall change thus:
(a) Australia—overall change 1956 to 1983 was -69.9%, of which the change between 1975 and 1983 contributed -21.5%.
(b) Finland—overall change 1956 to 1982 was -59.0% of which the change between 1975 and 1982 was -28.0%

Where comparisons can be made, DMFT figures have declined remarkably at age 12 in most industrialised countries listed, with the exception of France and Japan, where the figures have remained virtually unchanged. There is also some evidence that Brazil's figures for Thailand and Nigeria shows very marked increases.

However a recent decline in caries experience, particularly in children, has been amply documented in many, but not all, industrialised countries. the actual extent of the decrease varies in different countries and communities. In some countries like West Germany there has been little change if any, in caries prevalence in children.

According to 1980-85 classification, most countries in Africa, Asia and some in Middleast countries fall in the very low categories. Most of Soviet and Eastern block countries, India, Australia, and some of Europe experience moderate caries prevalence. DMFT score of Iran and Japan either is high or very high (1987).

Although caries prevalence is very low to low in most developing countries, the trends are disturbing. Of 20 such countries, 15 show a distinct increase in caries in 12-year-olds, two (China and Ghana) record no change, and only three (Argentina, Cuba and Sri Lanka) have had a decrease in decay. The increase in dental caries varies both in amount and rate from country to country but represents a serious deterioration in dental health (**Table 9**) and a major increase in treatment needs. (Newbrun 1987)

Table 9.
Increase in caries prevalence (DMFT) in 12-year-old children*
in some developing countries.
Source: Newbrun (1987)

Country	Dates	From	To	Increase	Years
Uganda	1966-72	0.4	1.5	1.1	6
Ethiopia	1958-75	0.2	1.5	1.3	17
Kenya	1952-73	0.1	1.7	1.6	21
Thailand	1960-77	0.6	2.9	2.3	17
Iraq	1967-76	0.7	3.5	2.8	9
Vietnam	1959-70	2.0	6.3	4.3	11
French Polynesia	1963-77	6.4	10.5	4.1	14

* World Health Organization, Oral Epidemiology Data Bank [7]

Two factors account for these trends in the developing countries. The first is an increase in sugar consumption. Rapid population shifts from rural to urban living have also involved changes in traditional dietary habits. Utilisation of sugar products such as confectionery, icecream and especially soft drinks has grown rapidly in the poorest countries. For example, in Mexico the average soft drink used is five bottles per week. The second factor is the lack of preventive intervention, whether at the public health level, by way of private practice, or by personal oral hygiene. Use of dentifrices, whether with or without fluoride, is minimal. For example, in Thailand less than 53 per cent of children in rural areas own a toothbrush; and in Korea, finger-brushing with salt or sand is still common practice. Furthermore, no communal water fluoridation exists in most of these developing countries, and systemic fluoride is limited to areas where water is naturally fluoridated.

It is interesting to note that, of the industrialised countries in this study, only Japan reports a rising DMFT figures over the 25 years period 1957-1981, although there is some evidence that the DMFT mean is just beginning to decline. While there has been an associated rise in per capita sugar consumption, Japan has the lowest (25 kg in 1982) consumption of all the industrialised countries. Japan has a well developed dental service with a dentist :population ratio of 1:2000 and there is a Health Center system where oral health guidance and preventive services are available for expectant and nursing mothers and infants.

Thus, it would appear that, of the hypotheses with which we have been dealing, Japan satisfies the requirements of:

- (i) Available dental resources
- (ii) Increasing dental awareness
- (iii) A preventive approach

However, although fluoride dentifrices became available in 1962, it is only in recent years that the market share for these dentifrices reached 15 per cent. In addition, there is no water fluoridation scheme and only about 110,000 schoolchildren (1 per cent of primary schoolchildren) are involved in a fluoride rinsing programme. It would appear that the most important missing factor in the Japanese situation, as compared with other industrialised countries, is the availability of fluoride. The strong environmental lobby inhibits the use of fluorides in its many forms except topical applications by dentist.

Caries free phenomenon

Apart from the decline in caries severity as detailed in Table 8, there are now reports of a parallel decline in prevalence data (per cent persons with or without dental caries experience). A number of references were made, in questionnaires returned, to the increasing numbers of children with a dmft/DMFT score of zero. These children are referred to as caries-free. Insufficient data are available to tabulate this phenomenon but a few examples are worth reporting.

Data from a survey carried out in North-East Friesland in the Netherland (Kalsbeek, 1982) show large increases in percentage of caries-free children at 12-years of age.

Age	1973	1976	1979	1982
12-year-olds	0%	6%	15%	23%

Caries-free figures for surveys carried out in the Hague, Netherland and Galway, Ireland provide remarkably similar results.

Finland and Australia reported marked improvements in caries-free percentages.

Finland:	1975	1977	1979	1982		
12-year-olds	1	1	2	7		
Australia:	1955	1977	1978	1979	1980	(1988)
12-year-olds	1	10	12	16	18	(39)

Treatment needs of schoolchildren

The review of data on oral health status from twenty selected developed and developing countries, identified changes in oral health of children and factors associated with these changes during the past 20 years.

Nine developed countries showed apparent substantial reduction (30-50%) in the prevalence of dental caries in 12-year-old children during the past decade. Caries in developing countries appears to have increased considerably. The most probable reasons for the decrease in dental caries in children in the developed countries were considered

to be associated with :

1. The widespread exposure to fluoridated water and/or fluoride supplements, and especially the regular use of fluoride toothpaste.
2. The provision of preventive oral health services.
3. The increased dental awareness through organised oral health education programmes.
4. The ready availability of dental resources.

The factor common to all countries with a substantial reduction in caries was fluoride, either as fluoridated water or toothpaste. Countries with decreased caries but no fluoridated water supplies had all experienced a rapid increase in the availability and the use of fluoride toothpaste during the past 10 years. The contribution of improved dental health programmes, other than those involving fluoride, could not be adequately assessed. Those changes, which appear to be continuing, have relevance also to similar countries which might just be entering the reduction phase. They also have relevance to developing countries in indicating how caries have been controlled and prevented. It is inevitable that in developed countries with reducing dental caries there will be a decreased need for dental services and hence a change in the need for dental personnel. However, the lack of adequate data in most countries makes prediction of future changes in oral health needs, a precarious procedure. The whole review indicates the urgent need for regular monitoring of oral health status in all countries for better planning and appropriate implementation, and gaining the best possible results.

2.2 EPIDEMIOLOGY OF PERIODONTAL DISEASE

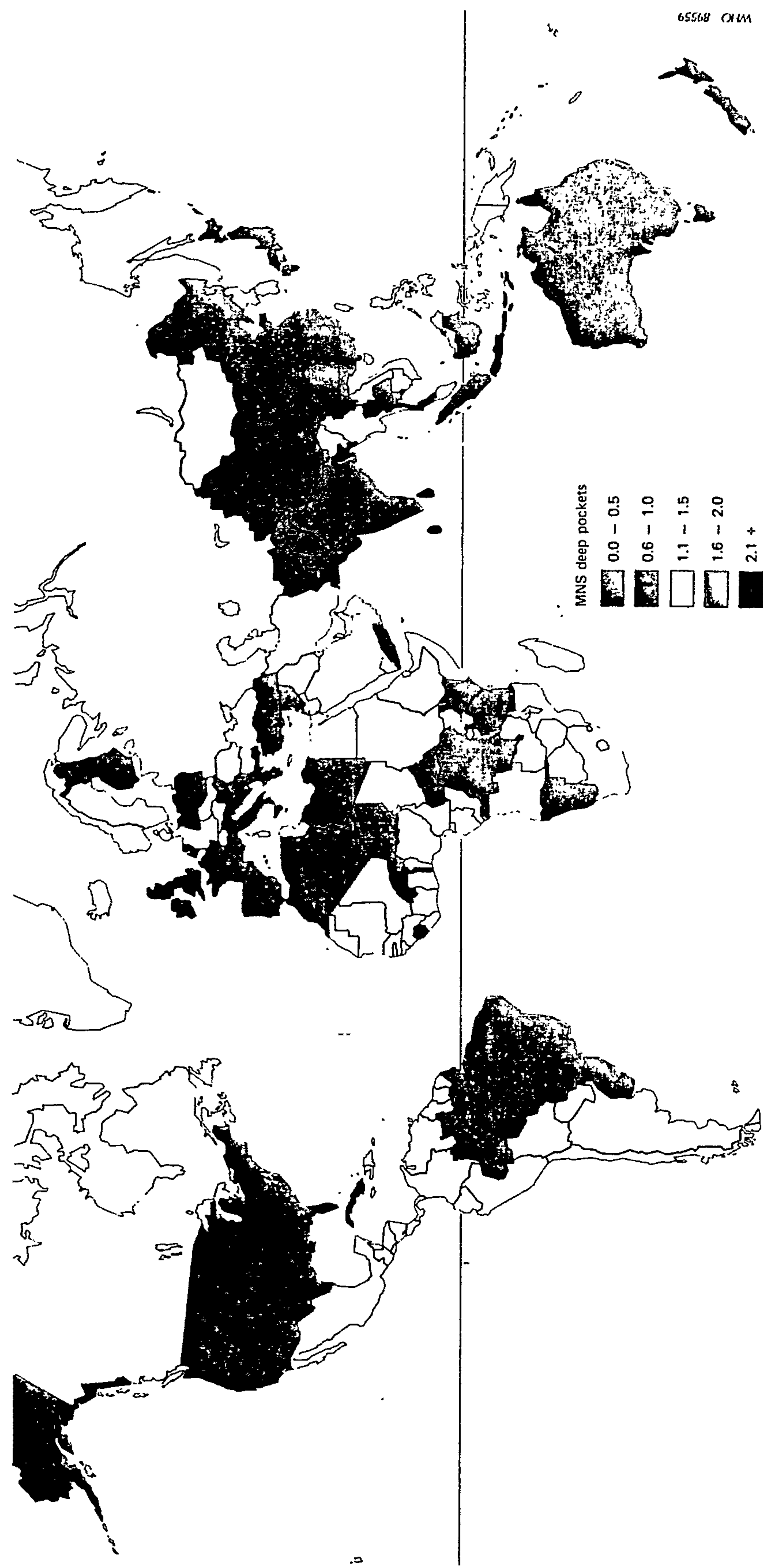
Periodontal disease is a generalised term for a range of pathological conditions affecting the supporting and investing structures of the teeth, it is said to be one of the most widespread disease of mankind (WHO 1978). Anthropological evidence indicates that periodontal disease, like dental caries, was present in ancient peoples, but it seems to have afflicted them more seriously, for ancient skulls even of quite young persons show considerable bone loss. Periodontal disease has been a remarkably persistent disease throughout human history, without the secular variations that characterise dental caries. (Toth 1970)

The nature and extent of the disease will vary from patient to patient and even from site to site in the same patient. The prevalence of these diseases is not known but existing information indicates that their occurrence is very high in the undeveloped and developing countries, and they afflict a large portion of adults in the developed countries. (Page 1986)

Gingivitis affects over 80 per cent of young children and almost the entire adult population have experienced gingivitis, periodontitis, or both. Therefore, they comprise a world-wide health problem of major proportions. (WHO 1978) The prevalence of deep periodontal pockets in different countries for persons aged 35-44 years is shown in **Figure 8**.

A large scientific effort in many countries has been under way for the past two decades aimed at obtaining an understanding of these diseases sufficient to devise better means of treatment and prevention. Advances in the past decade in our understanding of aetiology and progression of periodontal disease have been enormous, and knowledge is now sufficient to begin to make inroads into control and prevention. (Page 1986)

Figure 8
Worldwide prevalence of deep periodontal pockets at 35-44 years, 1989.
Source: WHO (1990)



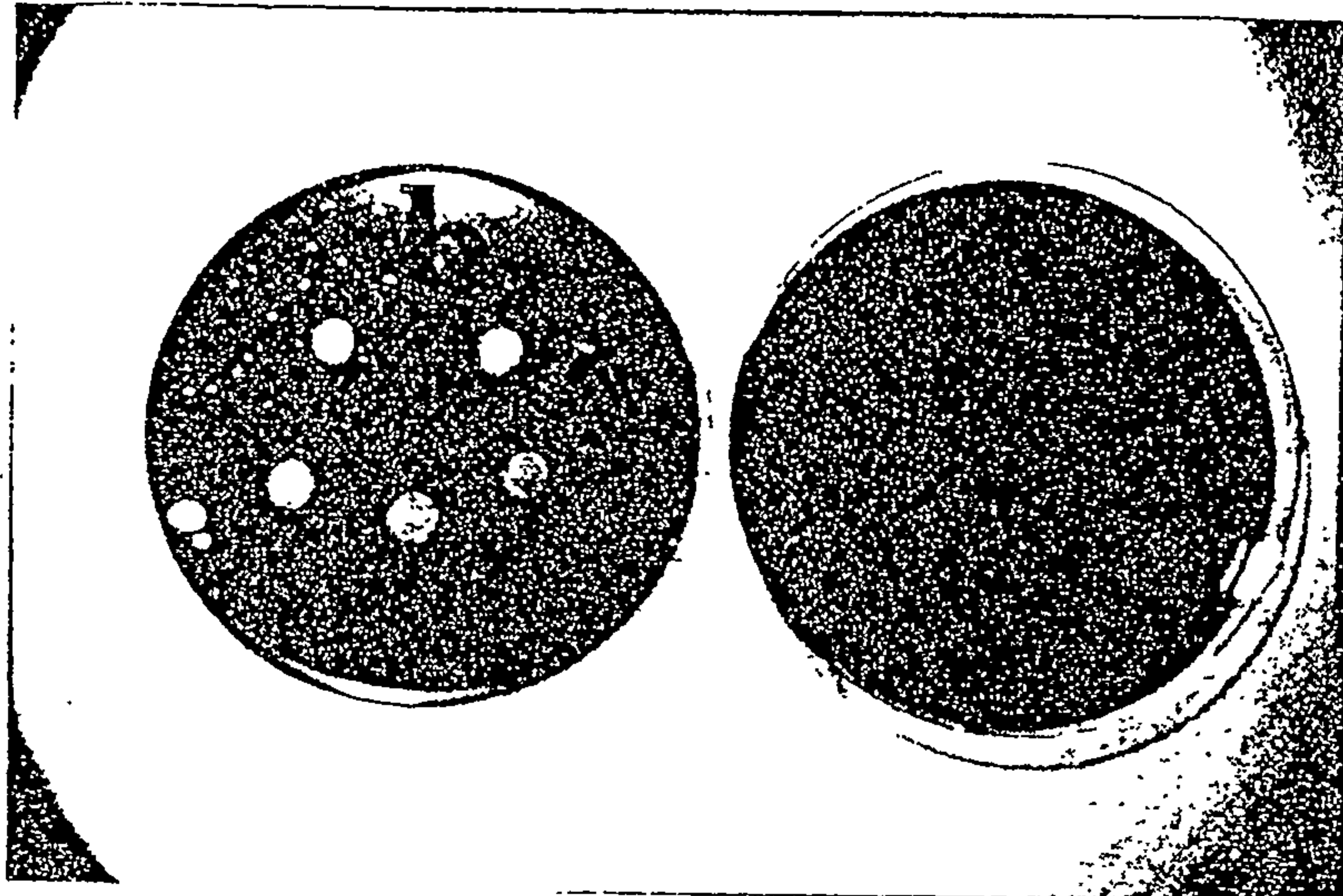
The ethology of the inflammatory periodontal lesion is complex and, to a certain degree, obscure. It represents the interaction of extrinsic and intrinsic factors that result in the production of a group of symptoms collectively termed periodontal disease. While the lesion is the result of an interaction of various agents and circumstances, the nature and extent of the disease will vary from patient to patient and even from site to site in the same patient. (Shapiro, Stallard 1982)

Bacterial plaque begins as a pellicle deposition on tooth structure. The primary source of the acquired pellicle is saliva, and it forms by a selective absorption of selected glycoproteins on the tooth. The acquired pellicle is covered by a bacteria-free matrix that subsequently is colonised by bacteria. (Shapiro, Stallard 1982)

The initial colonisation of the bacterial plaque is predominantly a gram-positive flora. Recent evidence indicates that *Actinomyces viscosus* plays a key role during the initiation of the inflammatory response. As the plaque flora becomes more heterogeneous with a relative increase in gram-negative species, the clinical inflammatory signs become more apparent. (Shapiro, Stallard 1982)

It is of interest to note that, in the normal establishment of the plaque flora, coccoid cells initially colonise the tooth surfaces, followed by filamentous and fusiform cells. The time sequence of bacterial colonisation is important, since it points out the unique nutritional interdependence between bacterial species. (Shapiro, Stallard 1982)

The metabolic products of the bacteria rather than the bacteria themselves are responsible for the inflammatory changes occurring in the periodontium. Bacterial enzymes such as collagenase and hyaluronidase are present; and capable of degenerating natural collagen (**Figure 9**), and may play a significant role in the initiation of the inflammatory lesion. As a secondary stage, gram-negative bacteria produce endotoxin that may be responsible for the inflammatory reactions in the gingival tissue. (Shapiro, Stallard 1982)

Figure 9**Degeneration of collagen.****Source: Shapiro & Stallard (1982)**

Although the bacterial products play a role in the initiation of the inflammatory lesion, they also may play a secondary role in an immunologic reaction in the gingival tissues. The immunologic reaction can be considered to be biphasic to a certain degree. While it may seem contradictory, the initial immune response in the gingival tissues is a cell-mediated type with a preponderance of lymphocytes on a histologic basis. As the lesion progresses, however, the cell-mediated response wanes, and a humeral reaction with an attendant increase in plasma cells predominates. (Shapiro, Stallard 1982)

Epidemiological surveys, controlled clinical trials and basic research unanimously indicate that periodontal disease is caused by the bacteria colonising the tooth surface (Lovdal et al. 1961, Russell 1963, L  e et al. 1965, Lindhe et al. 1975, Page and Schroeder 1981). There is overwhelming evidence that the direct cause of gingivitis and periodontitis is the accumulation of microbial plaque on and near the cervical region of the teeth and its extension apically along the root surface. (Schroeder, Attstrom 1980)

Extensive epidemiological studies performed in many countries have demonstrated a strong positive correlation between the presence of microbial tooth deposits and inflammatory disease. Periodontal pocketing cannot be induced in the absence of bacteria (Moore et al. 1982). As long as the tooth surface is kept free of bacterial deposits, the gingiva will remain healthy. If plaque is allowed to grow along the gingival margin, gingivitis will develop within a few weeks (Löe et al 1965). Spread of the supragingival plaque into a subgingival location, where the contact area between the plaque and the gingival tissue becomes larger, results in an increased tendency for bleeding from the inflamed pocket wall to occur. Destruction of the supragingival collagen fibres starts as soon as the dental plaque extends to a distance of less than 1 mm from the apical border of the epithelial attachment. At the same time, alveolar bone resorbs at a distance of 2 mm from the plaque. The progression of periodontal disease is thus determined by the rate of the apically directed growth of dental plaque. A well known example of rapid periodontal breakdown is that seen in juvenile periodontitis, in which a tooth may become totally detached from its bony socket before the affected individual reaches 20 years of age. (Saxen 1980)

Every practising dentist has seen individuals in whom the firm attachment of the teeth does not seem to be threatened even by life-long defective oral hygiene. As compared to someone with juvenile periodontitis, such a subject represents the other extreme in the range of variation in disease experience among individuals. In addition to the known effect of poor oral hygiene, individual variation is determined by differences in host response. According to the plaque principle, the same amounts of plaque result in more periodontal tissue destruction in individuals with a poor rather than with a good host response. (Ainamo 1984)

Epidemiological data on periodontal disease is dominated by information on chronic marginal gingivitis and adult-type periodontitis. In children and young adults gingivitis is the most frequent clinical finding. The current epidemiological evidence on disease in

young people indicates that gingivitis is universal (Massler, Schour 1949, Sheiham 1969, Poulsen et al 1972, Hugoson et al 1981). The prevalence and severity reported is dependent on the methods used for clinical assessment and statistical evaluation. It can be assumed that symptomless, plaque-associated gingivitis is common-to-endemic in many populations. Data are scarce on conditions such as acute necrotising ulcerative gingivitis, tooth eruption and pubertal gingivitis. (Cutress 1986)

Chronic gingivitis and periodontitis are the most common categories, while acute necrotising ulcerative gingivitis and juvenile periodontitis are the most destructive form of periodontal disease. Chronic gingivitis and chronic periodontitis account for most of the disease reported in epidemiological studies.

Chronic periodontal disease is characterised by chronic gingival inflammation which may extend into subjacent periodontal structures with loss of attachment (Ranney 1981). Clinically, it is usual to distinguish gingivitis from periodontitis on the basis of loss of the epithelial attachment in the latter. (Löe et al. 1978, Becker et al. 1979)

The composition of the subgingival flora from patients with the early onset forms of periodontitis, especially juvenile periodontitis, has received considerable attention (Newman et al. 1976, Slots et al. 1980, Zambon et al. 1983, Moore et al. 1985, Williams et al. 1985)

Extensive studies of the periodontal microflora have been performed over the last two decades. The flora is exceedingly complex within more than 150 different species identified (Newman et al. 1976, Slots 1979, Tanner et al. 1979, Slots et al. 1980, Moore et al. 1982, 1984, 1985, Zambon et al. 1983, Socransky et al. 1984, Williams et al. 1985). Many of these are too fastidious for in vitro culture, and many remain unidentified. In spite of this, much has been learned. Gingivitis is associated with a change from a gram positive, predominantly streptococcal flora to a more complex flora including gram

negative and spiral forms. As gingivitis appears, there is a shift from a STREPTOCOCCUS-dominated plaque to ACTINOMYCES-dominated plaque. With the passage of time the flora becomes more diverse with a great deal of variation among subjects. (Moore et al. 1982)

There is mounting evidence that some of the periodontal pathogens may be involved in important diseases other than periodontitis, e.g. brain abscesses, heart valve lesions, and other infections about the head and neck. The most notable feature of periodontal pocket flora is its complexity and variability. It is still impossible to account totally for the site-to-site and patient-to-patient variability. However, the recent evidence indicating that both gingivitis and periodontitis may be caused by a progression of species infecting in a sequential manner, could underline the variability. (Moore et al. 1982, 1984, Williams et al. 1985)

There is also increasing concern at the probable early development of the disease which may not resolve following permanent tooth eruption and pubertal changes (Ainamo, Ainamo 1981). International radiographic studies of 15-year-old children support the hypothesis that destructive periodontal disease may have an early onset. (Gjeramo 1982)

Each survey, report and study, while varying in detail, is quiet conclusive on the high prevalence, the early onset, the correlation between age and increasing severity and the controlling effect exerted by regular attendance at a dentist. (Croxon 1984)

Periodontal disease increases in prevalence and severity with increasing age. Even when groups are equalised for sex, race, and oral hygiene, age appears to be an independent variable related to an increasing intensity of periodontal disease. This relation is shown in the long-term study conducted by Loe and colleagues on the natural history of periodontal disease in man. (Ånerud et al. 1979, Loe et al. 1978)

Development of research methodology is essential to progress in any area of research, and a model for epidemiological and clinical studies of the progression to early periodontitis would clearly be of value. Such a model would have three requirements:

1. a valid and reliable measure of early periodontitis which was acceptable both to the examiner and to the subjects;
 2. a stable population who could be monitored over a period of time, some of whom would be susceptible to the disease; and
 3. data amenable to statistical analysis.
- (Clerehugh, Lennon 1986)

2.2.1 Predisposing Factors

It is only necessary to briefly mention some of these factors, since they are more appropriately dealt with in textbooks of dental surgery and pathology, but it is obviously desirable to consider them in addition to local factors when planning preventive measures. The parts that predisposing factors play is in conditioning the response of the gingival tissues to the local factors already discussed.

Avitaminosis may affect the gingivae, particularly the lack of vitamin C which gives rise to scurvy, but nicotinic acid deficiency also may precipitate gingival lesions too.

Blood dyscrasias such as agranulocytosis, leukaemia and purpura often exhibit gingival changes and these may even be the first symptoms experienced by the patient. In *acute fevers*, such as typhoid and measles, deterioration of the gingivae may occur due to the concomitant poor oral hygiene but an improvement should be shown on recovery from the fever. Among *endocrinal disorders*, diabetes often permits an increased inflammation of the gums, particularly if there is neglected oral hygiene. At *puberty* there is often a temporary upset in the gingivae characterised by a rather swollen haemorrhagic appearance. *Drugs* may cause gingivitis and one not uncommonly used for children is Dilantin, or sodium diphenylhydantoinate, an anti-convulsant and hypnotic used in the treatment of epilepsy. This drug may give rise to gingival hyperplasia starting at the interdental papillae and spreading over other areas too, occasionally completely covering the teeth. In some cases the gum is rather firm and shows little tendency to bleed, in others a super added gingivitis is present as well. (Goose & Hartles 1964)

2.2.2 Classification of Periodontal Disease

Classification systems are, helping us to understand one another better and to work more economically, efficiently and effectively. Voltaire said: *'If you want to talk to me, define your terms'*. (Topić 1990)

WHO classification:

The report of the WHO Expert Committee on Dental Health in 1961 suggested the following about the classification of periodontal disease.

Considerations of aetiology, although important, can play a secondary and accessory part in a classification by contributing certain details for minor subdivisions.

Clinical assessment lacks sufficient precision to serve as a foundation for classification, especially in view of the fact that different pathological processes may present closely similar clinical appearances. The most valid basis for classification of periodontal disease is therefore one based on general pathology. In this connection, three fundamental types of pathological process, differing distinctly in characteristics, origin and course, are well recognised.

- * Inflammatory processes (gingivitis, periodontitis)
- * Degenerative processes (periodontosis?)
- * Neoplastic processes.

In many cases, however, these processes are not found in a pure form but in association with one another.

Among the periodontal diseases the inflammatory types are not only by far the most common, but are also more readily preventable and treatable. The Committee therefore decided to concentrate its efforts on these and omit consideration of the rare periodontal diseases.

The following classification was proposed by the WHO Expert Committee:

* Gingivitis

I. Acute

- (a) Acute ulcerative gingivitis (Vincent's disease)
- (b) Acute non-specific gingivitis

II. Chronic

- (a) Chronic gingivitis
- (b) Chronic hyperplastic gingivitis

* Periodontitis

I. Acute (periodontal abscess, ulcerative periodontitis)

II. Chronic

- (a) Periodontitis simplex (marginal horizontal bone resorption)
- (b) Periodontitis complex (irregular bone resorption).

At the World Workshop in clinical periodontics 1977, only two forms of periodontitis were recognised by the American Academy of Periodontology (AAP). These were *Juvenile Periodontitis* and *Chronic Marginal Periodontitis*. Within the past decade, however, the idea has developed, and supporting data have been acquired, demonstrating that periodontitis comprises a family of related but distinct diseases that differ in ethology, natural history, progression, and response to therapy. In recognition of this development, the AAP adopted the following classification in November 1986:

I. Juvenile Periodontitis

- A. Prepubertal Periodontitis
- B. Localised Juvenile Periodontitis
- C. Generalised Juvenile Periodontitis

II. Adult Periodontitis

III. Necrotizing Ulcerative Gingivo-Periodontitis

IV. Refractory Periodontitis

(Nevines et al. 1989)

2.2.1 Periodontal Plaque and Dental Calculus

Plaque is the soft, non-mineralised, bacterial deposits, which form on teeth that are not adequately cleaned. It accumulates on tooth surfaces not exposed to friction from cheeks, lips, tongue and food, and its composition varies according to its location.

The earliest deposit on a cleaned tooth surface is the acquired pellicle. This is a structureless film of glycoproteins selectively adsorbed to the surface of hydroxyapatite crystals from saliva, and it is visible within minutes following a polish with pumice.

The formation of pellicle is accompanied by bacterial colonisation as micro-organisms in saliva are adsorbed to the pellicle. After three or four hours colonies of gram positive and gram negative cocci will be established. After seven days, gram positive cocci constitute about 50 per cent of plaque bacteria and, at this stage, gram positive and gram negative rods, filaments, fusobacteria, and spirilla are found. As the plaque matures further, spirochaetes and vibrios appear and filamentous bacteria, especially actinomyces may become predominant.

Streptococcus mutans is dependent on sucrose from which it synthesises extracellular polysaccharides to mediate its attachment. Plaque contains intracellular polysaccharides in the form of storage granules synthesised from dietary sugars. Micro-organisms constitute at least 70 per cent of the bulk of plaque and the intermicrobial matrix comprises a protein and carbohydrate substrate derived partly from endogenous sources v12 saliva epithelial cells and crevicular exudate, and partly from the diet.

Periodontitis is caused by subgingival downgrowth of those bacteria best able to evade host defences and survive in a low oxygen environment. In subgingival plaque, gram positive bacteria are found in lower proportions and gram negative bacteria in higher proportions than in supragingival plaque.

The tooth-attached plaque consists mainly of gram positive rods and cocci while the unattached plaque contains a predominance of gram negative organisms including motile forms.

Mineralisation within plaque results in calculus formation. Its inorganic content is mostly crystalline and amorphous calcium phosphate. The organic component includes protein, carbohydrates, lipid, and various nonvital micro-organisms, predominantly filamentous ones.

Calculus is always covered by soft plaque and retains toxic bacterial products. *Materia alba* is a disorganised white debris probably comprising the outer layers of mature plaque, and stains are caused by food substances such as tea, coffee, tobacco, by the products of chromogenic bacteria or by metabolic particles; these pigments are absorbed by plaque or pellicle.

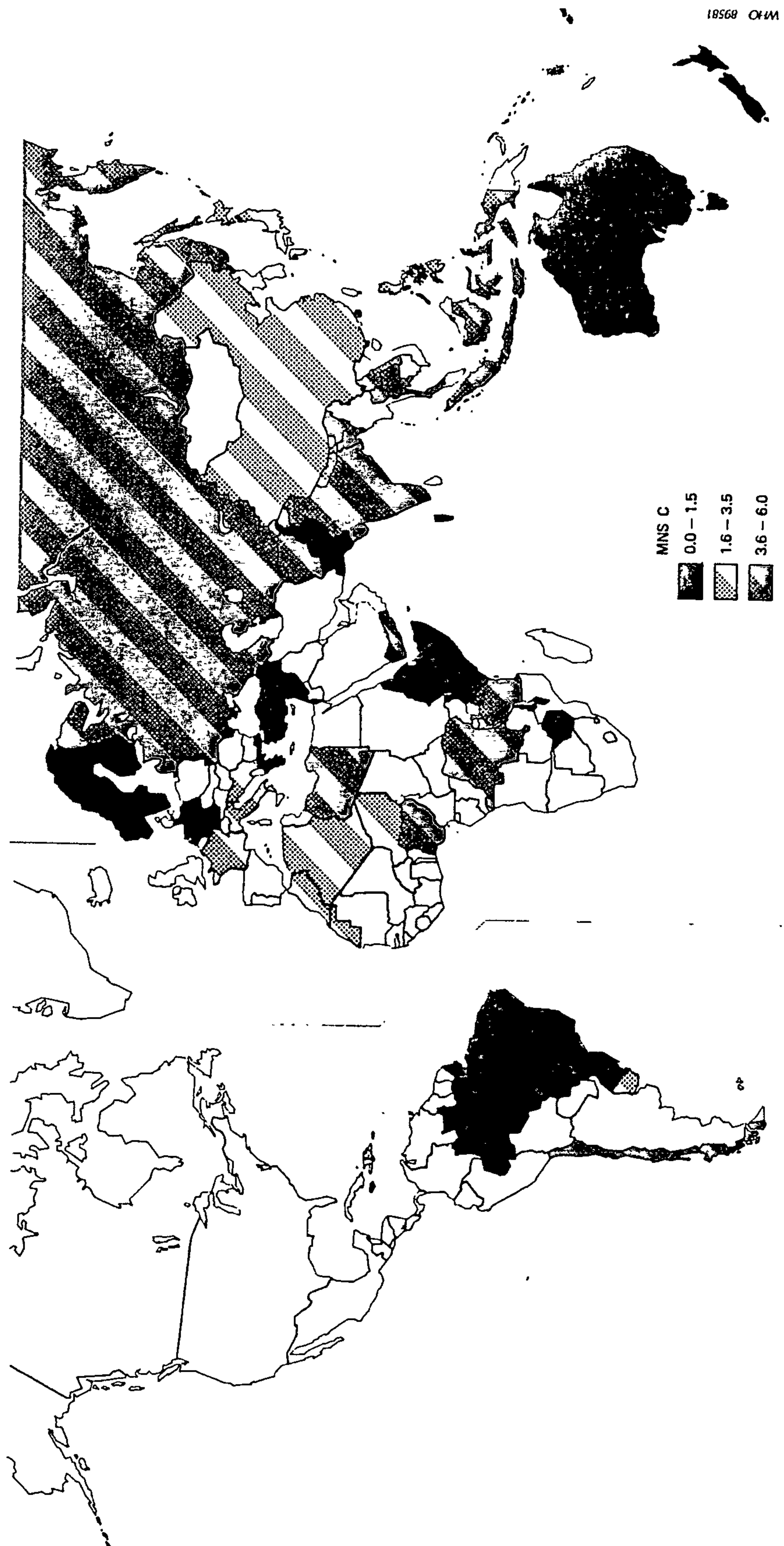
Subgingival calculus forms more slowly, on the other hand, it differs from supragingival calculus in its formation and composition. Selective deposition of mineral ions from the sulcular exudate precipitates the formation of subgingival calculus and then acts as an irritant to further the inflammatory reaction.

Other factors: Traumatic occlusal forces may alter the arrangement of the fibre barrier system and allow the inflammatory exudate to progress directly into the osseous structures with the consequent development of intraosseous lesions. Improper tooth contact, allows food impaction.

In a study of approximately 1,700 children 9 to 14 years of age by Suomi and associates (1971), it was found that a relatively high percentage of children of all racial-ethnic groups had calculus (both supragingival and subgingival). From 56 per cent to 85 per cent of the children in the various age, sex, and racial-ethnic groups had supra-gingival calculus.

Figure 10 shows the global distribution of this condition. The findings of this study indicate that most children 9 to 14 years of age who are of low socioeconomic status would benefit from inclusion in a preventive periodontal disease program based on improving oral hygiene. (McDonald 1974)

Figure 10
Prevalence of dental calculus at 15-19 years, 1989.
Source: WHO (1990)



2.2.4 Gingivitis

Gingivitis is a non-specific term denoting an inflammatory condition of the gingiva regardless of aetiology (Cutress 1986). Gingivitis is a gradual change from clinically normal gingiva to this early pathological state. It is recognised by signs of inflammation which may be manifest by presence of one or more of the following: redness, swelling, bleeding, exudation, and infrequently pain. (McMillan, Wolff 1969)

Gingivitis is the most common chronic disease affecting young people. Almost all teenagers exhibit gingival lesions in the interproximal area of posterior teeth (Löe, Morrison 1986). Careful examination of the whole mouth will reveal evidence of some gingivitis in all cases and this would agree with many surveys which reported prevalence figures for gingivitis of almost 100 per cent. (Addy, Dummer 1986)

Gingivitis has been found even in 3-year-old children. Above that age, the number of persons with gingival inflammation increases, therefore in adolescence most persons have either gingivitis or periodontitis. (Djukanovic 1986)

A New Zealand survey (Cutress 1979) showed that only 2 per cent of the population over 15-years of age had no gingival disease, 86 per cent had established gingivitis and 12 per cent had advanced periodontal disease. (Croxon 1984)

Carter and Wells (1960) observed in 29, 500 Kansas City, Missouri elementary school children ranging in age from 6 to 12 years that the average incidence of gingivitis was about 50 per cent. The incidence of gingivitis ranged from 37 per cent in 6-year-old boys to 57 per cent in 10-year-old boys. The papillae and margins were the most commonly involved gingival units. In independent studies Massler and associates (1951) observed that the incidence of gingivitis was highest in boys in the 9- to 17-year age group, whereas girls had the highest incidence in the age range of 5 to 8 years. (McDonald 1974)

Gingivitis was considered present when one or more papillae, margins, or attached gingival units were affected. The severity of gingivitis and the accumulation of oral debris were inversely related to socioeconomic status, whereas tooth brushing habits appeared to be directly related to socioeconomic status. (McDonald 1974)

Healthy periodontal tissues of humans are associated with a scanty microbial flora located almost entirely supragingivally on the tooth surface and consisting mainly of Gram-positive coccal form (Löe 1965, Listgarten et al. 1975, Listgarten 1976, Slots 1977a, Socransky et al. 1977).

Gingivitis is caused by supragingival bacterial plaque which contains more than 165 species and subspecies. No single organism or group of bacteria can be directly implicated in the development of gingivitis. (Löe, Morrison 1986)

The initial gingival lesion and its subsequent progression are strongly associated with the presence of bacterial plaque at or beneath the gum margin. In this case gingivitis usually presents as a plaque-associated marginal chronic inflammation of the gingiva which can be restored to normal health by adequate plaque control. (Cutress 1986)

It is generally accepted that plaque accumulation at the gingival margin will result in gingival inflammation (Löe et al. 1965). If plaque is allowed to remain at the gingival margin over a long period, either a long-standing gingivitis develops or periodontal breakdown occurs. This sequence is a simplistic summary but helps to explain the high correlation seen in studies between plaque and gingivitis and further substantiates previous evidence that plaque accumulation leads to gingivitis. (Löe et al. 1965, Ash et al. 1964)

Acute and chronic forms of gingivitis associated with hormonal, haematological, genetic and nutritional factors, although clinically important, appear to contribute little to the general epidemiological prevalence of disease. Most mouths, especially in the mixed dentition stage, on close examination, show some areas of minor inflammatory changes of the gingiva. Gingivitis associated with physiological changes like tooth eruption and puberty are also common but transitory. Although these latter conditions have only passing clinical interest they contribute substantially to the high prevalence of gingival

disease reported in young people and confuse the epidemiological picture. With few exceptions even relatively uncommon forms of gingivitis are triggered by the presence of local microbial deposits. For example, acute necrotizing ulcerative gingivitis is a particularly specific form of disease of uncertain aetiology which may be systemically or microbiologically initiated.

In some studies on experimental gingivitis the predominant organisms are almost entirely gram-positive with an increase in numbers of some of the forms found in the limited amounts of plaque from healthy sites (Löe 1965, Listgarten 1975, Syed et al. 1975). On the other hand, in long-standing gingivitis, although the microbial plaque appears to be predominantly gram-positive, approximately 25 per cent of the organisms may be Gram-negative organisms located primarily on that area of the plaque in contact with the tissues in subgingival sites (Van Palenstein Helderman 1975, Listgarten 1976, Slots 1979). When subgingival plaque associated with destructive periodontitis is examined anaerobic Gram-negative organisms (e.g. BACTEROIDS, FUSOBACTERIA EIKENELLA, WOLLINELLA, EUBACTERIUM) predominate (Slots 1977b). In juvenile periodontitis numerically important organisms include various Gram-negative facultatively anaerobic rods, namely ACTINOBACILLUS ACTINOMYCETEMCOMITANS and CAPNOCYTOPHAGA species (Slots et al. 1980, 1982, Mandell, Socransky 1981).

The time sequence of bacterial colonisation is important, since it points out the unique nutritional interdependence between bacterial species. The metabolic products of the bacteria rather than the bacteria themselves are responsible for the inflammatory changes occurring in the periodontium.

Bacterial enzymes such as collagenase and hyaluronidase are present, and capable of degrading natural collagen.

As a secondary stage, gram-negative bacteria produce endotoxin that may be responsible for the inflammatory reactions in the gingival tissue. Presence of secondary factors contribute significantly to the aetiology of the lesion, calculus formation is the mineralised end product of plaque accumulation on the tooth surface. (Shapiro, Stallard 1982)

2.2.5 Periodontitis

Periodontitis is an inflammatory disease of the gingiva and the deeper structures of the periodontium. The disease is considered a direct extension of gingivitis and it is characterised by presence of gingival inflammation, pocket formation and loss of alveolar bone. Clinically, it is often difficult to distinguish between gingivitis and early periodontitis (McMillan et al. 1969). This situation would exist when there has been recurrence of gingivitis in a reduced but healthy periodontium, as would occur following successful therapy for periodontitis. (Caton 1989)

Periodontitis occurs before 20 years of age, it is also first found in the interdental areas of posterior teeth and is preceded by gingivitis. It progresses slowly through the decades of adult life with varying rates in different individuals and teeth within the same mouth. Subgingival plaque contains more gram-negative, anaerobic organisms and more motile bacteria than supragingival plaque. Progression of periodontitis coincides with the occurrence of certain BACTEROIDS species, fusobacteria and other anaerobic motile rods as well as spirochaetes. However, at this time the concept of specific pathogeneticity cannot be applied. Rapidly progressing localised or generalised periodontitis is characterised by the rate of periodontal destruction and usually occurs in less than one per cent of juveniles. These patients exhibit increased prevalence of ACTINO BACILLUS ACTINOMYCETEMCOMITANS and abnormalities in neutrophil function. Simple clinical screening test that can predict who will and who will not suffer from chronic periodontitis, that can provide early identification of high risk patients or forewarn the development of juvenile periodontitis are non-existent. Research in this area is seeing significant progress and several technologies have shown promise. While awaiting new screening methodologies, the clinician must continue to rely on periodontal probing, radiographic techniques, visual inspection and clinical acumen as the main means of periodontal diagnosis. (Löe, Morrison 1986)

There are good reasons for believing that periodontitis, like gingivitis, occurs in several forms with differing aetiologies or modifying factors. On clinical and pathological grounds Page and Schroeder (1982) proposed differentiating periodontitis into several categories. Four major forms of periodontitis: adult, rapidly progressive, juvenile, and prepubertal.

Adult Periodontitis

This is by far the most common form of periodontitis; its most characteristic features are seen in adults from age 30 years onwards. It appears to be a progression from marginal chronic gingivitis. (Cutress 1986)

Rapidly Progressing Periodontitis

The main clinical features of this condition are characterised by severe gingival inflammation, rapid loss of connective tissue attachment and alveolar bone support, and its early onset (post pubertal and early adulthood) (Caton 1989), with a tendency to haemorrhage from the gingiva at this time. The prevalence has not been reported. (Cutress 1986)

Juvenile Periodontitis

Juvenile periodontitis occurs in children and young adults and can be classified into:

(1) periodontitis which occurs in otherwise healthy individuals, and (2) periodontitis which occurs in juveniles with systematic disease.

The periodontitis which occurs in otherwise healthy individuals consists of two major forms:

(a) juvenile periodontitis, also called periodontitis or localised juvenile periodontitis (LIP), and (b) generalised juvenile periodontitis which includes early onset adult periodontitis, recurrent necrotizing ulcerative periodontitis and the true generalised form of juvenile periodontitis.

Periodontitis in systematically diseased individuals can be divided into three subgroups:

(a) juvenile periodontitis associated with primary neutrophil disorders,
 (b) juvenile periodontal disease in which neutrophils are secondarily abnormal, and
 (c) juvenile periodontitis associated with other diseases.

Juvenile periodontitis is perhaps the best understood form of periodontal disease. A major infecting organism, *ACTINOBACILLUS ACTINOMYCETEMCOMITANS*, is strongly associated with the disease, and may be an exogenous pathogen since it is not found in healthy individuals or in healthy sites in LJP patients. It is virulent with marked leuco aggressive properties and it induces a marked antibody response in infected patients. Eradication of *ACTINOBACILLUS ACTINOMYCETEMCOMITANS* requires attention to the fact that it invades the tissue and hence systemic antimicrobials or surgical excision of the tissues is necessary for eradication. Marked suppression of the organism from subgingival sites is associated with healing. Host responses in LJP have also been well described and most immune functions studied appear to be normal. The notable exception is neutrophil chemotaxis which is depressed. Associated with depressed neutrophil chemotaxis is a reduction of neutrophil receptors for several chemotactic factors including C5a the fifth component of complement. The chemotactic abnormality in LJP is familial, and the odds of an individual with a neutrophil chemotactic defect having LJP is 10.8 times greater than individuals who do not have this defect. Hence LJP appears to be an infection caused by *ACTINOBACILLUS ACTINOMYCETEMCOMITANS* and susceptibility to this infection is markedly increased by defective neutrophil chemotaxis. Based upon our understanding of the disease, anti-infective treatment is successful when monitoring of *ACTINOBACILLUS ACTINOMYCETEMCOMITANS* as well as clinical signs and symptoms are used as indicators of completion of therapy. (Genco, Christersson, Zambo 1986)

Prepubertal Periodontitis

This is a rare condition and occurs as a generalised or localised disease. GENERALISED PUBERTAL PERIODONTITIS affects primary and secondary teeth and begins with eruption of primary teeth. It is characterised by severe gingival inflammation, rapid bone loss, mobility, and tooth loss. LOCALISED PUBERTAL PERIODONTITIS affects only some of the primary teeth and is less aggressive. (Page et al. 1983, Waldrop 1987)

2.2.6 Periodontosis

The Committee on Nomenclature of the American Academy of Periodontology defined periodontitis as a *'degenerative non-inflammatory destruction of the periodontium originating in one or more of the periodontal structures characterised by migration and loosening of the teeth in the presence or absence of secondary epithelial proliferation and pocket formation or secondary gingival disease'*. (Topic 1990)

There are several reservations to be made to this definition.

- * Nothing is stated about the general health of the individual.
- * It is unclear as to whether the disease affects the primary or permanent dentition or both.
- * The degenerative nature of the disease has not been documented.
- * Migration and loosening of the teeth is never observed as an early manifestation.

Evidence to support the conventional concept of periodontosis is unsubstantiated. It was the consensus of the World Workshop in Periodontics (1966) that the term periodontosis is ambiguous and that the term should be eliminated from periodontal nomenclature. Nevertheless, the Committee was aware that some evidence exists to indicate that a clinical entity different from adult periodontitis may occur in adolescents and young adults. Baer (1961) prefers to define periodontosis as a disease of the periodontium occurring in an otherwise healthy adolescent and characterised by a rapid loss of alveolar bone around more than one tooth of the permanent dentition. He describes two basic forms: in one, only the first molars and incisors are affected; in the other more generalised form, most of the dentition is affected.

There are several distinctive features of this disease that differ from periodontitis.

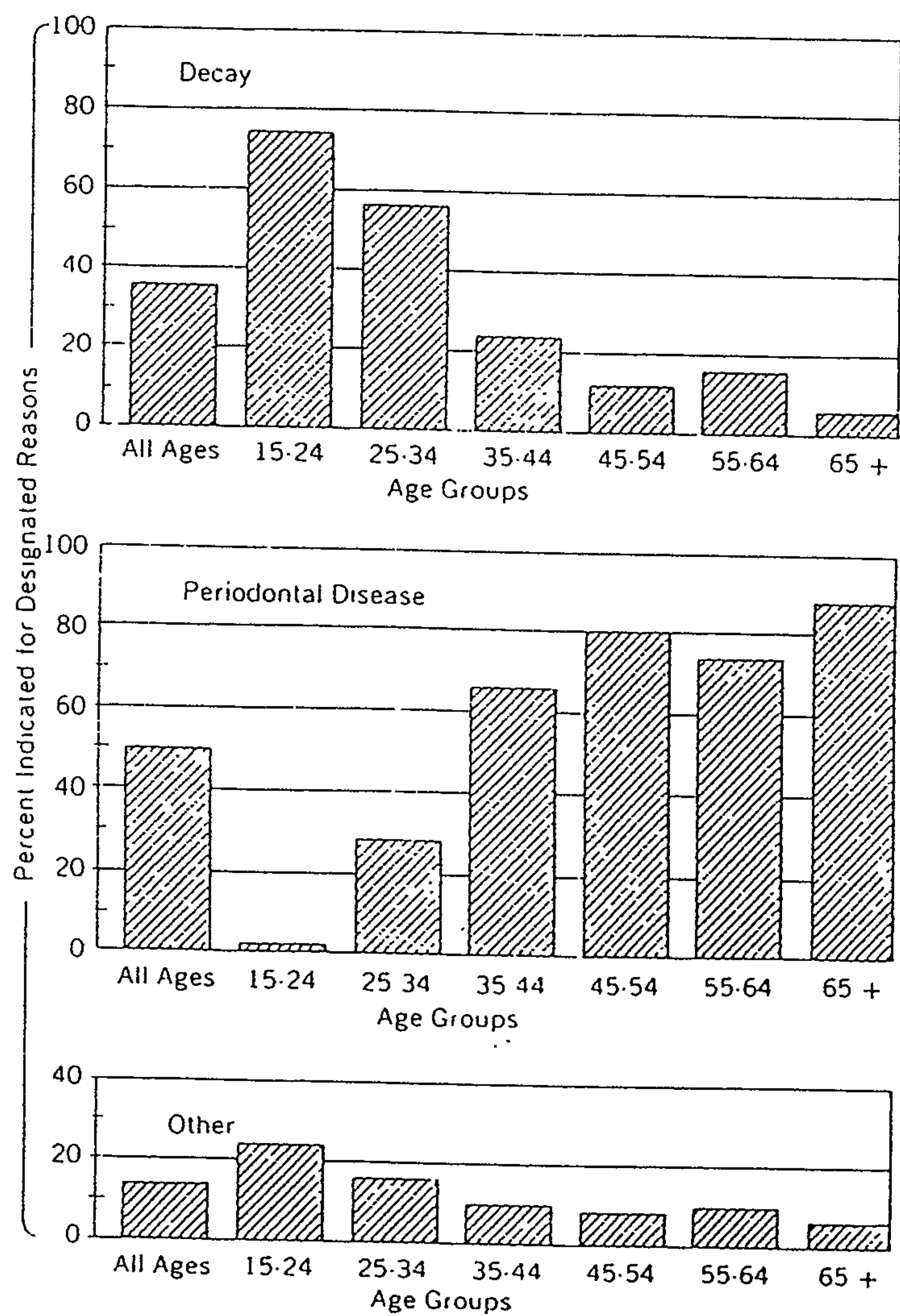
- Age of onset.
- Sex ratio.
- Familial background.
- Relationship between local aetiological factors and severity of periodontal response.
- Distinctive radiographic pattern of alveolar bone loss.
- Rate of progression.
- Disease of the primary teeth.

2.2.7 Tooth Loss

The end result of untreated dental caries and periodontal disease is tooth loss. The data relating to tooth loss in a community are a reflection of both the extent of disease and the adequacy of treatment for established disease.

Generally, loss of permanent teeth in childhood is attributable to advanced dental caries. In adults aged 35 years and over, however, periodontal disease is usually regarded as the periodontal cause of tooth loss. **Figure 11** shows that although caries is the major reason for tooth loss in younger years, periodontal disease increases significantly as a reason for tooth loss with advancing age.

Figure 11
Tooth loss with age.
Source: Burt (1983)



Löe and his colleagues have stated that by age 40, some 8 to 10 per cent of teeth are lost because of periodontal disease. Their studies on the natural history of periodontal disease indicate that without intervention, tooth loss from periodontal disease increases rapidly after that age. (Löe et al. 1978)

Total tooth loss not only represents the results of oral disease, but it also reflects the availability and type of dental treatment in the community and attitudes toward that treatment and to dental health in general. There is considerably less total tooth loss in higher socioeconomic groups than in lower socioeconomic groups. Increasing loss of teeth with increasing age is apparent, also females suffer a greater degree of total tooth loss at all ages than do males and also tend to become edentulous at a younger age. (Gray et al. 1963, Todd, Whitworth 1974, US Public Service National Center for Health Statistics 1974)

2.2.8 Community Periodontal Index of Treatment Needs

An index has been defined by Russell (1969) as a numerical value describing the relative status of a population on a graduated scale with definite upper and lower limits, which is designed to permit and facilitate comparison with other populations classified by the same criteria and methods.

Requirements of a Periodontal Disease Index

The requirements of periodontal indices for prevalence studies have been defined by Davies (1988) as follows :

1. An index must be simple to use and permit the study of a large number of persons with a minimum of time and cost.
2. The criteria defining the components of an index should be clear, readily understandable and promote accuracy and diagnostic reproducibility, both within and between examiners.
3. If it is used to describe severity, the index should be equally sensitive throughout the scale and should indicate in a meaningful way the clinical stages of the disease process.
4. The index should be amenable to statistical analysis.

Objectives of Periodontal Disease Indexation

The objectives for a scoring system, or an index, for periodontal disease were summarised by Ramfjord (1959):

1. To map distribution of the disease (prevalence)
 - (a) In population groups
 - (b) Within each dentition
 - (c) Around each individual tooth
2. To record the progress and behaviour of the disease either by longitudinal studies of the same group or by comparing prevalence status of various age groups within the same population (incidence).
3. To serve as a basis for evaluation of the role of various ethologic factors in the pathogenesis of periodontal disease.
4. To estimate the total need for periodontal therapy in population groups.
5. To educate the dental profession, the public and government authorities regarding the need for periodontal care and treatment.
6. To estimate future needs for dentists and auxiliary personnel.
7. To evaluate the clinical effectiveness of various procedures or agents in the prevention and treatment of periodontal disease.
8. To enable dentist to classify patients into disease categories and relate them to treatment.

Background of Periodontal Disease

A large number of indices have been developed over the years to measure periodontal disease prevalence, and the use of different methods has led to some difficulty in comparing the results of different studies. Moreover, relatively few of these indices are easy to translate into meaningful statistics which may be used for the purposes of planning and providing care. (Manji, Sheiham 1986)

Up to the late 1960s periodontal indices for epidemiological assessment of calculus, plaque, debris and the status of the gingival and periodontal tissues, provided health planners with only the most peripheral information on treatment needs. Conversion of epidemiological data into estimates of treatment needs are needed by planners and administrators as baseline data for planning, organising and evaluating oral health services. There were many deficiencies and much dissatisfaction expressed with the existing basic methods of measuring periodontal treatment needs in both individual patients and population groups.

During 1973-1977 it became clear that there were certain deficiencies in available periodontal disease indices when used as epidemiological tools, both with respect to examiner variability and in failing to provide information of practical use for the planning and development of preventive or curative services. All the data comparisons, whether local community, national or international, tended to indicate just one simple but important fact, namely that good oral hygiene reduced the prevalence of plaque, gingivitis and calculus. There was a need to know more than this single fact. (Barnes 1984)

Some dates in the development of periodontal indices:

- 1918 - Black classification, is the first and oldest mechanism to investigate what percentage of the population at various age levels had evidence of 'periodontal infection'.
- 1947 - Periodontal index system, was developed concerning at papillary, marginal and attached gingiva (PMA index).
- 1957 - PMA index was modified
- 1956 - Russell, developed Periodontal Index (PI or RPI); this index was designed

- 1959 - solely to be an epidemiological tool and not meant to be used clinically. Ramfjord, introduced Periodontal Disease Index (PDI). It was designed to meet the needs of both epidemiologist and clinician. This index contains criteria for assessing gingival status and measuring loss of attachment.
- 1960 - Oral Hygiene Index (OHI), developed by Greene and Vermilion.
- 1964 - Oral Hygiene Index Simplified (OHIS), simplified by Greene and Vermilion which is rapid evaluation of oral cleanliness in population groups.
- 1963 - Gingival index and plaque index introduced by Loe and Silness ; these two indices made it possible to demonstrate the indisputable correlation between plaque formation and initiation of gingivitis.
- 1971 - Bleeding index was developed by Muhlemann and son, which it was more positive than Loe's gingival index system and considered to be a simple, reproducible and rapid screening method.
- 1977 - The WHO Scientific Group Meeting on Epidemiology, Ethology and Prevention of Periodontal Disease proposed a new survey method based on separate recordings of pockets, calculus and bleeding for a restricted number of teeth. After extensive field-testing this method has been accepted.
- 1978 - CPITN index was developed by a WHO/FDI joint committee of experts.
- 1982 - CPITN was introduced for rapid assessment of both prevalence and treatment needs of periodontal disease.
- 1984 - A simplified periodontal examination system for dental practitioners utilising the CPITN, was introduced by WHO/FDI.

Knowledge of the periodontal treatment needs of a population is important for the appropriate planning of public dental health services. The World Health Organisation's suggested index, the Community Periodontal Index of Treatment Needs (CPITN), is good to assess the periodontal treatment needs on a population basis. (Ainamo, Barmes, Beagrie, Cutress, Martin, Sardo-Infirri 1982)

Over recent years the CPITN has been increasingly adopted as a procedure for classifying periodontal conditions with respect to the complexity of care and oral health personnel required to restore periodontal tissues to a healthy condition. Some profiles of the periodontal conditions of populations are becoming evident from completed surveys. Although originally intended as a screening procedure for epidemiological purposes the index has been adopted for other purposes: in a promotional role in developing periodontal health awareness programmes, for initial screening and for monitoring changes in periodontal needs of individuals in clinical practice. (Cutress, Ainamo, Sardo-Infirri 1987)

Scope and Purpose

The CPITN procedure is recommended for epidemiological surveys of periodontal health. Also this index provides guidance on the planning and monitoring of the effectiveness of periodontal care programmes and the dental personnel required. A modification of the procedure has been developed for use by clinicians (dental practitioners and dental auxiliaries) for periodontal screening and monitoring of their patients on a routine basis (Cutress et al. 1986) (Periodontal Index, WHO Periodontal Status Index). The CPITN is a procedure which uses clinical parameters and criteria relevant to planning for the prevention and control of periodontal diseases. The CPITN is not intended as a comprehensive assessment of total past and present periodontal disease experience. Several studies validate the use of the CPITN (Schaub 1984, Sivanewaran 1985, Miller & Benamghar 1987). Essentially they conclude that using the appropriate criteria and index teeth the partial recording method is a practical and reliable means of recording periodontal treatment needs in epidemiological surveys. The method has been incorporated in the WHO Manual, Oral Health Surveys Basic Methods, 3rd edn. (WHO 1987)

The CPITN records the common treatable conditions, namely periodontal pockets, gingival inflammation (identified by bleeding on gentle probing), and dental calculus and other plaque retentive factors. It does not record irreversible changes such as recession or other deviations from periodontal health such as tooth mobility or loss of periodontal attachment.

The major advantages of CPITN are simplicity, speed and international uniformity. Its limitations include partial recording, exclusion of some important signs of past periodontal breakdown - notably attachment loss - and absence of any marker of disease activity or susceptibility (satisfactory methods for latter of course, are not currently available).

CPITN is, therefore, not a diagnostic tool and should not be used for planning of specific clinical treatment of individual patients. Primarily the CPITN is a screening procedure for identifying actual and potential problems posed by periodontal disease both in the community and by the individual. With this information appropriate oral care services can be planned for populations and for individuals. Social, economic, personnel and other

factors will influence decisions on priority use of resources and thus the actual periodontal care services provided. In many countries the clinical personnel necessary to provide periodontal treatment for even a small part of the population are not available. However, identification of the magnitude of the need provides an essential basis for promoting primary health care programmes and monitoring achievements of such programmes in improved periodontal health of populations.

Codes and Criteria

The appropriate code for each sextant is determined with respect to the following criteria.

The codes (excepting X) are listed in descending order of treatment complexity as follows:

CODE X: when only one tooth or no teeth are present in a sextant (third molars are excluded unless they function in place of second molars).

CODE 4: pathological pocket of 6 mm or more, that is, the black area of the CPITN probe is not visible.

NOTE : If the designated tooth or teeth are found to have a 6 mm or deeper pocket in the sextant being examined, a code of 4 is given to the sextant. Recording of CODE 4 makes further examination of that sextant unnecessary - that is, there is no need to record the presence or absence of pathological pockets of 4 or 5 mm. calculus or bleeding.

CODE 3: pathological pocket of 4 or 5 mm. that is, when the gingival margin is on the black area of the probe.

NOTE: If the deepest pocket found at the designated tooth or teeth in a sextant is 4 or 5 mm. a CODE 3 is recorded - there is no need to examine for calculus or gingival bleeding.

CODE 2: calculus or other plaque retentive factors such as ill-fitting crowns adapted edges of restorations are either seen or felt during probing.

NOTE : If no pocket depth are observed which involve or exceed the coloured area of the CPITN probe, but supra or subgingival calculus or other plaque retentive factors are detected, CODE 2 is assigned - it is unnecessary to examine for gingival bleeding.

CODE 1: bleeding observed during or after probing.

NOTE : If neither pathological pocketing nor calculus is observed, but bleeding occurs after the gentle probing, (that is, a sensing force corresponding to 20 g or less is used) a code of 1 is recorded for the sextant. The gingiva of the designated tooth or teeth should be inspected for presence or absence of bleeding before the subject is allowed to swallow or close his mouth. At times bleeding may become evident only 10-30 seconds after probing. Any gingival bleeding is scored CODE 1.

CODE 0: healthy tissue.

NOTE : If no findings of treatment need (pockets, calculus, bleeding), then CODE 0 (zero) is recorded for the sextant.

(Cutress, Ainamo, Sardo-Infirri 1987)

Examination Procedure

The aim is to determine the highest score applicable to each sextant with the least number of measurements.

First decide whether the sextant can be validly scored. The requirement is that more than one functional tooth is present. If 'no', then score X and move to next sextant. If 'yes', examine Index Teeth (in epidemiological procedure) or all teeth (in clinical screening procedure) for presence of 6 mm or deeper pockets, 4 or 5 mm pockets, calculus or other plaque retentive factor, and bleeding only, in that order. Determine appropriate highest score for each sextant. As soon as the highest scored criterion has determined there is no need to examine for the presence of lower score criteria.

(Cutress, Ainamo, Sardo-Infirri 1987)

False Pockets

In subjects under 20 years of age, the second molars are omitted as index teeth to minimise the risk of recording false pockets. Sometimes false, that is non-inflammatory in origin, pockets may measure 6 mm or deeper and be recorded erroneously as indicating the need for complex treatment. Care should be taken not to record false pockets with Code 4. Also for children under 15 years, because of recently erupted teeth, the examination of 6 index teeth should only include scoring for bleeding and calculus. False pocketing may also occur in the retromolar area of adult dentitions.

(Cutress, Ainamo, Sardo-Infirri 1987)

Excluded Teeth

Index (and substitute) teeth are excluded from CPITN scoring when the decision has been made to extract for any cause. (Cutress, Ainamo, Sardo-Infirri 1987)

Substitution for Excluded and Missing Teeth

The ten CPITN Index Teeth are the first and second molars in the posterior sextants and a central incisors in each of the two anterior sextants. When one or more of the Index Teeth are missing or excluded at the time of examination, substitute teeth are selected

using the following rules:

1. Remember that two or more functioning teeth must be present in a sextant for it to qualify for scoring.
2. If in a posterior sextant, one of the two index teeth is not present or has to be excluded, then the recording is based on examination of the remaining index tooth.
3. If both index teeth in a posterior sextant are absent or excluded from examination, all the remaining teeth in that sextant are examined and the highest score recorded.
4. In the anterior maxillary sextants if tooth 11 is excluded, substitute 21, if 21 is also excluded then identify the worst score for the remaining teeth. Similarly, substitute tooth 41 if tooth 31 is missing.
5. In subjects under 20 years of age, if the first molar is not present or has to be excluded, the nearest adjacent premolar is examined.
6. If all teeth in a sextant are missing or only one functional tooth remains the sextant is coded as missing.
7. A single tooth in a sextant is considered as a tooth in the adjacent sextant and subject to the rules for that sextant. If the single tooth is an index tooth then the worst index tooth score is recorded.

(Cutress, Ainamo, Sardo-Infirri 1987)

A full periodontal examination is known to be time-consuming (Davies et al. 1961, Brady, Martinoff 1982). The reduced set of six teeth proposed by Ramfjord (1959) has been found to give a very good expression of the average severity of periodontal disease in a given population (Jamison 1963, Kjome 1975) but has been questioned, even by Ramfjord himself, with regard to the information obtained about the prevalence of periodontal disease (Jamison 1960, O'Leary 1964, Ramfjord 1969).

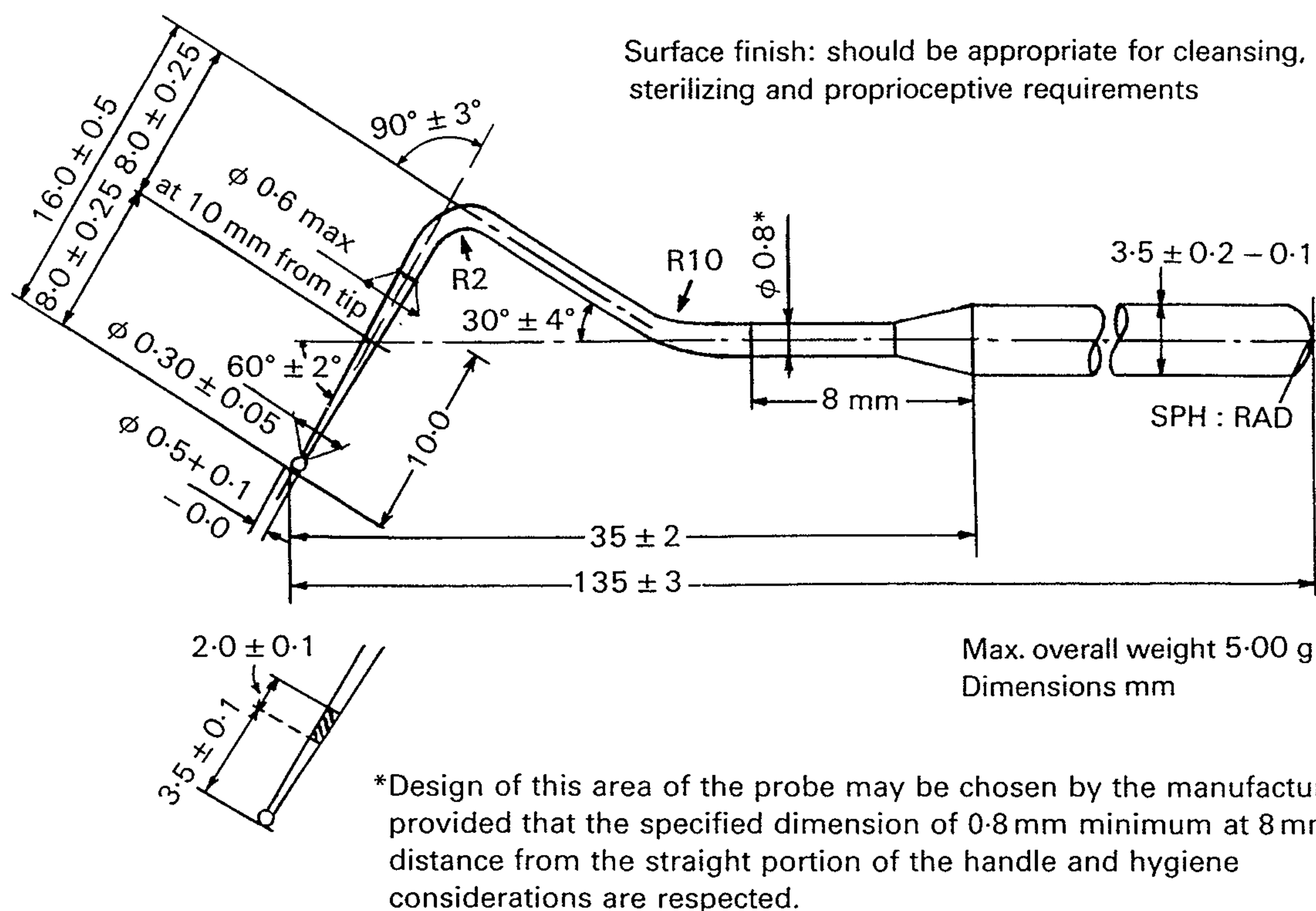
The great majority of past studies on the epidemiology of periodontal disease have been based on the average severity rather than on the prevalence of various indicators of pathology (Waerhaug 1966, Carranza 1979, Ainamo 1983). For the purpose of descriptive epidemiology, and also for clinical trials, reporting of average severity has proved quite adequately and has, indeed, given valuable information about the aetiology and pathogenesis of periodontitis. (Koch 1988)

Ainamo and Ainamo (1985) found that partial examination in the assessment of the average severity and the prevalence of periodontal disease is not reliable enough for the determination of the periodontal treatment needs of individual patients.

The CPITN Probe and Probing

The recommended periodontal probe for use with CPITN was first described in the WHO technical report series No. 621 (WHO 1978), and later reported in detail by Emslie (1980), and is available from Morita Corporation, Japan. The essential features of the instrument, however, require emphasis. Since it was designed for two purposes, namely measurement of pocket depth and detection of subgingival calculus, the probe is both thin in the handle and of very light weight. Therefore it is possible to use with only the very delicate pressure necessary for pain-free insertion. This avoids artificially splitting the junctional epithelium or penetrating the epithelium to enter the periodontal membrane. The pocket depth is measured through colour coding with a black mark starting at 3.5 mm and ending at 5.5 mm (**Figure 12**). The probe has a 'ball tip' of 0.5 mm diameter that allows easy detection of subgingival calculus. This feature, combined with the light probe weight, facilitates the identification of the base of the pocket, thus decreasing the tendency for false reading by over measurement. (Cutress, Ainamo, Sardo-Infirri 1987)

Figure 12
The WHO CPITN Periodontal probe.
Source: Cutress et al. (1987)



It was realised that the use of any pocket probe does not provide the clinician with accurate measurements of pockets in millimetres which, even if feasible, are of doubtful value. Instead, the probe measures what is 'normal' and 'abnormal' with indications of treatment requirements being derived from 'abnormal' score. A force of no more than 25 g (Ainamo et al. 1982) was considered sufficient to reveal pathology without causing pain to the subject. (Ainamo, Barmes, et al. 1982)

A sensing force is used both to determine the pocket depth and for detecting subgingival calculus, the pocket depth, and for detecting subgingival calculus. The sensing force should correspond to 20 g or less. The probe is inserted between the tooth and the gingiva and the sulcus depth or pocket depths 'sensed' and read against the colour code or measuring lines. The direction of the probe during insertion should, whenever possible, be in the same plane as the long axis of the tooth. The ball-end should be kept in contact with the root surface. Pain to the patient during probing is an indication of a too heavy sensing force. (Cutress, Ainamo, Sardo-Infirri 1987)

This type of 'tactile' probing or sensing instrument, should be considered to be an 'extension' of the examiner's fingers. The CPITN probe is particularly designed for gentle manipulation of the often very sensitive soft tissues around the teeth; as such it is different in concept from probes for dental caries and most other oral care instruments in current use. For this reason examiners will need to become accustomed to its use. (Cutress, Ainamo, Sardo-Infirri 1987)

For calibration purposes the following training is suggested: practise on gingival sulcus of your own front teeth, or use the fingernail test by identifying a pressure which allows gentle insertion of the probe tip under a fingernail without causing pain or discomfort, or use a pressure sensitive device of similar dimensions. (Cutress, Ainamo, Sardo-Infirri 1987) To enhance both the fine control of the movement of the probe and the accuracy of the sensing of small movements of the tip of the probe in the gingival sulcus a light not a firm grip of the instrument is recommended. (Cutress, Ainamo, Sardo-Infirri 1987)

The conventional periodontal probe is a tool of much controversy - uncertainty about its size and what it measures and its difficulty of use have led to its disuse, particularly by the

general dentist. The WHO probe, used with appropriate technique, should overcome these problems. The importance of the probe lies less in its measurement of pocket depth and more in differentiating between 'normal' and 'abnormal' (Ainamo 1982). Clearly, the practitioner cannot evaluate periodontal disease treatment needs without using a suitably designed probe.

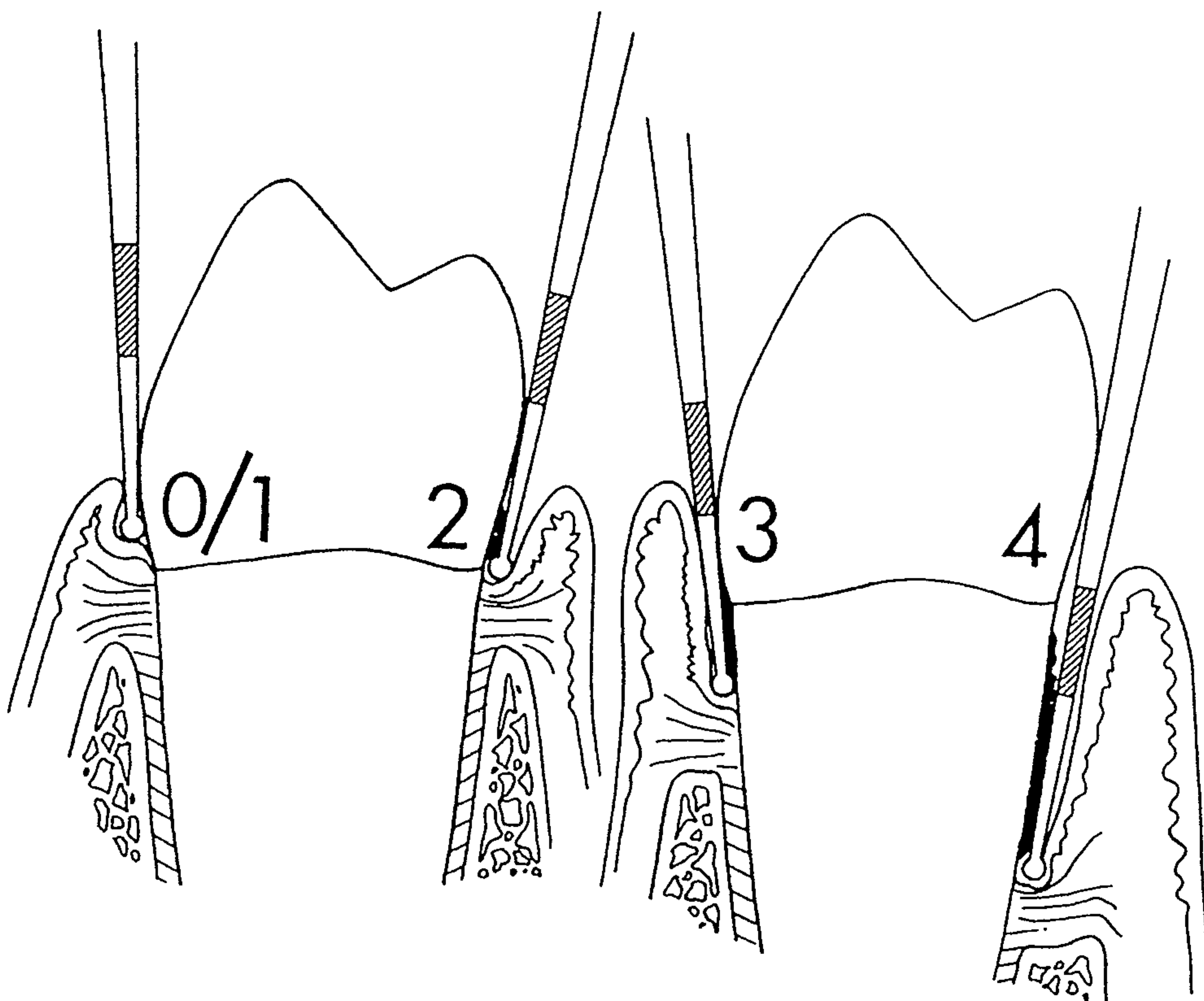
Number of Probings per Sextant

The gingival crevice around each tooth is probed (**Figure 13**). The tip of the CPITN probe is gently inserted between tooth and gingiva to the full depth of the sulcus or pocket, and the probing depth read by observation of the position of the black band. In practice this means about six probings per tooth. Recommended sites for probing are mesial, mid-line, and distal on both facial and lingual/palatal surfaces. The probing may be done by withdrawing the probe between each probing or alternatively, with the probe tip remaining in the sulcus, the probe may be 'walked' around the tooth. Sites in addition to the recommended ones should be probed if there is suspicion that a higher scoring condition is present. (Cutress, Ainamo, Sardo-Infirri 1987)

Figure 13

CPITN probing of the gingival crevice.

Source: Ainamo et al. (1982)



Treatment Needs

'Treatment Needs' implies that the CPITN assess only those conditions potentially responsive to treatment, but not non-treatable or irreversible conditions (i.e. recession, attachment level). Thus the term 'Treatment Need' is intended as a guide to the level or magnitude of need for care using accepted periodontal criteria. If no disease is observed, no care is required; if gingivitis is present but no evidence of calculus or pocketing, then self-care (plaque control) is recommended; if calculus or shallow pocketing is present its control would require involvement of trained persons; if deep pocketing is evident its control would need the services of specially trained personnel. However the Treatment Need should not be interpreted or used as a specific prescription for clinical treatment required. Rather it provides an indication of the level of complexity of care needed if the periodontal conditions are to improve. The individual clinical care implemented will, of course, be dependent on proper diagnosis based on a comprehensive examination of both oral and systemic signs and symptoms of disease history, activity and susceptibility. Factors such as resources, manpower and other priorities then become relevant. Nevertheless the identification of a population (or individual) by the hierarchy of needs provides a basis from which the requirements for periodontal care can be assessed and appropriate actions taken or recommended. For a community these may be implemented as a comprehensive programme of periodontal disease control and preventive measures, or may involve only selective or limited implication of certain primary, or secondary preventive measures. Used with these realistic objectives in mind, the CPITN procedure provides an overview of the magnitude of periodontal care services necessary to improve the periodontal health of the population. (Cutress, Ainamo, Sardo-Infirri 1987)

Reasons for attempting to control periodontal disease and promote good periodontal care include improved quality of life, enhanced general well-being and appearance, reduced halitosis, elimination of bleeding from the gums, reduced potential threat to longevity of teeth, and improved mastication. Although each reason is moderated by social, economic and ethic factors, in general the aim of good oral care and health services is to promote oral and general health. (Cutress, Ainamo, Sardo-Infirri 1987)

The authors of the CPITN recommend that a subject or a sextant be classified according to periodontal treatment needs into one of the following categories:

- Category 0: no treatment (score 0);
- Category I: improvement of oral hygiene only (score 1);
- Category II: I+ scaling (score 2 and 3);
- Category III: I+II+ complex treatment (score 4). (Manji, Sheiham 1986)

These treatment categories, when considered in terms of maximal treatment need, correspond to primary, secondary and tertiary prevention of periodontal disease,as proposed by the WHO as early as 1970. (WHO 1970)

Classification of Treatment Needs

Population groups or individuals are allocated to the appropriate Treatment Need(TN) category on the following basis:

- TN 0: A recording of CODE 0 (health) or X (missing) for all six sextants indicates that there is no need for treatment.
- TN 1: A code of 1 or higher indicates a need for improving the personal oral hygiene of that individual.
- TN 2: (a) A code of 2 or higher indicates need for professional cleaning of the teeth and removal of plaque retentive factors. In addition, the patient obviously requires oral hygiene instruction.
(b) Shallow to moderate pocketing (4 or 5 mm, Code 3). Oral hygiene and scaling will usually reduce inflammation and bring 4 or 5 mm pockets to values of or below 3 mm. Thus sextants with these pockets are placed in the same treatment category as scaling and root planning, i.e. Treatment Need 2 (TN 2).
- TN 3: A sextant scoring Code 4 (6mm or deeper pockets) may or may not be successfully treated by means of deep scaling and efficient personal oral hygiene measures. Code 4 is therefore assigned as 'complex treatment' which can involve deep scaling. root planning, and more complex surgical procedures.
(Cutress, Ainamo, Sardo-Infirri 1987)

In order to translate the findings (disease status) into treatment needs,the following guide may be used:

Disease status score		Treatment need code
0	----->	0
1	----->	I
2 or 3	----->	II
4	----->	III

The Use of CPITN in Epidemiology and in Clinical Practice

The dentition is divided into six parts (sextants), defined by tooth numbers 17-14, 13-23, 24-27, 37-34, 33-43 and 44-47. A sextant is examined only if there are two or more teeth present and not indicated for extraction. When only one tooth remains in a sextant, it is included in the adjacent sextant.

In epidemiological surveys for adults, aged 20 years or more, only ten teeth, known as the Index Teeth, are examined. These teeth have been identified as the best estimators (WHO 1984, Sivaneswaran 1985) of the worst periodontal condition of the mouth. The 10 Index Teeth are:

17-14	13-23	24-27
47-44	43-33	34-37

The molars are examined in pairs and only one score, the highest, is recorded. Only one score is recorded for each sextant.

For young people, up to 19 years, only six Index Teeth; 16, 11, 26 and 36, 31, and 46 are examined. The second molars are excluded as Index Teeth at these ages because of the high frequency of false (non-inflammatory, associated with tooth eruption) pockets.

For screening and monitoring purposes in dental practice all teeth in a sextant are examined for adults over age 19 years. Only one score, the highest, is recorded for each sextant.

When examining children less than 15 years pockets are not recorded although probing for bleeding and calculus are carried out as routine.

Recording Data

The following 'box chart' is recommended as the epidemiological and dental office chart for recording CPITN data.

Each sextant is given a score. For epidemiological purposes the score is identified by examination of specified Index Teeth. For use in clinical practice the highest score in each sextant is identified after examining all teeth. Essentially the CPITN considers the periodontal treatment needs of each sextant with respect to scores 0-4 which are discussed later. (Cutress, Ainamo, Sardo-Infirri 1987)

The modified CPITN recording used to score the CPITN code number for each tooth. False pockets are separated into those with (GB+) or without (GB-) gum bleeding after gentle probing as follows:

- 0 = healthy periodontium
- 1 = bleeding after probing
- 2 = calculus or overhangs of fillings
- 3 = 4-5mm pathologic pocket
- 4 = 4-5mm false pocket(GB+)
- 5 = 4-5mm false pocket(GB-)
- 6 = 6mm or deeper pathologic pocket
- 7 = 6mm or deeper false pocket (GB+)
- 8 = 6mm or deeper false pocket (GB-)

1. Under age 20 CPITN recordings are based on the examination of the periodontal status of 16, 11, 26, 36, 31 and 46.
2. Assessment of periodontal treatment needs is started at 7 years of age. Earlier than this problems are rare and the index teeth are often still unerupted.
3. At 7-11 years of age the index teeth are examined only for bleeding of their gingiva, for calculus and/or overhangs of fillings. The presence of true pathologic pockets would be extremely rare at this age. Bleeding after probing of a false pocket is recorded as a need for oral hygiene instruction (Code 1).
4. At ages 12-19 the full range of CPITN recordings is used, again after examination only the same index teeth. At this age it would be rare to find true pathology at other teeth without the index teeth being affected. Whenever pathologic pocket depths are recorded, the alveolar bone level is checked by means of bite-wing radiographs.
5. At ages 7-19 three digits only per individual are transferred by computer to a central data bank. The first digit represents the highest code number recorded, the second the number of healthy (Code 0) sextants and the third the number of missing sextants which in this case means the number of missing index teeth.

(Ainamo 1984)

Currently available CPITN data have contributed to the understanding of the frequency of periodontal breakdown in humans. (Ainamo, Tervenen, Nordblad, Kallio 1987)

Recommendations for Reporting of CPITN Data

Standard reporting of data is necessary for comparability of epidemiological and other surveys. A careful description of the sample and the method of selection of subjects is needed. The origin of the population studied, year of survey and the method of sample selection should be described, and the proportion of edentulous subjects should be stated.

Global Trends of Periodontal Disease

Data on periodontal diseases collected by various methods in the 1960s and 1970s indicated very high prevalence in all populations, and related generally to the oral hygiene practices of each population. However, the methods utilised did not provide the type of information that could be used for the planning of prevention or care programmes. Since the development of the Community Periodontal Index of Treatment Needs (CPITN) by the joint WHO/FDI working group in 1981, it has been possible to draw a more detailed picture of periodontal health and treatment needs around the globe. (Leclercq et al. 1978)

Standardised epidemiological methods generally provide valuable data for comparing prevalence and patterns of periodontal disease in one population with those of another, in the same population at different times, and between several subgroups within a population. (Truin et al. 1981) Until a large number of countries have agreed to adhere to one method of measurement and until several surveys within each country have been completed, using the same method, comparative data will not become available. (Renson, Crielaers, et al. 1985)

Data, based on CPITN, now accumulating at the WHO Global Oral Data Bank are just beginning to provide a global picture of periodontal disease patterns. For a preliminary view of the disease pattern and profile we have to rely on the relatively few studies where very careful calibration of examiners and the use of a standard methodology have provided us with comparable data (Renson, Crielaers, et al. 1985). Many epidemiological reports show an alarming change of trend: each year the global mean for 12 yr, based on data obtained from developing countries and processed by the WHO Global Bank, shows a marked increase. At present, data on CPITN are available for 64 countries, from a total of 108 surveys in the bank. Because of the limited experience with this index, it is only possible to present an initial analysis of the overall picture of periodontal diseases (Leclercq et al. 1987). Among these data, 1302 children aged 12 and 19 years and 173 adults aged 35-44 years have been surveyed by one investigator (Barmes, Leous 1986) in 16 countries. Data are shown in **Table 10** analysed in terms of the applicability of the CPITN for assessing periodontal status in different populations and for use in development of measurable objectives for health of the periodontal tissues. (Barmes, Leous 1986)

Table 10

Community periodontal index of treatment needs survey data 1982-1985.

Source: Barmes, Leous (1986)

Locality	Age	No.	Sex	% affected	Percentage of persons with:				Number of Sextants with:					Treatment Needs: Percentage of persons and average No. of sextants per person		
					Bleeding	Calculus	Period. pockets		Healthy	Bleeding	Calculus	Period. pockets		OHI	Scaling	Special periodontal care
							4-5 mm	6+ mm				4-5 mm	6+ mm			
Kabul	12	20	M/F	93	7	85	—	—	1.5	4.5	2.4	—	—	93%	86%(2.4)	—
Afghanistan	15	50	M/F	100	12	65	23	—	1.4	4.6	3.7	0.3	—	100%	88%(3.7)	—
(A)	35-44	43	M/F	100	—	12	50	38	0.1	5.9	5.7	2.7	0.6	100%	62%(5.7)	38%(0.6)
Dhaka	12	40	M/F	100	5	90	5	—	1.2	4.8	3.2	0.15	—	100%	95%(3.2)	—
Bangladesh	15	20	M/F	100	5	70	25	—	0.9	5.1	3.7	0.4	—	100%	95%(3.7)	—
(B)																
Havana	12	40	M/F	98	10	88	—	—	2.8	3.2	2.6	—	—	98%	88%(2.6)	—
Cuba	15	20	M/F	95	5	65	25	—	1.5	4.5	4.2	0.3	—	95%	90%(4.2)	—
(C)	35-44	20	M/F	100	—	55	40	5	0.2	5.8	4.6	0.8	<0.1	100%	95%(4.6)	5%(<0.1)
Bratislava	12	20	M/F	95	10	85	—	—	3.5	2.5	2.0	—	—	95%	85%(2.0)	—
CSSR																
(D)																
Kuopio	13*	20	M/F	75	15	60	—	—	4.1	1.9	1.2	—	—	75%	60%(1.2)	—
Finland																
(E)																
Erfurt	13*	25	M/F	92	16	76	—	—	3.1	2.9	1.7	—	—	92%	76%(1.7)	—
GDR																
(F)																
Yamanashi	12	20	M/F	65	5	60	—	—	3.9	2.1	1.5	—	—	65%	60%(1.5)	—
Kofu	15	20	M/F	95	5	90	—	—	3.1	2.9	2.5	—	—	95%	90%(2.5)	—
Japan																
(G)																
Amman	12	20	M/F	100	5	95	—	—	1.9	4.1	3.4	—	—	100%	95%(3.4)	—
Jordan	15	70	M/F	99	3	85	11	—	1.3	4.7	4.0	0.16	—	99%	96%(4.0)	—
(H)																
Kaishadoris	12	40	M/F	92	45	47	—	—	2.2	3.8	2.1	—	—	92%	47%(2.1)	—
Lith. SSR	15	40	M/F	95	35	60	—	—	2.1	3.9	2.3	—	—	95%	60%(2.3)	—
(I)																
Drammen	12	20	M/F	85	55	30	—	—	4.3	1.7	0.6	—	—	85%	30%(0.6)	—
Norway	15	20	M/F	80	35	45	—	—	4.0	2.0	0.8	—	—	80%	45%(0.8)	—
(J)																
Aden	12	40	M/F	78	7	69	2	—	3.2	2.8	2.2	0.02	—	78%	71%(2.2)	—
PDRY	15	40	M/F	100	5	83	12	—	1.8	4.2	3.8	0.15	—	100%	95%(3.8)	—
(K)	35-44	30	M/F	100	—	36	47	17	0	6.0	6.0	1.6	0.2	100%	83%(6.0)	17%(0.2)
14 Loca-	12	280	M/F	98	8	87	3	—	1.9	4.1	3.1	0.1	—	98%	90%(3.1)	—
ities	15	269	M/F	100	5	80	15	—	1.3	4.7	3.8	0.2	—	100%	95%(3.8)	—
SPLAJ	35-44	80	M/F	100	—	13	53	34	0.3	5.7	5.6	2.5	0.6	100%	66%(5.6)	34%(0.6)
(L)																
Tyresö	12	20	M/F	100	35	65	—	—	3.5	2.5	1.5	—	—	100%	65%(1.5)	—
Sweden	15	20	M/F	100	15	85	—	—	2.9	3.1	1.7	—	—	100%	85%(1.7)	—
(M)																
Sweida	12	20	M/F	100	—	100	—	—	1.1	4.9	3.9	—	—	100%	100%(3.9)	—
Syria	15	20	M/F	100	—	85	15	—	0.5	5.5	5.0	0.15	—	100%	100%(5.0)	—
(N)																
Ban Pong	12	48	M/F	92	6	82	4	—	0.9	5.1	3.8	0.1	—	92%	86%(3.8)	—
Yaeng-Nok																
Thailand																
(O)																
Novi Sad	12	20	M/F	100	—	100	—	—	2.1	3.9	2.8	—	—	100%	100%(2.8)	—
Yugoslavia	15	20	M/F	100	5	95	—	—	1.7	4.3	3.5	—	—	100%	95%(3.5)	—
(P)																

* Summarized in presentation as 12 years.

In another Study, CPITN data from 40 countries have been used to assess periodontal status at ages 12, 15 and 35-44 years. There are broad differences in the numbers of healthy sextants between developing countries and those which are highly industrialised. At 12 years this component of the Index could provide the basis of a global indicator of periodontal health-not less than 3 healthy sextants per child by year 2000. At 15 years zero sextants with periodontal pockets is a feasible aim. It is less easy to set goals for periodontal health in adults. (Barmes, Leous 1986)

Periodontal problems are generally considered to affect mainly the adult and elderly sections of the population. Hence, most of the CPITN-data collected so far deal with subjects who are at least in their late teens or older. On the other hand, the gingivitis which in a part of the population develops into irreversible loss of tooth attachment, usually starts in the mixed dentition. For effective primary prevention it would, therefore, seem essential to pay attention to periodontal problems as early as the age of 7, which seems to be the age of onset of gingivitis. (Massler, Schour 1949)

The set of CPITN data in the WHO Global Oral Data Bank is constantly adjusted and updated as results of new surveys are received. A recent update of the GODB for the adults in the key age group 35-44 years-as on July 1987- is presented in Table 11.

Table 11
Periodontal conditions measured by CPITN, and estimated national percentages of edentulousness at age 35-44 years: WHO Global Oral Data Bank, 1987.
Source: Barmes, Leous (1986)

Country	Year	N	Percentage of persons who have as highest score					% Edentulous (national estimate)	Mean number of sextants with					
			0 No periodontal disease	1 Bleeding only	2 Calculus	3 Shallow pockets	4 Deep pockets		0 No periodontal disease	1+2+3+4 Bleeding or higher score	2+3+4 Calculus or higher score	3+4 Shallow pockets or higher score	4 Deep pockets	X Excluded less than 2 teeth
Australia	1984	223	11	10	67	8	4	15*	2.3	3.0	2.2	0.3	0.1	0.7
Bangladesh	1982	78	2	0	0	34	65			5.8	5.6	5.2	2.1	
Burkina Faso	1986	355	0	0	1	25	75	<1	0.1	5.9	5.9	5.4	2.1	0.0
Byelorussian SSR	1986	327	0	0	23	45	31		0.2	5.0	4.6	2.5	0.7	0.7
Central African Republic	1986	108	1	1	14	52	32	<1	0.5	5.5	5.1	3.1	0.8	0.0
China	1984	154	0	2	51	36	9		0.4	5.6	5.5	0.9	0.2	0.0
Cook Islands	1984	148	0	0	34	57	9	<1	0.1	5.9	5.7	1.5	0.1	0.2
Finland†	1984	299	2	7	56	29	6	12	0.5	4.1	3.4	0.8	0.1	1.5
France	1985	167	1	4	39	41	15		1.0	4.8	4.0	1.5	0.3	0.2
	1986	75	17	35	21	19	8		3.0	2.6	1.1	0.4	0.2	0.4
German Democratic Republic	1986	335	1	16	38	36	9	<1	1.5	4.0	2.2	1.1	0.1	0.5
Greece	1985	741	8	13	39	26	14	<1	1.9	4.1	3.1	1.4	0.3	0.0
Hong Kong	1982	760	3	4	52	37	5	<1	1.2	4.6	4.0	0.8	0.1	0.2
	1984	668	1	0	28	56	16	<1	0.4	5.5	5.4	1.8	0.3	0.1
	1986	74	0	0	53	43	4	<1	0.2	5.8	5.7	1.0	0.1	0.0
Hungary	1985	893	5	8	51	26	8	<1		3.5	2.8	0.7	0.1	0.0
Indonesia	1984	499	12	3	65	16	4	<1	1.9	3.9	3.7	0.4	0.1	0.2
	1985	504	14	8	63	14	2	<1	1.3	4.0	3.4	0.3	0.1	0.7
	1986	437	0	0	36	53	10	<1	0.4	5.2	5.0	1.5	0.2	0.4
Italy	1985	21352	3	4	45	36	12	<1	0.8	4.8	3.9	1.3	0.2	0.4
Japan	1983	451	6	11	32	34	17	<1	1.3	4.0	3.0	1.4	0.3	0.7
	1984	80	11	8	28	41	13	<1	2.4	3.1	2.4	1.3	0.2	0.6
	1984	182	7	4	44	38	7	<1	2.1	3.9	2.9	1.0	0.1	0.0
Kenya	1984	199	1	4	31	49	14	<1		5.4	5.1	2.5	0.2	
Libya	1982/83	80	0	0	13	53	34			5.7	5.6	2.5	0.6	
Malta	1986	286	0	1	78	17	2		0.1	4.8	4.1	0.3	0.0	1.0
Morocco	1983	794	4	4	46	28	14	4		3.8	2.3	1.2	0.3	
	1986	391	3	5	31	40	16	4	0.8	5.2	3.9	2.2	0.2	0.0
Nepal	1984	131	0	2	45	25	28	<1	0.0	6.0	4.9	1.8	0.7	0.0
	1986	79	0	1	43	25	30	<1	0.1	5.9	5.9	2.3	0.7	0.0
Netherlands	1981	85	4	2	18	66	11	9‡	1.6	3.8	3.6	2.0	0.2	0.6
	1983	180	1	4	33	49	13	9‡	0.9	4.4	3.5	1.7	0.2	0.8
	1986¶		4	6	34	48	7	9‡	0.9	4.4	3.3	1.7	0.2	0.7
New Zealand	1982	263	7	23	26	36	8	16	2.1	3.5	1.7	1.2	0.2	0.4
Niger	1985	150	4	5	52	35	3	<1	0.5	5.5	4.7	1.2	0.1	0.0
	1986	629	1	20	53	26	0	<1	0.6	5.1	3.2	0.8	0.0	0.3
Portugal	1984	616	3	0	47	38	8	2		4.3	4.1	0.9	0.1	
Spain	1985	975	7	7	36	31	18	<1		5.1	3.7	1.9	0.4	
Sri Lanka	1984	1867	5	1	55	27	10	2		4.4	4.2	0.9	0.2	
Tanzania	1982	124	1	0	28	63	7	<1	0.9	5.0	4.5	2.2	0.1	0.1
Thailand	1982	128	0	0	50	34	16	<1		5.5	5.1	1.4	0.3	
	1984¶		0	0	42	47	11	<1	0.2	5.6	5.6	1.8	0.2	0.2
Togo	1986	238	35	3	35	21	6		4.1	1.9	1.6	0.7	0.1	0.0
United Kingdom	1984	109	2	5	36	45	12	7-24	1.4	4.4	3.4	1.3	0.2	0.2
Zaire	1985	227	1	1	93	4	0		0.7	5.3	5.0	0.1	0.0	0.0
Zimbabwe	1986	159	10	0	87	3	1	<1	4.5	1.5	1.5	0.1	0.0	0.0

* 1980 figure: Queensland 1984=5. † 35 years. ‡ 1986 estimate ¶ national weighted data.

The tentative conclusions are that the periodontal conditions for which specific interventions might be considered are of notable magnitude in adult populations. However, for the large majority, in most of the populations observed, the progress of periodontal diseases has been slow and seems to be compatible with the retention of the natural dentition until at least the age of fifty, i.e. a few years beyond the upper age limit of the group from which the data were derived. Compared with previous perceptions this conclusion permits a much more optimistic outlook for periodontal health and for the retention of a functioning dentition for life (Pilot & Barmes 1987). Moreover, high scores at the early stages of the disease do not necessarily lead to a high level of advanced disease or tooth loss. It is becoming increasingly apparent that the main preventive effort should be concentrated at the primary health care level for both oral hygiene instruction and prophylaxis. (Leclercq, Barmes, Sardo-Infirri 1978)

The emerging global picture is consistent with more systematic mouth cleaning habits in industrialised countries than in developing countries. In all probability, therefore, the disease was formerly higher in all countries and has been reduced progressively in industrialised countries during the last 40 years as tooth brushing and other oral hygiene procedures have been adopted as the social norm. (Renson, Crielaers, et al. 1985)

If resources are available, early interceptive care should be considered for subjects who have been unable to control the formation of calculus and pocketing and whose self-care, therefore, has lost much of its potential effect. (Ainamo, Tervonen, et al. 1987)

The development of a periodontal treatment needs index, would allow global comparisons of disease status and would allow dental health administrators to plan preventive measures as well as to calculate what type and numbers of dental personnel are required to cope with the treatment needs. (WHO 1978)

To date, the use of the CPITN has substantially increased our knowledge about periodontal treatment needs. Thus, the WHO index seems to have established itself as one of the research tools in periodontology. (Ainamo, Tervonen, et al. 1987)

By the use of this index, it is likely that the earlier general picture of higher prevalence in developing than in industrialised countries will be confirmed, as well as the indications that the difference represents a change in the latter as a result of better oral hygiene methods and programmes. (Barmes 1984)

In many epidemiological studies of children and young adults, only the prevalence of gingival inflammation was recorded because periodontal disease in such populations is most often very mild. (Djukanovic 1986)

Compared to the many reports on caries prevalence in children or periodontal disease in adults, the epidemiology of childhood oral mucosa lesions had received scant attention (Muñiz et al. 1981). In order to obtain a comprehensive view of the prevalence of dental disease in schoolchildren, oral health status should be registered at entry and exit from primary school. (Beatriz, De Muñiz 1985)

Existing data clearly indicate that periodontal treatment needs arise at an early age. Indicating a need to emphasise the implementation of proper self-care measures at an early enough age for the improved oral hygiene to have a preventive effect on both gingivitis and calculus. (Ainamo, Tervonen, et al. 1987)

Improvements could best be achieved by means of primary preventive measures starting early at 7 years of age. (Ainamo, Ainamo 1981)

2.3 EPIDEMIOLOGY OF DENTO-FACIAL DEFORMITIES

MALOCCLUSION

Dental occlusion generally refers to the relationship of the teeth in the maxillary and mandibular alveolar arches when the jaws are closed. The term **MALOCCLUSION** has been defined as *"that condition in which dental structures are not in acceptable equilibrium with each other or with the facial structures and/or the cranium, thus interfering with or posing a potential threat to normal tissue development and maintenance, effective function, or a physiological behaviour problem."* (Moyers, Jey 1959) Thus, this definition embraces irregularities of the individual teeth, alveolar arches, soft tissues, the neuromuscular system, the jaws, or any combination of these irregularities.

That malocclusion has existed since the beginning of mankind is apparent from illustrations or reproductions of the skull of Neanderthal man. The earliest written report of irregularities of the dentition was made by Hippocrates (460-377 B.C.) in the sixth book of *EPIDEMICS*. The first report on treatment or preventive orthodontics was made by Celsus (25 BC-AD 50). He wrote: *"If a second tooth should happen to grow in children before the first had fallen out, that which ought to be shed is to be drawn out and the new one daily pushed toward its place by means of the finger until it arrives at its just position."* (Weinberger 1948)

Attempts at correction of malocclusion have been carried out for centuries. These, however, were based on the desire of patients for a more aesthetic appearance. Orthodontics did not emerge as a science until Angel developed a classification of malocclusion and established a school of orthodontics at the beginning of this century.

Relatively few reports have appeared which deal with the prevalence of malocclusion. When one realises that an estimated twenty to thirty million children, in the U.S.A. alone, suffer from some form of malocclusion, it becomes apparent that extensive and well-planned clinical surveys are needed to answer the many still-existing questions regarding the anomaly.

2.3.1 Ethological Factors

Although a great number of studies have been undertaken aimed at clarifying the ethology of malocclusion, many answers concerning its causes are still being sought. Most authorities on the subject agree that the possible ethologic factors of malocclusion can be placed in two groups: *genetic and environmental*. This conventional division of the ethologic factors does not signify that all types of malocclusion are caused exclusively by factors of one group or the other. Many of the anomalies are most likely caused by or associated with a combination of inherited tendencies and one or more environmental factors.

The following is a typical list of possible ethologic agents that appears in a textbook of orthodontics edited by Lundstrom (1960):

- a) Diseases or deficiency conditions affecting the mother during pregnancy,
- b) Birth injuries,
- c) Bottle feeding, breast feeding,
- d) Composition of diet,
- e) Consistency of diet,
- f) Thumb-sucking and other habits,
- g) Diseases of the ear, nose and throat; mouth breathing,
- h) Premature loss of deciduous teeth,
- i) Loss of permanent teeth,
- j) Trauma, burns, etc.

Oral habits and premature loss of tooth structure are the two environmental factors that have received most attention.

2.3.2 Classification

A number of studies have based their assessment of malocclusion on the classification suggested by Angle (1907), which is based on the mesio-distal relation of the maxillary and mandibular first permanent molars. Angle listed three main classes of malocclusion:

Class I (neutroclusion): Malocclusion in which there is a normal mesiodistal relationship of the mandible to the maxilla. There is, however, malocclusion of the individual teeth.

Class II (distocclusion): Malocclusion in which there is a distal relationship of the mandible to the maxilla.

Class II-Division 1: A Class II occlusion in which the maxillary incisors teeth are labially inclined.

Class II-Division 2: A Class II occlusion in which the maxillary incisor teeth are near normal anteroposteriorly or slightly lingually inclined.

Class III (mesiocclusion): Malocclusion in which there is a mesial relationship of the mandible to the maxilla.

The unilateral deviations of Classes II and III were termed subdivisions by Angle.

The Angle classification has withstood the test of time as a workable classification of malocclusion for the practising orthodontist. However its subjectivity and the inability of others to convert the classification to numerical values for statistical manipulation have led to a search for a classification system having more objectivity, and one which is readily reproducible by investigators interested in applying epidemiologic techniques to the malocclusion problem.

Moore (1948) developed a classification of malocclusion to yield information directly related to treatment needs and the complexity of treatment, that is, the time required for correction.

In 1951 Massler and Frankel suggested an index based on the number of maloccluded teeth; that is, the individual tooth was used as *"the unit of occlusion rather than a segment*

of the arch." This type of quantitative index approaches the now generally accepted DMF index utilised in most epidemiologic studies of the prevalence of caries.

In 1957 an index of occlusion, the Occlusion Feature Index (OFI), was developed by Poulson and Aaronson. The OFI is based on the evaluation of the following features:

- (1) lower anterior arch crowding,
- (2) cuspal indigitation looking at the right premolar-to-molar area from the buccal aspect,
- (3) vertical overbite, measured by that portion of the lower incisors covered by upper central incisors in occlusion, and
- (4) horizontal overjet, measured in occlusion from labial surfaces of upper incisors to labial surfaces of lower incisors.

A value is assigned to each of these features according to an established yardstick and a total score is obtained by adding them together.

According to Poulson and Aaronson (1957), a preliminary test showed the Occlusion Feature Index to be a workable method of recording malocclusion in population studies.

2.3.3 Prevalence of Malocclusion

As mentioned previously, the lack of an objective index for malocclusion and the lack of comparability among reports on the prevalence of this anomaly make any attempt at establishing an overall picture of the prevalence of malocclusion a hazardous undertaking. Nonetheless, it has been estimated that about half of the school-age population in the U.S.A. needs some kind of treatment, and that one in five children suffers from malocclusion that could be considered severe. (Survey Report 1961)

In a number of studies the age grouping of the population samples was based on the conventional division of the development of the dentition into three distinct stages, each occurring during a certain age period. These three developmental stages are: (1) *the deciduous dentition*, (2) *the mixed or transitional dentition*, and (3) *the permanent dentition*.

The findings of selected clinical surveys pertaining to the prevalence of malocclusion are summarised in Tables 12 & 13. Table 12 lists the findings of seven surveys of the prevalence of malocclusion in the deciduous dentition, and Table 13 summarises the prevalence of malocclusion in the mixed and permanent dentition.

Table 12.
Prevalence of malocclusion in the deciduous dentition (Angle's classification).
Source: Moller (1969)

Location	Number examined	Age	Percentages with malocclusion			Total	Reference
			Class I	Class II	Class III		
Germany	643	6	33.3	12.8	4.8	43.1	(27)
U.S.A. (New York)	152	2-6	26.9	8.5	2.6	38.0	(31)
U.S.A. (St. Louis)	5,563	5-6	12.4	3.0	1.5	17.0	(9)
England	2,711	2-5	---	25.1	1.5	---	(25)
U.S.A. (Michigan)	51	5	33.0	18.0	9.0	60.0	(6)
Canada	268	3	41.1	23.2	1.8	66.1	(11)
U.S.A. (Mass.)	491	3-5	31.3	2.7	1.0	35.0	(12)

Table 13.
Prevalence of malocclusion in the mixed and permanent dentitions.
Source: Moller (1969)

Location	Number examined	Age	Percentages of subjects with malocclusion					Total maloccl.	Reference
			Class I	Class II		Class III	Total		
				Div.1	Div.2				
Germany	568	14	41.7	---	---	13.2	0.5	55.4	(27)
U.S.A. (New York)	1,214	6-14	38.2	9.2	13.1	22.3	1.7	63.3	(38)
U.S.A. (New York)	623	7-11	47.0	---	---	11.0	2.0	60.0	(31)
U.S.A. (Michigan)	500	16-32	63.6	4.8	10.8	15.6	12.2	91.4	(24)
U.S.A. (Illinois)	2,758	14-18	50.1	16.7	2.7	19.4	9.4	78.8	(32)
Norway	2,349	7-8	30.1	---	---	21.3	7.3	58.7	(48)
U.S.A. (Philadelphia)	586	6-12	28.0	21.0	3.4	24.4	1.7	54.1	(28)
U.S.A. (Michigan)	51	16	39.0	---	---	36.0	12.0	87.0	(6)
U.S.A. (Pennsylvania)	398	adults	55.8	12.1	13.3	25.4	4.3	85.4	(18)
England	1,000	6-15	65.7	3.0	0.8	8.1	0.4	74.2	(19)
U.S.A. (New Jersey)	3,355	6-14	38.2	---	---	13.2	0.5	51.9	(39)
Hungary	4,230	16-18	25.0	6.8	8.7	15.5	1.7	42.2	(1)
England	2,956	7-15	24.8	11.7	4.4	16.1	2.9	43.8	(21)
Canada	211	8	52.2	---	---	24.0	2.0	78.2	(11)
Canada	199	12	54.4	---	---	31.6	2.0	88.0	(11)
U.S.A. (Wash., D.C.)	3,289	12-16	66.4	10.5	1.6	12.1	5.0	83.5	(2)
Israel	214	13-14	23.8	22.6	6.2	28.8	0.5	53.1	(43)

2.3.4 Malocclusion and Dental Caries

The possible causal relationship of malocclusion and dental caries has long been recognised. It is generally accepted that individuals with malpositioned teeth are more prone to dental decay than those with a good occlusion. Theoretically, disturbances in the arrangement of the teeth may increase the number of areas where food is likely to be retained, thus increasing the opportunity for development of plaques, one of the prime requisites for the formation of dental caries. It is recognised also that untreated dental caries causes a breakdown of contact points and eventually, premature loss of the teeth. The lost tooth structure may cause an abnormal reduction in the dental arch length or "space loss". This space loss is considered by many to be one of the prime causative factors of malocclusion. For example, The premature loss of the deciduous molars may lead to another drifting of the first permanent molars, which encroach on the space intended for the bicuspid, so that crowding or impaction of these teeth sometimes results.

Effect of Malocclusion on the Prevalence of Dental Caries

Four reports on the effect of malocclusion on the prevalence of dental caries were reviewed, these reports agree that individuals with malocclusion showed higher caries rates than those with good occlusion. Brucker (1943) surveyed 1,668 children aged 5 to 15 years and found the average number of cavities in children with malocclusion was 4.2 per child versus 2.6 in children with no malocclusion. In a survey of 270 14-year-old English children, the average DMF rate was 8.27 in children with normal occlusion and 9.49 in children with malocclusion. (Miller & Hobson 1961)

Effect of Dental Caries on the Prevalence of Malocclusion

A few reports in the literature have described attempts to estimate the production of malocclusion because of the loss of tooth structure due to dental caries. Korkhaus (1928) found that in a group of 6-year-old German children only 1.4 percent showed malocclusion due to premature loss of teeth, versus 27.3 per cent among 14-year-old children. Korkhaus states that the low incidence in the younger age group may be due to the benefits of a

systematic dental hygiene regime which was in effect at the time of the study. The 14-year-old group was not subject to this dental hygiene treatment.

McCall (1944) stated in a report of a survey of 2-6 and 7-11 year old children that malocclusion directly related to drifting caused by premature extractions was found in only 3.9 percent of the younger group and in 12.0 percent of the older children. However, he states also: "*A high percentage of malocclusion of various types is found in those who have experienced such extractions.*" In a survey of 6-15-year-old English children, measurable loss of space due to dental caries or premature loss of the deciduous molars was found in 19 percent of the children. (Gardiner 1956)

The low percentage found in the younger age groups by Korkhaus (1928) and McCall (1944) may be in part due to the fact that the first permanent molars had not erupted and that the disturbances caused by anterior drifting of these teeth had not manifested themselves at this young age.

2.3.5 Malocclusion and Periodontal Disease

Abnormalities in arrangement and function of the teeth have long been considered a likely causative factor in diseases of the supporting structures of the teeth. Clinical evidence appears to support this hypothesis. Malalignment of the teeth could obviously decrease the efficiency of natural hygiene and lead to food impactions and traumatisation of the gingival tissue. Disturbances in the direction of the occlusal force and the overloading of individual teeth caused by malocclusion have been considered an important factor in the ethology of periodontal disease. (Anderson 1960, Glickman 1964, Salzman 1957)

Although these observations have been made by clinicians for a number of years, there are few reports available in the literature that can supply quantitative data to support them. Considering the previous lack of professionals skilled in epidemiologic methods, a good start has been made toward objective evaluations of malocclusion and periodontal disease. Even assuming widespread use of acceptable indexing methods, the interplay of systemic factors in any consideration of cause and effect evaluation of malocclusion and periodontal disease would remain a problem, as has been emphasised by Glickman (1964):

An increased occlusal force is not traumatic if the periodontium can accommodate to it. A physiologic force may become traumatic if the adaptive capacity of the periodontal tissue is impaired.

Ditto and Hall in 1951-52, investigated the association between the occurrence of malocclusion and periodontal disease in 143 cases. They came to the conclusion that crowding of the teeth is an important factor in the occurrence of periodontal disease.

A well-conducted study of malocclusion and periodontal disease was reported by Poulton and Aaronson (1961). The survey was performed on 908 male subjects between 17 and 26 years. The Occlusion Feature Index was utilised for the evaluation of the occlusion and the Russell Index was used to establish the periodontal status of the subjects. Poulton and Aaronson found a significant correlation between malocclusion and the periodontal status. Not only did they find an increase in periodontal disease with increasing malocclusion, they

also observed a significant relationship between periodontal status and each of the following conditions: (1) *vertical incisor overbite*, (2) *posterior cuspal interdigitation*, (3) *lower anterior crowding*, and (4) *horizontal incisor overjet*. They concluded that:

"malocclusion may be an important causative factor in periodontal disease."

A similar survey of 800 individuals in Bombay reported by Bilimoria (1963) substantiates the conclusion of Poulton and Aaronson (1961); as the occlusion deviated further from the accepted normal, periodontal disease also increased.

Judgement from clinical observations and the findings of a few carefully conducted surveys, a highly significant correlation appears to exist between malocclusion and periodontal disease, emphasising the need for early treatment of malocclusion, not only for the sake of the immediate problem but in order to prevent later deterioration of the supporting structures of the teeth.

2.3 EPIDEMIOLOGY OF DENTO-FACIAL DEFORMITIES

CLEFT LIP AND PALATE

Many magnificent victories over diseases affecting the human race have occurred in the first half of the twentieth century. With the control and prevention of numerous disorders of infectious and nutritional origin, medical scientists have directed their studies in the last three decades toward the problem of congenital malformations, among other health problems. Structural defects present at birth are collectively termed "congenital malformations". These defects may occur in various parts of the body with varying degrees of severity. The two congenital malformations of specific interest to the dental profession are cleft of the lip and the palate.

Cleft lip and palate are presently among the most common of congenital deformities, and they probably have occurred in man since very early times. Evidence that man suffered from these malformations 4000 years ago is apparent from the presence of a cleft palate in an Egyptian mummy. In the second century, the Greek physician and writer, Claudius Galenus, mentioned the occurrence of cleft lip (Dorrance 1933). The writings of Roland Cappelutti and other physicians of his time, and the discovery of a 500-year-old skull with a cleft alveolar process in Hungary (Berndorfer 1962) indicate that these anomalies were recognised in the Middle Ages. There is evidence also from ancient Peruvian skulls that cleft palate occurred in that hemisphere many centuries before Columbus' voyage. (Thoma 1963) Josiah Flagg, one of the earliest American oral surgeons, advertised that he "*sews up hare-lips and fixes gold roofs and palates, greatly assisting the pronunciation and the swallow.*" (Weinberger 1948)

Although cleft lip and palate occurred in earlier times, nothing became known of their incidence or the fate of patients after treatment until the latter part of the nineteenth century. The earliest information on the incidence of cleft lip and palate comes from Russia. Frobilius (1965) reported 118 cases of cleft lips and palate among 180,000 children in a hospital in St. Petersburg. The mortality rate was incredibly high; of the 118 affected children, 42 did not survive surgical treatment.

In the early twentieth century there appeared three noteworthy publications on cleft lip and palate. Two were by Europeans, one originating in France (Peron 1929) and the other in Germany (Gonther 1931). J.S. Davis of Baltimore, Maryland, was responsible for the third (Davis 1924). These three publications agree on a general frequency of approximately one child with a cleft for every 1000 births. Although the ethology of these clefts is unknown, there is considerable knowledge related to their occurrence and distribution and clarifying data showing the epidemiology of the anomalies so far.

2.3.6 Classification

The so called "classical theory" of formation of clefts of the lip and palate rests on the assumption that individual facial processes fail to fuse in the developing embryo. Discrepancies exist in the literature among the classifications utilised in many of the studies of cleft lip and palate. The one advocated by Davis and Ritchie (1922), designated the alveolar ridge as the anatomical landmark for distinction between lip and palatal clefts. They listed three principal groups:

- Group I Prealveolar (process) cleft (lip cleft, alveolar process normal);
- Group II Postalveolar (process) cleft (palate cleft, alveolar process normal);
- Group III Alveolar (process) cleft.

For the purpose of uniformity and ease of comparison, the classification is described and presented in **Table 14**.

Incidence of some of the more common types of cleft lip and palate in the U.S.A are presented in **Table 15**.

Table 14

Classification of cleft lip and palate.

Source: Davis & Ritchie (1922)

Main Groups	Description	Subdivision
Group I	All groups lying anterior to the incisive foramen, i.e., clefts occurring in the primary palate. This group embraces all forms and degrees of isolated cleft lip and combinations of cleft lip and cleft alveolar process.	Isolated cleft lip: left, right, bilateral. Cleft lip and alveolar process: left, right, bilateral.
Group II	All clefts lying posterior to the incisive foramen, i.e., isolated clefts of the soft palate or soft and hard palates. These clefts may vary in degree from a bifid uvula to a complete cleft of the secondary palate.	Cleft of soft palate.
Group III	All combinations of clefts involving both the primary and secondary palates, i.e., any combination of Groups I and II.	Cleft of primary palate and complete cleft of secondary palate: left, right, bilateral. Cleft of primary palate and cleft of soft palate: left, right, bilateral.

Table 15

Classification of cleft lip and palate.

Source: Davis & Ritchie (1922)

Location and study period	Source of material	Sample size	Number of cases	Rate per study population	Rate per 1000 births	Reference
Baltimore, Maryland 1899-1924	Matern. hosp. rec.	28,085	24	1:1170	0.85	(13)
Hawaii 1938-1939	Birth records	18,024	35	1:515	1.94	(39)
Pennsylvania 1942	Birth records	202,501	250	1:810	1.23	(29)
Wisconsin 1935-1944	Birth records	567,509	736	1:771	1.30	(68)
San Bernadino, Cal. 1945-1949	Birth records	30,380	42	1:723	1.38	(15)
Cleveland, Ohio 1947-1951	City public schools	63,135	71	1:889	1.12	(47)
New York City, N.Y. 1951	Birth records	162,755	128	1:1271	0.79	(86)
Los Angeles, California 1936-1951	Matern. hosp. rec.	72,107	70	1:1030	0.97	(52)
Pennsylvania 1951-1955	Birth records	1,201,976	1,269	1:947	1.06	(41)
	Multiple sources	1,201,976	1,592	1:755	1.32	(41)
New York City, N.Y. 1952-1955	Matern. hosp. rec.	30,398	48	1:633	1.58	(77)
New York State, exclusive of N.Y. City 1948-1955	Birth & death rec.	1,242,744	1,414	1:879	1.14	(27)
California 1955	Birth records	313,164	368	1:851	1.18	(50)
Michigan 1958	Multiple sources	205,791	264	1:780	1.28	(38)
New York City, N.Y. 1949-1958	Matern. hosp. rec.	27,087	21	1:1289	0.78	(76)
Utah 1951-1961	Matern. hosp. rec.	59,650	90	1:663	1.51	(90)
Montana 1955-1961	Birth records	123,114	229	1:538	1.86	(85)
California 1956-1960	Birth records	1,765,746	2,185	1:808	1.24	(31)
Hawaii 1956-1960	Birth records	85,180	128	1:665	1.50	(31)
Pennsylvania 1956-1960	Birth records	1,242,408	1,446	1:859	1.16	(31)
Wisconsin 1956-1960	Birth records	485,104	692	1:701	1.43	(31)
Iowa 1957-1961	Birth records	321,411	410	1:784	1.28	(65)

Certainly the classification introduced by Veau in 1931 (as shown on Table 16 is still widely used in Europe. Referral to a 'Veau 1 cleft' clearly identifies to many people a cleft restricted to the soft palate. These systems were not sufficiently comprehensive and failed to include some common variants of the deformity. (Edwards, Watson 1980)

Table 16

Veau's classification of clefts (1931).

Source: Edwards, Watson (1980)

Group I	Cleft of the soft palate only
Group II	Cleft of the hard and soft palate to the incisive foramen
Group III	Complete unilateral cleft of the soft and hard palate, and the lip and alveolar ridge on one side
Group IV	Complete bilateral cleft of the soft and hard palate, and the lip and alveolar ridge on both sides

In 1942 Fogh-Andersen published the results of his study of the incidence of cleft lip and palate in Denmark. This classification, with its sound foundation on embryological and aetiological differences, is the basis of the variety of systems of nomenclature which are in use today. (Edwards, Watson 1980)

The names introduced by Kernahan and Stark (1958) (Table 17) are probably those most commonly used. Unfortunately this simple and straightforward system has significant disadvantages. In an attempt to resolve these confusions, the American Cleft Palate Association introduced their much more complex classification (Table 18). (Edwards, Watson 1980)

Table 17

Kernahan & Starks's classification of clefts (1958).

Source: Edwards & Watson (1980)

Clefts of primary palate only
Unilateral (right or left)
Complete
Incomplete
Median
Complete (premaxilla absent)
Incomplete (premaxilla rudimentary)
Bilateral
Complete
Incomplete
Clefts of secondary palate only
Complete
Incomplete
Submucous
Clefts of primary and secondary palates
Unilateral (right or left)
Complete
Incomplete
Median
Complete
Incomplete
Bilateral
Complete
Incomplete

Table 18

American Cleft Palate Association's classification of clefts (1962).

Source: Edwards & Watson (1980)

Clefts of prepalate		
Cleft lip	—Unilateral	—right, left
		—extent in thirds (l, l, l)
	—Bilateral	—right, left
		—extent in thirds
	—Median	—extent in thirds
	—Prolabium	—small, medium, large
	—Congenital scar	—right, left, median
		—extent in thirds
Cleft of alveolar process—Unilateral		—right, left
		—extent in thirds
	—Bilateral	—right, left
		—extent in thirds
	—Median	—extent in thirds
		—submucous right, left, median
Cleft of prepalate	—Any combination of foregoing types	
	—Prepalate protrusion	
	—Prepalate rotation	
	—Prepalate arrest (median cleft)	
Clefts of palate		
Cleft soft palate	—Extent	—posteroanterior in thirds
		—width (maximum in mm)
	—Palatal shortness	—none, slight, moderate, marked
	—Submucous cleft	—extent in thirds
Cleft hard palate	—Extent	—posteroanterior in thirds
		—width (maximum in mm)
	—Vomer attachment	—right, left, absent
	—Submucous cleft	—extent in thirds
Cleft of soft and hard palate		
Clefts of prepalate and palate	—Any combination of clefts described under clefts of prepalate and clefts of palate.	

In deciding on a way of describing clefts it is important to distinguish between two quite separate requirements: there is the need in clinical practice to describe a particular cleft concisely and clearly to one's colleagues, and there is the different need to record the precise details of the deformity to allow later comparison of the progress of different groups of patients either within one unit or between different centres.

(Edwards & Watson 1980)

To fulfil the first requirement the Kernahan and Stark classification is excellent, although it may often be best to use terminology which everyone understands (Edwards, Watson 1980). For the second one, there should be a method for reporting morphological observations in considerable detail, using standardised terminology and a universal coding system, so that quantities of comparable data may be recorded anywhere in the world and stored in a compatible form, available for retrieval and computer treatment. (Berlin 1979)

2.3.7 Ethology

Pertinent literature indicates that studies to date have concentrated on heredity or environmental agents as major ethologic factors. A number of environmental factors, including maternal nutritional deficiency, hormones, roentgen rays, and rubella, have received consideration relative to cleft lip and palate.

2.3.8 Incidence and Distribution

Although a few older reports on the incidence of cleft lip and palate are available in the literature, included here are only the more reliable studies. The incidence of the anomalies is presented as the rate per study population and the rate per 1000 birth. The incidence of the clefts is also considered with relation to such variables as sex, type of cleft, and race. The relationship between the cleft lip and palate and birth rank, parental age, seasonal variation, associated malformations, birth weight, and length of gestation is also considered.

A great number of studies on cleft lip and palate lend themselves to the grouping as described in **Table 15**. The comparative frequencies of the three groups in a number of these studies are listed in **Table 19**. Analyses of the findings of the 21 studies presented in **Table 19** indicate general agreement on some points.

Table 19
Distribution of clefts by groups.
Source: Moller (1969)

Location and study period	Total no. cases	Frequency by groups						Reference
		Group I		Group II		Group III		
		No.	Percent	No.	Percent	No.	Percent	
Denmark 1910-39	625	138	22.1	127	20.3	360	57.6	(19)
Wisconsin 1935-44	1134	247	21.7	294	25.9	593	52.3	(68)
Ontario, Canada 1943-49	634	195	31.0	123	19.0	316	50.0	(40)
Birmingham, England 1940-50	285	66	23.2	114	40.0	105	36.8	(56)
New York City 1951	128	53	41.4	48	37.5	27	21.1	(86)
Japan 1948-54	171	47	33.3	35	20.5	79	46.2	(61)
New York City 1952-55	48	9	18.7	24	50.0	15	31.3	(77)
California 1955	368	102	27.7	111	30.2	155	42.1	(50)
Tasmania, Australia 1945-57	160	38	23.8	53	31.1	69	44.1	(71)
Northumberland and Durham, England 1949-58	574	181	31.5	188	32.8	205	35.7	(48)
Singapore 1949-59	359	90	25.1	45	12.5	224	62.4	(79)
Finland 1948-60	2108	242	11.5	1117	53.0	749	35.5	(34)
Oxford, England 1950-60	456	93	20.4	211	46.3	152	33.3	(24)
California 1956-60	2185	622	28.6	629	28.7	934	42.7	(31)
Hawaii 1956-60	128	38	29.7	47	36.7	43	33.6	(31)
Pennsylvania 1956-60	1446	392	27.1	395	27.3	659	45.6	(31)
Wisconsin 1956-60	692	157	22.7	199	28.8	336	48.5	(31)
Allentown, Pennsylvania 1959-60	155	28	18.0	48	31.0	79	51.0	(2)
Utah 1951-61	2828	1242	43.9	455	16.1	1131	40.0	(26)
Iceland 1956-62	64	16	25.0	20	31.3	28	43.7	(59)

The incidence by cleft groups, presented as rate per population sample and per 1000 births, is shown in **Table 20**. Except for the Japanese findings reported by Neel (1958), general agreement appears to exist among the findings listed in this table. The Japanese incidence of Groups I and II are among the highest listed in **Table 20**, and the Group III incidence is by far the highest listed, a ratio of 1:808 births, compared to the Icelandic ratio of 1:1,178, the second highest incidence in these series.

Table 20
Incidence by cleft groups.
Source: Moller (1969)

Location and study period	Sample size	Frequency of Clefts per number of births			Rate per 1000 births			Reference
		Group I	Group II	Group III	Group I	Group II	Group III	
Birmingham, England 1940-50	218,693	1:3314	1:1918	1:2092	0.27	0.52	0.48	(56)
New York City 1951	162,755	1:3071	1:3391	1:6028	.33	.29	.17	(86)
Japan 1948-54	63,796	1:1119	1:1823	1:808	.89	.55	1.24	(61)
New York City 1952-55	30,398	1:3378	1:1267	1:2027	.30	.79	.49	(77)
California 1955	313,164	1:3070	1:2821	1:2020	.33	.35	.49	(50)
Tasmania, Australia 1945-57	96,510	1:2540	1:1821	1:1399	.39	.55	.71	(71)
Northumberland and Durham, England 1949-58	404,124	1:2233	1:2150	1:1971	.45	.47	.51	(48)
California 1956-60	1,765,746	1:2839	1:2807	1:1891	.35	.36	.53	(31)
Hawaii 1956-60	85,180	1:2242	1:1812	1:1981	.45	.55	.50	(31)
Pennsylvania 1956-60	1,242,408	1:3169	1:3145	1:1885	.32	.32	.53	(31)
Wisconsin 1956-60	485,104	1:3090	1:2438	1:1444	.32	.41	.69	(31)
Utah 1951-61	59,650	1:2485	1:3728	1:1193	.40	.27	.84	(90)
Iceland 1956-62	32,979	1:2061	1:1649	1:1178	.49	.61	.85	(59)

The lowest incidence of cleft lip and palate was reported for New York City, one child with a cleft in 1,289 births, and the highest in Hawaii, one child in 515 births. The lowest incidence was reported in Canada, one child with cleft in 959 births, and the highest in Japan, one child in 373 births. The remaining studies report incidence figures ranging from one child with cleft in 767 births to one in 515 births. Stanley (1989) reported a figure of 1.9 per 1000 (1/520) live births for Western Australia.

Many of the studies on cleft lip and palate have given special attention to the connection between parental age and occurrence of these anomalies. Most of these studies have reported a positive relationship between increased parental age and the incidence of cleft lip and palate. A number of studies from various parts of the world were analysed for frequency of cleft lip and palate according to type of cleft and sex. Moller (1969) notes that the study results agree generally that:

1. males are more frequently affected by cleft lip and palate than females;
2. cleft lip with cleft palate is the most frequent type of cleft among males, and isolated cleft palate most frequent among females;
3. when the lip is involved in these malformations, the left side is affected approximately twice as frequently as the right side, in both males and females.

2.4 EPIDEMIOLOGY OF ORAL CANCER

Oral cancer is probably the only death-producing disease commonly seen by dentists. Compared to the frequency of attack of dental caries and periodontal disease, oral cancer, however, is encountered rather infrequently. Yet every classification of human tissues under the supervision of a dentist, except teeth, has cells which may transform into a malignant state. Cancers of the oral cavity, then, are essentially diseases of the supporting structures of teeth, that is, of bone and soft tissues of the surrounding and nearby structures, the skin, mucous membranes, and their underlying tissues, including salivary glands and muscle.

The relative infrequency of oral cancer is offset by its seriousness and by the attendant scarring and disfigurement of a patient's face, jaws, and tongue following most forms of treatment. Fear of impending death and the shock of the mutilation accompanying treatment of oral cancer are factors which are encountered in few other diseases.

(Hayes 1963)

Oral cancer specifically refers to malignant neoplasms of the buccal cavity and pharynx which are numbered 140 to 149, inclusive, in the application of the Application of the International Classification of Disease to dentistry and stomatology (ICD-DA). (WHO 1978)

2.4.1 Histopathological Classification

The family that comprises most malignancies of the oral cavity are histologically classified as squamous cell carcinomas because they arise from the squamous epithelium that lines the oral cavity. Squamous cell carcinomas in and about the lips tend to be lower grades of malignancy than those in the floor of the mouth or the tonsillar area and they usually begin as a superficial surface ulcer or area of thickening. (Russell 1964)

The second family consists of those malignancies which arise from the submucous glands. These less common adenocarcinomas first appear, clinically, as a lump or bulge under overlying normal mucosa. A third family is made up of malignant tumours arising in the jaws, including bone sarcoma or locally invasive epithelial tumours, such as ameloblastomas.

Malignant neoplasms of interest to dentists include not only those classified under the heading of neoplasms of the buccal cavity and pharynx (International Classification No. 140-149, of the second edition) but also some of those listed under neoplasms of bone, particularly bones of the face and skull (No. 170.0), the lower jaw (No. 143.1), and the maxillary sinus (No. 160.2). In addition, melanomas of the skin which involve the lip (No. 172.0X), other skin neoplasms involving the lip (No. 173.0X), connective tissue neoplasms of the head, face, and neck (No. 171.0X), and secondary unspecified neoplasms in the same site (No. 196.0X) are of considerable dental interest.

In Factsheet No. 14, The 'oral cancer' includes cancer of the lip (ICD 140) and all intraoral sites (tongue ICD 141 and elsewhere in the mouth)*. In the U.K. there are around 1900 new cases and 960 deaths each year and as Table 21 shows, the disease is more common in men than women (M/F incidence ratio 1.8:1.0). The majority (over 90%) of oral

malignancies are squamous-cell carcinomas and the prognosis is best for patients with cancer of the lip, the most accessible site. (FDI 1990)

Table 21
Number of new cases and of deaths in the United Kingdom.
Source: FDI (1990)

1984			1988	
Numbers of new cases			Numbers of deaths	
Males	Females		Males	Females
267	78	Lip	31	13
414	275	Tongue	268	154
556	322	Mouth*	320	169
1237	675	"Oral"	619	336

*** Throughout factsheet No. 14 "elsewhere in the mouth" is refereed to as "mouth" and includes 9th revision ICD codes 143 (gum) 144 (floor of mouth) and 145 (other) and unspecified parts of mouth.**

2.4.2 Incidence: World-wide distribution and trends

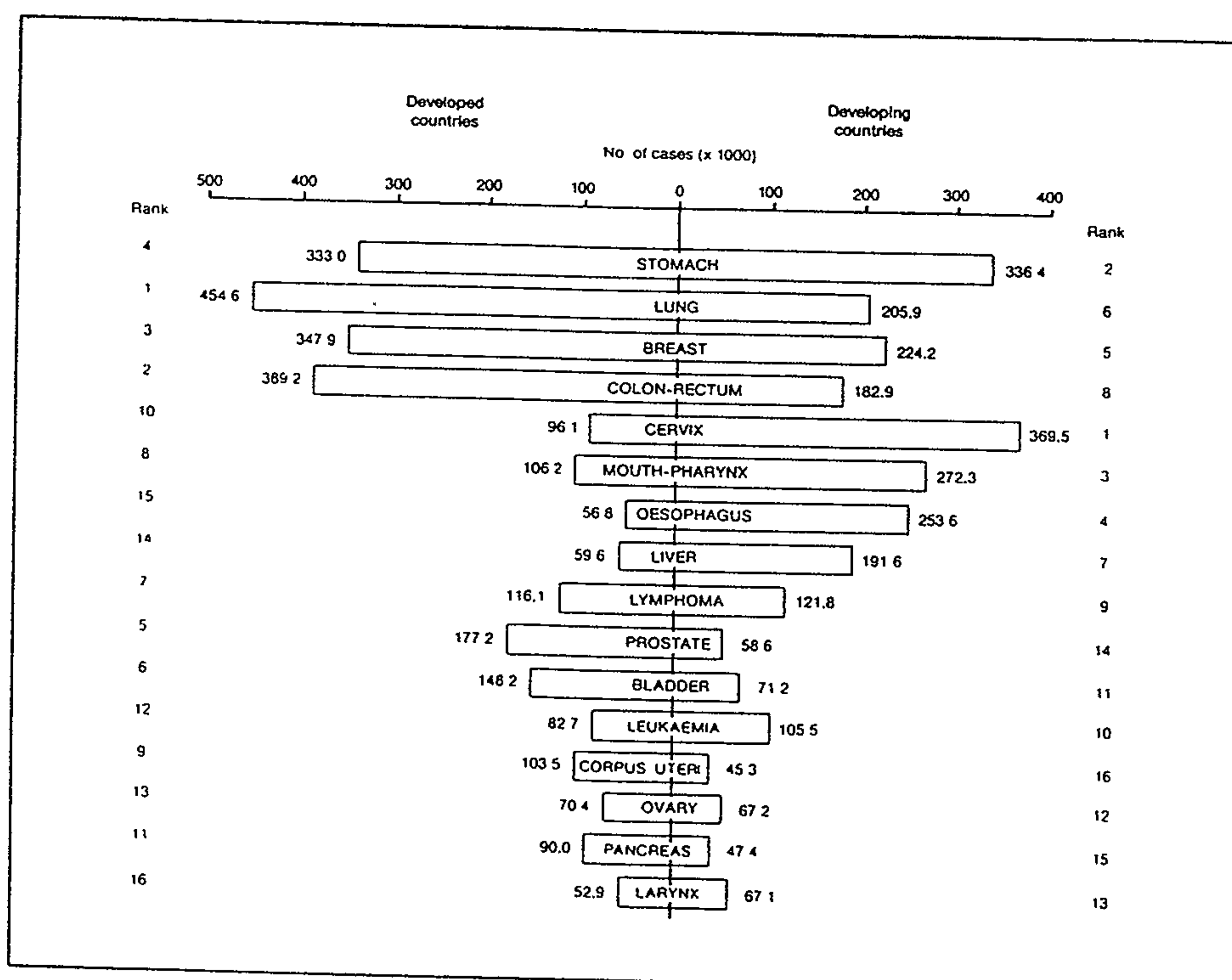
The world-wide incidence of oral cancer varies enormously. The highest reported rates are in India, where oral cancers are often the commonest site for malignancy, sometimes causing over 40 per cent of all cancers compared to less than 1 per cent in the UK. Other areas of high incidence include parts of South America such as Brazil and Papua New Guinea. (FDI 1990)

Generally the highest rates of oral cancer are found in the developing world where oral cancer and pharynx combined is the third commonest site of cancer causing over 272,000 new cases each year - see **Figure 14**. However, there are pockets of high incidence in Western countries such as Bas-Rhin in France and Newfoundland (lip cancer only) in Canada. In addition, in several Western European countries the rates have increased in recent decades (see Trends). (FDI 1990)

Figure 14

Number of new cases and ranking in developed and developing countries.

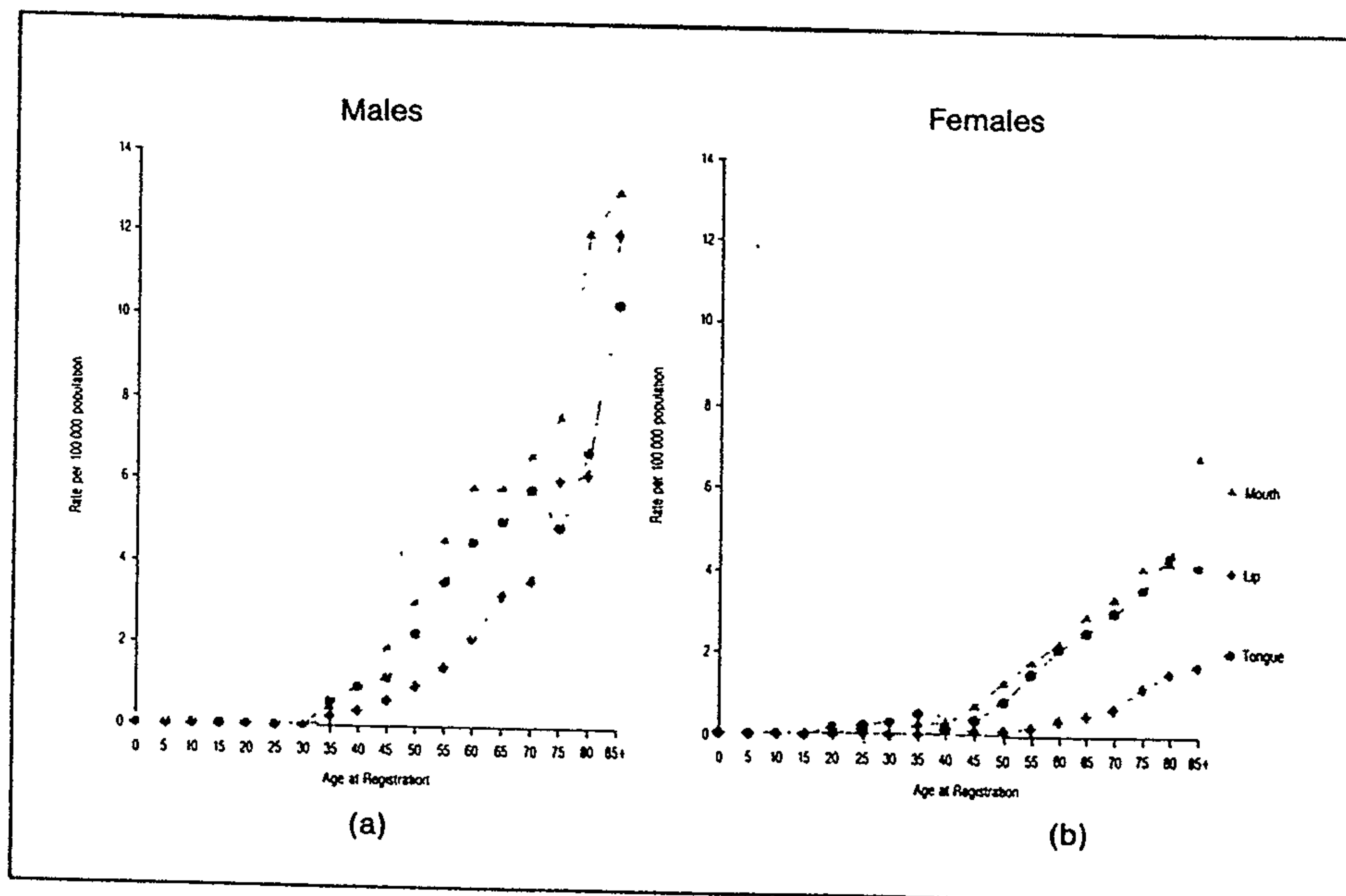
Source: FDI (1990)



Age distribution: The incidence of oral cancer increases with age and in Britain the majority of cases (85%) occur in people aged over 50 years - the age - specific rates are shown in Figures 15a and 15b. However, in high prevalence areas in the developing world, it is relatively common in younger people and the teenage use of oral snuff in Western countries has been linked to oral cancers appearing in the third and fourth decade of life. (FDI 1990)

Figure 15a and 15b

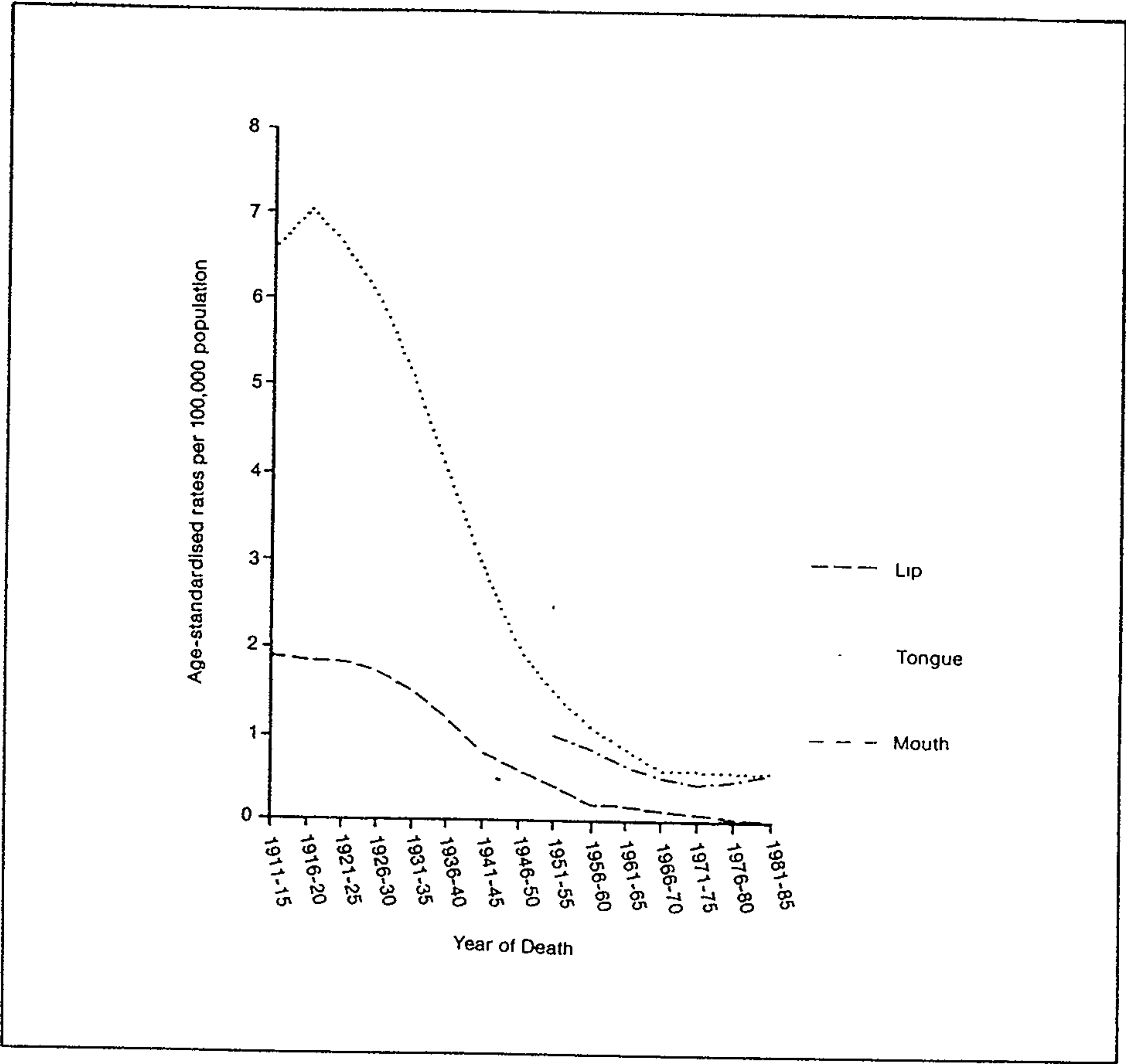
Age specific incidence rates for males and females 1982-84 England and Wales.
Source: FDI (1990)



Sex distribution: The disease has always been commoner in men than women but the sex ratio has decreased as male rates have fallen proportionately more than female rates. Fifty years ago oral cancer caused five times more deaths in men than women, but now the mortality ratio is less than two to one. In certain high risk areas in South Asia female rates are as high as or higher than the male rates. (FDI 1990)

Eighty years ago cancer of the lip and tongue alone caused over 1200 deaths each year in England and Wales compared to 400 today. The striking decrease in mortality for male oral cancers is shown in **Figure 16**. The age-standardised mortality rates per 100,000 population have decreased from 6.7 to 0.6 for tongue and 2.0 to 0.1 for lip between 1911 and 1985, and from 1.0 to 0.7 for mouth between 1951 and 1985. The corresponding rates for women are: 0.1 to 0.01 for lip, 0.5 to 0.3 for tongue and 0.2 to 0.2 for mouth. (FDI 1990)

Figure 16
Age-standardised death rates:males England and Wales 1911-1985.
Source: FDI (1990)

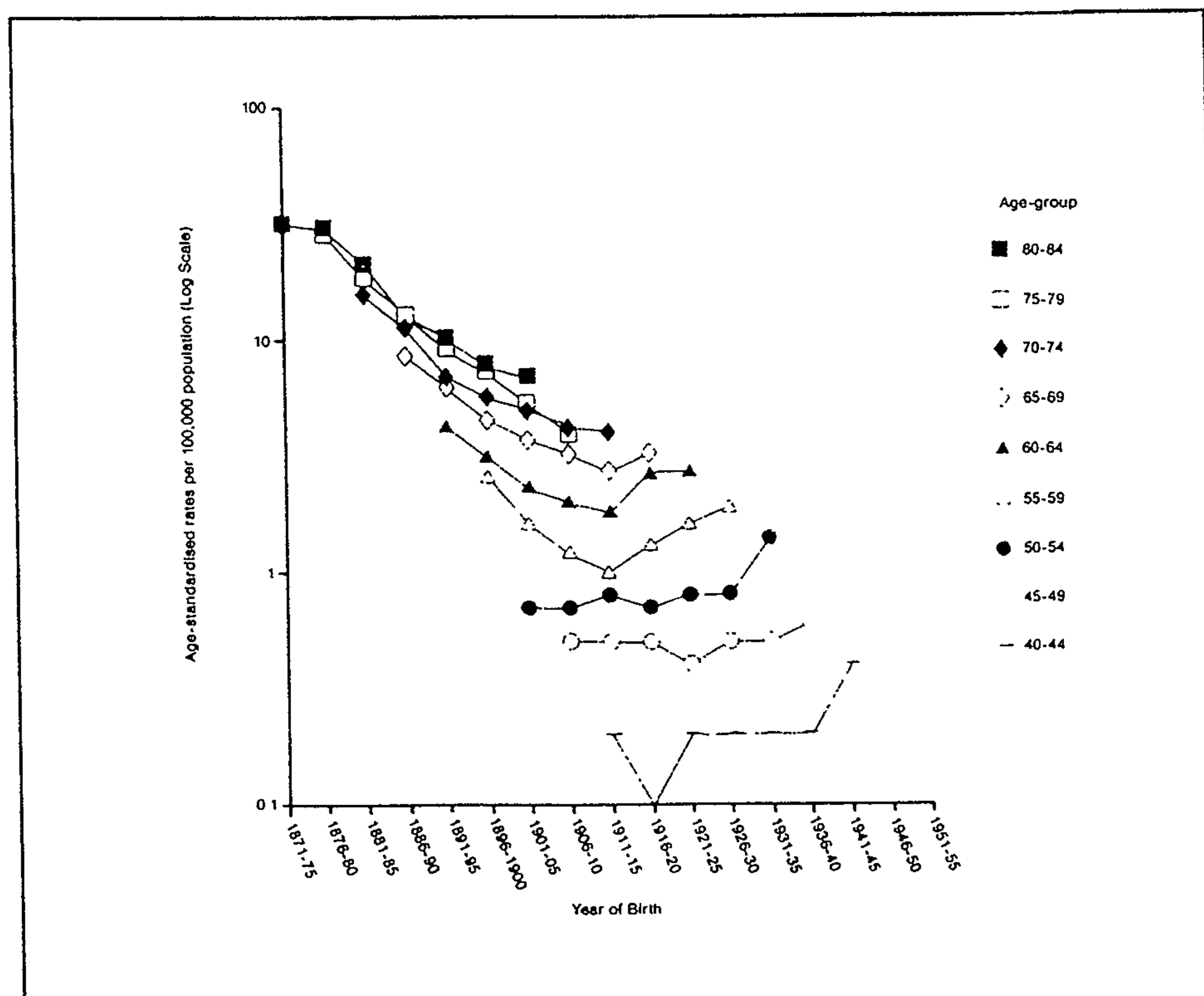


However, in recent years the incidence and mortality rates have started to increase for cancer of the tongue and mouth, especially in younger men. Analysis of these trends* suggest that there is a strong cohort effect, with men born since 1910 having higher rates. This is shown in **Figure 17** where the age specific death rates are plotted against the approximate year of birth. In North America the increase in tongue cancer has been linked to the growth in smokeless tobacco consumption, but this is very unlikely to be the main cause in the UK, as consumption of smokeless tobacco is very low. Increases in mortality from cancer of the oral cavity and pharynx over the past 20-30 years have also been reported for almost all the EC countries. (Dunn 1960)

Figure 17

Death rates by birth cohort: Cancer of the tongue males, England and Wales 1871-1951.

Source: FDI (1990)



2.4.3 Treatment and Survival

The standard treatments for many years have been radiotherapy and surgery. More recently chemotherapy has been used and its effectiveness is currently being evaluated in clinical trials. However, major advances have been made in reconstructive surgery over the past two decades which can improve immensely the quality of life for the patient. (FDI 1990)

The 5-year relative survival rates for all patients registered in England and Wales in 1981 are shown in **Table 22** and survival rates by stage from a hospital series of patients. Lip cancers have the best prognosis: they tend to be less aggressive tumours and their position on the face generally leads to earlier detection and treatment than for the intraoral cancers. For all the cancers, the 'early' stage cases have by far the best outcome which emphasises the importance of early detection when primary prevention has failed. (FDI 1990)

Table 22

Five-year relative survival rates England and Wales 1981.

Source: FDI (1990)

	Males	Females
ICD 140 Lip	94	71
ICD 141 Tongue	37	43
ICD 143 Gum	41	58
ICD 144 Floor of Mouth	39	52
ICD 145 Other and unspecified parts of mouth	51	56

2.4.4 Risk factors

The main causes of oral cancer are well known and many causes of the disease could be prevented. The two most important aetiological factors are tobacco and alcohol, whilst ultraviolet light is implicated in the development of lip cancers and diets lacking in certain elements may predispose the individual to develop oral cancer. The role of viruses remains controversial. (FDI 1990)

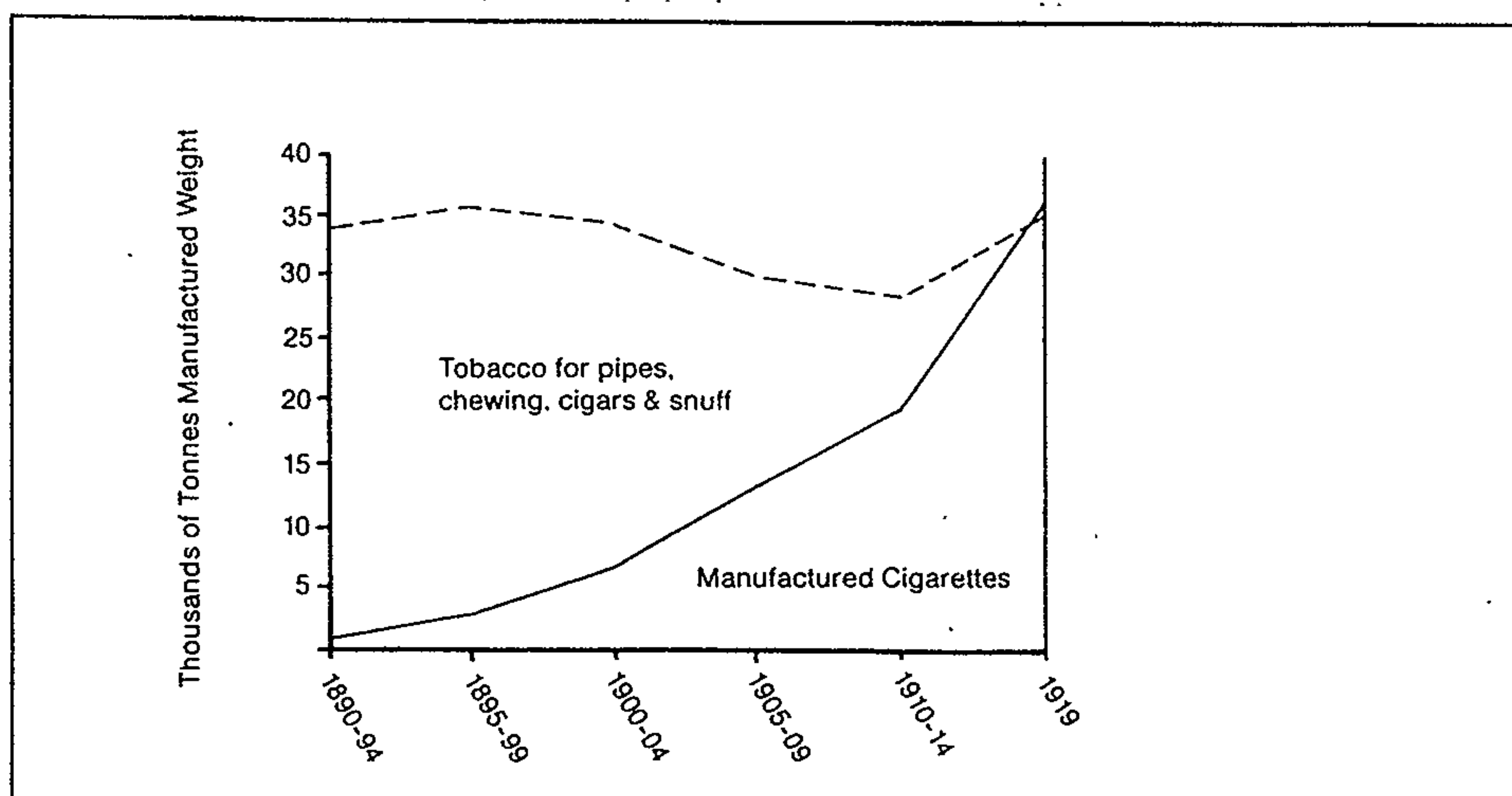
Tobacco

Tobacco consumption can take many forms and the primary causes of the very high incidence of oral cancer in South East Asia is the widespread habit of chewing a betel quid to which tobacco is added. The longer the quid is kept in the mouth, the higher the risk and if chewing is combined with smoking tobacco, then the risk is even higher. All forms of smoking tobacco carry a risk of oral cancer and particularly high rates occur when reverse smoking, with the lighted end inside the mouth, is practised. Reverse chutta smoking is common in some parts of India, where it is particularly popular amongst women and carries an even higher risk than betel chewing. In Western countries cigarette, cigar and pipe smoking are the main forms of tobacco use. In the earlier parts of this century, pipe smoking was associated with lip cancer and its decline in popularity may be linked with some of the decrease in lip cancer. However, the main form of tobacco consumption since 1919 (Wald 1987) is cigarette smoking (Figure 18) which is a risk factor for oral and many other cancers, especially lung cancer. (FDI 1990)

Figure 18

Total annual sales of tobacco products 1890-1919 UK.

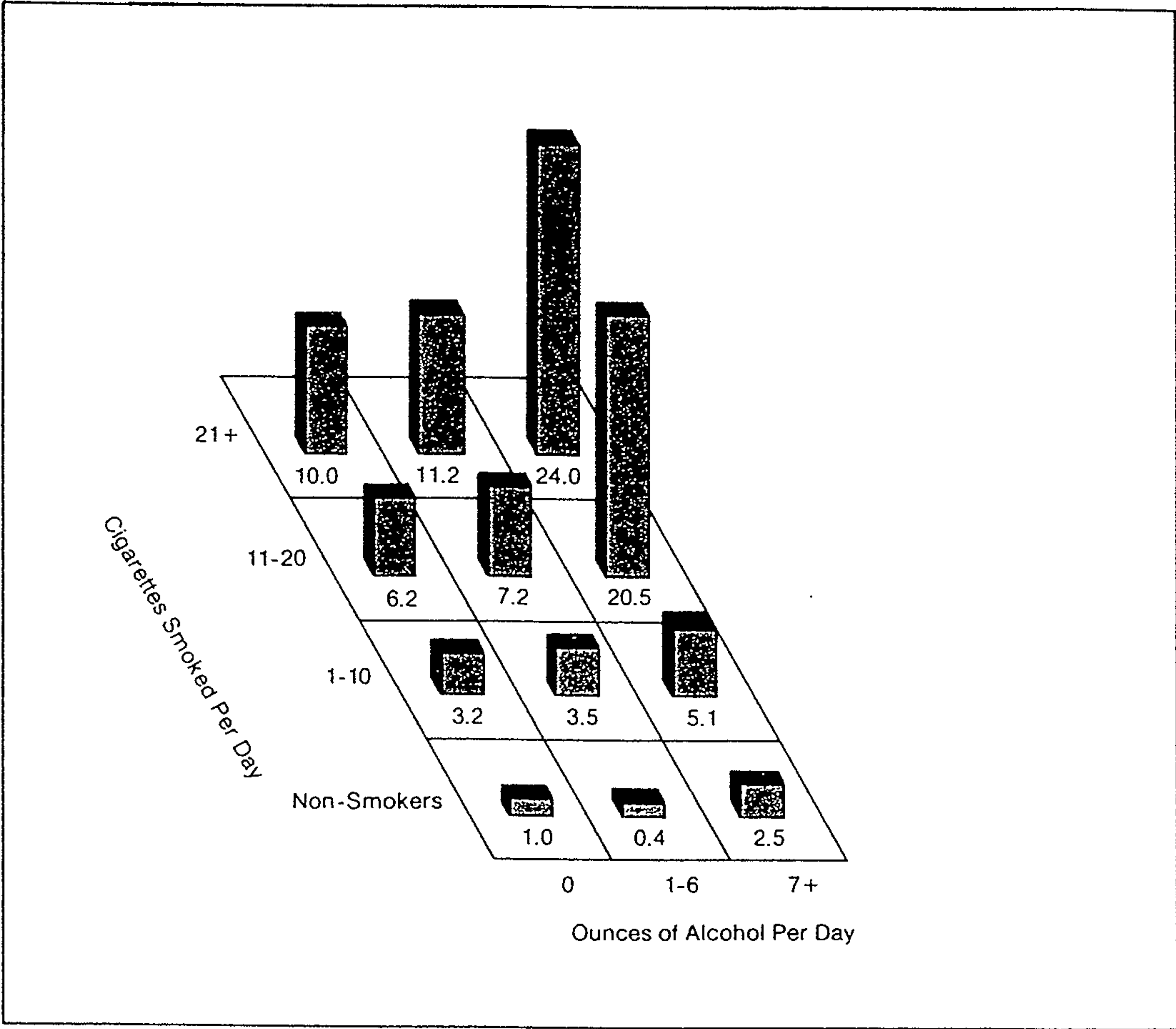
Source: FDI (1990)



Alcohol

Alcohol is the second major risk factor for oral cancer as well as for cancers of the pharynx, oesophagus, larynx and liver. Alcoholics and other heavy users of alcohol are at much higher risk and conversely, populations with a low alcohol intake have very low risk. There is also strong evidence that alcohol acts synergistically with tobacco to multiply the risk of oral cancer as shown in **Figure 19**. In Denmark, the alarming rise in oral cancers has been attributed predominantly to increased alcohol consumption (Moller 1989)

Figure 19
Relative risks of oral cavity cancer by daily consumption of alcohol and cigarettes
males.
Source: FDI (1990)



Diet and nutrition

People whose diets have low level of vitamin A (and related carotenoids), vitamin C, iron and possibly other trace elements are at a higher risk of developing oral cancer (Oral Cancer 1989) which may be one reason why the highest incidence rates are found in the poorest countries. Intervention studies where diets have been supplemented have shown a beneficial effect on certain pre-malignant states.

Ultraviolet light

Cancer of the lip is more common in men with outdoor occupations and it is generally believed that high exposure to ultraviolet light may cause lip cancers as well as being the main cause of skin cancers. (FDI 1990)

Trauma

Trauma to the soft tissues resulting from poor dentition and ill-fitting dentures may play a role in localising a site where tumours develop, but both this and oral sepsis are very unlikely to cause oral cancer in the absence of these risk factors. (FDI 1990)

2.4.5 Pre-Cancer

Many oral cancers arise DE NOVO and seem to present as invasive new lesions without the patient or clinician being aware of any pre-existing changes. However, several oral lesions and conditions can precede oral carcinoma the most common and important of these are, leukoplakia (white patches) and erythroplakia (red patches), the latter being potentially more dangerous. People with these conditions are at a greater risk of developing oral cancer than normal populations, even though the rate of malignant transformation is low, between 2 and 6 per cent for leukoplakia. (FDI 1990)

2.4.6 Prevention

Primary prevention

With such well-known risk factors as tobacco and alcohol, it is theoretically possible to prevent a substantial proportion of oral cancer. The benefits of eliminating tobacco use and reducing alcohol intake are well documented in Western countries and would reduce mortality from many cancers as well as other diseases such as ischaemic heart disease.

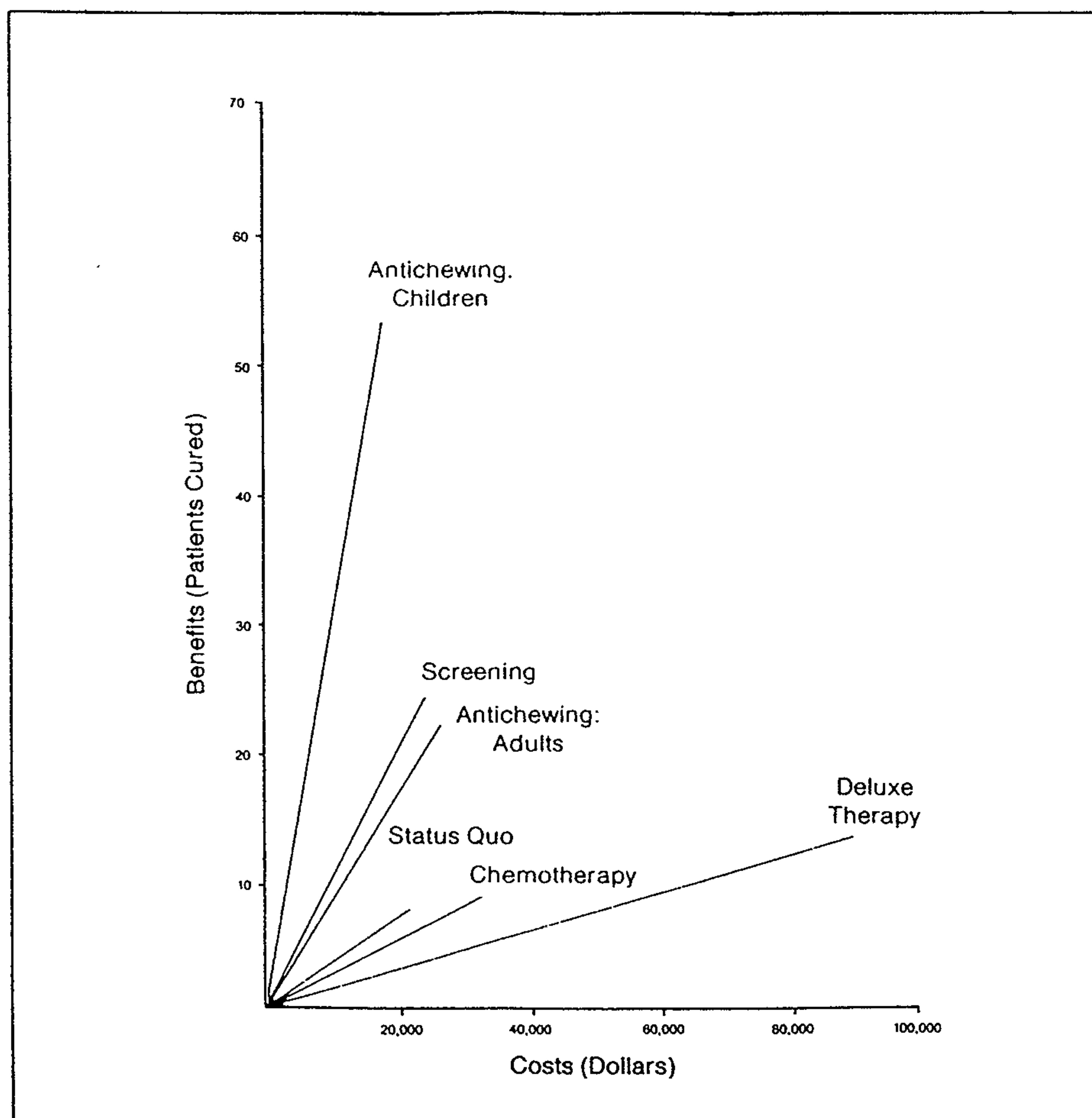
The European 10-point code advises people to stop smoking and drinking alcohol.
(FDI 1990)

In India and Sri Lanka successful efforts are being made to reduce the prevalence of the traditional habit of betel chewing and as **Figure 20** shows, the greatest cost-benefit is gained by educating children not to take up the chewing habit (Stjernsward). Studies have shown that dietary supplements play a protective role against the development of oral cancer. One method of lowering the risk of oral cancer would be to give dietary supplements or better still to ensure a balanced diet which would also reduce the risk of many other diseases. (FDI 1990)

Figure 20

Cost benefit analysis of oral cancer control in Sri Lanka.

Source: FDI (1990)



Secondary prevention

As the survival section shows, patients whose cancer is detected at an early stage generally have much longer survival times and also very importantly, treatment will be less radical.

A recent British study (Scully 1986) showed that delay by the patient was the main reason for late referral. This indicates the need for more public education about the early signs of oral cancer. The dental profession in both developing and developed countries is uniquely placed to play a key role in the early detection of oral cancer. Information on the early signs of the disease should be given in their surgeries and elsewhere. Patients with leukoplakia, erythroplakia and persistent mouth ulcers should be encouraged to seek dental (or medical if the former is unavailable) advice.

Screening programmes are recommended (Warnakulasurya 1984) for the early detection of oral cancer and pre-cancer in high risk areas of the Third World and in high risk groups in western countries. (FDI 1990)

3 PREVENTION METHODS AND PROGRAMS FOR ORAL DISEASE

Every year, there are many new victims of carious lesions; a lot of children have malocclusion conditions; many more have periodontal disease and increasing number of teeth must be extracted, and many dentures or bridges must be supplied.

Why is dental disease so prevalent when we have the preventive techniques to stop a great percentage of the periodontal and caries lesions? Even when dental disease develops, many people are either not cognisant of, or not concerned with, its presence. In other cases, it may be such factors as lack of money or fear of pain. Nationally, nearly 50 per cent of the children under 17 years of age have never been to a dentist; among them many poor children who have never visited a dentist because of financial problem, therefore 100 per cent of decayed teeth in this indigent group go unfilled. Poverty is not the only reason for poor dental care; affluent people are also afflicted. For instance, in U.S.A., where poverty is not much concerned, 8 of every 10 children still have dental disease by age 9 and only 40 per cent of the U.S.A. population goes regularly to the dentist.

Treatment is not the answer to solving oral problems of the people; instead, prevention is the key to good dental health. The American Dental Association has established a policy that dental health is the responsibility of the community, the family, and the individual. According to this enunciation, the responsibility for good dental health resides with the consumer, not the provider. Two key question must be raised in relation to this policy:

1. Who is to educate (and motivate) consumer as to WHAT to do, WHY it needs to be done, and HOW to do it?
2. While the individual is learning to accept responsibilities, how can oral health best be protected by preventive and treatment programs? This question is especially applicable to school populations.

The answers to these two questions will be discussed later in this chapter.

Philosophically, ALL children should be entitled to receive maximal primary preventive dental care that includes the routine application of the five general methods for control of the plaque disease-use of fluorides, pit and fissure sealants, sugar discipline, plaque control, and education. (Harris 1987)

A comprehensive school program should:

1. Be administratively sound.
2. Be available to all children.
3. Provide the facts about dentistry and dental care.
4. Aid in the development of favourable attitudes towards dental health.
5. Provide the environment for the development of psychomotor skills necessary for tooth brushing and flossing.
6. Include primary preventive dentistry programs - prophylaxis, fluoride programs, and use of pit and fissure sealants.
7. Provide screening methods for the early identification and referral of pathology.
8. Ensure that all discerned pathology is expeditiously treated.

(Harris 1987)

Any public health dental program must be precisely and accurately planned to ensure the maximum of success with the available resources. In general, any solution developed to attain better oral health in school children must be supported by the educator, and the dental profession.

PROGRAM OUTLINE FOR IR IRAN

Superficially the situation can be subjectively analysed and short term solutions can be implemented. If this persists we gradually develop a "Jigsaw Puzzle" type program where the pieces will not fit together in a proper and efficient form. One cannot stress too strongly the need to comprehensively assess the current situation to provide the basis for long term planning even when the implementation must be progressive due to financial and/or, educational limitations. (Report of Panel 1979)

3.1 SITUATION ANALYSIS IN IRAN

- 1. About 80 per cent of children at age 5-6 years have dental caries of the deciduous dentition
- 2. Average 4.0 DMF teeth at age 12 years
- 3. About 4.7 sextants have periodontal disease (CPITN) per person at age 15 years
- 4. Provision of systematic dental care for schoolchildren varying from 0 to 4 per cent

National goal
=====

To provide systematic dental care for 60 per cent
or more of schoolchildren

=====

Situation in a province
=====

Options for 10-year projection
=====

- A. There is no systematic dental care for school children
- B. Less than 20 per cent of school children are in systematic school dental programs
- C. From 20 to 50 per cent of school children are in systematic school dental programs

- A.1 Provision of systematic dental care type 1 (minimal)* - to 60 per cent or more of schoolchildren
- A.2 Provision of systematic dental care type 2 or 3 - to 60 per cent or more of schoolchildren
- B.1 Provision of systematic dental care type 2 - to 60 per cent or more of schoolchildren
- B.2 Provision of systematic dental care type 3 or 4 - to 60 per cent or more of schoolchildren
- C.1 Provision of systematic dental care type 3 or 4 - to 60 per cent or more of schoolchildren
- C.2 Provision of systematic dental care type 3 or 4 - to 80 per cent or more of schoolchildren

Note: Options depends on manpower situation
* WHO (1980)

3.2 MEASURABLE GOALS FOR PREVENTION

All the Member States of WHO have adopted the goal of health for all by year 2000, and all national oral health care systems must take their share of responsibility in efforts to meet this goal. (WHO 1987)

Overall goals of the program is the oral health improvement of the population of the IR Iran to the extent that the major WHO global oral health targets are met.

Objectives by the year 2,000	Situation by January 1990
=====	
1. To increase proportion of caries-free children at age 5-6 years to 50% or more	On average less than 20% of children at age 5-6 years are caries-free
2. To reduce prevalence of dental caries to DMFT 3.5 or less at age 12 years	Average 4.0 DMF teeth at age 12 years
3. To increase proportion of healthy periodontal tissue to 2.5 sextants or less (CPITN) per person at age 15 years	Average 1.3 healthy sextants (CPITN) per person at age 15 years
4. To provide systematic dental care for 60% or more of school-children	Provision of systematic dental care for schoolchildren varying from 0-4 per cent
5. To provide dental services on demand to 30% of rural population	Maximum 10% of rural population have dental care on demand
6. To provide professional dental care on demand to urban population	About 30-40% of those receiving dental care in urban areas treated by unregistered "dentist"
=====	

Strong and sustained efforts should be made to insure that there is no gap between the accepted goal that dental care should be available to all members of target group, regardless of income or geographic location, as rapidly as resources will permit and it is our professional responsibility to make real efforts to reach such an objective.

(Mistry 1980)

3.3 PRIMARY PREVENTIVE MEASURES

The following measures are feasible to the given situation:

1. Oral health education/promotion
2. Oral hygiene instruction/self-care
3. Use of fluoride systemic/topical
4. Diet counselling/provision
5. Use of fissure sealants

3.3.1 Oral Health Education and Promotion

Health is a way of living and is a part of everyday experience in the home, in the school, in the community. In the widest sense, *health education may be defined as the sum total of all influences that collectively determine knowledge, belief and behaviour related to the promotion, maintenance and restoration of health in individuals and communities*. These influences comprise formal and informal education in the family, in the school and in society at large, as well as in the special context of health service activities (Downine 1990). The ultimate objective of dental health education is improved dental health through a voluntary change in patient's "dental" behaviour (WHO 1987). Improved behaviour toward good emotional and physical health practices is the ultimate goal.

Health promotion is the responsibility of all those who are concerned with bringing about the improvement of health. French (1985) said health education is an aspect of health promotion and one of its roles is to provide individuals with information, skill, and experiences through which they can exercise a greater degree of control over their own health.

The WHO model of strategy suggests a high degree of community involvement. In order to involve a community, a family, or an individual in assuming responsibility for their own dental care, two main ingredients are necessary: *KNOWLEDGE and MOTIVATION*.

There are 55,000,000 people and only about 3,000 dentists in the Islamic Republic of Iran. It is impossible for the dental profession to assume the tremendous task of teaching the public on a one-to-one basis the facts that need to be known about dental health care.

Such mass education can only be accomplished through the various news media and best through public school systems. Also, in a school setting, both group and face-to-face communication can be used for the same audience. The latter is considered a powerful motivating force, since the instructions meet the needs and problems of individuals.

There is generally a lack of planned integration of oral health information at different grade levels to accomplish the objectives effectively; and finally, the lack of funding prevents the preparation of outstanding displays to rival the appeal and wide coverage as given by commercial advertising in some other countries.

There is considerable concern about what should be taught by the public schools; reading, writing, and arithmetic are traditional. There are continual demands and need for curriculum time to teach about current concerns of our society. This demand for more time results from the great number and complexity of cultural, ethnic, economic, social, physical, and mental problems inherent in a school population. Despite the great competition for the little time available in the curriculum, it should be emphasised that the purpose of education is: to provide the information and the experience for people to earn a living; and to provide the information and the experience to make that living more worthwhile. *Optimal oral health contributes to a more worthwhile life.*

(Harris 1987)

Public schools have traditionally accepted the responsibility of teaching dental health as a part of general health; in fact, time for oral health education is included in almost

all school curricula. Yet, despite this apparent emphasis, dental health among children continues to be poor. Therefore, oral health teaching should extend throughout the school years into adulthood, then into parenthood, and finally into the community as a public service.

Health education as a part of the school curriculum is one of the principle measures for health education and controlling dental disease in younger generation. It is felt that the *School Environment is a logical place to teach Oral Health Education* as children have the highest learning ability, and the school setting offers a great potential for effective Oral Health Education as it provides excellent opportunity for communication with virtually all persons within the entire school age group. (Haefner 1967)

The continuing educational influence can be exerted on school children over a considerable time period. The program can begin at an early age when habit patterns are still in the process of being formed rather than being firmly established and resistant to changes as in adults. (Young, Striffler 1969)

Overall findings suggest that school-based oral health education should continue to be a part of public health programs designed to prevent and control dental disease. Educational programs have resulted in significantly increased oral health knowledge. The awareness, through an educational program during the school-age years, could be a factor in determining future health-related behaviour. (Walsh 1985)

3.3.2 Aims of Oral Health Education

The general aim of oral health education is that to promote the life-long maintenance of a dentition which is comfortable, functional, socially acceptable, and promotes good general health. (Ashly 1989)

The specific aims of oral health education are:

- a. Adoption of appropriate attitudes and life styles
- b. Making the best of conditions and disorders which cannot be prevented or treated adequately;
- c. Encouraging better use of dental services.

3.3.3 Principles and Methods of Oral Health Education

1. Every available preventive oral health procedure includes Educational components.
2. Target groups for comprehensive educational program:
 - Policy makers
 - Food manufacturing industry
 - All health care providers
 - Parents
 - School personnel
 - Primary health care workers
 - Program participants
 - School students *
 - Dental and medical profession
3. Educational materials: should be designed to gain or focus attention, to provide new knowledge, to facilitate interpersonal and group discussion, and to reinforce or clarify prior knowledge and behaviour. Materials such as leaflets, news releases, posters, films and slide series, are appropriate educational aids.
4. Oral health education should be built into general health education program.
5. In all community and school-based settings, oral health instruction should be consistent and compatible with scientific knowledge as well as with the local culture, the educational system, and social goals.

(WHO 1984)

* it should be an integral part of any regulatory effort, legislation, or preventive service program

3.3.4 Oral Health Education and Communication

A successful oral health education program is the one which is able to plan effective health education. This kind of plan is usually suitable for the growth patterns or age group of target groups who might be:

- Young children
- Adolescents
- Young adults
- Middle aged adults
- Old people

Hornsby noted that *"if a dentist has established rapport or has formed a positive relationship with patients, then he is more likely to positively change their home oral hygiene procedures. A strong positive relationship is necessary for the patient to act upon the information"*.

Since all perceptions are determined by previous experiences and because communication, by definition, is a two-way process, it is the responsibility of the dental health professional to tailor communication to the individual patient.

Perceived need for care is a key determinant in performing self-care and in seeking provider-based services (Gift 1984,1986). Some people simply do not consider seeking dental services. They have no perceived need and have low interest and involvement (Bureau 1979, Gift 1984, Sogaard 1985, Bakdash 1986). Pain is a frequent criterion of perceived need. (Gift 1988)

The problem for many people, is that they don't know how to initiate changes in their behaviour. So it is our position to help and let any correction necessary to be learned resulting attitudes altered and improved. If a patient "doesn't understand", the failure rests with the dental profession as much or more than with the patient.

Most people believe they have good oral health (Bureau 1979, Petersen 1983, Murtomaa, Masalin 1984, Shanley & Ahern 1984, Arnijot et al. 1985, Sogaard 1985, Bakdash 1986) which would suggest they have low perceived need for treatment. (Gift 1988)

Many people, however, are able to improve their ability by becoming more aware of their communication, something we might call consciousness-raising or self-monitoring, and by learning specific communication behaviours to replace informative habits. This dual process can gradually lead to significant improvements in one's skill as a communicator.

Verbal as well as non-verbal communication is of value in establishing baseline information. By assessing the patient's initial behaviour through interview and observation, the dentist and dental team will be better prepared to:

1. Recognise the emotional aspects that determine the patient's behaviour.
2. Recognise the socioeconomic aspects that have contributed to the patients attitudes, motives, and values.
3. Identify the patient's perception of dental problems, knowledge, and misconceptions.
4. Identify routines and current practices, using direct and non-threatening questions.
5. Identify oral health status.
6. Determine the interests of the patient. **(Figures 21)**

Methods of health education communication could be summarised as:

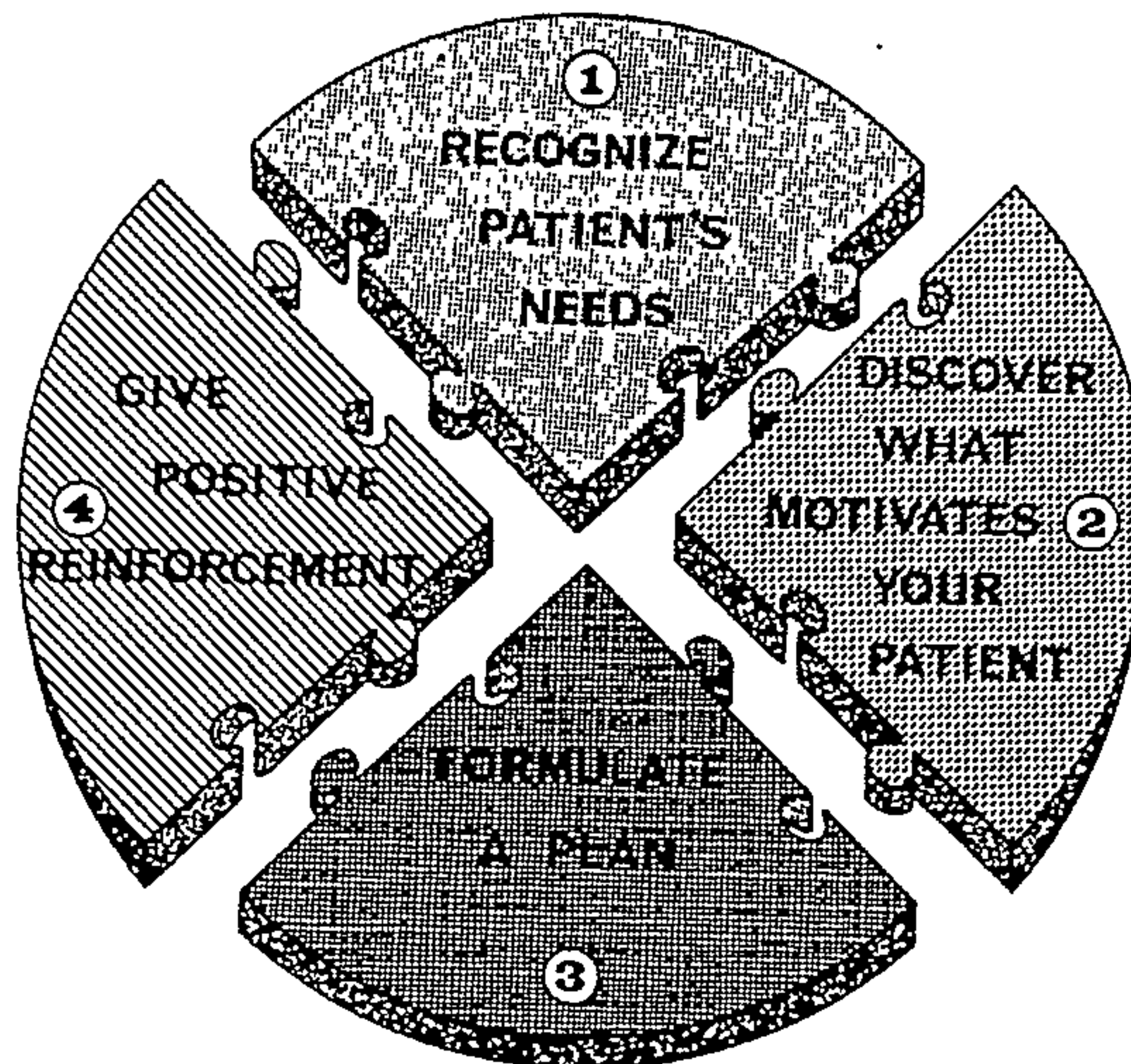
1. One-to-one communication
2. Group presentations of information, group discussion
3. Community organisational strategies
4. Disseminating information through mass communication channels ie. newsletters, radio and television

Moreover, the teeth have different degrees of importance to different individuals. Some protect their teeth because of their functional and aesthetic value; others look after them because of their contribution to social and mental well-being. To many individuals, the teeth are seemingly of such low value that few attempts are made to preserve or protect them (WHO 1970). Therefore health information and messages must not only be accessible, but also acceptable and effective to them. (Durham 1989)

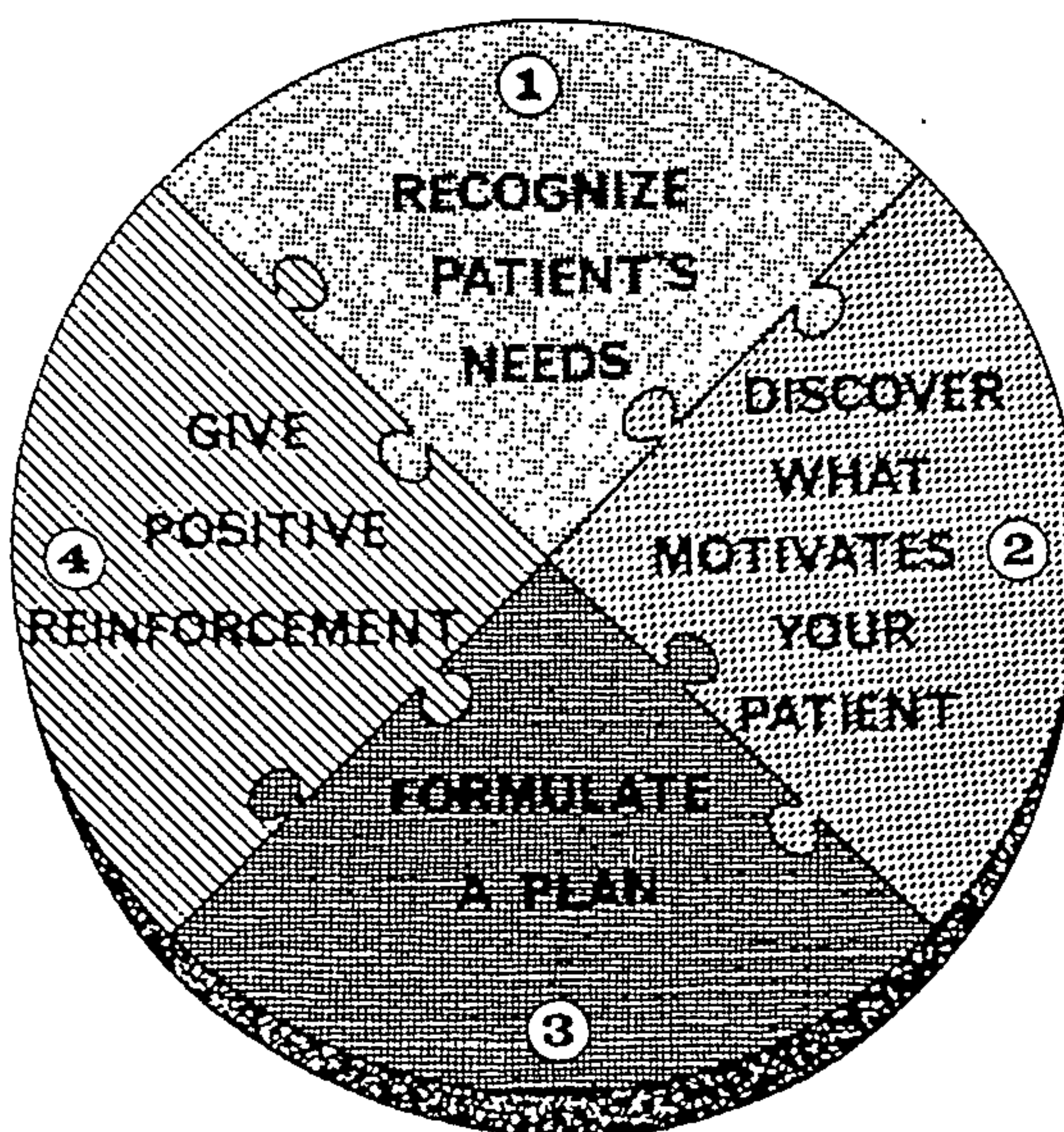
Figure 21

Conceptual model for patient motivation and education.

Source: Jones (1982)



The model is composed of four separate, sequential parts. Each part of this model defines the various motivational and of this model defines the various motivational and educational processes necessary for long-lasting oral health.



Successful motivation and long-term oral health can be acheied when all parts of the model are fitted together in a puzzle-like sequence.

Messages are the most effective when they require the least effort by the recipient. When delivering dental health messages, it should be done slowly a step at a time. When the recipient starts to talk, it is important to listen to find out whether the message has been understood. Audience capability varies from nil upwards.

The message must be meaningful and understandable to the receiver and must have relevance to him. In general, people select those items of information which promise them greatest rewards. The content determines the audiences.

Messages should be expressed in short statements, long garbled messages may cause the intent of the message to be overlooked. Messages should have the power to arrest the attention of the casual reader.

A message must be in simple terms. Simplified explanation helps to induce desired results.

Repetition with variations contribute to both factual and attitude learning.

Health education has been found to be more effective in the one-to-one situation using personalised messages and adaptable procedures. (Durham 1989)

In brief communication principals are:

- a. Tailor language to suit the individual patient
- b. Repeat the message
- c. Allow time for questions
- d. Provide written instructions additionally
- e. Ask the patient to repeat key instructions
- f. Present key pieces of information early in the presentation.

3.3.5 Curriculum Adjustment

Usually, the amount of oral health taught in school is too little to be comprehended by students, and not long enough to be conducive for good evaluation or follow-up intercession. (Harris 1987)

The practical type of exercises used to enhance the delivery of oral health information should consist of procedures, such as flossing and brushing, that permit the student to develop oral hygiene habits to be carried into adult life. It is easier to learn habits at an early age than to change habits when older.

Therefore the children should understand:

1. how to brush their teeth effectively,
2. the role of sugar in the aetiology of dental caries,
3. the meaning of the word plaque and its role in the causation of caries and periodontal disease,
4. the value of fluoride and how it strengthens teeth,
5. the concept of non-sugar snacks and their relevance to a healthy mouth, and
6. that permanent teeth are not replaced.

(Macintyre 1985)

The ability of the child to learn depends on the age of development. Health education, therefore should be planned according to the needs of different stages of age development. (Leatherman 1982)

In order that a curriculum can be constructed for integrated use at the various grade levels, it is first necessary to consider what information is applicable for each grade level. One example of the best grade-to-grade programs yet developed for the teaching of facts about dentistry and oral health is the *TATTLETOOTH* program in the USA. The lesson plans for this teaching program were constructed through a cooperative effort of outstanding Texas school teachers, dental educators, and public health officials. All lesson plans are fully prepared for the classroom teacher, containing both the objectives and the teaching materials needed to attain these objectives. Each grade level program is well written,

interesting, attractively displayed, and closely integrated with the information of other grade levels. This program covers the materials needed from kindergarten to senior high school grade levels. (Harris 1987)

By the time that high school is reached, the students should have an advanced lay knowledge of the terminology, anatomy, and functions of the oral cavity and the etiology and consequences of oral disease. They should also have a knowledge of what to do in order to accept responsibility for: (1) *PREVENTING ORAL DISEASE*; (2) *IDENTIFYING THE PRESENCE OF ORAL DISEASE AT AN EARLY STAGE*; and (3) *SEEKING TREATMENT ONCE ORAL DISEASE IS SUSPECTED OR IDENTIFIED*. In other words, students should be taught to open their eyes, when they open their mouths. (Harris 1987)

Adolescents should be motivated to carry out effective and efficient oral hygiene and to choose safe snacks between meals, as part of an integrated curriculum experience.

One motivation approach is based upon the cognitive learning of the KAB model: *Information leads to Knowledge (K), which leads to Attitude (A) changes, which in turn lead to the desired changes in Behaviour (B)*. This approach is based upon a behavioral learning model which aims to create appropriate skills and behaviours in the hope of formation of good habits. (Sheiham 1983)

Program period/objectives for adolescents may be summarised as:

WEEK 1

1. Understanding - the difference between prevention and cure.
2. Understanding - the functions of teeth, biological and social.
3. Understanding - the nature of bacterial plaque.
4. Experiencing - how to see plaque and how to remove it effectively.

WEEK 2

1. Reinforcing - the distinction between prevention and cure.
2. Understanding and experiencing - the difference between whole healthy and diseased disabled teeth and gums.
3. Understanding - the role of plaque and sugar in dental disease.
4. Considering - personal choice, prevention(health) or cure (disease)?

WEEK 3

1. Reinforcing - prevention; the difference between whole healthy and diseased teeth.
2. Understanding and experiencing - the production of acid from plaque and sugar.
3. Understanding - body-made and ready-made sugar; the importance of frequency, not quantity of sugar eaten.
4. Considering - personal choices, can you influence your own health?

School teachers should receive sufficient dental information in their undergraduate training; in fact, the college texts in this area must contain adequate materials. (Harris 1987)

Data shows that in the schools, improved oral hygiene was correlated with teachers who were enthusiastic and used a cooperative style.

The dental student should receive long and intensive training to equip him to care for his patients effectively and efficiently. In this case he is encouraged to develop a pattern of thinking and a method of approach which, when followed, is most likely to lead to desirable results. If it is recognised that the same pattern of thinking and the same methods of procedure are employed in public health, the task of comprehending the meaning of public health should be greatly simplified. In the one case the individual patient is the object of concern. In the other, it is the people of a community. Although the tools employed in handling each may vary somewhat, the basic procedural pattern is virtually identical. (Young, Striffler 1969)

The *curriculum of UNDERGRADUATE and POSTGRADUATE DENTAL EDUCATION* must include three fundamental elements:

1. An armamentarium of knowledge and clinical skills to fit the recent graduate for modern dental practice.
2. A scientific education to equip the dentist with the capacity to adapt to change.
3. A capacity for self-assessment, to allow the dentist to monitor personal standards of performance, and to recognise needs in continuing education as a response to changes in disease patterns and consequent changes in the count of dental practice. (WHO 1987)

Similar procedures are applicable to dental auxiliaries and other dental team members.

3.3.6 Oral Health Teaching - Teacher or Parent Responsibility

In Iran there are over 12 million students in public schools. These children are almost totally dependent on parent or school-based interest for inclusion in preventive dentistry or dental treatment programs (if available). Many teachers believe that dental care should be the responsibility of the parents and the dental health professional - not the teacher. This belief might be legitimate if parents could and would accept the responsibility for the care of their children's teeth. A child from a home where the parents are subject to cultural, ethnic, and economic disadvantages is usually dentally neglected. In these homes, parental intercession in the oral health of a child usually begins with seeking help to relieve pain. Even with highly motivated parents, their knowledge about oral health is usually less than should be the case for teachers. This fact is reflected by the great number of adults who have carious lesions, periodontal disease, and dentures. In other words, the parents themselves often do not know what to do and thus do not provide a good model for their children. Another argument for school-based programs is the fact that behavioral change is often more difficult to influence at home under parental guidance than under the tutelage of the teacher.

3.3.7 Parent Participation

The parent should not be omitted from a school-based program. Many times one or both of the parents can exert a powerful influence on a child. Ideally, parent education should parallel child education so that the parents can be given the knowledge to better their own oral health, as well as to have the guidelines to aid their children. This educational process for parents is essential in order to overcome the barriers of their past adverse experiences with possible dental disease and related financial difficulties. Children's low level of utilisation of dental health services emphasises the need for parents to be given the background information to stimulate them to accept the desired level of responsibility for the oral health of their children.

As it was stated by Blinkhorn (1978) there is a direct association between a parent's personal practices and the child's behaviour (Rayner 1970, King 1978). Young children copy the tooth brushing habits of their parents and teachers.

The principal objective in parent teaching and motivation is oral hygiene practise in a way so as to prevent the onset of dental disease. In this regard attention should be paid to:

1. Increasing the resistance of the tooth to bacterial invasion by the use of fluoride in one or more of the many forms described earlier. The parent should be made to understand that fluoride ions to the teeth of every child is necessary at least from birth to adolescence. It should be explained to parents that the object is to build fluoride into the enamel structure and thus increase the stability of the enamel and limit acid activity in the plaque. We should also explain that fluoride encourages remineralisation of the enamel where demineralisation has occurred, perhaps best described as an 'ionic see-saw'.
2. Teaching parents plaque control means systematic brushing at least once per day preferably at night. In the very young the parents or teacher must use disclosing tablets and assist with brushing and the use of dental floss.
3. Teaching parents and teachers the importance of avoiding harmful nutritional habits, i.e. they must aim for a minimum intake of fermentable carbohydrate, especially in between meals or in snacks, and elimination of the use of comforters.
4. Establishing confidence at a very early age by arranging visits by parents and their young children to the dentist and his team.

Dunning (1970) says that expectant mothers and nursing mothers are almost always in need of dental health information and are motivated to make use of it. He says that they have a great influence on growing children and should, therefore, be an important object for oral health education.

Lamb and Ford (1960) state *"A clear cut dental health education program needs to be initiated for the mother during the child's prenatal period as well as for the pre-school and the school- aged children through informed parents...."*. Davies (1967) suggests that a start should be made in antenatal clinics, in consulting rooms and in the home; and that there is a need to get the doctor and family health visitors to include concerns for dental health with the total health of the child.

In a successful preventive dental caries scheme, advice was first given when the child was 6 months old or less (Holt et al. 1985). Oral health education through home visits to mothers of very young children had brought about changes in attitude and practice which might be of subsequent benefit to their children. Uptake of free fluoride drops by mothers in this group was high, and 67-70 per cent continued to give them to their children up to age of two and half years. (Winter et al. 1981) This could be very well accomplished by Behvarz and Family health and disease control technicians in Iran.

3.4 ORAL HYGIENE INSTRUCTION

Children do not learn new behaviours through passive absorption but through activity (Piaget, Inhelder 1969). Therefore in oral hygiene instruction, participation of children in school activities are important in learning or behavioral change.

3.4.1 Tooth Brushing Programs

It is necessary to distinguish between tooth brushing and plaque removal. There is little evidence to indicate that tooth brushing alone reduces caries incidence; there have been reported studies to indicate that tooth brushing with fluoride is effective. Studies show that there is only questionable evidence that tooth brushing has any long-term effect on gingival status, although it is known that plaque control can be effective in controlling some forms of periodontitis in adults. (Harris 1987)

In school tooth brushing programs, it is necessary to separate the teaching of plaque control as a technique from the daily use of plaque control measures to maintain oral health status. Most teachers are willing to accept the former responsibility because of the perceived importance of tooth brushing; however, many are reluctant to accept a long-term daily commitment to oral health procedures that will infringe upon essential teaching time. The daily brushing of teeth in the school may be an ideal objective. (Harris 1987)

In teaching tooth brushing in the school, six to eight children can be taught as a group. Each is given a cup, a napkin, and a kit containing a disclosing tablet, a toothbrush, and a tube of fluoride dentifrice. The children are asked to demonstrate how to remove some imaginary (and some not so imaginary) dirt from between the cuticle and the thumb nail. Most children will place the brush at a 45 angle and use short vibratory strokes similar to those used in the mouth in performing the Bass technique. The mastery of the 45 angulation and the short vibratory strokes can then be repeated on an oversize dentoform model. Emphasis should be placed on the need to follow a definite brushing sequence to ensure that all tooth surfaces are brushed.

Next the children are asked to chew a disclosing tablet and to swish it around the mouth for 30 seconds. The excess saliva is expectorated into the cup. The children's teeth are viewed, with appropriate emphasise on the fact that the red stain colours the plaque in which the bacteria lives. Next, a magnifying mirror is passed around so the participants can note that their teeth are no different from those of their neighbours - that all people have plaque. Guided brushing can then begin, with the instruction establishing the sequence of teeth to be brushed. At the end, the mirror is again passed around to show that progress has been made. During the entire process, appropriate corrections and reinforcement of brushing techniques should be emphasised. (Harris 1987)

3.5 SCHOOL-BASED FLUORIDE PROGRAM

The use of fluoride is recognised as the most effective means available for the prevention of dental caries in community-based program. Current knowledge indicates that the benefits of fluoride are produced by one or more of the following mechanisms:

- fluoride incorporated into enamel during tooth development produces an enamel crystalline structure more resistant to acid action;
- fluoride, by its presence in the oral environment, reduces the metabolism of sugars by bacteria, thus in turn reducing acid production and plaque growth;
- fluoride, by its presence in enamel and plaque, encourages the "repair" of the early caries lesion by reprecipitation of enamel crystals-the process commonly known as "remineralisation".

Methods of fluoride application and other preventive methods are summarised in Table 23.

Generally these methods are topically or systemically beneficial.

Table 23

Methods for the prevention of dental caries.

Source: WHO Global Oral Health Data Bank (1984)

Preventive method	Concentration or amount of fluoride	Reported reduction in dental caries* and gingivitis (%)	Frequency and duration of application
Fluorides			
<i>Systemic and topical benefits</i>			
Community water fluoridation	0.7–1.2 mg/litre	50–65	Lifetime consumption
School water fluoridation	4.5 times optimum for community water fluoridation	40	Through school years
<i>Dietary fluoride supplements:</i>			
Drops or tablets (home)	Depends on age of child and fluoride concentration of water	50–80	Birth to at least 14 years
Tablets (school)		25–40	Through school years
Fluoridated salt	250 mg/kg	60	Lifetime
<i>Topical benefits only</i>			
Professionally applied topical fluoride	20 g/kg sodium fluoride, 80 g/kg stannous fluoride, Acidulated phosphate fluoride (12 g/kg F); fluoride varnishes	30–40	Once or twice a year, depending on individual's rate of tooth decay
<i>Self-applied fluoride:</i>			
Mouth rinses (home, school)	0.5 g/l sodium fluoride daily 2 g/l sodium fluoride weekly or fortnightly	20–50	At least through school years
Fluoride dentifrices (toothpastes)	1–2.5 g/kg	20–30	Lifetime
Sealants			
Applied to occlusal surfaces	—	40–99 (occlusal surfaces only)	Prevents pit and fissure decay after permanent teeth erupt (ages 6–7, 12–13 years); replace as needed
Control of sugar-containing foods and drinks			
Control of sugary foods at school; reduction in frequency of intake; reduction of national consumption	—	Proportional to reduced frequency of intake	Lifetime
Oral hygiene measures			
Closely supervised (school)	—		
Brushing		Equivocal	Lifetime
Flossing		Equivocal	Lifetime
Unsupervised (school + home)	—		
Brushing		Equivocal	Lifetime
Flossing		Equivocal	Lifetime

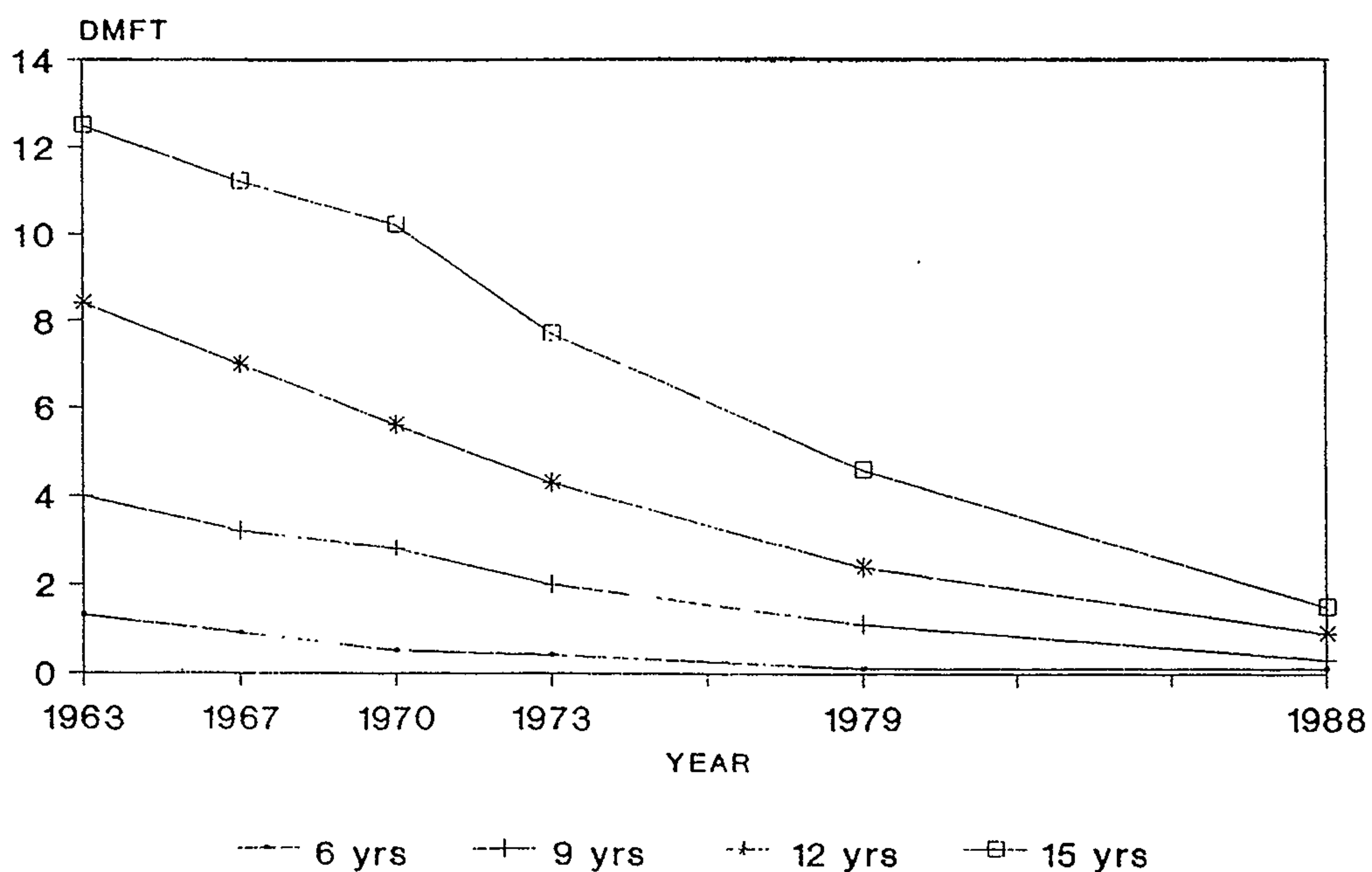
Source: WHO global oral health data bank
* Percentage caries reductions reported from short-term (2–3 years) clinical trials may underestimate the effect of lifetime use of a fluoride procedure. However, it should also be appreciated that if a fluoride procedure is terminated, for example when children leave a school-based programme, its effect may be short-lived.

From a dental health viewpoint, 1ppm of fluoride in the water supply will reduce dental decay by a factor of 60 per cent. In the Tamworth dental survey in Australia (Barnard & Sivaneswaran 1990), a 65-70 per cent decrease in the dental caries DMFT index was observed in all school children between 1963 and 1988. Decrease for some age groups is shown in Figure 22.

Figure 22

Decrease in dental caries - DMFT, Tamworth dental survey 1963-1988.

Source: Barnard & Sivaneswaran (1990)



SCHOOL CHILDREN aged 6,9,12,15 yrs

Daily ingestion of dietary fluoride supplements from shortly after birth until at least age 13 can provide protection against dental caries of approximately the same magnitude as derived from the consumption of fluoridated water, that is about a 50-60 per cent lower prevalence of dental caries. (Thylstrup et al. 1979)

School fluoridation plants and fluoride tablet, mouth wash or use of fluoride drops programs will need to be broadened. Such programs will demand cooperation of pediatricians, school officials, parents and profession. (Harris 1987)

One alternative to the fluoridation of community water supplies, in areas where such supplies are lacking, is to fluoridate the drinking-water of schools. This water is fluoridated at a higher concentration than is a community supply because children consume only a proportion of their total drinking-water at school (Harris, Simonsen 1987). At fluoride concentrations of 4.5 times the optimum recommended for community fluoridation, school fluoridation has produced significant caries reduction without dental fluorosis. (Horowitz 1973)

3.5.1 Fluoride Mouth Rinsing and Fluoride Tablets

Two other feasible and highly effective fluoride programs can be performed in the classroom by school teachers, after adequate instruction and with continued support by the school nurse, oral health worker, or any other member of dental team. These two programs are the (1) *Fluoride MOUTHRINSE program* and (2) *Fluoride TABLET program*. A once-a-week mouthrinse can be expected to result in an approximate 20 to 40 per cent reduction in dental caries. In most studies, children have rinsed either daily with 0.05 per cent sodium fluoride or weekly with 0.2 per cent sodium fluoride. The major reduction in caries occurs on the interproximal surfaces, reaching 86 per cent in one study.

The fluoride rinse dispenser, cups, napkins, and plastic disposal bags used in the program are available in a commercial kit for less than 1 dollar per child for a 32-week year (Stone 1984). The dispenser consists of a plastic container with a plastic pump, graduated so that a 2.0 gm package of sodium fluoride powder can be placed in the jug, and water added to the 1000 ml mark. A recommendation has been made that the sodium fluoride be purchased in tear proof packages, and that the rinse be non sweetened and non flavoured to discourage swallowing. Rinsing programs are advised for grades 1 to 12, but not below. Many younger children cannot master the technique of swishing without swallowing. If desired, the use of plain water rinse would provide a good educational experience for kindergarten children. (Harris 1987)

Four students are selected from the classroom-one to be the "pump pusher," another the "cup-passer-outer," and another the "host/hostess" who distributes the napkins. The last child is the "trash person." After all children have received a cup and napkins, they file past the pump pusher, who dispenses 5 ml of rinse into the cup. When all the children have returned to their seats, they are told to rinse the solution around the mouth for 1 minute, after which they are to spit carefully into the cup. The rinsing starts when the second hand of the clock gets to a pre announced number. During the swishing period, the teacher must keep up an active chatter - "this girl is doing better than the others there is a good swisher" - in order to maintain class attention. After 50 seconds, the children are advised that in 10 seconds they are to carefully spit the contents of their mouth into the cup. The napkin is used to wipe the mouth, after which it is forced into the bottom of the cup to absorb all fluid. The trash person then collects the cups. After the first introductory session approximately 5 minutes are needed to complete a classroom mouthrinse.

A weekly program of mouth rinsing with 0.2 per cent sodium fluoride is recommended as the preferred school-based procedure. Daily rinsing with 0.05 per cent sodium fluoride is recommended for individual self-care as a procedure which fits in better with an individual's daily routine. (Burt et al. 1984)

Fluoride mouth rinsing programs received official recognition of safety from the Food and Drug Administration in 1974 and by the Council on Dental Therapeutics of the American Dental Association in 1975. In other places free mouthrinse programs are funded by the State Dental Service Corporations. The estimates for children enrolled in fluoride mouthrinse programs in the United States vary from 8 to 10 million. (Harris 1987)

The post-treatment caries protective benefit of fluoride rinsing is directly related to the duration of past participation in the program. Following termination of a rinse program, the children appear to have both a lower prevalence and a lower incidence of caries. (Harris 1987)

Some advantages of weekly mouth rinsing with fluoride as a school-based caries preventive program are:

1. established effectiveness (consistently positive findings);
2. little time is required (about 5 minutes per week for weekly mouth rinsing);
3. the technique is easy for school-age children to learn;
4. it is inexpensive - all needed materials (in the USA) currently cost about 80 cents US per child per year;
5. non-dental personnel with minimal training are able to supervise the procedure;
6. participants generally accept the procedure well.

(Horowitz 1980)

A few studies (Radike et al. 1973, Driscoll et al. 1981) show that mouth rinsing with fluoride is also effective in children who reside in fluoride communities. Because the procedure is so inexpensive, fluoride mouthrinse is also cost-effective in these communities.

The fluoride tablet program is easier to accomplish. One tablet is given to each student. The students then chew, swish the 2.2 mg sodium fluoride (1 mg fluoride) around the mouth for a minute and then swallow. The swish-and-swallow technique provides benefits a topical application-as with the mouthrinse; it also provides the optimum systemic benefits of fluoride ingestion that occur during the period of tooth development. The daily tablet is more effective than the weekly rinse.

Several studies have shown that dental caries can be reduced by approximately 30-35 per cent when children ingest fluoride tablets under supervision in a school-based program.

(Driscoll 1974, Binder et al. 1978)

Fluoride tablets confer systemic benefits to unerupted developing teeth as well as topical benefits to erupted teeth. Because fluoride tablets are ingested, they should be used only in area where fluoride in drinking water is deficient.

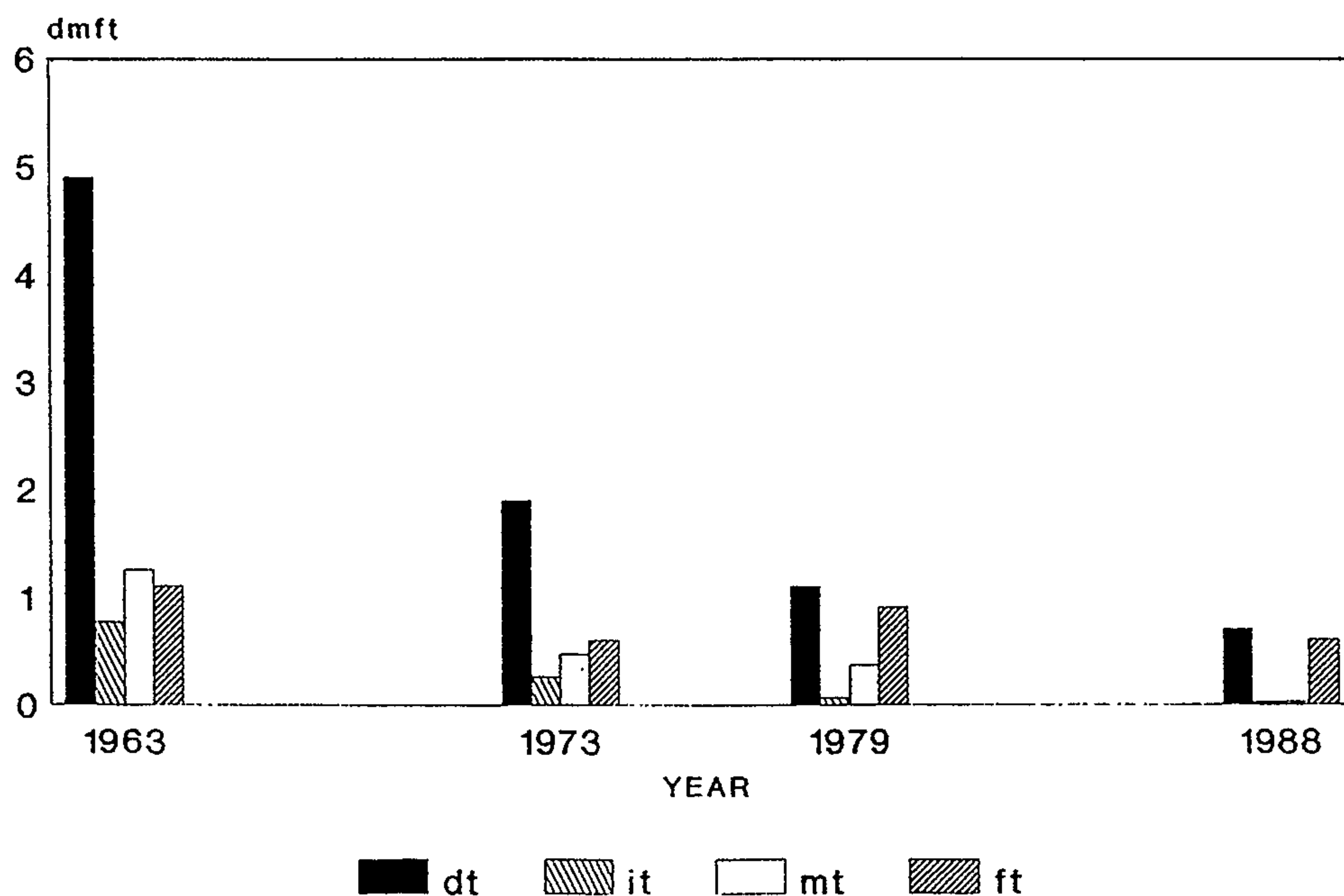
Studies have shown that few parents and children follow the consistent daily regimen necessary for maximal caries prevention with dietary fluoride supplements (Newbrun 1980). Therefore, supplying fluoride tablets for children's use at home is not as good a public health method as community water fluoridation, though private practitioners may prescribe their home use for selected, motivated patients.

The finding showed a differential effectiveness according to time of tooth eruption; earlier erupting teeth (incisors and molars) that were already in place when the children began to attend school had 31 per cent fewer DMF surfaces, whereas surface of later erupting teeth (canines, pre-molars and molars) that received both topical and systemic exposure to the fluoridated water in school developed 57 per cent fewer DMF surfaces. The rate of extractions per 100 teeth decreased by 65 per cent during the 12 year period of the study. The result of the Tamworth study in Australia (Barnard 1989) showed (Figure 23) that during the period of study decrease in the DMFS was greater than for DMFT.

Figure 23

Decrease in dental caries - DMFS, Tamworth dental survey 1963-1988.

Source: Barnard & Sivanewaran (1990)



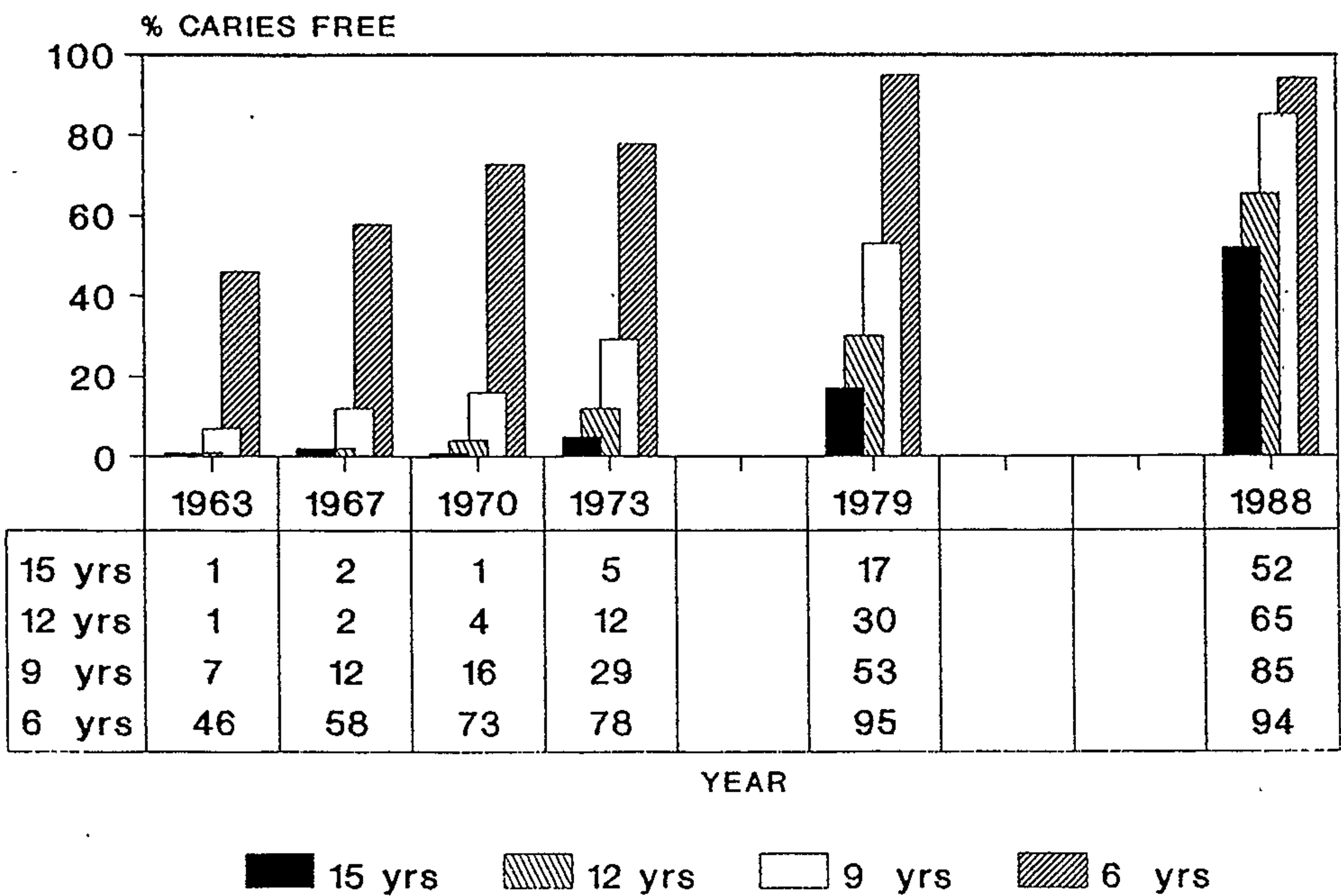
SCHOOL CHILDREN aged 6 yrs

However, studies show that mouth-rinsing with fluoride solution in fluoridated communities or combination of mouth rinsing, fluoride supplements and use of a fluoride dentifrice in areas with negligible fluoride concentration in drinking water (Horowitz et al. 1980) provide highly effective, economical protection to children teeth.

Without doubt, the use of dental fluoride therapy contributes significantly to the control of dental caries; however, one cannot expect to control dental caries completely through the use of fluorides alone. Further, since no single fluoride treatment procedure provides the maximal degree of caries protection that is possible with fluoride, the use of multiple fluoride therapy is advocated. In particular the dentist should identify the needs of school students age group and institute a multiple fluoride treatment program defined specifically to fulfil those needs. (Stookey 1978)

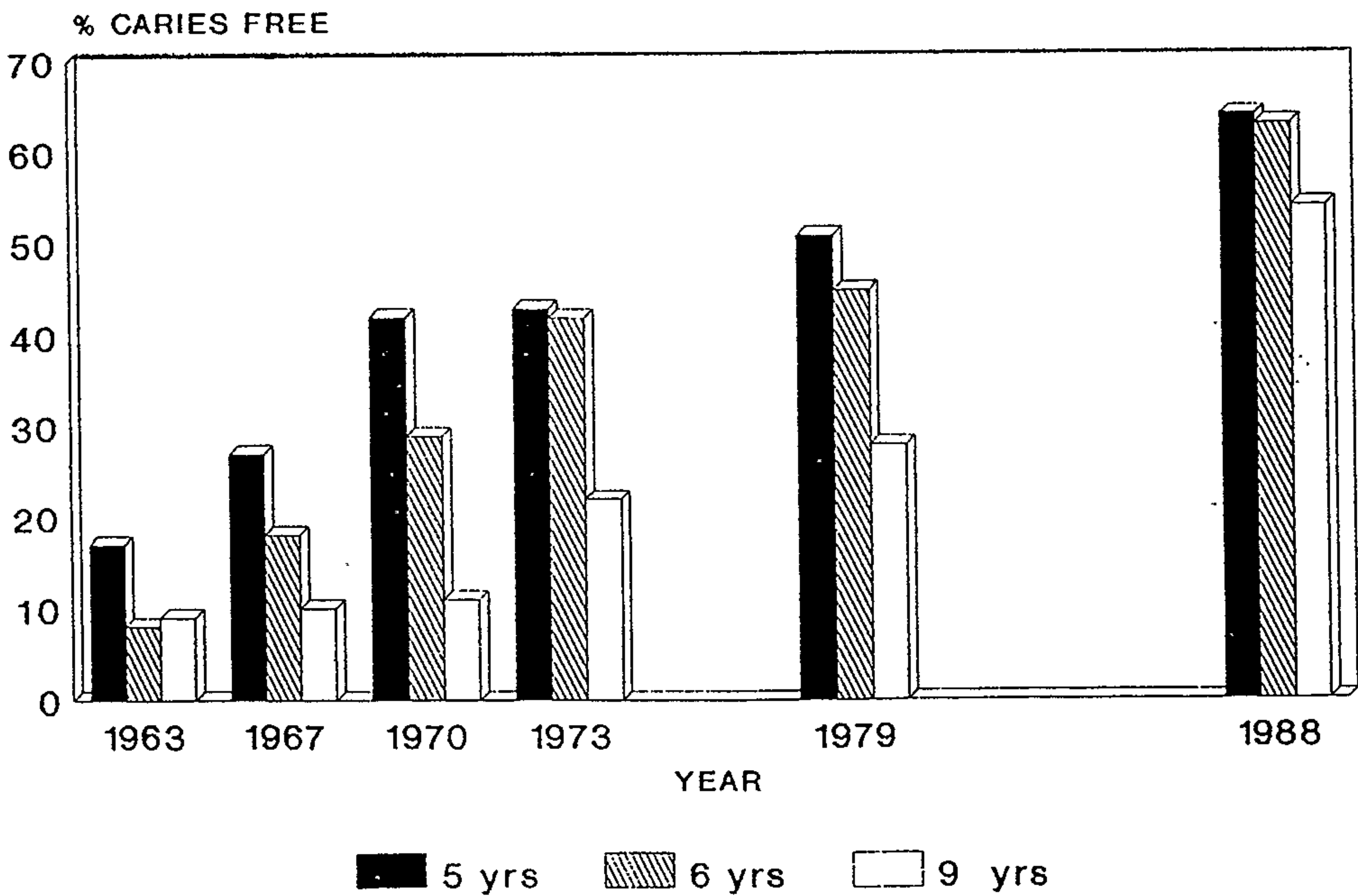
The principal indicator for oral health is the proportion of caries-free children (Tala 1987). The Tamworth survey (Barnard, Sivanewaran 1989) shows **(Figures 24 & 25)** tremendous increase in caries free rates during the period of study.

Figure 24
Increase in caries free - DMFT=0, Tamworth dental survey 1963-1988.
Source: Barnard & Sivaneswaran (1990)



SCHOOL CHILDREN aged 6,9,12,15 yrs

Figure 25
Increase in caries free - dmft=0, Tamworth dental survey 1963-1988.
Source: Barnard & Sivaneswaran (1990)



SCHOOL CHILDREN aged 5,6,9 yrs

3.6 CONTROL OF CARIOGENIC DIETS

Sugars and other refined carbohydrates, especially sucrose are considered to be one of the most important etiologic factor in dental caries. Dietary sugars are either natural or added to foods by manufacturers, or the consumer. The natural sugar (which could be found in milk and fresh fruits) is considered relatively non-cariogenic.

- Cooked staple starchy foods, such as rice, potato and bread are of low cariogenicity.
- Honey is less cariogenic than refined sugar, because of ESTERS which reduce dissolution of enamel.
- Raw sugar contains CATIONS (Ca,Fe,Cu) which reduces enamel solubility in buffer solutions.
- Cocoa may have a caries protective effect (ie. effect of cocoa + milk).

3.6.1 Factors Increasing Cariogenicity of Food

1. Total sugar consumption
2. Frequency of sugar intake
3. The degree of food clearance
4. Physical property of sweets

According to the main conclusions of the Vipeholm study:

- a) Consumption of sugar, even at high level, is associated with only a small increase in caries increment if the sugar is taken up to four times a day at meal and non between meals.
- b) Consumption of sugar both between meals and at meals is associated with a marked increase in caries increment. (Rugg-Gunn 1989)

Three alternatives can be chosen to modify high-sugar diet to less cariogenic ones:

1. To reduce sugar from food (or selected foods)
2. To substitute non-cariogenic sweeteners for sucrose/glucose in foods.
3. To modify sugar-containing foods so that they are less cariogenic.

In many countries, legislation and regulation to control production, importation, labelling, advertising, and marketing of certain foods tend to restrict the availability of sugary foods and help consumers to exercise informed choice. In addition, appropriate low-sugar food or sugar substitutes could limit consumption of sugar and alter the availability of sugar in products frequently used as snacks. (Rugg-Gunn 1989)

3.7 USE OF FISSURE SEALANTS

The pits and fissures of occlusal surfaces are the tooth sites where caries most commonly begins (Graves, Burt 1975); they are also the sites which benefit least from fluoride.

Fissure sealants are materials which are designed to prevent pit and fissure caries. Fissure sealing is a very conservative way of tackling the problem of occlusal caries, and involves a minimum of pre-operative treatment, usually no more than polishing the teeth in order to remove plaque and food debris. There is now considerable evidence that fissure sealants substantially reduce the incidence of occlusal caries; the majority of trial results 2 years after application demonstrate reductions in occlusal caries greater than 70 per cent. (Ripa 1980)

Fifty per cent or more of the occlusal surfaces seen in a dental practice can be expected to become carious. The teeth that will become carious cannot be predicted; however, if the surface is sealed with a pit and fissure sealant, there will be no caries as long as the sealant remains in place. Recent studies indicate an approximate 90 per cent-and-over retention rate of sealants 1 year after placement. Even when sealants are eventually lost, most studies indicate that the caries incidence for teeth that have lost sealants is less than that of control surfaces that had never been sealed. Research data also indicate that many incipient and small overt lesions are arrested when sealed. Not one single available report has shown that caries developed in pits or fissures when under an intact seal. Sealants are easy to apply but their application is an extremely sensitive technique. The surfaces that are to receive the sealant *MUST BE COMPLETELY ISOLATED FROM THE SALIVA DURING THE ENTIRE PROCEDURE, WHILE ETCHING, FLUSHING, AND DRYING PROCEDURES MUST BE TIMED IN ORDER TO INSURE ADEQUATE PREPARATION OF THE SURFACE FOR THE SEALANT*. Sealants are competitive with amalgam restorations for longevity and do not require the cutting of tooth structure. Sealants do not cost as much to place as do amalgams. The use of sealants has been endorsed by the ADA and the U.S. Public Health Service. It is required that the dental schools teach sealant usage, so that the hygienist and other auxiliary personnel could be permitted to apply them. (Harris, Simonson 1987)

The placement of pit and fissure sealants is ideally suited for school programs. The prophylaxis programs may be used for the placement of plastic sealants. Only a minimum of additional supplies is required. The placement procedure for the sealants is rapid and painless; once placed they are highly effective in protecting the occlusal pits and fissures. Sealant placement, when coupled with a follow-up application of fluoride (in addition to the classroom fluoride mouthrinse or fluoride tablet program), helps provide continuous protection of the WHOLE tooth. (Harris 1987)

3.8 PREVENTIVE PROGRAMS

The first six years of life are most important for the development and maintenance of the health of our children's teeth. During this period the first and most of the second dentition are formed or in the process of forming prior to eruption into the mouth. Loss of even a single tooth has a harmful effect on the development of the secondary dentition, their function and appearance. If necessary preventive measures are followed, children's teeth will have a good chance of lasting for the rest of their life. (Storey 1983)

The most efficient way to prevent caries and periodontal disease is to control them in childhood and in young adult life. It is especially important to take advantage of the school setting for it is possible to reach all schoolchildren with well-planned preventive measures.

The location of a dental clinic may be fixed or mobile, whether inside the school or in a nearby area. Students with calculus are seen in increasing numbers as they progress toward senior high school. Periodontal disease has its beginning in these early school years; it does not suddenly emerge as the leading cause for extraction around the 35th year of life. The periodic removal of calculus during the school years can delay the onset of the irreversible stage of gingival damage, hopefully for a sufficiently long time to allow the teenager to learn to accomplish plaque control procedures efficiently. (Harris 1987)

Dentists, whether they be in private practice or in government service, have a responsibility to provide dental care services to their patients and to uphold their professional aim of improving the oral health of the total community. To be successful it must be a team effort, the dentist cannot do it alone - it requires community recognition at the Ministerial level of the need to ensure optimal oral health.

3.8.1 Early Identification and Treatment

Some studies report that in children of 2 years of age some teeth are so completely destroyed that only tooth remnants remained. It should be noted that at this age 60 per cent of the total caries experience is found in the anterior teeth.

In many countries the school dental nurse is responsible for the early recognition, screening and much of the treatment of dental disease. (Croxon 1984)

From the data of his examinations on dental condition of children, Konradi concluded as long ago as in 1905 that dental treatment of children must be started at the age of 3 years. It should be emphasised that regular examinations, and treatment when necessary, should be initiated between 3 and 4 years of age. There are some periods of human life which are considered of particular importance to the dentition such as the age of 6 and 24 months for eruption in the deciduous dentition and the 6th year for the permanent dentition. Hidasi (1962), concluded that the fourth year of life is of special importance and may be regarded as a critical year in the caries attack rate of the deciduous dentition, and prophylactic measures should be instituted early enough to mitigate the damage in this critical year. (Toth 1970)

The first fillings are recorded in 4-year-old children. Thus, at an age when eruption of the deciduous dentition is completed insertion of fillings can be started. (Toth 1970)

The effectiveness of preventive measures can be judged by the postponement of the crisis in this 4th year or by its absence. The later this critical age of deciduous dentition appears, the more effective is the measure of prevention. The study of caries in deciduous teeth and its prevention offers quicker results because the total life span of the primary dentition is only about 10 years, while the permanent teeth last for several decades. Thus the critical year has a certain importance from the epidemiological point of view. (Toth 1970)

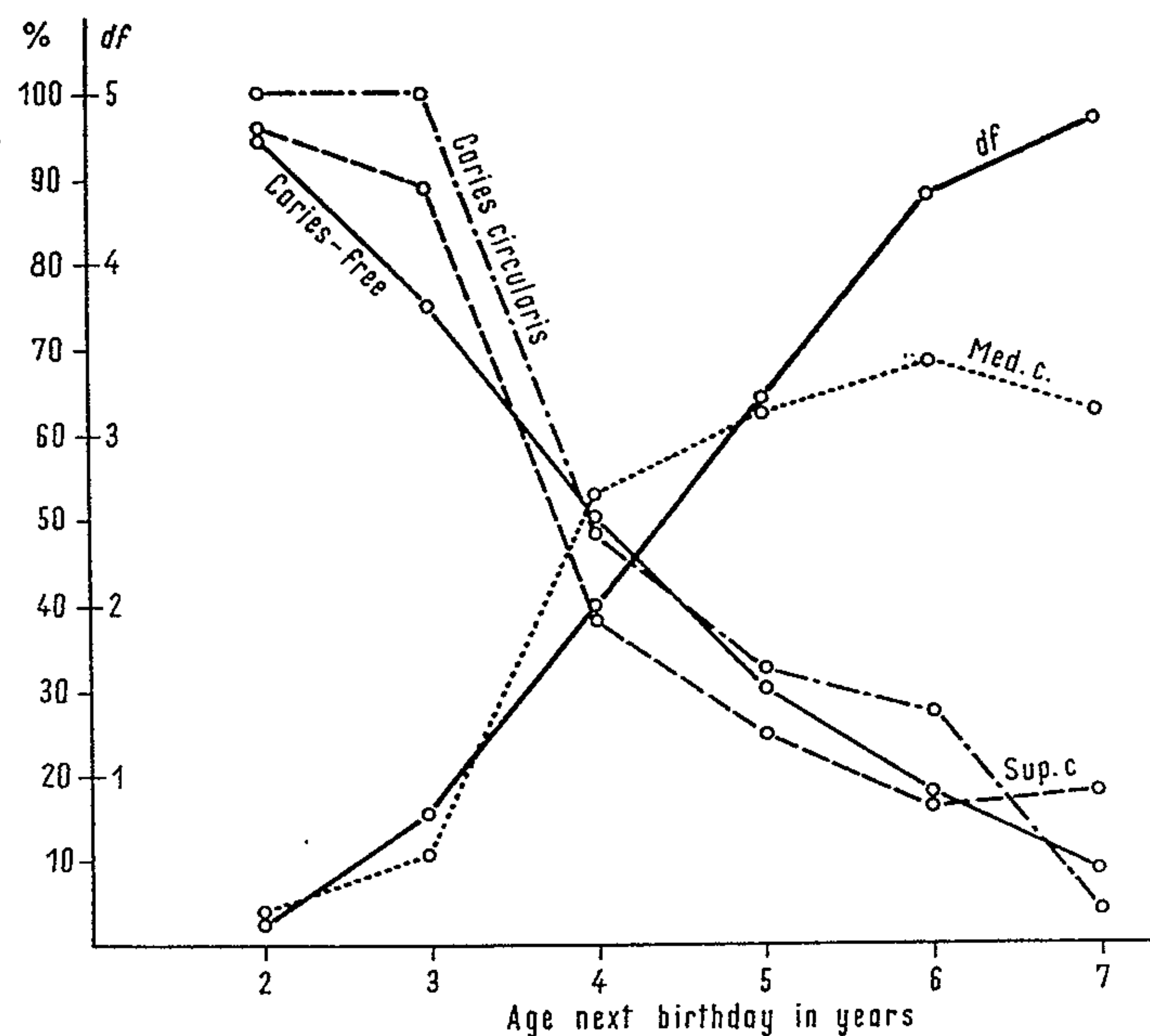
The fourth year of life appears to be of importance. What is so particular about this age?

Figure 26 gives an answer to this question.

Figure 26

The importance of the "critical" year.

Source: Toth (1970)



With the progress of caries in the deciduous dentition there is a steady increase in the defect count, also in the number of medium and deep carious lesions and of affected roots. At the same time there is a decrease in the number of superficial carious defects. The curves of the graph (Figure 26) intercept at 4 years which means that at that age children with carious primary teeth become more numerous than children with caries-free dentition and the superficial carious lesions give way to medium and deep carious cavities. Hidasi (1962) concluded that the fourth year of life is of particular importance in relation to dental caries in primary teeth. The steep rise in the curve representing absolute and relative caries experience of teeth which are highly susceptible to caries shows a decline at the fourth year. Thus, the fourth year of life is of special importance and may be regarded as a critical year in the caries attack rate of the deciduous dentition. At this age therefore

regular dental treatment should be initiated and prophylactic measures should be instituted early enough to mitigate the damage in this critical year. The effectiveness of preventive measures can be judged by the postponement of the crisis in this fourth year or by its absence.

Ideally the students should be screened at least once every school year for the presence of caries, periodontal problems, calculus, or other visible oral pathology. Additional opportunities for identifying pathology would occur each time the dental hygienist performed a prophylaxis or placed a pit and fissure sealant. Once pathology is seen, or suspected, there is a need to establish an expeditious means to secure treatment. There are three measures by which this can be accomplished. (Harris 1987)

First, the school nurse or hygienist can send home a note indicating the need for treatment and suggest that the child be taken to the dentist. A second option for referral involves contracting with local practitioners to offer specific procedures for predetermined fees. In this case the referral can be a direct transaction between the school and the dentist(s). A third option is for the school system to employ a school dentist directly. In this case, the dentist could provide services, either through a fixed clinic or in a mobile clinic that visits several schools. The same dentist could plan priorities, and supervise the activities of the other members of dental team and act as a resource person for the school system. (Harris 1987)

Caries is theoretically preventable by regular and careful oral hygiene procedures to remove that plaque. Studies show success with prophylactic technique applied at 2-weeks intervals to young children by trained dental auxiliaries. In older children, the interval between cleaning was extended to 8 weeks after an initial 2 years at 2-weeks intervals. Reported reduction in caries were remarkably high, up to 98 per cent and attributed to plaque removal rather than to fluoride effects. (Axelsson, Lindhe 1974)

Periodontal problems are generally considered to affect mainly the adult and elderly sections of the population. Hence, most of the CPITN-data collected so far deal with subjects who are at least in their late teens or older. On the other hand, the gingivitis which in a part of the population develops into irreversible loss of tooth attachment, usually starts in the mixed dentition (Ainamo et al. 1984). Thus dental practitioners must be the first to recognise periodontal disease and then must persuade the patient to take personal action and to seek professional assistance (Croxon 1984). Improvements could best be achieved by means of primary preventive measures starting early at 7 years of age. (Ainamo, Ainamo 1981)

The most efficient way to prevent caries and periodontal disease is to control them in childhood and in young adult life. It is especially important to take advantage of the school setting for it is possible to reach all schoolchildren with well-planned preventive measures. At the same time, most children have only a mild form of disease that can be treated easily. If a systematic program of preventive measures for schoolchildren, including regular check-ups, is carried out, it is to be expected that after some years the oral health of the entire population would be much improved.

To improve the present situation in Iran the following measures should be taken:

1. The use of preventive and therapeutic measures to combat periodontal disease, particularly in children and young adults, should be intensified.
2. A dental plaque control program should be carried out as widely as possible.
3. Efforts should be concentrated on the diagnosis and treatment of early periodontal disease.
4. A good recall system, especially for children and young adults should be organised.
5. The dental service network and the organisation of continuing education for all dental staff should be improved.

(Djukanoric 1986)

3.8.2 Professional Topical Application of Fluoride

There are many studies to show that professionally applied topical applications of solutions of 2.0 per cent sodium fluoride (NaF), 8.0 per cent stannous fluoride (SnF₂) and acidulated phosphate fluoride (APF, 1.2 per cent fluoride ion in 0.1 M phosphoric acid either in a solution or gel) can reduce the incidence of dental caries. Children in areas with insufficient fluoride in their water supplies have been shown to develop 30-40 per cent less decay when these agents are applied semi-annually. (Horowitz, Heifetz 1975)

Application of APF or SnF₂ solutions are recommended at least annually for public health programs, though better results have been achieved with 6-month applications (Horowitz 1973). APF is frequently preferred because it does not discolour decalcified enamel, has an acceptable taste and is stable when kept in a plastic container. APF in gel form also has the advantage that application time can be reduced by making whole-mouth applications with flexible pre-formed trays. (Ripa 1981)

Professionally applied topical fluorides in public health program in fluoridated area, however, usually are not considered justified on cost-effectiveness grounds. Even in non fluoridated areas, professionally applied topical applications are an expensive way to provide the dental benefit of fluoride in public program when compared to water fluoridation or self-administration by mouth rinsing (Corpron 1979). Professionally applied topical fluorides may, however, be more appropriate for special groups such as the mentally handicapped.

Any school-based primary preventive dentistry program, other than classroom education, should be selective in order to target the children most at risk.

3.8.3 Advantages of a Comprehensive School-Based Program

Public health programs present an almost infinite variety in size and content, from small local programs to great national ones. Certain basic activities are to be found in all these programs, but the method of approach and degree of specialisation will greatly vary with the size of the program, and detailed content will vary with the needs of the areas involved. (Dunning 1962)

Dunning (1978) has pointed out the advantages to a school-based program:

- (1) The children are available for preventive or treatment procedures,
- (2) school clinics are less threatening than private offices,
- (3) a school dental program facilitates central education on dental subjects,
- (4) the dental services supplements the nursing services by helping to provide total health care for school children.

In New Zealand, approximately 98 per cent of all school children are enrolled in the nationwide school dental program, while in Sweden the number approaches 100 per cent. A strong emphasis on preventive dentistry programs would reduce the learning time used in going and coming from a treatment facility as well as actual operative time. When the dental visit is an emergency, additional learning time is lost because of pain, apprehension, and recovery. (Harris 1987)

A school primary preventive dentistry program should be cost-effective in manpower, money, and material; and it should produce observable results. These guidelines can be met by considering three different levels of care. The first level program involves only participation by the *EXISTING* school staff and superimposes no additional time commitment than expected within the present school curriculum. In this program, the teacher would devote the regularly allocated time to teaching good nutritional practices and facts about the mouth. In addition, the teacher could supervise a weekly mouthrinse or daily fluoride tablet program. These two actions-teaching, which has long-range general health benefits, and the use of fluoride, which has immediate benefits-require only more effective utilisation of present teacher time and the support of the nurse in making fluoride

rinses, tablets, and supplies available on a schedule suitable to the teachers. A cost of 0.5 to 1.0 cents a day per child is needed for the additional supplies. Depending upon the program used, a 30 to 50 per cent reduction in caries incidence can be expected. Thus, even at this low level of preventive dentistry activity, major health benefits can be realised.

The dental hygienist is the key individual to the accomplishment of the next level of sophistication in a school-based primary preventive dentistry program. The placement of pit and fissure sealants could be instituted in the same facility without the need for extra additional equipment and at little extra cost for supplies. As a part of this second level, the hygienist can assume an active teaching role as well as acting as a resource individual for the school faculty. (Harris 1987)

The third and final level of preventive dentistry sophistication is the identification and referral of pathology. Ideally, the hygienist could accomplish an annual screening with referral of obvious oral pathology through a predetermined channel. Once the primary preventive dentistry procedures have reduced the incidence of oral disease to that of the annual workload treatment capability, the number of extractions should approach zero. (Harris 1987)

3.9 SYSTEMATIC DENTAL CARE

The following WHO (1980) systematic dental care options are recommended for Iran:

TYPE 1

- (a) First five primary school years: contingency care, conservative treatment on demand for the permanent dentition and emergency care (extractions) for the primary dentition.
- (b) Final primary school year: conservative care for the permanent dentition.

TYPE 2

- (a) First primary school years: conservative care for permanent dentition only and emergency care (extractions) for the primary dentition.
- (b) Second, third, fourth, and fifth primary school years: contingency care, conservative treatment on demand for permanent dentition and emergency care (extractions) for the primary dentition.
- (c) Final primary school year: conservative care for the permanent dentition.

TYPE 3

- (a) First primary school year: conservative care
- (b) Every year: conservative care

3.10 TARGET GROUPS

Groups of population	Recommended Preventive Measures
1. 6-12 years old	Oral health education Oral hygiene instruction Fluoride rinses, toothpaste Systematic dental care
2. Expectant mothers	Oral health education
3. 0-5 years old	Oral health education (also parents)
4. 13-18 years old	Oral health education and, Oral health training

3.11 MANPOWER

3.11.1 Manpower and Oral Health Services

It is only in the last decade that the existing traditional, curative-restorative-rehabilitative oral health delivery systems, staffed by highly-qualified personnel and served by sophisticated technology, have been seen as unsuccessful in halting the deterioration in oral health in developing countries. Such delivery systems fail to provide basic oral health care to the whole population. This has resulted from several factors, which include:

1. lack of experience in program analysis for appropriate program planning;
2. inadequate and inappropriate training of oral health care personnel;
3. shortage of aids relevant to preventive program;
4. lack of establishment of systematic oral health care measures;
5. inability to provide a comprehensive service even to those members of the population seeking treatment, and
6. use of inappropriate equipment.

These shortcomings of the existing system must be overcome in order to provide comprehensive oral health program with a prevention-oriented approach related to disease prevalence, manpower availability, economic resources and other relevant factors in the developing countries. The strategy for a primary health care delivery system will need to:

1. be developed as a national plan with measurable goals for oral health of schoolchildren;
2. be planned and implemented cost-effectively in the use of available resources;
3. be devoted to prevention and changes of behaviour to increase oral health of schoolchildren;
4. emphasise community involvement at the primary health care level;
5. provide services accessible and equitable to all members of the community target groups, especially in rural areas;
6. require less complex and more affordable methodology, technology and equipment;
7. lend itself to monitoring and systematic evaluation.

3.11.2 Manpower and Prevention of Oral Disease

Prevention techniques such as oral hygiene instruction, oral health education, topical fluoride application or supervision in a fluoride rinsing program, are ideally applied at the primary health care level. They can be carried out by non-dental personnel. These non-dental personnel could be those existing in the community such as teachers, village health volunteers, health workers, midwives, etc. Health workers and midwives in the primary health care centers and teachers should also be given training in oral health education, practical preventive measures and first aid for the relief of oral pain and infection.

In summary, the future functions and responsibilities of the oral health manpower team, as it may be expected to operate in national health systems, using the primary health care approach, will be:

Dentists

- to provide leadership in planning, developing, monitoring and evaluating program of prevention, control and treatment;
- to act as specialists in oral health rendering only complex care based on advanced diagnosis;
- to supervise the training and effective use of auxiliary personnel and other primary health care personnel.

Auxiliary personnel

- to provide routine preventive, curative and restorative services;
- to monitor primary oral health care activities;
- to supervise primary health care personnel;
- to refer those needing complex care to oral specialists.

Primary health care

- to advise on oral hygiene practices and oral health education;
- to provide preventive services and care based on simple technology;
- to examine and refer those needing routine and complex care to auxiliaries and specialists.

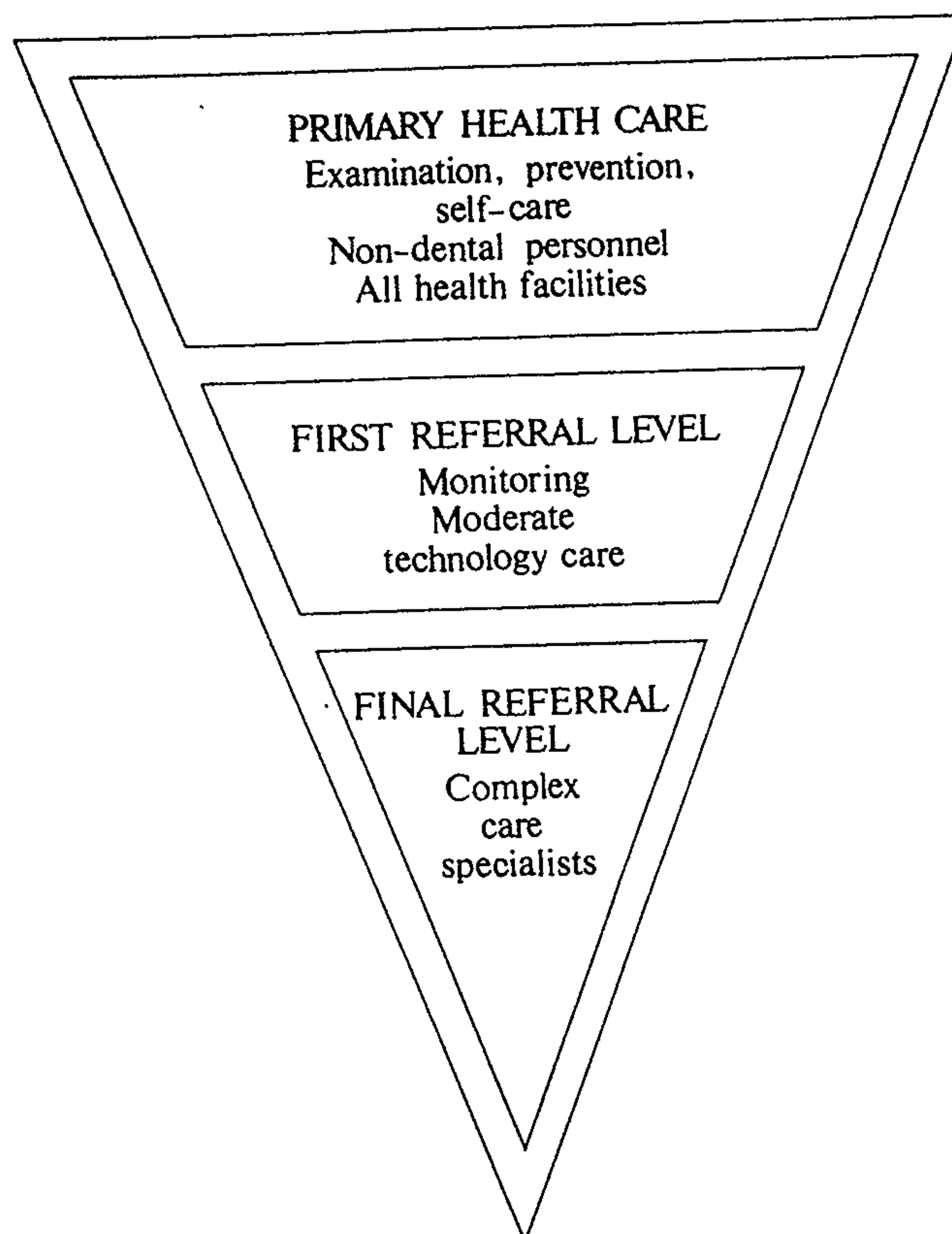
These levels of personnel would constitute the future oral health team appropriate to the universal three-level strategy for primary health care modelled by the Oral Health Unit, World Health Organisation as shown in **Figure 27**. This model requires a high degree of community involvement especially at the primary health care level and a change toward

multiple rather than single unit facilities at referral levels, emphasising management, quality control and system evaluation. This concept of a fully integrated health team would comprise a specialist in oral health at the final referral level, dental auxiliaries of varying type at the first referral level and non-dental personnel at the primary health care level (WHO 1983).

Figure 27

Oral health personnel model.

Source: Renson (1984)



In the process of estimating the quality of each type of manpower needed, the traditional method using the ratio of dentist or health personnel to population will no longer be relevant. Instead, the oral care needs of the population should be estimated and these needs related to the number of the various members of oral health team as well as to other health professionals and auxiliaries who will participate in primary health care.

There is a need to establish a long-term plan for the production, utilisation and distribution of personnel, including the reorientation of existing categories and the creation of categories of auxiliaries and voluntary workers to support primary health care.

Not only must the process of oral care personnel development be constantly monitored and evaluated, but appropriate scientific research should be undertaken. This research should test possible solutions in the developing model, to implement plans of action using the most suitable model and to translate these into training program suitable to the social, cultural and economic constraints.

The model has as its main emphasis community involvement at the primary health care level as well as the use of personnel trained in a performance simulation system. In addition, it is an attempt to systemised referral, quality control and overall monitoring of the system by using numerical language. Hopefully, this will enable epidemiological evaluation of community status and the quality and effectiveness of care provided. Eventually, an oral health status which eliminates the need for care in all members of the community will be the ultimate goal of the model.

3.11.3 Manpower Development in Iran

Three type of operating dental personnel are being trained in Iran: Dentist with 6 years course, Oral health workers with 3 years course and Dental Hygienist with 2 years course. At present the first two categories are doing extraction, simple fillings and pain relief on demand in governmental dental clinics. The Dental Hygienists are few in the government service and they assist the private dentist or performing oral prophylaxis.

In a review of the fifty years in which the School Health Services has existed in Iran it was most evident that there had been a great improvement in the general health of the children during this time. (Goose, Hartles 1964)

School systems can add a dental hygienist to their health care staff, to perform oral prophylaxis, sealant placement, screening, dental examinations, and treatment referral actions accomplished in a school environment, for the improvement of oral health of schoolchildren as experienced in many other countries.

Table 24 shows the main features of manpower development in Iran.

Table 24

Dental manpower development in Iran.

Source: Oral health office - Iran (1989)

Type of Personnel	Total number			Personnel/population ratio	
	1987	1989	2000	1989	2000
Dentist	2300	2905	7000	1:15,000	1:8,000
O.H.W.	540	600	1600		

Because of shortage of dental personnel, and their maldistribution (most of dentists are in the capital or other large cities), there are large number of unqualified practical "dentists" in the country. They mostly do extractions and removable dentures, at less expensive rates. The number of registered experienced "Dentist" increasing from about 2,000 in 1987 to about 3,000 in 1990. The dental operating personnel ratio of developed countries show at least one to 2300 (the most favourable ratio is 1:850 in Sweden). (FDI/WHO 1985)

Oral Health Workers (O.H.W.) can continue their education for 3 more years for a doctorate degree (DDM) after 5 years of work in a designated rural health centres.

3.11.4 The Future Role of Oral Health Personnel

To achieve the oral health program, oral health care personnel with skills appropriate to the extent, and severity of oral disease and the demands of the population are needed. The greatest challenge in the health field today is that of training and deploying the personnel required in a way that will make health care less costly yet fully capable of meeting the stated goals. The optimum solution in this sense is not one which includes a high proportion of health professionals, but rather that which uses manpower whose questions are more in accordance with the needs and demands of the services to be provided to the population, at a cost compatible with the resources of the country (Mejia, Fülöp 1978). It is expected that oral health workers will be the key personnel for primary prevention of oral disease in Iran.

In order to fulfil oral health service needs in developing countries, the current and future role of oral health personnel will have to be a public health and prevention oriented one, responsible for:

1. planning and evaluation,
2. services to meet needs and demands, and
3. prevention of oral diseases.

The responsibilities, the type of oral health personnel needed, and their specific skills, knowledge and attitudes has been elaborated earlier in this thesis.

3.12 ECONOMIC AND FINANCING FOR DENTAL CARE SERVICES

Important roles in promoting and maintaining health are played by the health-related sectors such as environmental, education, agriculture and housing. Participation in health for all is not just a question of democratic rights, it is an essential requirement for the effective and equitable planning and allocation of resources. (WHO 1988)

Commitment precedes action, and the collective commitment of all concerned is required in order to ensure the equitable distribution of resources for health. Given the magnitude of the task of attaining health for all, and particularly of securing adequate economic support, concerted and coordinated action at all levels is indispensable. Action taken within any one component affects the action to be taken within the others. Hence, the shared responsibility which rests upon the government, the individual, the community, other national agencies and international agencies consists of specifying not what is possible, but what is necessary; not what can be done, but what must be done. (WHO 1988)

In this section the responsibilities of different entities involved in health matters, the roles to be played by each in pursuing the goals of health for all, and the relationships between them are discussed. These include: the government health agencies and other relevant agencies; the private sector; the community; the non-governmental organisations; and the external agencies and cost of dental care and preventive programs. (WHO 1988)

3.12.1 Government Responsibility

Much of the action required to meet the goals of health for all falls within the responsibility of the government. While no universal blueprint can be applied to all governments, the essential characteristics of health systems stated in the Global Strategy for Health for All define the means of developing infrastructures for optimum health delivery based on primary health care. (WHO 1988)

Governments' responsibility for health originates in the realisation that individuals, voluntary organisations, and the private sector are unable to meet all health needs through their own efforts alone. Similarly, services that benefit the country as a whole should be provided without charges to individuals by the government. This would, for example, include mass immunisation (the successful smallpox eradication campaign is an excellent case in point), and the control of vector-borne diseases. (WHO 1988)

National profiles of health and disease indicate the vast inequalities in health status that exist in many countries. Most of the underprivileged in health terms are women and children whose well-being requires special attention within primary health care. Particularly in developing countries, these underprivileged elements of society are politically weak and are often too sick, uneducated, or geographically dispersed to become politically active. Thus, the responsibility for improving the prospects for these groups will fall upon the more privileged groups. Concern for the care, protection and promotion of the health of the vulnerable and underprivileged groups must be the task of governments, which have, after all, the responsibility for ensuring an equitable distribution of society's resources based on the principles of social justice. (WHO 1988)

Disadvantaged people not only suffer from poor health but receive poor health care. Conversely, wealthier people enjoy not only better health but better access to health-related facilities. Government money alone will not guarantee the achievement of health for all. Political commitment and support are also critical to health for all. Indicators of the degree of political commitment are, of course, qualitative in nature and comprise the following:

1. Official declaration of high-level commitment;
2. Allocation of adequate resources (the most important indicator);
3. The degree of equity in the distribution of financial resources;
4. The degree of community involvement; and
5. The establishment of appropriate organisational frameworks and managerial processes (including monitoring and evaluation) to move step by step towards health for all.

The importance of government intervention in the distribution and utilisation of health resources varies with the service to be provided.

Improving the health status of the population cannot simply be achieved by governments expanding or developing the health services. Prevention and control of disease and the promotion of health must be part of a combined effort for the improvement of well-being as a whole. Thus, health care must be supported by improvements in the overall social and economic structure and contributions from sectors other than health. The health sector has the important role of coordinating these inter-sectoral efforts, by defining major problems, by suggesting preventive strategies, by proposing shifts in priorities and resource allocations, by encouraging positive action in other sectors, and by participating in advisory committees responsible for these efforts (WHO 1988). The main motivation for government involvement in priority health care has been to ensure that no one is denied care on the basis of income or wealth.

The increasing pressure of recurrent costs on public budgets is forcing governments to review the mechanisms used to finance health care. Three areas of consideration are apparent. First, limitation of resources tends to diminish the quality of services provided. Next, financing through general tax revenues may cause a redistribution of economic resources from the unserved to those obtaining services. Third, those services that are available are not being distributed equitably. (WHO 1988)

One proposal for mobilising additional resources is to impose charges on non-emergency users of hospitals who have not been referred by a lower-level health facility. In addition to generating revenues, such user charges would also discourage the bypassing of primary care facilities. In effect, the charge would represent the additional cost of managing a health problem at a hospital rather than at a dispensary or health centre.

Redistribution of consumption in the health care system could also be rationalised by introducing a compulsory health insurance system to pay for health services. Such insurance systems would levy insurance contributions on those with regular jobs who generally have access to services, but would exclude those who do not.

3.12.2 Priority for Government-Supported Dental Care

The goal for large government-supported dental care programs has usually been comprehensive care for people of all ages on an incremental basis, just as it would be rendered in private practice. Financial and other limitations, however, have produced patterns of a more limited nature, from mere emergency service upwards.

Next in priority comes simple restorative care using amalgam and other plastic materials; this phase, involving immense blocks of chair time, is now offered generally only to children, partly because of the opportunity to prevent premature tooth loss and partly because children are easily reached through their school systems.

Incremental dental care, starts at the earliest available age: usually age six, when children enter the first grade of elementary school. The object is to bring all children up to date with needed dental care, so that only the increments of need occurring between visits will require care at the next periodic visit to the dentist. Periodic recall of all children, is usually on a yearly basis.

INCREMENTAL CARE: May be defined as periodic care so spaced that increments of dental disease are treated at the earliest time consistent with proper diagnosis and operating efficiency. In this way there is a minimal accumulation of dental needs. In private practice, six months is the most common interval; in public health programs, one year intervals are usually planned.

In public health planning, incremental care has usually been implemented at the earliest available age, when the child enters into some public health or public school program. This is commonly around age six.

This approach to incremental care, long popular in the United States, had its economic justification in reasoning that was well described in 1960 by the Commission on the Survey of Dentistry in the United States. The assumption of this Commission, as stated in its summary report, is that increments of dental disease occur so regularly in the child population that low annual maintenance costs per child for young children can be considered sufficient, without increase, up to the end of the high school period. (Field, Jong 1971)

In view of the fact that large numbers of Iranians have been receiving "virtually no" dental care, it is of interest to consider the demand priorities that exist when dental care is first made available in underdeveloped areas. Emergency care for relief of pain comes first of course. Much as it may seem advisable to neglect the accumulated needs of adults in order to provide incremental care to children, no program will receive broad support if it neglects acute conditions arising among patients of any age. Fortunately, relief of pain can usually be accomplished with a relatively small expenditure of time, either through tooth extraction or palliative measures. Dentists, of course, are best qualified to render these services, but in underdeveloped areas, where dentists are often unavailable, oral health workers may best do the job.

From the overall literature review the writer can suggest the following package for dental care for the National Program of near future in Iran:

EMERGENCY CARE. It is a basic human-service postulate that people in actual pain should receive care first. Emergency dental care does not take very much time if it is confined to the relief of immediate pain. It also creates instant gratitude and a "teachable moment," when the patient can most easily be motivated to seek more definitive and preventive dental care. Any dentist can provide emergency care to a group much larger than he could possibly handle on a comprehensive basis. Those with experience in large public programs realise how difficult it is to make age distinctions among people in pain. Emergency care should, therefore, be available to all-comers, with referral of the patient later to outside sources of care if comprehensive care is not available within the program.

The American Dental Association endorses emergency care FOR ALL, as part of any national health insurance program and Dunning (1976) believes it can be delivered.

The problem with emergency care, is the difficulty in defining it and in preventing abuse of the category. The ill-will evoked by a medical care program that includes relief of pain in other parts of the body without relief of dental pain is so great, however, that the writer is convinced that *emergency dental care MUST be included*. We must learn how to define it reasonably well, and must learn to live with a few unavoidable abuses.

PREVENTIVE SERVICES. The best preventive service in the dental field is community water fluoridation. This measure may be assisted by certain general provisions of a national health insurance act, but it will not be accomplished through systems for delivering health care to individuals. The use of dietary fluoride supplements, however, together with topical fluoride treatments, dental prophylaxis, toothbrush instruction, and the like, are widely applicable upon an individual basis.

Children should receive first priority in the development of preventive services, partly because of their increased caries-susceptibility, partly because they are more easily accessible, and partly because they are more teachable. Even among children, however, such items as topical fluoride treatments and dental prophylaxis require a relatively long period of professional attention in proportion to the demonstrable results.

School water fluoridation and topical fluoride therapy are recommended for inclusion in the National primary preventive oral health program in all those areas where the water fluoride content is not sufficient in IR Iran.

Topical fluoride therapy could probably be delegated to auxiliaries at minimum possible prices below the current level, where the dentist himself is expected to do much of the work. This procedure could be part of a good national program; and could be delivered to large child population groups.

COMPREHENSIVE CARE FOR CHILDREN. We should not forget that incremental care cannot be maintained on any very perfect basis, even among children. The comprehensive care for all is the ideal type of health care system if the necessary resources are available. If resources are limited, then comprehensive care for school age children would be the very best priority to start a National preventive program.

With the ideal use of auxiliaries, comprehensive dental care could be supplied to the entire schoolchildren of the country up to the age of 17 (at end of high school) to cover the teenage period of most rapid tooth decay, on a national health insurance basis.

Therefore, a national health insurance policy that includes at the outset a dental component that gives priority to preventive and therapeutic services for children and emergency dental care for all is recommended for Iran, therefore:

1. The provinces should mandate fluoridation.
2. Dental Health should be a part of the Comprehensive Health Planning program.
3. Dental auxiliaries should be trained to undertake certain duties now performed by dentists.
4. School health education programs should include dental health.
5. Dental services should be included in health insurance through the government.

Eligibility should adequately be determined, if not, abuses may occur, and thus divert considerable amounts of money to individuals who are not eligible for benefits. All these difficulties reduce the availability of health care to the deserving poor, making it difficult for people to enter the health care system. (Field, Jong 1971)

An example from Australia of eligibility for free dental treatment is as follows:

1. Holders of the following Department of Social Security cards are eligible for free dental treatment in New South Wales Deental Clinics:-
 - A. Health Benefit Card
 - B. Pensioner Health Benefit Card

C. Health Care Card

The card should be current. The patient is responsible for showing the card prior to acceptance for treatment. If the card can not be produced the patient should seek an interim voucher from the Department of Social Security to establish that they are eligible for treatment.

2. Holders of Medicare Cards (or their dependants) will be considered for emergency treatment - this should only cover trauma and facial swelling (infection). Toothache in the normal course of events is not considered an emergency and patients should see their own general dental practitioner or clinic.
3. In addition, children up to the age of 15 are eligible for free treatment. However, they should be encouraged to seek treatment at school clinics where possible.
4. Orthodontics will only be offered to children who are dependants of a health card holder (vide supra).

3.12.3 Dental Insurance System

It is a principle that, access to available health care is a "human right" and a responsibility of governments on a par with public education, although health care has been considered primarily the responsibility of the individual. (Field, Jong 1971)

Professor Rashi Fein, Economist at the Harvard Center for Community Health and Medical care concludes that national health insurance is indeed necessary. (Field, Jong 1971)

National health insurance, however, has been slower to reach the whole country than many other countries, and therefore an overall improvement is expected especially with regards to dental care through a preventive approach.

By definition health insurance is the set of arrangements in operation to eliminate or reduce the financial burden of illness experienced by individuals. Three parties are involved in any national health insurance program.

1. The consumer or the beneficiaries (employed or unemployed).
2. The financial agent (government or private agency).
3. The vendor (the dentist and all providers of health services who deal with patients directly).

Each country has developed and implemented a system for meeting the required/ relatively required expenses of member of their populations. Detail of these arrangements, however, vary widely from country to country. For example in the UK the government provides directly most health services to the entire resident population without charges. In USA the government pays subsidy of the costs borne by specific groups, notably the aged and the poor. Insurance on health is made available by private health funds and services are provided by private individuals and organisations. In other countries generally some form of health insurance is provided for their entire populations. In many cases this is administered and financed by a government agency; in other instances independent health funds (subjecting to government regulations).

Here the writer would like to review the health insurance systems in some other countries:

GERMANY (West): Has the oldest health insurance system in the world (1883). With compulsory coverage for all workers whose income falls below a certain level, for most pensioners and for many self employed persons. All dental services are provided but the fees are not charged as indicated in regular fee scale for some type of services like prosthetic and orthodontics. Government claims are reimbursed on a fee-for-service basis, with payment routed through the vendor's own professional organisation. Indemnities are paid by the government, and the rest of the bill is paid by the patient. Two thirds of the dentistry done in Germany is through social health insurance agencies.

SWEDEN: Health insurance has been compulsory and universal since 1955. It is administered by special government agency (RFV). 100 per cent of the population is covered and 40 per cent of the dentists in the country are employed by the state, they are paid according to governmentally-determined fee-for-service schedule. Dental care for children and pregnant womens is rendered free of charge, but all other dental care is paid for by the patient on a fee-for-service basis. The international standing of Sweden's health care quality is high.

UNITED KINGDOM: In 1948, the National Health Service (NHS) started operation. Children and expectant and nursing mothers receive free dental care. All other patients had to pay 30 shillings per visit (1968) to their dentists for each treatment, with the excess to be covered by the NHS insurance. Patients also paid 50 per cent of the cost of dentures. Fees have been adjusted in such a way that practitioners in NHS are paid by the hour upon completion of a certain quota of work. The majority of dentists have been shown to be strongly in favour of continuing under a system that seems to them to offer the best possible treatment for the greatest number of patients.

USA: Medicare and Medicaid, cover approximately 20 per cent of the population (1971). Medigap as a voluntary health insurance system would be federally financed, mainly for low-income groups and in part for all other persons. By modification of the program dental care was included later. Children between age of 2-6 are eligible for comprehensive dental care as well as emergency care for everyone under 65 years of age.

Comprehensive health insurance in the USA (1974) has 3 separate programs:

1. An employee health insurance plan to be paid for mostly by the employer.
2. An assisted health insurance plan covering low-income persons and other not covered by the employee plan; and
3. An expanded medicare plan covering persons age 65 and over.

Dental care was to extend up to age 13, free of deductible and coinsurance clauses.

The Health Security Act 1973: This system was suggested to cover all US residents under government control. Major government resources are allocated for dental and medical education. Nearly complete coverage of health services was specified, including dental services for children up to age 15, except for orthodontic treatments.

AUSTRALIA: Health insurance has been the focus of a great deal of political activity for at least the past 40 years. In 1953, the first government insurance scheme was introduced by Earle Page. This scheme was primarily a method whereby the Commonwealth Government (CG) subsidised private insurance by meeting part of the cost of the rebates for medical expenses. In 1969, an alternative health insurance program was introduced by the ALP government. This program was designed to cover the entire population and to be administered by CG authority. In 1975, Medibank was administered by a commonwealth authority named the Commonwealth Insurance Commission. It was funded entirely by commonwealth revenue and designed to cover all Australian residents. Dental services are provided by medibank, for example mouth examination, X ray, scaling and cleaning, fluoride application, amalgam filling, simple extraction, orthodontic treatment, denture, crown and bridge.

It is of prime importance that prevention takes a top priority in the provision of dental services through government and private practice. Direct government service in Australia employ dentists and therapists to provide dental services for priority groups in the community, including the armed services, pensioners, indigent, those in institutions, Aborigines, schoolchildren and persons in remote areas. (Barnard 1980)

There has been since 1975 a very marked and rapid changes in the availability of dental benefits schemes through Australian health and medical benefit organisations. A few funds had a long history of dental benefit schemes but it was not until the introduction of Medibank that the funds offered the possibility of budgeting (with some insurance) by premium payments against the cost of dental services. By October 1978 there were some 58 funds with an estimated 46 per cent of the Australian population able to claim rebates against the direct payments they had made to dentists in private practice. (Barnard 1980)

Higher appreciation of own dental health status, a desire to retain natural teeth, and a greater availability, accessibility and acceptability of the dental services, has lead to increase in dental service utilisation in Australia. Utilisation is related to sex (female), age (school age), education, income, occupation, socioeconomic area, and length of time residing in Australia. The utilisation of services by individuals has changed from attendance for emergency care for relief of pain to attendance for regular check-ups. In a number of surveys carried out by Barnard during the 1970s in Australia, about 50 per cent of persons attending have indicated that they were going for a check-up. In 1984, Medicare suggested and designed to cover all Australian residents by 1986, but no dental care services are provided. (Barnard 1980)

The best dental health package is the one which is covering:

1. Emergency care,
2. Preventive services; and
3. Comprehensive care for children. (Dunning 1977)

3.12.4 Individual and Family Responsibility

Primary health care originates with people and their health concerns. With this dominant role in health, people have to be actively involved rather than passively receiving care "from above". The rights and privileges of the people include the right to equal opportunity for health; the right to health care; the right to be informed; and the right to be involved.

As parents in the health for all strategy people should have an opportunity to share responsibilities and to contribute activity at individual, family, group, and community levels. They should develop the ability to define and express their needs, with the awareness of when and how to use health care to satisfy those needs. They have the right to use the opportunities that exist to obtain the required information, to analyse it and to draw their own conclusions. Once people are aware of health problems they should have access to the knowledge and information that allow them to make choices in health care. The right of people to be actively involved in health care ensures that satisfactory prerequisites for health exist for all people; that their environment is healthy; and that their health care system is responsive to their needs. (WHO 1988)

There is, of course, a continuing debate over the issue of self-help in both the political and professional fields, which could lead to a critical assessment of the quality and efficiency of the health care system in general. (WHO 1988)

3.12.5 Role of the Private Sector

The private sector constitutes an important component of the health system in many developed and developing countries. Profit-seeking organisations already manufacture and sell drugs, build and equip health care facilities, water treatment plants, etc. Thus the issue is not whether private and public health institutions ought to work together, since they already do; but, rather, how can governments shape relationships with private agencies in order to achieve social, and particularly, health for all goals promptly and more efficiently. (WHO 1988)

Private health professionals have an important role to play in all countries. Their expert knowledge and the influence they have in the health sector relative to politicians and the general public can be instrumental in mobilising support and initiating change for the health for all movement. Further, they can accord higher priority to health promotion, disease prevention, care and rehabilitation than is often the case at present. (WHO 1988)

Of course there are some training, regulatory, and information roles that only the public sector can perform in overseeing and guiding the activities of private providers. The public health sector needs to take the lead in training health workers, testing them for community, and licensing private facilities. The government must set standards and regulations to protect the people from unethical or untrained practitioners, especially where such supervision is not yet adequate through professional associations. Governments need to develop a legal framework for health insurance systems, and disseminate information to inform and educate the consumers. (WHO 1988)

Precise information is lacking in most developing countries about the extent of the private sector's involvement in health care. Even the term "private" is given different interpretations in different countries. Available data shows private sector finances over half of the health care services, especially in the urban areas. The role of the private sector and the methods for its full participation in national health for all strategies have not been defined in most developing countries. (WHO 1988)

3.12.6 Community Responsibility

It is generally agreed that community participation is an essential principle of the primary health care approach, and no declaration on the subject by a national government or an international organisation appears to overlook this requirement. (WHO 1988)

There is widespread agreement that communities can play an important role in the identification of health problems and in the search for appropriate and cost-effective solutions. Where public funds are insufficient to extend basic health services to those without access, communities may be called upon to share the burden through contributions in labour, materials, or money. (WHO 1988)

The political and administrative structure of some countries lends itself to local community involvement. Many countries, especially those with large rural populations, have long-standing traditions of community participation in all local development activities. The support of a variety of local mechanisms, often reinforcing traditional systems, has contributed to progress in local primary health care development. Conversely, low levels of education, differing customs or beliefs concerning the causes and nature of ill health, and long dependence on central government for all actions and resources breed passivity and forestall successful community involvement. (WHO 1988)

A clear division of responsibilities between the community and the health system, and effective mechanisms for mutual support and communication as well as administrative decentralisation, are of critical importance in mobilising full partnership for health promotion from the local communities.

3.12.7 Non-Governmental Organisations

Generally the aim of non-governmental organisations, in the context of health care, is to assist people in the lower-income segments of the population of countries in which they operate to organise and utilise better their own resources, both human and material, with special emphasis on the local community level. (WHO 1988)

While it is difficult to arrive at accurate estimates of the financial contributions by NGO's, health financing in 1982 by these agencies accounted for 18 per cent of all health contributions and equalled the total input by the United Nations health-related specialised agencies.

Many Non-Government Organisations deal with problems that are intersectoral in nature, growing out of such basic causes as poor education, poor health and nutrition, inadequate community infrastructure, high population growth rates, low productivity, insufficient income-earning opportunities, lack of effective community organisation, and attitudes, and frustrating problem-solving competence at the local level. Since their motives are generally not suspect, NGOs can deal with these problems with effective, timely, and flexible inputs of relevant resources. The growing awareness and wider acceptance of the role NGOs play in health care have resulted in a number of successful initiatives and projects which demonstrate the value of the partnership approach. (WHO 1988)

The Technical Discussions on the Role of Nongovernmental Organisations in the Strategy for Health for All (held in 1985) suggested many practical measures for enhancing partnerships between governments and nongovernmental organisations. Non-governmental organisations as operational partners can make a crucial contribution to the national health for all strategy and to international cooperation. (WHO 1988)

3.12.8 International Cooperation

Many external agencies provide support to health programs. These include bilateral agencies, multilateral agencies, including those of the United Nations system, international nongovernmental organisations and private foundations. In some of the developing countries, such support can be very significant. (WHO 1988)

Each agency works within its specific policy framework and operational procedures. These may not always be in concordance with each other and sometimes may even be in apparent conflict. When these efforts have not been well coordinated, recipient countries have been confronted by contradictory requirements and approaches. Sometimes, the national priorities are influenced by the level of external inputs intended for a specific health problem or program. (WHO 1988)

There is a need for effective coordination between external agencies and countries to develop realistic and effective national health strategies. Some countries have established coordinating mechanisms under one single agency, such as the planning agency, which serve to harmonise national health practice and external agency inputs and to coordinate international cooperation. Such mechanisms are needed in all countries. (WHO 1988)

3.12.9 Cost of Dental Care and Mechanisms of Payment

The total expenditure on dental care by Americans was \$10 billion in 1977 and \$13.6 billion by 1979. These figures represent about 6.5 per cent of all health expenditures (Burt 1983) and include Government direct financing of health care and Public financing of dental care or a combination of both.

Mechanisms of payment for dental care may be: (Burt 1983)

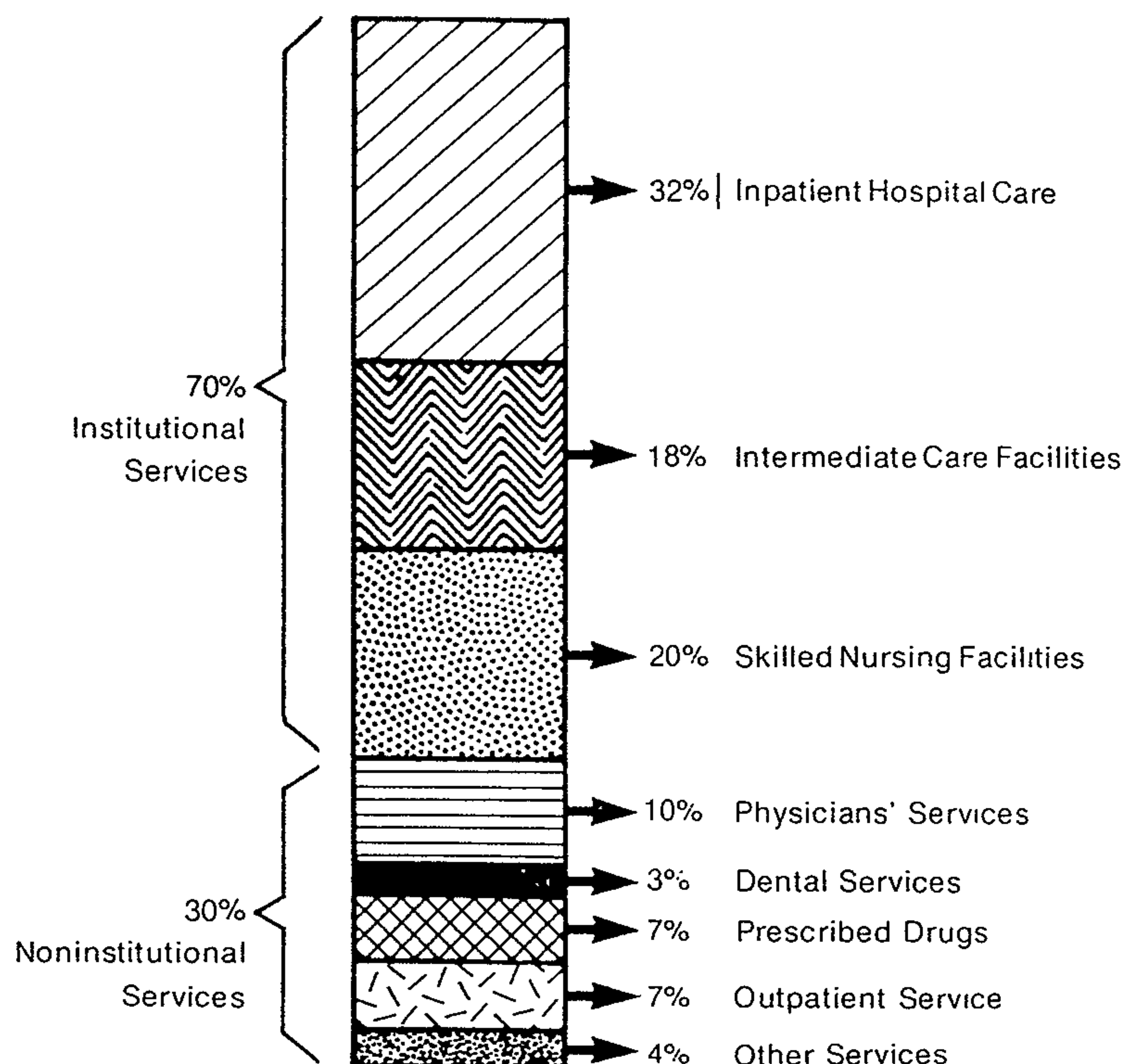
1. Private fee-for-service.
2. Post payment plans.
3. Private third-party prepayment plans.
 - a. Commercial insurance companies.
 - b. Non-profit health service corporations.
 - c. Prepaid group practice,
 - d. Capitation plans.
4. Salary.
5. Public programs.

Eligibility standards vary widely from state to state, as do the expenditures on authorised services (Burt 1983). Medicaid expenditures type of services are shown in **Figure 28**, which shows that 3 per cent of total expenditures were for dental services. (Yet Medicaid in 1977 accounted for nearly 80 percent of all public expenditures for dental services. (Gibson, Fisher 1978)

Figure 28

Proportion of medicaid expenditures going to various services in USA.

Source: Burt (1983)



The EPSDT program, enacted into law in 1968, was supported by the ADA because for the first time a federal program mandated dental care for indigent children. EPSDT therefore had the potential of bringing into the dental care system millions of indigent children and youth. (Burt 1983)

In its purest form *COST-BENEFIT ANALYSIS* implies to the dollar/(currency) measurement of a benefit in comparison to the cost of securing that benefit. The best we can usually do is to set the cost of a preventive procedure against the cost of care if the preventive procedure had not existed and the disease or disorder had developed. (Dunning 1977)

A ratio obtained by dividing the benefit by the cost of achieving it. The formula, where only the cost of caring for a disease is measurable and other benefits are negligible is:

$$\text{Cost-benefit ratio} = \frac{(\text{cost of care without new program}) - (\text{cost of care with new program})}{(\text{cost of new program})}$$

Any ratio larger than 1 indicates that the program will at least pay its own way, while any program with a ratio less than 1 will be a loser (Smith 1968). No such number can be accepted without estimating intangibles. (Dunning 1977)

COST-EFFECTIVENESS ANALYSIS

Another problem is to compare the cost of achieving a specified set of health results by one method with the cost of achieving the same results by another method. This last-named type of study is more accurately called *COST-EFFECTIVENESS ANALYSIS*.

In the dental field, this method has been most useful, in comparing different delivery systems providing a specified amount of dental care. A considerable number of studies are available. (Dunning 1977)

Each country has a unique historical, cultural, and political tradition, and has evolved a somewhat different pattern of health service arrangements. Although the problems are substantially the same everywhere, the emphasis, quality and mixture of resources, and specific arrangements all differ. In general, where the decision-making with respect to arrangements all differ. (Bonnet, Ruderman 1972)

It is widely believed that whenever resources are scarce a more equitable system is likely to result from coordinated, even if not fully centralised, decision-making. (Bonnet et al. 1972) The three general types of systems developed by human society have usually been called *primitive medicine*, *folk medicine*, and *scientific medicine*. *Primitive medicine* involves magical rites and rituals to solicit the aid friendly spirits or to fend off unfriendly ones. *Folk medicine* relies on the use of herbs, unguents, and heat and cold, the benefits of which (actual or believed) have been learned by experience and handed down to succeeding generations. *Scientific medicine* utilises the knowledge and technical apparatus developed through conscious testing, measurement, and controlled experiments. None of these has wholly replaced the others. Today, all three systems operate in different proportions in different parts of the world. One unstated premise in comprehensive health planning is that the objective should be to increase scientific and rational medicine and to reduce the domain of primitive and folk medicines - a premise which deserves some explicit examination in a more appropriate context. (Bonnet, Ruderman 1972)

Two community recognised systems are the private sector and the public sector. Rarely does either exist in pure form. Everywhere, health services involve some mix of private and public effort, although in widely varying proportions. Even in the USSR, which has one of the larger public sectors, a small private sector continues to function.

Consumer ignorance is much more of a concern in the health field than in most other fields because consumers often are unaware of their own needs. Beyond this, translation of a given need or want into an economic demand for specific health services is a technical matter which lay consumers are often unable to handle. (Ruderman 1972)

The relationship between need and effective demand is influenced by the increasing acceptance of the principle that access to health services is a basic right rather than a privilege. This principle brings the question of ability to pay to the foreground and, when some classes of consumers are unable to pay for needed services, leads necessarily to government and third-party intervention in the health care system. (Ruderman 1972)

Population growth and changes naturally affect the need for medical facilities and services. Uncertainties regarding future growth rates and distribution of the population form part of the forecasting problem. Population changes, especially qualitative ones, go beyond the matter of forecasting, however, and deserve attention on their own. To illustrate, the close tie between medical education and the provision of free hospital care has kept the level of medical services in the central cities of the United States higher than it would otherwise be. With increased government participation, however, patients who receive free care furnish a steadily declining fraction of all teaching material. This will affect decisions regarding the relationship between teaching and services, the location of facilities, and concern on the part of medical institutions for population shifts to and from the areas where they are located. (Ruderman 1972)

From the point of view of statistical measurement, the distinction between investing in *HEALTH* or in health *SERVICES* is important. An investment in health must measure its return in indices of health. (Ruderman 1972)

3.12.10 Costs of Prevention Programs

DERIVATION OF COST DATA: This section presents direct costs of six types of caries-prevention programs: water fluoridation; fluoride supplements; fluoride mouthrinses; school WATER fluoridation; sealants; and fluoride gel applications (see Tables 25-34). It should be noted that the cost information provided in this section includes primarily direct program costs. "Other costs" are detailed below each table. All cost data are reported in 1988 dollars. (Gacia 1989)

Operational costs for community water fluoridation systems shown in Tables 25 and 26. For community water fluoridation systems, the equipment was estimated to last 15 years and to have virtually no resale value. (Garcia 1989)

Table 25

**Direct cost of community water fluoridation in the US, 1988
based on the capital cost of existing equipment (in US\$).**

Source: Garcia (1989)

State	Pop. Served	Initial Capital Cost*	Year In- curred	Initial Cost in '88 Dollars	Annual Capital Cost in '88 Dollars†		Type of Chem- cal	Oper. Cost/ Year**	Total Direct Cost/Year		Cost/Person/ Year in US Dollars	
					(2%)	(4%)			(2%)	(4%)	(2%)	(4%)
1	4,900,000	601,000	1975	1,319,296	102,675	118,659	H ₂ SiF ₆	918,125	1,020,800	1,036,784	0.21	0.21
2	1,100,000	139,000	1986	149,780	11,657	13,471	H ₂ SiF ₆	116,520	128,177	129,991	0.12	0.12
3	1,031,000	114,000	1973	303,230	23,599	27,273	H ₂ SiF ₆	190,000	213,599	217,273	0.21	0.21
4	750,000	118,336	1986	127,514	9,924	11,469	H ₂ SiF ₆	100,722	110,646	112,191	0.15	0.15
5	237,350	101,900	1983	120,827	9,403	10,867	H ₂ SiF ₆	23,000	32,403	33,867	0.14	0.14
6	110,000	34,512	1973	91,799	7,144	8,256	Na ₂ SiF ₆	11,553	18,697	19,809	0.17	0.18
7	28,765	19,485	1982	23,846	1,856	2,145	H ₂ SiF ₆	4,930	6,786	7,075	0.24	0.25
8	20,500	9,557	1981	12,417	966	1,117	Na ₂ SiF ₆	3,696	4,662	4,813	0.23	0.23
9	20,000	5,529	1978	10,015	779	901	Na ₂ SiF ₆	3,491	4,270	4,392	0.21	0.22
10	13,800	13,282	1988	13,558	1,055	1,219	NaF	6,500	7,555	7,719	0.55	0.56
11	5,280	9,500	1983	11,265	877	1,013	Na ₂ SiF ₆	2,779	3,656	3,792	0.69	0.72
12	2,800	10,224	1987	10,629	827	956	H ₂ SiF ₆	1,718	2,545	2,674	0.91	0.95
13	2,000	5,510	1985	6,269	488	564	NaF	1,050	1,538	1,614	0.77	0.81
14	1,300	5,520	1981	7,172	558	645	NaF	567	1,125	1,212	0.87	0.93
15	800	3,828	1981	4,973	387	447	H ₂ SiF ₆	312	699	759	0.87	0.95
16	498	3,567	1986	3,844	299	346	H ₂ SiF ₆	234	533	580	1.07	1.16
									Mean=\$0.46		\$0.49	
									Median=0.24		0.24	
									Range=0.12-1.07		0.12-1.16	

*Equipment and engineering costs. †Annualized at 2% and 4% over 15 years. **Cost of chemicals, maintenance, and repair.

Table 26

Direct cost of community water fluoridation in the US, 1988
based on equipment*replacement costs (in US\$).

Source: Garcia (1989)

State	Pop. Served	Initial Capital Cost ('88\$)	Annual Capital Cost in '88 Dollars†		No. Injec- tion Points	Type of Chem- ical	Oper. Cost/ Year**	Total Direct Cost/Year		Cost/Person/ Year in US Dollars	
			(2%)	(4%)				(2%)	(4%)	(2%)	(4%)
1	4,900,000	1,262,100	98,224	113,515	2	H ₂ SiF ₆	918,125	1,016,349	1,031,640	0.21	0.21
2	1,100,000	250,200	19,472	22,503	2	H ₂ SiF ₆	116,520	135,992	139,023	0.12	0.13
3	1,031,000	307,800	23,955	27,684	2	H ₂ SiF ₆	190,000	213,955	217,684	0.21	0.21
4	750,000	130,170	10,131	11,708	2	H ₂ SiF ₆	100,722	110,853	112,430	0.15	0.15
5	237,350	173,230	13,482	15,580	2	H ₂ SiF ₆	23,000	36,482	38,580	0.15	0.16
6	110,000	100,980	7,859	9,082	1	Na ₂ SiF ₆	11,553	19,412	20,635	0.18	0.19
7	28,765	29,228	2,275	2,629	1	H ₂ SiF ₆	4,930	7,205	7,559	0.25	0.26
8	20,500	16,343	1,272	1,470	1	Na ₂ SiF ₆	3,696	4,968	5,166	0.24	0.25
9	20,000	15,481	1,205	1,392	1	Na ₂ SiF ₆	3,491	4,696	4,883	0.23	0.24
10	13,800	26,564	2,067	2,389	2	NaF	6,500	8,567	8,889	0.62	0.64
11	5,280	14,250	1,109	1,282	1	Na ₂ SiF ₆	2,779	3,888	4,061	0.74	0.77
12	2,800	13,598	1,058	1,223	6	H ₂ SiF ₆	1,718	2,776	2,941	0.99	1.05
13	2,000	9,367	729	842	1	NaF	1,050	1,779	1,892	0.89	0.95
14	1,300	9,108	709	819	1	NaF	567	1,276	1,386	0.98	1.07
15	800	7,503	584	675	1	H ₂ SiF ₆	312	896	987	1.12	1.23
16	498	4,637	361	417	1	H ₂ SiF ₆	234	595	651	1.19	1.31
									Mean=\$0.52	\$0.55	
									Median=0.25	0.26	
									Range=0.12-1.19	0.13-1.31	

*Estimated equipment replacement cost and installation. †Annualized at 2% and 4% over 15 years. **Cost of chemical, maintenance, and repair.

Direct costs of school fluoridation programs are summarised in Table 27. The initial capital costs incurred by school fluoridation programs are comparable to those of community fluoridation systems. They include the cost of fluoridators, testing equipment, engineering, and installation. Consequently, similar assumptions were used to derive costs for those two types of programs. Capital expenditures were estimated using equipment replacement costs in 1988 dollars. Capital costs annualized at 2 per cent and 4 per cent over a period of 15 years were added to the cost of chemicals, maintenance and repair, testing, personnel, and "other" costs to obtain the annual cost per student. Operational and equipment costs used in Tables 27-28 were provided by fluoridation engineers and technicians from each program, and in some instances by state (provincial) dental directors. (Garcia 1989)

Table 27
Direct cost of school water fluoridation programs in the US, 1988
based on equipment replacement costs (in US\$).
Source: Garcia (1989)

State	No. Schools	No. Students	Initial Capital Costs ('88\$)*	Capital Costs/ Year†		Costs of Chemical /Year	Oper. Costs/ Year**	Personnel Costs/ Year‡	Other Costs	Cost/ Student/Year	
				(2%)	(4%)					(2%)	(4%)
1	4	2,500	8,100	630	729	300	400	200	500 ^a	0.81	0.85
2	103	28,896	154,500***	12,024	13,896	2,100	10,300	76,400		3.49	3.55
3	89	37,000	195,800	15,238	17,610	4,450	8,900	95,408	26,700 ^b	4.07	4.14
4††	134	48,500	241,200	18,772	21,694	16,000	NA	175,970	1,500 ^c	4.38	4.44
5	14‡‡	3,300	24,500	1,907	2,204	896	1,400	10,710	400 ^d	4.64	4.73
6††	28	4,880	63,280	4,925	5,691	2,500	NA	40,000		9.72	9.88
All										Mean=\$4.52	\$4.60
										Median=4.23	4.29
										Range=0.81-9.72	0.85-9.88

*Includes equipment replacement cost, testing equipment, and installation.
†Annualized capital cost at 2% and 4% over 15 years.
**Cost of lab testing and routine maintenance and repair.
‡See Table 14.
***No installation costs included; state employees install equipment.
††Source: Dr. R. Gerlach (1989).
‡‡Program discontinued Dec. 1988.
^a=travel \$350/year, postage \$150/year; ^b=travel, repair parts, \$300/school/year; ^c=all other costs; ^d=secretarial costs \$400/year.

Table 28
Direct annual personnel costs for school water fluoridation programs
in the US, 1988 (in US\$).
Source: Garcia (1989)

State	Type of Personnel	Cost (\$)	Total Cost/Year
State 1	Honorarium for program supervisor	200	200
State 2	2 full-time program representatives @ \$31,000/year	62,000	
	1 technician @ \$14,400/year	14,400	76,400
State 3	4 fluoride specialists and 1 support person \$922/school/year	82,058	
	1 school employee @ \$5.00/hour x 30 hours/year x 89 schools	13,350	95,408
State 4	1 engineer @ \$45,000/year (10% time)	4,500	
	6 technicians, appr. @ \$22,048/year (70% time)	92,603	
	1 clerk \$203.08/year	203	
	1 lab employee @ \$20,000/year	20,000	
	Administrative costs \$58,664/year	58,664	175,970
State 5	1 fluoridation technician @ \$765/school/year	10,710	10,710
State 6	1 engineer @ \$21,000/year (50% time)	10,500	
	1 technician @ \$22,000/year	22,000	
	Clerical \$4,000/year	4,000	
	Administrative costs \$3,500/year	3,500	40,000

SEALANT PROGRAM. This can be conducted in a variety of ways depending on the availability of space, personnel, and characteristics of particular state program. Therefore, sealant services can be provided as part of an existing clinical program, initiated as a distinct program. The calculation of annual costs as shown in Table 29. (Garcia 1989)

Table 29

Direct annual costs of sealant programs in the US, 1988 (in US\$).

Source: J Pub Health Dent (1989)

	No.	Age or	Type of	Personnel Costs/ Year*	Materials & Supp- lies/Year	Equipment Costs/Year†		Other Costs/ Year	Total Direct Costs/Year		Cost/Student/ Year (US\$)	
State	Students	Grade	Sealant	Year*		(2%)	(4%)	Year	(2%)	(4%)	(2%)	(4%)
1	1,450	7-12	Light- cured	14,862	2,790	445	493	800 ^a	18,897	18,945	13.03	13.07
2	19,084	Gr. 2,3,6,7	Self- cured	210,100	31,400	11,873	12,684	19,800 ^b	273,173	273,984	14.31	14.36
3	1,603	Gr. K-6	Light- cured	31,283	4,800	1,500 ^c	1,500 ^c	300 ^d	37,883	37,883	23.63	23.63
4A	3,801	Gr. 2,3,6,7	Self- cured	78,944	6,890**	3,768	4,173	695 ^e	90,297	90,702	23.76	23.86
4B	3,392	Gr. 2,3,6,7	Self- cured	66,946	9,103	1,686	1,867	3,167 ^f	80,902	81,083	23.85	23.90
5	1,001	Gr. 2,6	Light- cured	24,112	2,410	1,232	1,365	506 ^g	28,260	28,393	28.23	28.37
All											Mean=\$21.14	21.20
											Median=23.70	23.75
											Range=13.03-28.23	13.07- 28.37

*See Table 16.

†Cost of dental vans are annualized at 2% and 4% over 5 years; portable equipment annualized at same rate over 10 years.

**Includes 100 kits of sealant materials donated by Johnson & Johnson @ \$45.95 each.

^a=Maintenance and repair \$200, travel \$600.

^b=Travel \$18,700, maintenance/repair \$1,100.

^c=Leased dental van \$1,500.

^d=Maintenance and repairs \$200, printing costs \$100.

^e=Travel \$495, maintenance and repair \$200.

^f=Maintenance and repair \$200, printing \$1,180, and travel \$1,787.

^g=\$174 m/repair, \$332 promotional materials.

Table 30**Direct personnel costs of sealant programs in the US, 1988 (in US\$).****Source: Garcia (1989)**

State	Type of Personnel	Cost	Total Cost/Year
State 1	Not available	\$14,862	\$14,862
State 2	63% of personnel cost for entire program, includes: 2 dentists, 6 hygienists, and 8 assistants	210,000	210,000
State 3	2 hygienists, 792 hours @ \$10/hour	15,840	
	2 assistants, 720 hours @ \$7/hour	10,080	
	1 dentist, 298 hours @ \$18/hour	5,364	31,284
State 4A	1 coordinator, 60% time	NA	
	3 hygienists @ \$10.85/hour plus benefits	NA	
	3 assistants @ \$7.01/hour plus benefits	NA	78,944
State 4B	1 program coordinator, 30% time	12,609	
	2 hygienists, 10% time, 12 months/year	30,402	
	2 assistants, 28 hours/week, 9 months/year	16,565	
	1 secretary, 10% time, 12 months/year	2,581	
	1 dentist, \$25/hour plus travel	4,789	66,946
State 5	1 program coordinator, 50% time	11,250	
	2 hygienists, 298.35 hours @ \$16/hour	9,547	
	2 assistants, 185.4 hours @ \$7/hour	2,595	
	1 dentist, 45 hours @ \$16/hour	720	24,112

COMMUNITY WATER FLUORIDATION. Costs of community water fluoridation were obtained from selected communities in the USA with systems that have been in operation from one to 14 years. Although these cost figures offer some geographic diversity, the selection of a particular system usually depended on the availability and quality of existing records. A total of 57 water systems throughout the US were surveyed and detailed records from 16 water plants were selected to provide an adequate array of systems. They are presented in **Tables 25-26**. The annual costs of fluoridation were also estimated using replacement costs for existing equipment as shown in **Table 26**.

It should be noted that the total costs of fluoridation in a given community will vary greatly depending not only on the water plant's capacity and population served, but also on the type of installation, type of chemical, number of injection points, and natural level of

fluoride. For example, communities #12 and #13 served approximately the same size population, yet the system serving 2,800 residents costs almost twice as much in annual capital cost (Table 26). This can be explained not only in terms of the higher installation cost for its equipment, but also in that the system has six injection sites compared to only one for the smaller town. It is also worth noting that the cost of chemicals in these communities ranged from 16 cents/lb for bulk purchases of hydrofluosilicic acid to 98 cents/lb for sodium fluoride. (Garcia 1989)

FLUORIDE SUPPLEMENTS. Seven states out of 17 states surveyed had dietary fluoride supplement programs in effect. Two were operated by Head State programs and no cost data were available from them. Costs for the remaining five programs, and details of the number of employees, type of personnel, and their salaries or wage rates are presented in Table 31. As with the community water fluoridation programs, differences in costs are obvious among the various locations. Inspection of these data reveals that programs vary in terms of the number, type, and salary of personnel, as well as in their involvement of community volunteers, teachers, and other school personnel. (Garcia 1989)

Table 31
Direct annual costs of supplement programs in the US, 1988 (in US\$).
Source: Garcia (1989)

State	No. Schools	No. Children	Age	Type & Dosage	Personnel Costs/ Year	Materials & Supplies/ Year	Other Costs/ Year	Total Costs/ Year	Costs/ Child/ Year
1	7	935	6-12	NaF (1 mg)	458	370		828	0.89
2	5*	657	4-5	NaF (1 mg)	NA†	756		756	1.15
3	49	10,751	5-14	NaF (1 mg)	17,264	5,805	1,200 ^a	24,269	2.26
4	12	3,000	5-12	NaF (0.5 mg)	5,278	2,000	1,500 ^b	8,778	2.93
5	—	9,721	4-5	NaF (1 mg)	39,290	12,000	1,200 ^c	52,490	5.40
				Tabs or drops					
All								Mean=\$2.53 Median=2.26 Range=0.89-5.40	

*Head Start programs affiliated with community health centers.
^a=Travel; ^b=printing, clerical; ^c=postage.
Direct annual personnel costs:
State 1: 1 hygienist @ \$22,882/year (2% time), benefits included.
State 2: none reported; program is conducted by Head Start staff.
State 3: 2 hygienists @ \$17,264/year (50%) time, no benefits.
State 4: 2 hygienists @ \$13.50/hour x 195.5 hours, no benefits.
State 5: 1 full-time coordinator @ \$36,000/year; 1 program director @ \$47,000/year (7% time), fringe benefits included.

FLUORIDE MOUTHRINSES. Direct annual costs of fluoride mouthrinse programs in the US are shown in Tables 32-33. From a total of 17 states surveyed, 13 operated such programs, and data were obtained from 11 of them. As with fluoride supplement programs, this type of preventive measure is conducted in schools and school personnel are frequently trained to carry out the weekly rinse activities. Not all programs, however, relied on school personnel to the same extent, nor did they hire similar numbers of people. (Garcia 1989)

Table 32
Direct annual costs of fluoride mouthrinse (0.2% weekly NaF)
programs in the US, 1988 (in US\$).
Source: Garcia (1989)

State	No. Schools	No. Children	Age or Grade	Personnel Costs/Year*	Materials & Supplies/Year	Other Costs/Year	Total Costs/Year	Costs/Child/Year
1	477	88,640	Gr. K-6	17,461	28,365		45,826	0.52
2	300	130,000	K-8	26,875	90,000		116,875	0.90
3	325	76,793	6-11 yrs	36,600	45,910		82,510	1.07
4	398	180,462	Gr. K-8	50,136	164,220		214,356	1.19
5	263	124,659	Gr. K-6	8,000	152,084		160,084	1.28
6	60	9,840	5-12 yrs	8,750	4,000		12,750	1.30
7	56	13,000	K-6	6,999	8,500	1,500 ^a	16,999	1.31
8	851	233,588	Gr. 1-6	69,500	245,700	46,800 ^b	362,000	1.55
9	136	36,155	Gr. K-6	37,125	12,405	9,960 ^c	59,490	1.65
10	137	26,907	7-14 yrs	15,400	29,060	1,200 ^d	45,660	1.70
11	1,537	358,263	Gr. K-8	467,458	170,900		638,358	1.78
All							Mean=\$1.30 Median=1.30 Range=0.52-1.78	

*See Table 12.
^a=printing costs; ^b=\$.20 per child, health department administrative costs; ^c=communications, travel, rent, and utilities; ^d=travel.

Table 33
Direct annual personnel costs for fluoride mouthrinse programs
in the US, 1988 (in US\$).
Source: Garcia (1989)

	State 1	State 2	State 3	State 4	State 5	State 6	State 7	State 8	State 9	State 10	State 11
Salaried											
# employed	4	1	1	8	1	2	None	4	1	NA*	None
Salaries	\$49,250	\$26,875	\$32,000	\$25,068	\$24,024	\$16,400		\$47,000	\$31,778		
(% effort)	10	100	100	25	33.3	25		33	25		
	\$18,927					\$18,600		\$24,000			
	33					25		100			
	\$11,545							\$20,000			
	20							75			
	\$9,905							\$20,000			
	20							75			
Subtotal	\$15,461	\$26,875	\$32,000	\$50,136	\$8,000	\$8,750	—	\$69,500	\$7,945	—	—
Contract											
# employed	3		1				5		16		25†
Wages	NA*		\$15/hr				\$13.50/hr		\$14.59/hr		\$8.90- \$17.50/hr
# hours			306.7				103.69		125.0		
Subtotal	\$2,000	—	\$4,600	—	—	—	\$6,999	—	\$29,180	—	—
TOTAL	\$17,461	\$26,875	\$36,600	\$50,136	\$8,000	\$8,750	\$6,999	\$69,500	\$37,125	\$15,400	\$467,458

*Information not available.
†Includes 1 coordinator, 5 field supervisors, 17 field consultants, 1 inventory specialist, and 1 secretary.

Cost of materials and supplies for the rinse programs can vary depending on how materials are dispensed. The least costly method is the use of pumps, which can be sterilised and reused several times, or the use of paper cups to distribute the rinsing solution to students. Premixed fluoride rinses are also available that do not require separate paper products for dispensing the solution, but are significantly higher in cost. The range in material costs per child can be demonstrated by examining data from programs in states #2 and #5. Although the target population for these programs is somewhat similar, state #2 spent 69 cents/child/year in rinse products and paper supplies, while state #5 spent \$1.22/child/year using pre-mixed rinses. (Garcia 1989)

Only direct costs are summarised in **Table 32**, namely the cost of personnel, materials, supplies, and, in a few instances, administrative, travel, and printing costs. No costs were included for teachers' and volunteers' time. As noted in the discussion of fluoride supplement programs, the annual cost of fluoride mouthrinse programs per student is based on the intended population, rather than the actual number of students participating in the program. These costs ranged from 52 cents to \$1.78 per child per year. (Garcia 1989)

SCHOOL WATER FLUORIDATION. From the total of 17 states surveyed, cost data were obtained from three programs currently in operation, and from another program where school fluoridation had been discontinued in 1988. Information for the fifth and sixth programs, one of which is also no longer in operation, were obtained from a recent survey of school water fluoridation in the US (Gerlach R, Division of Dental Health, Vermont Department of Health 1989). Although a number of other states, notably in the south west and Alaska, have programs in effect, most are small installations not likely to be representative of other regions of the country. (Garcia 1989)

Capital costs for programs listed in **Table 27** were based on the replacement cost for existing fluoridation and testing equipment. Installation costs were also included as initial

capital expenditures, except for one location (state#2) where state employees install their own fluoridators. The cost per system and cost per installation did not vary greatly among the six programs, ranging from \$1,500 to \$2,200 per unit/school (fluoridator, testing equipment, pump, plumbing), and from \$300 to \$500 per installation per school. In contrast, the cost of chemicals ranged from \$20.30 per school per year to \$119 per school/year. The greatest difference in program cost can be noted in the number and cost of personnel utilised by the programs, are summarised in **Table 28**. (Garcia 1989)

SEALANTS, **Tables 29-30** show the data obtained for a number of sealant programs in operation in the US. Cost information was available from five states; the remaining 11 states surveyed either offered sealants as part of a clinical program, did not have cost data, or had no program. Only two of the six programs listed in **Table 29** had initiated sealant activities during 1988 (states#1, #3), all others were ongoing projects implemented during earlier years. Thus, initial equipment costs for programs in states #2, 4A, 4B, and 5 needed to be expressed in 1988 dollars by either adjusting for information, or by using new equipment costs. Because the type of equipment being used in these four programs was known, and similar if not identical models are still available from the manufacturers, replacement costs were used. Once annualized, equipment costs were added to personnel, materials, supplies, and other costs to derive the cost per student per year. (Garcia 1989)

One could argue that the cost of a sealant program is not only the cost of placing sealants, but also the cost of examining all students and subsequently treating those eligible for the service. Thus a distinction should be made between the annual cost per student sealed and the cost per student examined. The annual cost, which ranged from \$13.08 to \$28.43 per child/year, represents (with two exceptions, States #4A and 4B) the cost per student sealed, not per student examined. The real cost of a program is therefore likely to be higher when the cost of screening is included. (Garcia 1989)

The direct cost of the various caries prevention programs are summarised in **Table 34**. All cost data are presented as reported from dental public health personnel, water plant operators, and fluoridation engineers. (Garcia 1989)

Table 34

Direct costs of prevention programs in the US 1988, (in US\$).

Source: Garcia (1989)

Program	Annual Cost per Person		
	Mean	Median	Range
Water fluoridation	0.54	0.26	0.12-1.31
Fluoride supplements	2.53	2.26	0.89-5.40
Fluoride mouthrinses	1.30	1.30	0.52-1.78
School fluoridation	4.56	4.26	0.81-9.88
Sealants	21.17	23.73	13.03-28.37

3.13 QUALITY OF CARE AND EVALUATION

3.13.1 Quality Assurance in Dentistry

Appraising the quality of dental care, has always been a matter of great importance in the practice of dentistry.

Quality of care is defined by Sanzaro as "quality of care is the extent to which scientifically established procedures in diagnosis and management are properly applied to the patients who can benefit from their application".

The word coverage in broad range might be applied to a coverage achieved by any public health program with in the eligible group for which it is designed. Therefore quality of health care or treatment could be evaluated either at individual or group level, this also could be at clinical or non clinical (mouth, person, family or community) phase.

Any health program also could be tested at different levels (ie technical, logical, organisational and financial). Another simplified procedure is testing at three levels namely:

1. structure
2. process, and
3. outcomes

If we are planning quality appraisal, three valuable levels of study could be performed:

1. Observational studies
2. End-result studies
3. Record review studies

Observational studies must be conducted during the actual rendering of dental care. End result studies are much easier to institute in dental the field than in many others, because the finished restorations and/or results are available for inspection. Record review studies, or post-audits as they are commonly called, are probably the easiest approach to quality appraisal in a large governmental programs.

The term audit, which usually applied to the study of claim forms or bills for health care procedures may also be applied to other evidence such as pre-and-post operative radiographs or study models , and may be combined with clinical examination for end-result study of the patients themselves.

3.13.2 Objectives of Checking Quality of Care

1. To assess the quality of care in accordance with standards of the health department.
2. To ascertain where there is over-utilisation or under-utilisation of services (either performed) by the practitioner or (received) by the patient
3. To identify fraud.
4. To educate practitioners and recipients in the appropriate use of publicly-funded health care programs.

3.13.3 Review by Government Agencies

This could be performed by a mechanism operated through a team of dental consultants who receive a one-week refresher course to insure uniform quality standards. In addition, a set of guidelines and a check sheet for local directors should be developed. Post treatment recall of patients may arrange on a semi-random basis, with a bias toward those cases with prior approval treatment items or those for whom the provider's bill seemed to indicate a possible problem.

An example of well-developed governmental system is that of the Indian Health Service in the USA, an elaborate manual with check sheets and guidelines prepared for the use of supervising dentist. The work on patients was divided between observed items and the work of a whole services until was studied for adequacy of coverage of assigned population, proper distribution of services among preventive and treatment categories, and general appraisal of the oral health of the assigned population.

3.13.4 Peer Review

Five methods have been reported in the medical field:

1. Implicit process judgment
 To whether the medical care process used in a given case was adequate or inadequate.
2. Implicit outcome judgement
 To whether the outcome experienced by the patient could have been improved if the medical care process has been better.
3. Implicit quality of care judgment.
 To whether the quality of the care received by the patient was acceptable or unacceptable by professional standards, and whether outcome was unsatisfactory, whether this was the fault of the patient or of the medical care system.
4. Explicit process judgment
 When the medical care rendered to the study case was then compared with the criteria set by groups of general practitioners and selected group of specialists.
5. Explicit outcome judgment
 When the estimates of practitioners (experience + literature) compared to the patient outcomes in the study reports.

Application of (both) process judgment in dentistry is very hard but outcome judgments (both implicit and explicit), can be made by inspection of the finished work.

The indirect method of improving the quality of health care is much more effective and pleasant for the profession. Regular staff meetings which promote discussion of difficult or interesting cases. Inspection of treated referral cases by specialist provide sufficient opportunity for consultation and the best outcome. Also the organised profession has the responsibility for upgrading and updating the scientific information of the members.

Generally observing and measuring the true overall quality of a dental program is difficult, because of the differing criteria applied by different observers to determine the technical excellence of dental care.

The criteria first established used the following scales:

- Good quality
- Poor quality

In the second instance:

- Superior or outstanding
- Highly satisfactory
- Satisfactory
- Needing some improvement
- Unacceptable

Most systems will probably use 3 or 4 categories for evaluating the clinical quality of restoration:

1. Meets all standards
2. Observe at next visit
3. Replace for prevention
4. Replace statim

Other criteria are concerned with ratios. Ratios may be used as measures of dental care, for example:

1. Ratio of teeth filled to teeth extracted
2. Ratio of fixed bridges to partial dentures
3. Ratio of full mouth X ray to bitewing X ray surveys

According to the American Dental Association principles of ethics "the dentist has an obligation to report to the appropriate agency of his component or constituent dental society instances of gross and continual faulty treatment by another dentist.

Patient satisfaction is another measure of the patient's care quality, this is increasing with the degree of education.

In the USA, PSRO (Professional Standards Review Organisation) involve at present medicare, medicaid and dentist would probably be reviewed by dental review committees set up as component parts of PSROs. Efforts are underway to involve dentistry more directly in the PSRO mechanisms.

3.13.5 Evaluation

One of the major objectives of health programs is the elimination or reduction of hazards to health. The methods employed to accomplish this purpose may be broadly classed as preventive and therapeutic. The first may be used to eliminate hazards, such as disease and its consequences, through the prevention of their occurrence. The second or therapeutic method may be used to lessen the ill effects of disease through the application of treatment procedures to mitigate or interrupt the course of the disease. Whichever method is used as the basis for a disease control program, the effectiveness of the program is measurable in terms of reduction in occurrence of disease or its effects such as disability, illness or death. The evaluation of the accomplishments of a dental program, therefore, is primarily concerned with a quantitative measurement in term of the prevention of dental disease or the reduction of its consequences. To measure results, however, it is essential that base line data be available against which findings of surveys conducted at different periods throughout the program can be reflected. The appraisal may be concerned also with the costs of control measures and with the expense of the program in relation to the results achieved.

The important qualifications of a method of program evaluation are that it is reliable, simple, rapid, and inexpensive of application; that it requires minimum effort and disturbance of the population concerned; and that it is based on objective data which can be readily processed. The recognised need for a method which would meet these several criteria has prompted the development of indices of dental health and simplified procedures for estimating the prevalence of specific dental diseases.

During the evaluation stages, the results of the program are measured against the objectives developed during planning. The bottom line in evaluation is accountability-to consumers, to providers, to all involved agencies. The evaluator must look at the results and, using previously determined criteria, ask, "Were the objectives of this study or program successfully met? If not, why not?" Summarising what went well and what did not, or drawing conclusions based on intuition, is not adequate; the objectives themselves must be specifically addressed. Inherent in this approach is the possibility of attaining a negative outcome, that is, the conclusion that the objectives have not been met.

However, at the same time this does not mean that the program was a failure. If a program is evaluated properly, so that negative outcomes become learning experiences and indicators of future programming and research, then in some sense it has been a success. (Cormier, Levy 1981)

The professional evaluates not only to determine effectiveness but also to contribute his or her experience to the existing body of knowledge, with the goal of creating better programming in the future.

Evaluation can be viewed as a twofold process: a performance is MEASURED under standard conditions, and then INTERPRETED by some standard of quality or excellence. This second feature distinguishes evaluation from assessment, which involves measuring performance, without interpreting or making value judgments.

The criteria for evaluating programs may be summarised as follows:

1. EFFECTIVENESS - Has the stated goals been attained as a result of program?
2. EFFICIENCY - How much has the attainment of the stated goal cost in absolute terms and in comparison with what was anticipated ?
3. APPROPRIATENESS - Has priority been given to the useful strategy for attainment of the stated objectives ?
4. ADEQUACY - Has the program covered the total health problem it was aimed at?
What are the levels of availability to the various sections of the population?

There are two basic types of evaluation-process and product. PROCESS evaluation is concerned with the steps by which certain goals or objectives are attained, while PRODUCT evaluation deals with the results of these steps. Process evaluation would, for example, measure children's actions while brushing their teeth, whereas in product evaluation, the changes in their oral hygiene levels would be evaluated.

Both process and product evaluation can occur during any stages of the project; what distinguishes them is whether an ongoing activity or its end-product is being measured. The type of process and product evaluation to be employed must be decided during planning, not at the completion of a project.

3.13.6 Process Evaluation

EVALUATION PROCESS. This should be planned at the beginning and it:

- Should have clear and measurable objectives, and
- Should involve recipients of the program.

For the process of evaluation it is necessary to use the same indices and criteria that were used for the survey carried out at the beginning of the planning period.

Appropriate times for assessment in a 10 year plan is:

- 5th year: to see if plan should be modified within its duration
- 9th year: to be able to re-plan for next 10 years.

Process evaluation basically concerns itself with evaluation of the treatment and activities of the program. The techniques can be categorised by those that measure how much treatment is being provided (quantity) and those that evaluate how good the treatment is (quality).

QUANTITY is usually assessed through utilisation rates. For example, a statement that 60 per cent of the children used the oral hygiene center in their classrooms is a piece of process evaluation data. This information can then be evaluated. Is 60 per cent an indication of inadequate utilisation? If so, further investigation is indicated. Perhaps the children need to be reminded that they are scheduled to use the center. Thus process evaluation can eliminate operational flaws before they result in unsuccessful outcomes, in this case a lack of improvement in oral hygiene scores.

QUALITY can be addressed in several ways. Record-keeping, time-sampling, and the criterial-incident technique are three important approaches to this type of process evaluation.

3.13.7 Product Evaluation

Product evaluation, by contrast, looks at outcomes and results. Here the objectives come clearly into focus. The nature of the research design will obviously determine the course of product evaluation. For example, if a study is conducted based on an experimental design, so that a HYPOTHESIS, or prediction, is set forth in planning, product evaluation will consist not only of evaluating outcomes but also of evaluating whether or not these outcomes provide evidence to support the hypothesis.

Product evaluation can also be approached by looking at the two dimensions of a program - effectiveness and efficiency. EFFECTIVENESS deals with the attainment of objectives, while EFFICIENCY addresses questions of cost-effectiveness, that is:

- * If a program has met its goals, how cost-effectively did it do so ?
- * Could costs have been reduced ?

During product evaluation the issues are again addressed:

- * Was prevention started in the program ?
- * Were manpower resources utilised optimally ?
- * Were barriers to access successfully removed ?
- * Was quality successfully assured within the program ?
- * Was the program cost-effective, and did it offer viable financing mechanisms for the community ? (121)

Evaluation is such an important part of the total dynamic process of planning that many functioning units are called "planning and evaluation units." At one time there was a conceptual problem growing out of the notion that we were dealing with three separate activities - planning, implementation, and evaluation. The modern view, however, is that it is all one process of a cyclic nature, with the evaluation step leading directly into the initiation of a new planning cycle. (Taylor 1972)

Two fundamentally different types of evaluation must be distinguished: continuing evaluation for administrative purposes and a periodic, more focused evaluation specially for plan revision. Particularly important to the administrator is continuing self-evaluation by local administrative health units. If the planning process can encourage local units to undertake systematic self-evaluation and provide them with appropriate know-how and mechanisms, this will be perhaps the best possible means of building in continuous improvement. In addition, a major role of the planning organisation is to undertake continuing administrative evaluation to see that standards and targets are being met. One of the best ways for planners to establish their usefulness is to show that they can fulfil an important service role to the administrators. A natural service activity with great practical value to most senior administrators is a tough, frank approach to evaluation. In any centralised-decentralised balance, this naturally tends to continue as an important role of the central units.

The second major type of evaluation is more definitely related to planning process. A centrally-directed activity has to be set up with the primary purpose of quantifying achievement in particular planning periods. Such activity tends to be timed to precede the evaluation of a new major plan or the modification of an existing one. This kind of exercise should go considerably beyond mere measurement of achievement in terms of previous standards and targets. It should concentrate on assessment of such basic issues as whether the original goals and objectives were in fact appropriate; whether resources development is actually moving in the direction most suited to local conditions, both in terms of facilities and manpower; whether the priority setting was, in fact, justified by further experience; and especially whether the data gathering system is producing useful information. Such an evaluation does not spontaneously happen. It has to be worked out with as much ingenuity and innovative precision as any other part of the planning sequence. (Taylor 1972)

3.13.8 Monitoring and Evaluation in IRAN

MONITORING AND EVALUATION. Aims to assess the relevance of the programs of a plan to the set goals.

For the evaluation of oral health in Iran, the following parameters seems feasible:

1. Caries-free children at the age of 5 years
2. Average DMF teeth at the age of 12 years
3. Percentage of schoolchildren in systematic oral health care
4. Annual attendance of oral health clinic by adolescent patients
5. Level of dental care (LCD index)* in 12 and 18 years age groups

The evaluation system should be introduced gradually over a 4-6 years period. In first two years any available information on those five points collected from provinces. Then a special group of epidemiologists may be organised to carry out evaluation on a regular basis, so that every province is evaluated in a 3 years period. At a provincial level, the same evaluation system might be introduced.

$$* \text{ LDC index} = 100\% \frac{(D + R) \times 100}{\text{DMFT}}$$

D = Decayed teeth

R = Missing teeth not replaced by denture

DMFT = Decayed, Missed, Filled teeth

4 DEVELOPMENT OF DENTAL HEALTH POLICIES

4.1 DEFINITION

The term 'policy' is used in a variety of ways to cover many quite different types of statement, intention and action. 'Policy' may refer to the following:

- * A very general statement of intentions and objectives. This interpretation is typified by the policy speeches of political leaders during parliamentary election campaigns. It includes statements such as 'Our policy is to introduce a comprehensive system of health insurance financed by taxation contributions'.
- * The past set of actions of government in a particular area, such as economic, foreign or health policy, for example 'Medicare (health insurance) has been the cornerstone of our health policy'.
- * A specific statement of future intentions, such as 'Our policy will be to allow people to opt out of Medicare in order to take up voluntary health insurance'.
- * A set of standing rules that are intended as a guide to action, or inaction, for example 'It is our policy not to interfere in those matters that are properly the responsibility of the States'.

Generally, the term 'health policy' embraces courses of action that affect that set of institutions, organisations, services and funding arrangements that we have called the health care system. It includes actions or intended actions, by public, private and voluntary organisations that have an impact on health. The term includes also political parties' policies that may be translated into government action at a later stage. Thus, policy may refer either to a set of actions and decisions, or to statements of intention. Government policy includes what governments say they will do, what they do, and what they do not do. (Palmer, Short 1989)

Normally, the term 'public policies' is used when we are dealing with those policies for which governments are primarily responsible. Public policies are carried out in the name of the people as a whole, and they affect the public interest. The term 'public' implies that a distinction can be made between these activities and those of private individuals and groups (Forward 1974). It should be recognised, however, that some public policy analysts prefer to use a wider definition, which embraces all policies that affect the public interest. (Davies et al. 1988)

The concept, adopted by the World Health Organization, of "healthy public policy" express this breadth of vision. (Reynolds 1989)

"Healthy public policy ... refers to policy decisions in any sector or level of government that are characterised by an explicit concern for health and an accountability for health impact. It is expressed through horizontal strategies such as intersectoral co-operation and public participation". (Mahler 1988)

In practice, these policy decisions and strategies often are expressed in legislation, and series of articles. (Reynolds 1989)

Heclo (??) puts it this way:

Thus policy does not seem to be a self-defining phenomenon; it is an analytic category, the contents of which are identified by the analyst rather than by the policy maker or pieces of legislation or administration. There is no unambiguous datum constituting policy and waiting to be discovered in the world. A policy may usefully be considered as a course of action or inaction rather than specific decisions or actions, and such a course has to be perceived and identified by the analyst in question.

Heins Eulau and Kenneth Prewitt (??) come to much the same understanding of policy:

Policy is a strictly theoretical construct inferred from the patterns of relevant choice behaviour. Policy is distinguished from policy goals, policy intentions, and policy choices. Policy is defined as a "standing decision" characterised by behavioral consistency and repetitiveness on the part of both those who make it and those who abide by it.

Understanding public policy, and the "behavioral consistency and repetitiveness" associated with efforts in and through government to resolve public problems. Used in this way, policy is a highly dynamic term. As Eulau and Prewitt (??) point out: "What the observer sees when he identifies policy at any one point in time is at most a stage or phase in a sequence of events that constitute policy development.

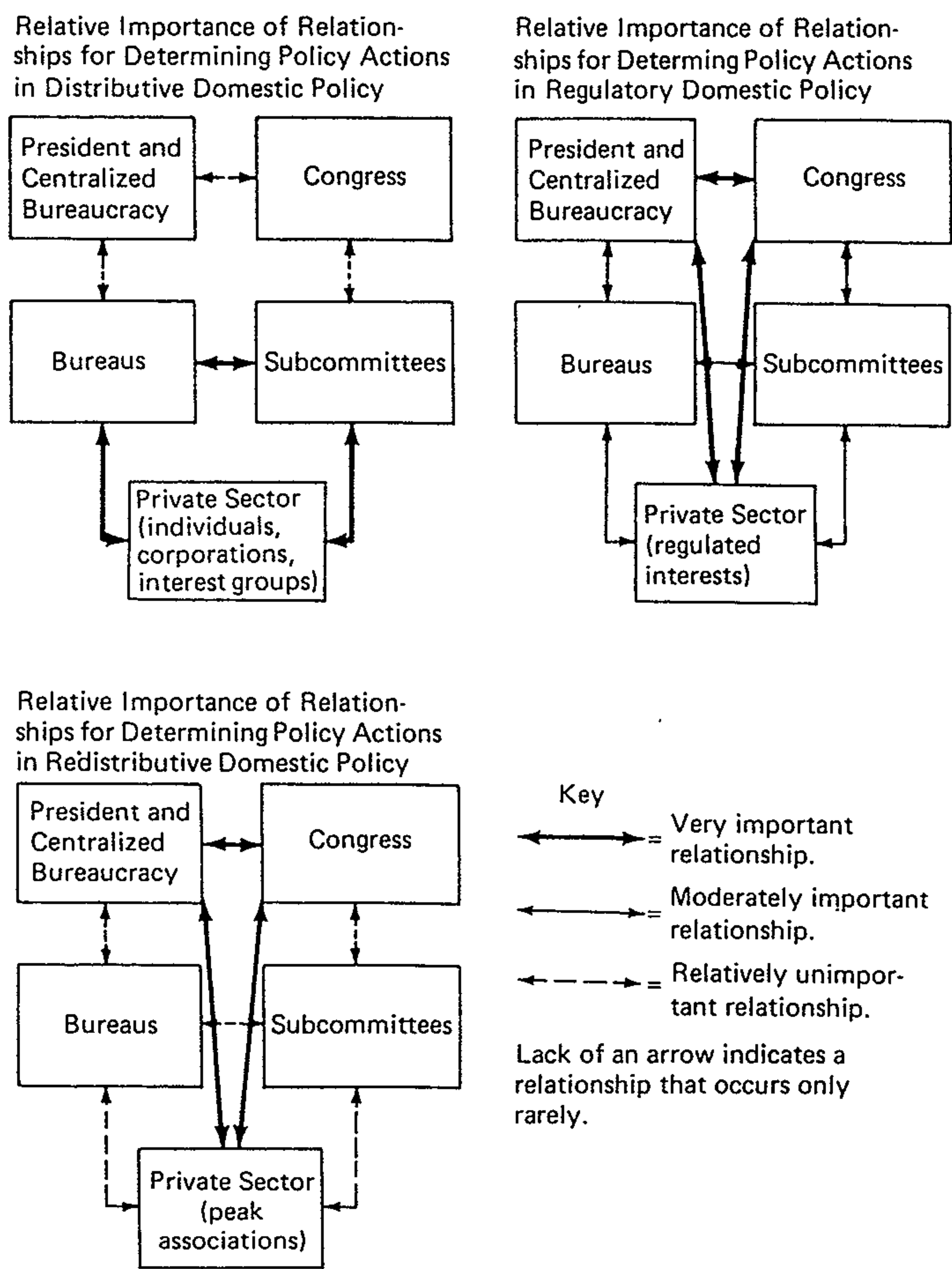
The importance of understanding the "how" of public policy - how problems get to government, how they are defined there, how they are acted on, etc..., it is the nature of problems themselves, come to influence how various processes develop and work.

Therefore the study of public problems influence the processes designed to solve them, the processes in turn help to explain programs and policies, and the policies affect what problems emerge in society and get to the agenda of the government. (Jones 1977)

In framing a government which is to be administered by men over men, the difficulty lies in this; you must first enable the government to control the governed; and in the next place oblige it to control itself. (Jones 1977)

The goals of policy making continue to change as new experience with policy throws new light on what is possible and desirable. In this sense, it is also better described as moving AWAY from known social ills rather than as moving TOWARD a known and relatively stable goal. (Braybrooke, Lindblom 1963)

Figure 29
Institutional relationships among different policies.
Source: Randall, Ripley & Franklin (1976)



4.2 TYPES OF PUBLIC POLICIES

Public policies affect society in a variety of ways. According to Lowi's (1964) very useful typology, as adapted by Salisbury and Heinz (1970), there are four distinct ways in which public policies are perceived to affect individuals and organisations:

- * **DISTRIBUTIVE POLICIES**, which consist of the provision of services or benefits to particular segments of the population. Distributive policies are characterised by the relative ease with which they can be adopted and implemented, since each policy can be implemented more or less in isolation from other policies, and without any noticeable reduction in the benefits provided to other groups.
- * **REGULATORY POLICIES**, which involve the imposition of limitations or restrictions on the behaviour of individuals or groups. Regulatory policies are reasonably specific and narrow in their impact. They determine who is restricted and who is given greater freedom.
- * **REDISTRIBUTIVE POLICIES**, which are characteristic of the 20th century 'welfare state', consist of deliberate efforts by governments to change the distribution of income, wealth, property, or rights between groups in the population. Health insurance for the poor is therefore subsidised by higher income earners. In general, redistributive policies tend to provoke strong disagreement between sections of the population. (Palmer, Short 1989)
- * **SELF-REGULATORY** policies are generally sought by an organization as a means of promoting its own interests. Self-regulation may benefit an organization directly or indirectly since being seen to be self-regulatory may enhance the official credibility of the organization.

The generalised relationships between the first three policies are shown in **Figure 29** (Jones 1977)

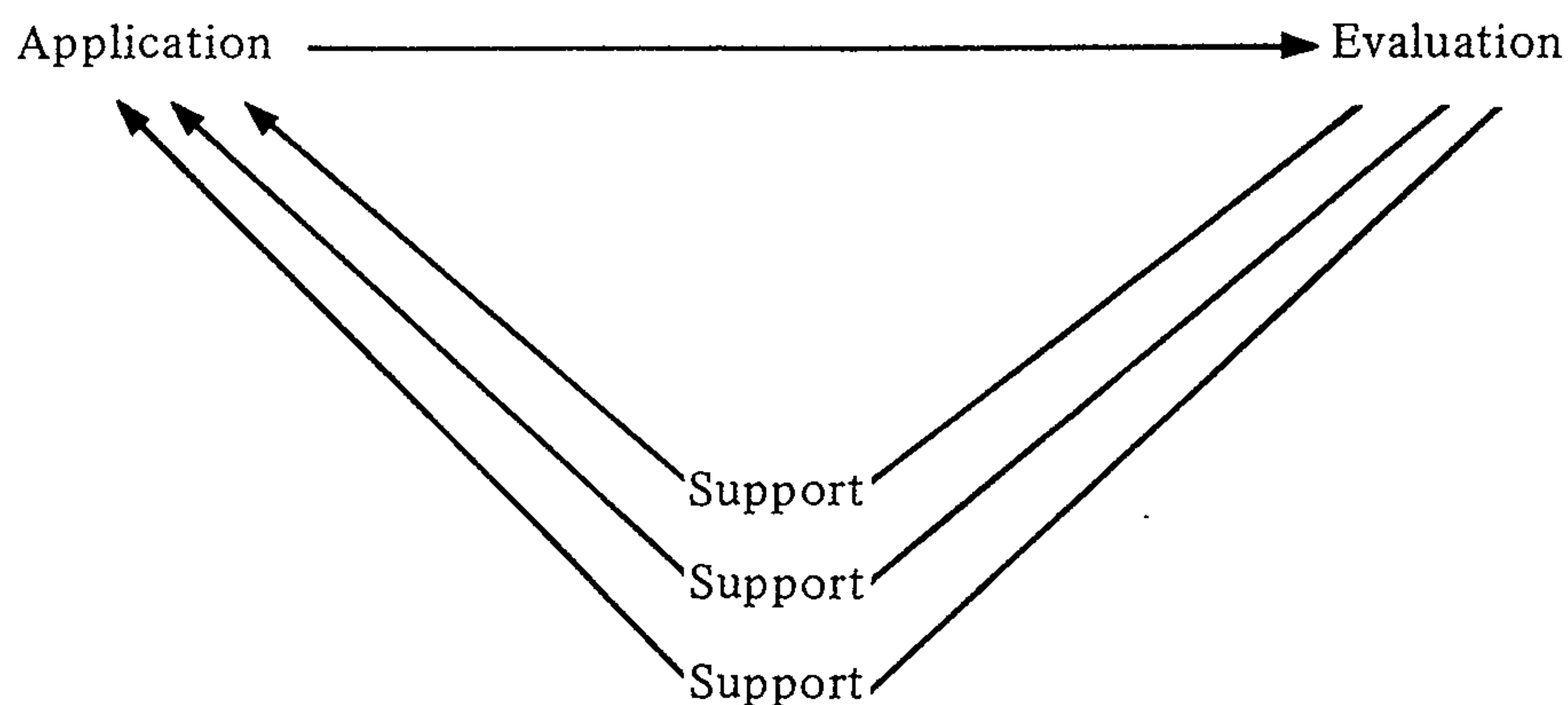
4.3 POLICY CYCLES

Cycles of policy are the ongoing patterns of accommodation in which various institutional actors play various roles in accomplishing the functional activities of the policy process. It also refers to a continuous process by which methods are tested, modified, tested again until the best method of implementation is found.

An example is when new problems are discovered in the process of evaluating certain programs. The output affects agenda setting as new demands are brought to the attention of government decision makers. Evaluation results in a kind of spin-off of another cycle. Various situations of possible output from evaluation suggest different types of policy cycles, or "rounds of events."

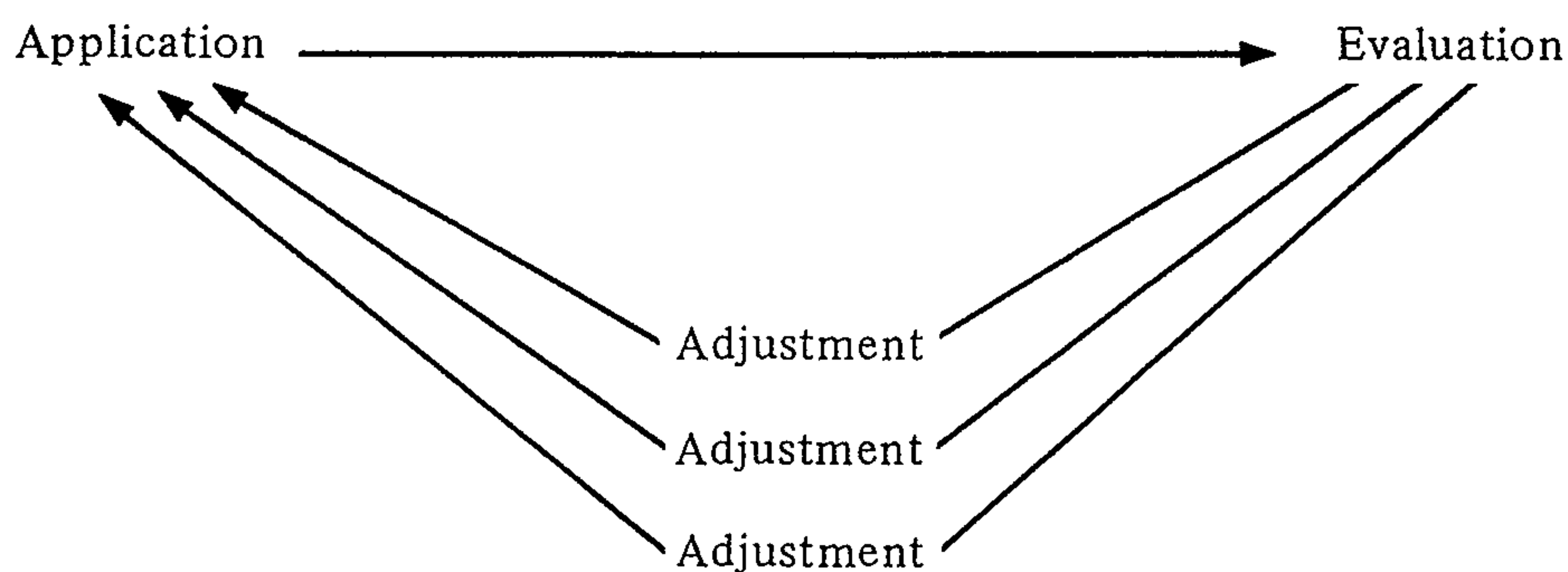
First is the very simple and frequently occurring cycle of support.

Figure 30a. The policy process. Gardner (1989)



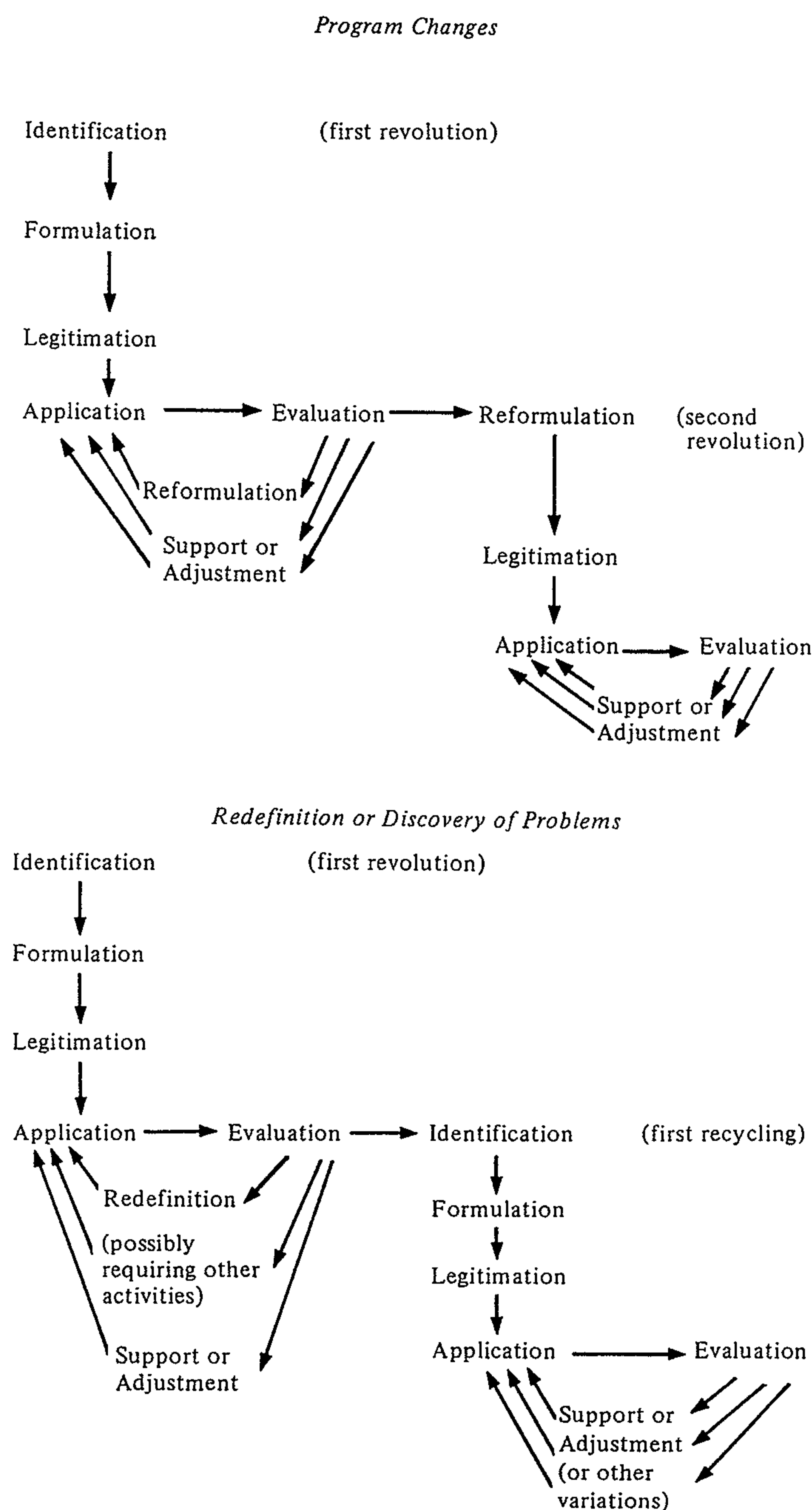
Second is the incremental adjustment cycle, occurring within the functional activities of application and evaluation.

Figure 30b. The policy process. Gardner (1989)



The third type of cycle is more complex. It may involve other functional activities beyond application and evaluation and two or more revolutions. Lindblom (1968) suggest two variations among many which might be proposed. The first involves programmatic shifts, either within existing authority or where new authority is required. The second captures those cases where the problem is redefined or new problems are identified. **(Figure 30c)**

Figure 30c. The policy process. Gardner (1989)



Policy makers in health, as in other fields, face the burden of the status quo: the high cost of curative services, their popularity with the public and with powerful professional interests, make a radical policy shift towards preventive programs difficult. Incrementalism as a method is thus likely to continue to guide most health policy making. (Gardner 1989)

A relation of the highly interdependent nature of policy as a field for action, or as a subject for study, leads the administrators to recognise that if policy making is to attain some degree of rationality and comprehensiveness it will need contributions from experts in a range of specialised occupations, while 'the study of public policy must rely on a range of disciplines'. (Weller 1980)

Health professionals have therefore an important contribution to make to policy making in all sectors of health. The study of public policy will help professionals to appreciate the 'complexity and interrelatedness' of government, and enable them to realise that most problems facing policy makers are not amenable to neat technical solutions, but are political problems. At the same time, the close contact health professionals have with the consumers of health services will contribute to the policy making process by ensuring that those who study it become engaged with 'real problems'. (Weller 1980)

4.4 POLICY ANALYSIS

Health policy analysis includes the study of the inputs to policy, the policy-making process and the outcomes of policy.

Corresponding to the variety of disciplines engaged in policy analysis is the great diversity of methods of analysis and evaluation that may be employed. These range from the techniques of literary, critical, and historical scholarship, and the use of simple measurement and statistical measures, to deployment of the more complex techniques of cost benefit analysis, experimental design and multivariate analysis.

Policy analysis may usefully enter no more than an appraisal of the coherence, consistency and underlying logic of the published policy statements. Elaborate empirical or statistical analysis may not be required in order to demonstrate that the policies are muddled, lack clear objectives, and contain elements that are logically inconsistent. Theoretical analysis may reveal that the intended outcome of the policy are unlikely to be achieved because key causal factors have been ignored, or because the underlying theory on which the policy is based can be demonstrated to be fallacious. Much of the evaluation of economic policy is of this kind.

Following Ham and Hill (1984), in health policy analysis we find it useful to acknowledge that there are three broad level of analysis, or emphasis, within which studies can be carried out: First, a micro-level, or decision-making level, within which analysts are concerned chiefly with identifying who makes decisions, and how choices are made within organisations; secondly, a middle level, which focuses on the health 'policy making process' and the actions and mechanisms whereby the agenda is defined, and policies brought into practice; and thirdly, a macro-level, where analysis, criticism and evaluation of the existing health care system within its economic, political and cultural context is the principal objective.

A framework of analysis summarised by Gardner (1989) is shown in Table 35.

Table 35

The policy process - a framework for analysis.

Source: Jones (1977)

<i>Functional Activities</i>	<i>Categorized in Government</i>	<i>and as Systems</i>	<i>with Output</i>
Perception Definition Aggregation Organization Representation	Problems to Government	Problem Identification	Problem to Demand
Formulation Legitimation Appropriation	Action in Government	Program Development	Proposal to Budgeted Program
Organization Interpretation Application	Government to Problem	Program Implementation	Varies (Service, payments, facilities, controls, etc.)
Specification Measurement Analysis	Program to Government	Program Evaluation	Varies (Justification, recommendation, etc.)
Resolution/ Termination	Problem resolution or change	Program Termination	Solution or change

4.5 HEALTH-POLICY-MAKING PROCESS

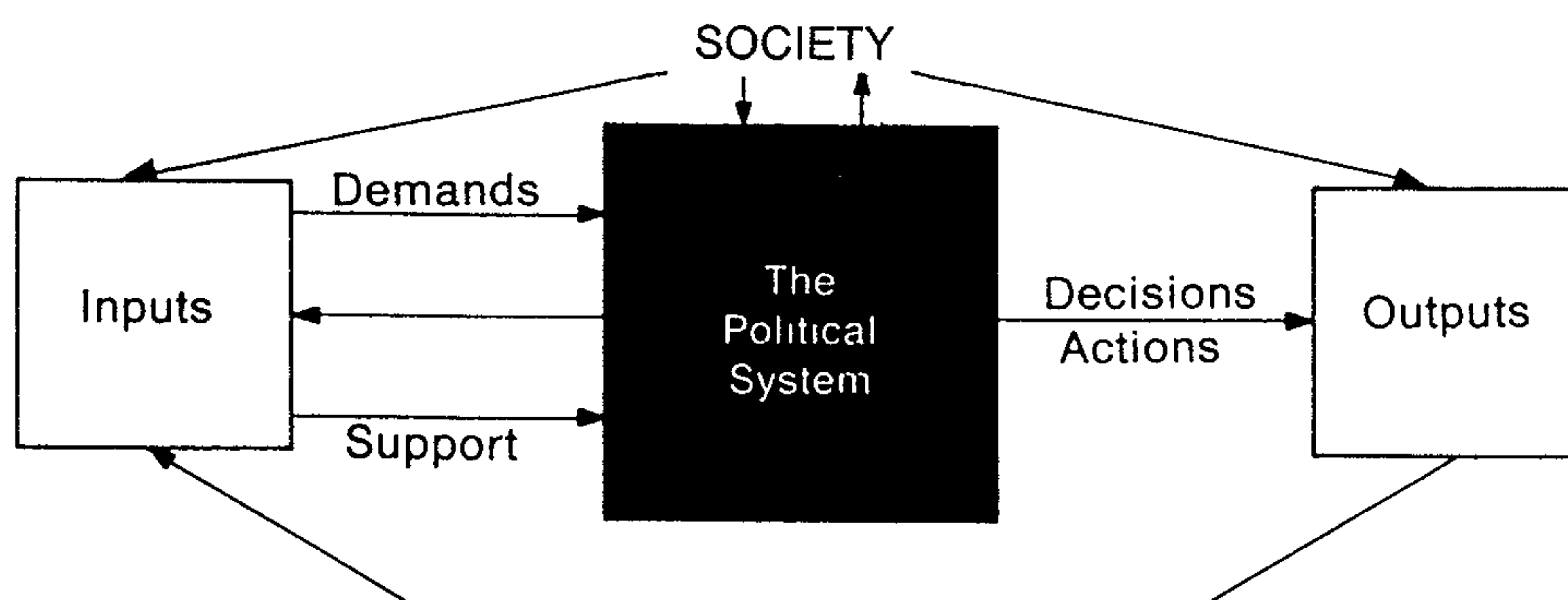
The policy-making process has been conceptualised by analogy to an engine, with inputs such as petrol at one end, being processed by the engine and converted into outputs such as movement and noise at the other. Such 'systems' thinking provides the analytical starting point for the field of study that focuses on the policy-making process. This idea was most influentially developed in Easton's (1965) work, which viewed policy making as a dynamic system of inputs, processes, and outputs. In this model, inputs include requests to deal with particular problems, and expressions of support, or otherwise, for particular lines of action. In the conversion process, or 'black box', of the policy-making process these inputs are transformed into decisions and actions, that is into policy outcomes. These outcomes then influence the inputs and the process, thus completing what is seen as ongoing feedback cycle.

In **Figure 31** the adapted Easton's basic system model to demonstrate more adequately factors that are discussed later in this chapter. Thus, the arrow running from the political system to the inputs expresses the perception that governments, for example, try to influence the inputs, such as demands for policy changes. The interaction of 'society' with the political system, and the influence of society on inputs and outputs, to indicate that all these processes are shaped by the values and norms of the wider community and by economic and other forces. (Kimberly, Zajac 1985)

Figure 31

A 'systems' model of the policy-making process.

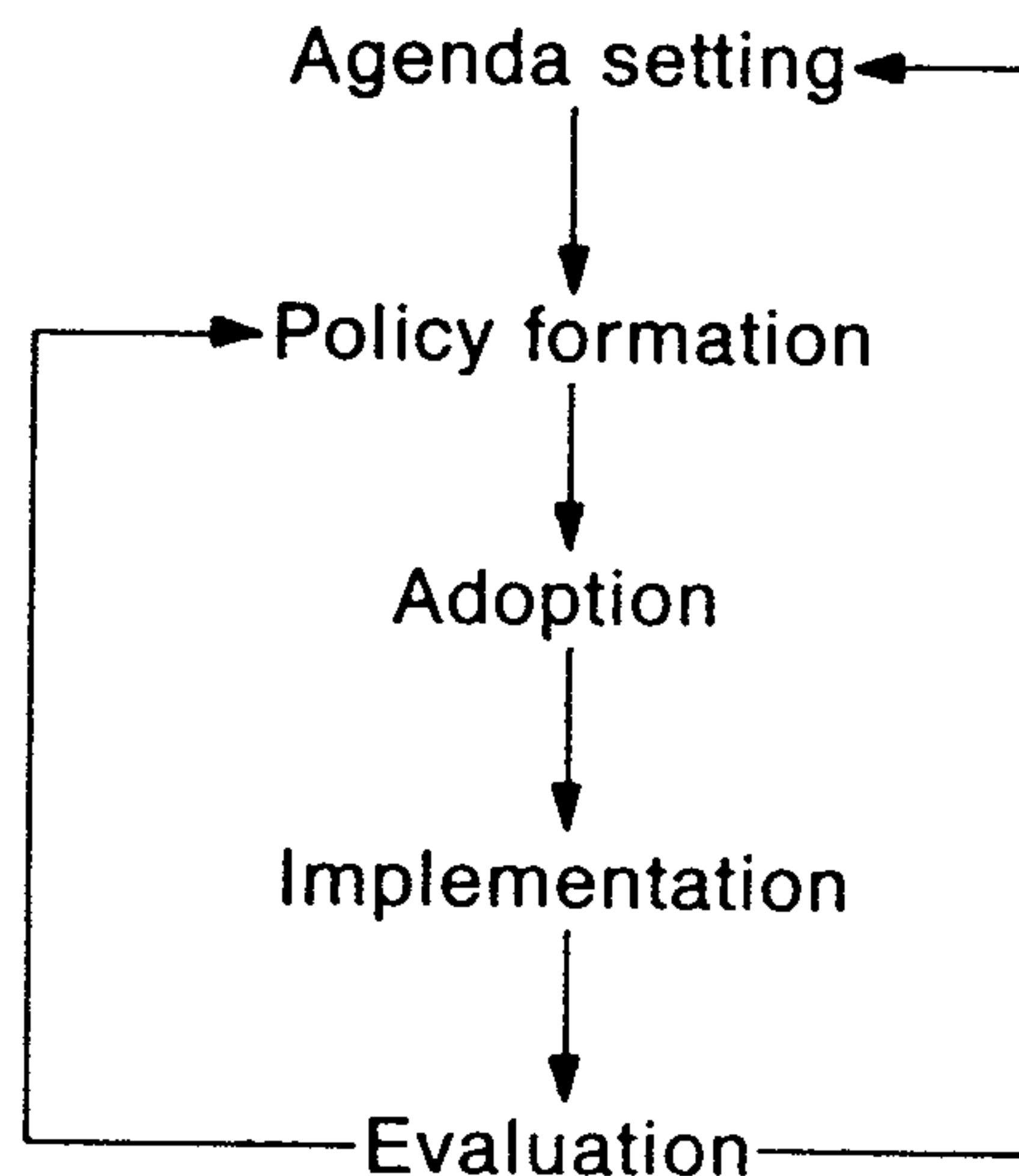
Source: Adapted from Easton (1965a)



This 'policy as process' perspective focuses on 'actors' in the policy system, those individuals and groups, including politicians, administrators, doctors, and community groups, who are active in the policy process. It should be emphasised, however, that this approach is limited in scope because important structural questions are left unasked and unanswered. For example why are the demands of some groups systematically more influential than those of others? However, the middle level of analysis does have considerable analytical power, particularly in describing how the stability of 'democratic' political systems is maintained.

The five key stages in the health-policy-making process are the following:

- * *PROBLEM IDENTIFICATION AND AGENDA SETTING*, in which policy problems are defined and the policy agenda set. Here it is acknowledged that public problems will only reach the political agenda if they are converted into political 'issues'. This usually occurs when an interest group demands government action on a problem, or when there is public disagreement over ways in which a problem should be addressed.
- * *POLICY FORMATION* is the stage in which policies are created or changed. Here it is emphasised that the content of a policy cannot be understood apart from the political context within which it develops. It is useful to understand policy formation as a social and political process in order to conceptualise how policies are formulated (Milio 1988). The formation stage, which is also referred to as policy formation, design, or development, will receive particular attention when we examine policies relating to issue such as tobacco industry regulation.
- * *ADAPTATION* is the stage when the policy is enacted, or brought into force, for example, by Province or Central government legislation. Note, however, that new or changed public policies are often adopted by means of a decision of the cabinet, or indeed of an individual minister, without any legislative change, if the existing legislation and administrative arrangements leave a good deal of discretionary power in the hand of the executive branch of government.
- * *POLICY IMPLEMENTATION* includes the action and mechanisms whereby policies are brought into practice, that is, where what is written in the legislation or policy document is turned into a reality. In this stage the content of the policy, and its impact on those affected, may be modified substantially, or even negated.
- * *POLICY EVALUATION*, the final stage in the health-policy-making process, includes monitoring, analysis, criticism and assessment of existing or proposed policies. This covers the appraisal of their content, their implementation and their effects. Moreover, evaluation is designed to help governments to implement policies in an effective and efficient manner. (Figure 32)

Figure 32**Key stages in the health-policy-making process.****Source: Palmer, Short (1989)**

The link between policy formation and implementation is an important aspect of the process because governments often encounter difficulties when attempting to translate intentions and promises into action. Implementation may be the most demanding aspect of policy making because of the failure to anticipate opposition to the policy or because the resources required for successful implementation have been underestimated.

If the whole governmental process is visualised as a giant 'system', with 'inputs' of funds, personnel and political pressures, with 'throughput' of ideas, people and a multitude of activities, then the 'output' of the system are the range of policies developed to meet various needs and demands, many of which will be implemented and eventually become 'settled' policy. (Gardner, Short 1989)

The government should follow a systematic experimentation strategy in seeking to improve the effectiveness of social action programs. (Rivlin ??)

The process will not be easy or quick or cheap. Nor can one look forward to an end to it. It would be a mistake to adopt systematic experimentation in the hope that it would "tell us what works." The phrase suggests that there is some all-time optimum way of organising social services and that we are going to find it and then quit. Clearly the world is not like this. What works for one place or one generation will not work for another. The

process of developing new methods, trying them out, modifying them, trying again, will have to be continuous. But unless we begin searching for improvements and experimenting with them in a systematic way, it is hard to see how we will make much progress in increasing the effectiveness of our social services. (Rivlin ??)

The process of policy suggested by Gardner (1989) is presented in Figure 33.

Figure 33

The policy process.

Source: Gardner (1989)

System		Activities	Output
Problem to Government Phase			
Problem Identification	Event	Perception (receiving and registering an event)	Problem
		Definition (bringing into sharp relief the effect of an event)	
		Aggregation (grouping)	
		Organization (developing structure)	Demand
		Representation (developing and maintaining access)	
		Agenda setting (theories, strategies)	Agendas 1. Problem Definition 2. Proposal 3. Bargaining 4. Continuing
Action in Government Phase			
Program Development	Legitimacy (authorizing and supporting government)	Formulation (developing a plan, a method, a prescription for acting on a problem): Includes routine, analogous and creative formulation.	Proposal
		Legitimation (approving a proposal by an accepted means—importance of majority coalition building)	Program
		Appropriation (approving program funds) 1. Formulation 2. Legitimation	Budget
Government to Problem Phase			
Program Implementation		Organization (establishing administrative methods and units)	Structure
		Interpretation (translating authorization into acceptable feasible directives—importance of discretion)	Working rules/ Standards
		Application (routine provision of services, payments, controls—importance of “mutual role taking”)	Varies (depends on program)
Program to Government Phase			
Program Evaluation		Evaluation (judging the merit of programs—as functional activity in all systems; as a systematic endeavor for specific programs)	Varies (depends on findings)
		1. Specification (setting purposes, criteria)	
		2. Measurement (collecting data—systematic, unsystematic)	
		3. Analysis (reviewing data—systematic, unsystematic)	
		4. Recommendation (proposing change)	
(Emergence of policy cycles of support, incremental adjustment, program change, redefinition or discovery of problems).			
Problem Resolution or Change Phase			
Program Termination		Resolution (effecting change in public problems)	Relative solution; social change
		Termination (organization adjustment)	

Health policy evaluation requires critical examination of the impact of policies on outcomes such as health status, outcomes that are extremely complex and difficult to measure. Health services are the main output of the health care system, improvement in the health of the population is its principle objective. The distinction between health care and health status is, therefore, archetypal of the distinction between outputs and outcomes.

Fundamentally, policy evaluation requires that we know the objectives of a given policy, how it is to be implemented, and what, if anything, has been accomplished towards attainment of policy goals. Further, we need to be able to distinguish between what occurred despite the policy, and what occurred as a result of the specific policy. Policy evaluation may reveal that policies are not achieving their stated goals, or that they have produce results that were not anticipated. (Palmer, Short 1989)

Health service evaluation generally focuses on two criteria: effectiveness and efficiency. Effective and efficient services may produce inequitable results in the sense that groups with relatively high levels of health status may benefit much more than those with lower levels of health status. Do particular policies yield services that are commensurate with variations in health status, and why do some group of people, continue to have such a poor level of health status? (Palmer, Short 1989)

In *MACRO POLICY ANALYSIS* the wider social, economic and technological context within which the existing policy-making system operates. A broad analytical perspective, which is sensitive to the historical, sociological, economic and political factors that shape and constrain the policy-making process, is necessary in order to augment the other levels of analysis. (Palmer, Short 1989)

4.6 PRINCIPLES OF POLICY DEVELOPMENT

Health is a national human and economic resource and access to health information should be a public right. Public access to health information is a primary responsibility of health policy makers, the health industry and health practitioners.

The basis for the development and future support of a national, preventive and community-oriented program must be appropriate initiatives tailored to the needs of local areas and specific population groups. Therefore we may consider the following principles:

- POLICIES:** An effective Community Health program, will require adequate management, funding and monitoring mechanisms to ensure that major policy goals are actively pursued and attained.
- ACCESS:** Community health services must be accessible to all groups (or if not possible, at least to all members of chosen target group) in need. To achieve this they must be relevant to perceived needs, geographically accessible, culturally appropriate and free of charge to users.
- COORDINATION:** Government initiatives should optimise coordination within and between health and related services. Attention must be given to all levels, down to the local, the most significant for the community.
- INVOLVEMENT:** The Central Government must promote the involvement of citizens and community groups in the direction of health services, and in the informed discussion of health issues.
- ACCOUNTABILITY:** Provinces and other recipients of community health funding must be accountable to the Central government for the expenditure of those funds on bona fide community-based health monitoring expenditure and services.
- PREVENTION:** Emphasis on resourcing preventive activities must be ensured through central government and provinces funding and sympathetic management procedures.

(Australian Community Health Association 1984)

It is apparent that the Central government must give clear policy directions to provincial authorities regarding goals and methods for the community health program. (Australian Community Health Association 1984)

In addition, it is proposed to institute a system of "Community Health Advisory Councils" with a watchdog role, increasing in responsibility over time. This will be a major starting in returning the control of health services to geographical communities.

Community health resources should be allocated to specific communities to control in order to most effectively identify and meet their own needs. These communities can be geographically defined or defined in terms of their community of interest, and must be given direct control over their health services.

The Department of Health should expect initial submissions and yearly returns from the Provinces and other recipients of community health program funding which detail the objectives, staffing and funding of community-based services on a regional or area basis. The Department can thus ensure that provincial activities follow central government policies.

In order to increase, in the longer term, accountability and accessibility within the health system, it is recommended that the Central government should explore ways of increasing the proportion of insurance funds going to salaried staff through the Community Health Program.

Primary health care services in the community should be comprehensive, multi-disciplinary and have an integrated management structure.

Primary health care provided by community health services must include medical care, as well as paramedical, pharmaceutical and dental services.

Equity remains an important goal in primary health care. Fees should not be attached to community health activities, nor should community health services rely on insurance or workers compensation reimbursements for services. (Australian Community Health Association 1984)

Health agencies should be requested to demonstrate their capacity to pursue solutions to health problems at local, regional, province and national levels. Structures for community involvement at each of those levels should be demonstrable.

Standards and accreditation for community health should emphasise prevention and education and make provision for community involvement in these areas.

The Central Government should provide funds to increase and develop ongoing professional education for community health workers.

Health Departments need structures and procedures that have the capacity to advocate for community groups who wish to influence social policy as a method of addressing their health problems. At times, people need to go beyond their locality in order to develop solutions to health problems.

Staff themselves must also be involved in the management of community health services. Effective work unit, in the form of multidisciplinary teams, have been one of the more successful features of the Community Health Program to date. Such units must be supported and developed further. Workers should be represented on all management and advisory committees, while control is vested in the community to be served.

Many of the staff working in community health have been trained in institutional or academic settings with little preparation for the realities of community health work. This must be overcome in future by provision of opportunities for a range of educational experiences in community health. (Australian Community Health Association 1984)

All communities should have access to health educators who will work with them to identify and assess health problems, and develop solutions. Such educators should have skills in social analysis, education and community development.

Prevention and education workers need to be supported by a structure that provides ongoing education, quality assurance, and resources for evaluation and research.

Education for community health workers is most effective when it gives opportunities for knowledge and skills to be learnt, applied and reinforced in the work setting.

Political commitment is essential for the attainment of health for all. It is therefore the first of the field for which indicators are considered here. But what are indicators of political commitment? The seriousness of political commitment, for example, can really only be measured by the extent to which socially relevant development strategies such as primary health care actually being implemented. (Australian Community Health Association 1984)

4.7 DENTAL HEALTH POLICY SUGGESTIONS FOR IRAN

In proposing a dental health policy for Iran it must be emphasised that the needs for prevention and control of dental disease are equally as important as the provision of other dental care services. An adequate and effective programme cannot be developed without the joint co-operation of the organised dental profession and the Department of Public Health. Each organization has a specific role to play which must be clearly established and defined to bring about the maximum use of trained personnel in order to improve the dental health of the residents of the country.

4.7.1 Pre-requisites

1.1 A Survey of Needs and Demands for Dental Treatment

WHEREAS any future planning for the provision of dental services to the community necessitates a factual basis from which plans can be formulated and implemented, it is recommended that the Government undertake or sponsor a dental survey to determine the present and projected future needs of the community and demands on the dental profession for dental services.

The surveys to have regard to the requirements of:

- (i) metropolitan areas; and
- (ii) provincial areas; and these be further subdivided under -
 - (a) pre-school children
 - (b) children under 15
 - (c) adolescents
 - (d) adults
 - (e) the indigent and pensioners and their dependent children
 - (f) institutional dentistry
 - (g) others.

In the above groups, consideration also should be given to the existing available dental manpower and to its productivity. The survey should currently be determined and thereafter repeated in subsequent census years, which are normally conducted at five-year intervals. Where possible, projected needs and demands for each five-year period should be estimated.

1.2 Prevention

Because it is necessary that the community be made aware of the importance of dental health and of the known means of preventing dental disease, it is recommended that a Division of Dental Public Health be established within the Public Health Education Unit. The function of this Division should be the conduct and co-ordination of dental health education programmes in conjunction with other bodies, since the success of any future programme of dental treatment depends upon an effective preventive programme.

4.7.2 Provision of Dental Care in the Community

2.1 Whereas dentistry is an essential health service, and

WHEREAS dentistry is an essential health service and *WHEREAS* it is recognised that dental treatment should be carried out only by trained persons,

it is recommended that

all dental treatment be rendered or supervised by a registered dentist and oral health workers.

WHEREAS in order that treatment be rendered at a high standard but in an efficient and economic manner,

it is recommended that the auxiliaries, which must be trained for the assistance of the registered dentist, shall be

- a the dental nurse;
- b the oral health workers; and
- c the dental technicians.

In this case the dentist, together with the auxiliary personnel as recommended, form the dental health team.

2.2 Increased Facilities for Undergraduate and Graduate Education

WHEREAS a dentist should be educated to the highest standards

it is recommended that in the first instance the equipment, accommodation, teaching staff and ancillary staff of the Dental School of the university of Tehran be brought to, and maintained at, the highest contemporary teaching standards, and there should be no restrictions on the acceptance of patients whose requirements are suitable for teaching purposes.

It is further recommended that where fully equipped dental departments are established at selected major hospitals, such hospitals may be used for the further education of dental undergraduates and graduates.

2.3 Government Subsidised Dental Insurance Scheme

WHEREAS most dental disease is cumulative and requires constant treatment, and *WHEREAS* the cost of providing such constant treatment is beyond the financial capacity of the community, it is therefore recognised that the cost of dental treatment is a significant barrier to the development of high dental health standards in the community, and *WHEREAS* the most economic and desirable method of preventing the bulk of dental services is by private practice permitting of free choice of dentist, **it is recommended that** a government-assisted voluntary contributory dental insurance scheme (dental benefits) be introduced.

Such a scheme should be initiated for children in the first instance because:

- a It would concentrate dental treatment on a group of the population at an early age with the ultimate aim of producing a dentally fit total population.
- b It would allow the introduction of a scheme covering persons for whom the need for dental treatment can be established.
- c It would provide a scheme capable of operation by present dental manpower.

4.7.3 Planning, Co-ordination and Implementation of Policy

WHEREAS the most effective approach to improving the dental health of the community and the provision of dental treatment is by co-ordination and co-operation between the Government and the dental profession,

It is recommended that:

An Advisory Committee be established to consider the future provision of dental services in the Islamic Republic of Iran, and that this committee consist of representatives of the Government and the dental profession.

The Committee should note that:

Dental care should be available to all sections of the community, irrespective of the individual's economic or social background.

Dental disease is widespread and only a small proportion is being treated. Therefore, any programme which is based purely on the provision of restorative services to improve dental health would be both ineffective and uneconomic.

In the immediate future, dental care for the treatment of active dental disease is essential, but effective treatment in the long term needs extended utilisation of proven preventive measures.

The implementation of a community dental health programme must take into account inter alia (a) the nature of the dental care, (b) preventive services which must be provided and (c) the personnel that will be necessary. This is a joint function of the dental profession and the department of public health.

A number of aspects of dental economics will need to be studied to determine dental care needs, the pattern of utilisation of dental care, the cost of services and whether they be provided by governmental or other agencies. The provision for dental health insurance plans must also be included.

Since problems still exist in Iran, especially for the more disadvantaged sectors of the population, and years of slow attrition have widened some of the gaps between needs and provision. Therefore the introduction of National Dental Insurance would certainly lower the barriers to access to basic services for the disadvantaged, and must be seen as the basic building block of a more equitable system.

(Australian Community Health Association 1984)

The general direction of national program is best expressed in the recent initiatives of the World Health Organization in articulating the goals of "health for all by the year 2000". There could be little argument about the value of improving the health status of the population, and ensuring equity in access to all levels of the health care system.

The strategies to achieve these general goals cannot be totally prescriptive, but must take a range of local factors into account. A set of guidelines for a national program must address the need for local action as the basis of durable changes.

(Australian Community Health Association 1984)

Community health policy should provide a major foundation for a National Preventive Health Care (WHO, 1978), subsequently elaborated in Towards Health for All (WHO, 1981) and New Approaches (WHO, 1983). In essence, these documents give prime importance to health education in promoting individual and community self-reliance and in developing people's ability to become full partners in health promotion and care.

(Australian Community Health Association 1984)

5 CONCLUSIONS

By nature the dentition is intended to last for a life time.

Oral health is an inseparable part of total health but has often been treated as if it were not, and left to develop rather independently. This attitude has led to the common experience of initial neglect of the oral health sector because too low a priority was allocated to it, followed by inordinate expenditure, private or public, on curative, restorative and rehabilitative services demanded by a public allowed to regress from low to high prevalence of oral disease. *Yet, the main oral diseases are eminently preventable or controllable.*

The worldwide prevalence of dental caries and periodontal disease is well recognised.

The incidence and prevalence of each may vary from one community to another, and all age groups may be affected, but dental caries tends to be more prevalent in young while periodontal disease more commonly affects the adult population. Both are chronic destructive diseases: dental caries destroys the hard tissues of the teeth, whereas periodontal disease destroys the supporting structures and tissues. *Both diseases may cause pain, infection, disfigurement, interference with function, and emotional problems.*

There is the presence of a common factor in the initial stages of development of both dental caries and periodontal disease. Both dental caries and periodontal disease are associated with accumulation of bacterial plaque on tooth surfaces. In neither disease is the aetiology simple and many cofactors have been postulated, and in some cases proven, to be aetiological or predisposing to these conditions. *In dental caries the importance of diet and tooth susceptibility is well established, whereas in periodontal disease variables, including those affecting plaque accumulation, host defence and local bacterial flora, are cited as of importance to the initiation and progression of the disease.*

Standardised epidemiologic methods generally provide valuable data for comparison of prevalence and patterns of disease in one population with those of another, in the same population at different times, and between several subgroups within a population. *Many epidemiologic reports show that oral health problems may be the most common disease throughout the world.* (Truin et al. 1981)

Data on the prevalence and intensity of oral disease, show alarming trends.

Each year the global mean for 12 year old children, based on data obtained from *developing countries* and processed by the WHO Global Bank, *shows a marked increase in dental caries.* In some cases, caries in many such countries has advanced from negligible proportion to a public health problem of the first order. This has been due primarily to the tremendous increase in the prevalence of dental caries, which probably started in the nineteenth century and accelerated in the early decades of the twentieth century. The effect of this increase, superimposed on an *already high prevalence of periodontal disease*, was that a growing proportion of the population suffered from repeated episodes of acute pain from early childhood to the third or fourth decade of life and from premature loss of teeth.

Today the occurrence of dental caries has become universal, affecting all ages and all races from all geographic areas of the world. The onset of dental caries in the age group of children having passed their first birthday caries frequency was found to be 5 per cent and the df count amounted to 0.15, according to the investigations of Toth and Szabo (1960). Studies reported for children of 2 years indicated that some teeth were so completely destroyed that only tooth remnants remained.

In comparing dental caries prevalence it is necessary to focus on a similar age group. Most attention has been paid to 12-year-old, as they provide data on caries at exit from primary school. At this age a DMFT range of 0.0 to 1.1 is very low, 1.2 to 2.6 is low, 2.7 to 4.4 is moderate, 4.5 to 6.5 is high and 6.6 or greater is very high.

The WHO goal for the year 2000 is that DMFT at age 12 yrs should be 3.0 or less.
 Another principal indicator for oral health is the proportion of caries-free children.

School oral health programs with emphasis on prevention are a necessity.

During the 12-year period that an individual attends school, dental caries occurs, calculus forms, and the early stages of periodontal disease often appear. Most school dental programs have focused on the teaching of dental information; few have included active preventive dentistry programs. School systems should employ dental hygienists as a resource person to aide in the teaching programs and/or to accomplish needed prophylaxis. Highly effective primary preventive dentistry techniques can be easily implemented in school programs with a relatively little requirement of time, manpower, money, and material. The use of these proven preventive approaches to better oral health could do much to bring the annual incidence of caries and periodontal disease down to a point where all those experiencing disease could be treated. The availability of dental hygienists provides an effective and economical means to screen school populations during the school year and to refer discerned pathology for definitive diagnosis and treatment. The combined effect of the teaching and clinical preventive programs has the potential of rendering the dental treatment workload of a school to the point that a zero or near zero extraction status would be achieved. This potential has been realised, that in school dental health program, the teacher, the hygienist, the school nurse and the oral health workers, should work as a team in broad-based preventive and referral program that could greatly improve the oral health status of all school children. (Harris 1987)

Periodontal disease needs to be recognised and prevented. Periodontal disease is a generalised term for a range of pathological conditions affecting the supporting and investing structures of the teeth, *it is said to be one of the most widespread disease of mankind* (WHO 1978). The disease ranges from simple marginal gingivitis to advanced chronic destructive periodontal disease. *Gingivitis affects over 80 per cent of young children and almost the entire adult population have experienced gingivitis, periodontitis, or both. Therefore, they comprise a world-wide health problem of major proportions.* (WHO 1978)

Chronic gingivitis and periodontitis are the most common categories, while acute necrotising ulcerative gingivitis and juvenile periodontitis are the most destructive form of periodontal disease. *Periodontal disease increases in prevalence and severity with increasing age.*

Chronic periodontal disease presents a challenge to the dental profession, not only in its recognition, diagnosis and treatment, but also in public and patient education.

Epidemiologic surveys may place the prevalence of the chronic gum diseases at the highest levels but the public has accepted the most obvious sign, bleeding, as 'normal' and only in the later stages of the disease which gingivitis may develop into irreversible loss of tooth attachment, then treatment is demanded. This condition starts at the mixed dentition period, thus dental practitioners must be the first to recognise periodontal disease and then must persuade the patient to take personal action and to seek professional assistance. *Improvements could best be achieved by means of primary prevention starting early at 7 years of age.* (Ainamo, Ainamo 1981)

In the past decade there have been many changes in periodontal concepts.

A more conservative basis to treatment and to general management is now well accepted, with disease control rather than cure as the major objective, and regular maintenance a necessity. Disease activity is the primary criterion by which both dentist and patient should recognise and monitor periodontal treatment needs. *Current concepts have been used to introduce a simple specific and realistic screening and monitoring examination.* It utilises the Community Periodontal Index of Treatment Needs (CPITN) developed by the Oral Health Unit of WHO with FDI in 1981. This index, designed for population surveys, has been adapted for use in general practice. *Data, based on CPITN, now accumulating at the WHO Global Oral Data Bank are just beginning to provide a global picture of periodontal disease patterns.* (Renson et al. 1985)

Review of epidemiological surveys of the periodontal conditions of young people has shown that chronic marginal gingivitis associated primarily with plaque, is global, very common and even endemic in some population groups. Data on the prevalence of transient gingival conditions associated with tooth eruption, puberty and systemic factors are lacking and therefore their contribution to the prevalence of periodontal disease is unknown. Reports of periodontitis in young people are relatively uncommon except in a few populations where it appears as an adult-type of chronic marginal periodontitis.

Juvenile periodontitis and other more destructive forms of periodontitis are not common. However, problems in epidemiological methodology and clinical differential diagnosis make comparative evaluation of survey data difficult and subjective. *Two epidemiological indices, the Periodontal Index and the Community Periodontal Index of Treatment Needs (CPITN) have been used for many surveys in varied population groups.* They provide data which agree on the ubiquity of gingivitis, whether identified visually or by bleeding-on-probing, and the low frequency of periodontitis. *Data from CPITN surveys reveal a higher prevalence of calculus (sub-gingival) associated with gingivitis in young people than previously reported. All the epidemiological data reviewed point to plaque as the primary aetiological agent in gingivitis.*

For a preliminary overview of the periodontal disease pattern and profile we have to rely on the relatively few studies where very careful calibration of examiners and the use of a standard methodology have provided us with comparable data (Renson et al. 1985). At 12 years components of the CPITN Index could provide the basis of a global indicator of periodontal health - not less than 3 healthy sextants per child by year 2000. At 15 years zero sextants with periodontal pockets is a feasible aim. (Barnes, Leous 1986)

Existing data clearly indicate that periodontal treatment needs arise at an early age.

This indicates a need to emphasise the implementation of proper self-care measures at an early enough age for the improved oral hygiene to have a preventive effect on both gingivitis and calculus. (Ainamo, Tervonen, Nordbland, Kallio 1987). *Improvements could best be achieved by means of primary preventive measures starting early at 7 years of age.* (Ainamo, Ainamo 1981)

There is a lack of an objective index for malocclusion and lack of comparability among reports on the prevalence of this anomaly. This makes any attempt at establishing an overall picture of the prevalence of malocclusion a hazardous undertaking. *Nonetheless, it has been estimated that about half of the school-age population in the U.S.A. needs some kind of treatment, and that one in five children suffers from malocclusion that could be considered severe.*

It is generally accepted that individuals with malpositioned teeth are more prone to dental decay than those with a good occlusion, because of increase in food impaction and retention. It is recognised also that untreated dental caries causes a breakdown of contact points and eventually, premature loss of the teeth, leading to malocclusion. *Reports agree that individuals with malocclusion showed higher caries rates than those with good occlusion.*

Malalignment of the teeth could obviously decrease the efficiency of natural hygiene and lead to food impactions and traumatisation of the gingival tissue. *Disturbances in the direction of the occlusal force and the overloading of individual teeth caused by malocclusion have been considered an important factor in the ethology of periodontal disease.*

From clinical observations and from the findings of a few carefully conducted surveys, a highly significant correlation appears to exist between malocclusion and periodontal disease, emphasising the need for early treatment of malocclusion, not only for the sake of the immediate problem but in order to prevent later deterioration of the supporting structures of the teeth.

There is a major need for effective planning for oral health services.

As people become more and more concerned with health problems of all types and because of social, economical and health-based reasons, the need for planning oral health

services and manpower structures to meet carefully defined measurable goals and in harmony with overall health sector plans is receiving recognition to prevent caries and pain where possible and make services more relevant and available. (Hansen 1981)

The lack of resources, manpower and money, combined with their other needs and demands, emphasises the necessity for careful planning of the oral health services in developing countries, and for prevention and control rather than for a curative, restorative, and rehabilitative approach. (WHO 1980)

Much of the action required to meet the goals of Health for All falls within the responsibility of the government. Governments' responsibility for health originates in the realisation that individuals, voluntary organisations, and the private sector are unable to meet all health needs through their own efforts alone. Similarly, services that benefit the country as a whole should be provided without charges to individuals by the government.

Most of the underprivileged in health terms are women and children whose well-being requires special attention within primary health care. Particularly in developing countries, these underprivileged elements of society are politically weak and are often too sick, uneducated, or geographically dispersed to become politically active.

Improving the health status of the population cannot simply be achieved by expanding or developing the health services at the ministerial level. Prevention and control of disease and the promotion of health must be part of a combined effort for the improvement of well-being as a whole. Health care must be supported by improvements in the overall social and economic structure and contributions from sectors other than health. The health sector has the important role of coordinating these inter-sectoral efforts, by defining major problems, by suggesting preventive strategies, by proposing shifts in priorities and resource allocations, by encouraging positive action in other sectors, and by participating in advisory committees responsible for these efforts. (WHO 1988)

The goal for large government-supported dental care programs has usually been comprehensive care for people of all ages on an incremental basis.

All the Member States of WHO have adopted the goal of Health For All By The Year 2000, and all national oral health care systems must take their share of responsibility in efforts to meet this goal. (WHO 1987)

In proposing a dental health policy for Iran it must be emphasised that the needs for prevention and control of dental disease are equally as important as the provision of other health care services. An adequate and effective programme cannot be developed without the joint co-operation of the organised dental profession and the Department of Public Health. *Each organization has a specific role to play which must be clearly established and defined to bring about the maximum use of trained personnel in order to improve the dental health of the residents of the country.*

Community health policy should provide a major foundation for a National Preventive Health Care (WHO 1978), subsequently elaborated in Towards Health for All (WHO 1981) and New Approaches (WHO 1983). In essence, these documents give prime importance to health education in promoting individual and community self-reliance and in developing people's ability to become full partners in health promotion and care. (Australian Community Health Association)

There are many new victims of oral disease; a lot of children have orthodontic conditions; many more of them have periodontal disease and increasing number of teeth must be extracted, or many dentures or bridges must be supplied. *Why is dental disease so prevalent when a considerable amount is known already about how to prevent both dental caries and periodontal disease?* If put into practice this would affect dramatically their prevalence or at least would slow down the rate at which they progress, so that the vast majority of people would be able to keep their teeth, in reasonable condition, for the whole of their lives. (Dental Division MOH Malaysia 1981)

By tradition, dentistry has been largely a reparative profession. However, reparative dentistry alone cannot bring about the control of dental disease which has now reached epidemic proportions in some countries. The result of basic research, applied research and clinical trials from many parts of the world have shown that *preventive dentistry can be highly successful.* (Silverstone 1978)

Dental practice is concerned with the prevention and treatment of oral disease and their sequelae. Practitioners, therefore, should be familiar with the epidemiology of the conditions they treat, because the type of treatment and services provided obviously relate to the diseases prevalent in the community. *Practitioners can apply the epidemiological methods in their own practices to provide a third dimension to help them evaluate the impact of their services.* (Burt 1983)

Dentists, whether they be in private practice or in government service, have a responsibility to provide dental care services to their patients and to uphold their professional aim of improving the oral health of the total community.

Strong and sustained efforts should be made to insure that there is no gap between *the accepted goal that dental care should be available to all, regardless of income or geographic location*, as rapidly as resources would be available and it is our professional responsibility to make real efforts to reach such an objective.

Success requires a team effort, the dentist cannot do it alone - it requires *community recognition at the Ministerial level of the need to ensure optimal oral health.*

It should be mentioned here that acceptance of the primary health care approach as a basis for planning health care in general, and dental services in particular, is the most recommended strategy. (Jacob 1989)

Primary health care services in the community should be comprehensive, multi-disciplinary and have an integrated management structure. If PHC is provided by community health services must include medical care, as well as paramedical, pharmaceutical and dental services. (Australian Community Health Association)

All communities should have access to health educators who will work with them to identify and assess health problems, and develop solutions. Such educators should have skills in social analysis, education and community development. (Australian Community Health Association)

Political commitment is essential for the attainment of health for all. It is therefore the first of the field for which indicators are considered here. But what are indicators of political commitment? *The seriousness of political commitment can really only be measured by the extent to which socially relevant development strategies such as primary health care actually being implemented. The concept of prevention inevitably finds its way into public health which is for the welfare of the group and of the individual at the same time.* (Dunning 1962)

School health as an important public measure constitutes a major endeavour for any department of public health. The gathering of children in a school not only imposes upon government a peculiar responsibility for the prevention of communicable disease, but gives government an unusual opportunity for health appraisal and the prevention of disease. In a quantitative sense, *dental health is one of the large components of any school health program.* (Dunning 1962)

One of the major objectives of health programs is the elimination or reduction of hazards to health. The methods employed to accomplish this purpose may be broadly classed as preventive and therapeutic. The first may be used to eliminate hazards, such as disease and its consequences, through the prevention of their occurrence. The second

or therapeutic method may be used to lessen the ill effects of disease through the application of treatment procedures to mitigate or interrupt the course of the disease. Whichever method is used as the basis for a disease control program, *the effectiveness of the program is measurable in terms of reduction in occurrence of disease or its effects such as disability, illness or death. The evaluation of the accomplishments of a dental program, therefore, is primarily concerned with a quantitative measurement in term of the prevention of dental disease or the reduction of its consequences.*

Evaluation can be viewed as a twofold process: a performance is *MEASURED* under standard conditions, and then *INTERPRETED* by some standard of quality or excellence.

The criteria for evaluating programs may be summarised as follows:

EFFECTIVENESS	Has the stated goals been attained as a result of program?
EFFICIENCY	How much has the attainment of the stated goal cost in absolute terms and in comparison with what was anticipated ?
APPROPRIATENESS	Has priority been given to the useful strategy for attainment of the stated objectives ?
ADEQUACY	Has the program covered the total health problem it was aimed at? What are the levels of availability to the various sections of the population?

To achieve the oral health programme, oral health care personnel with skills appropriate to the extent, and severity of oral disease and the demands of the population are needed. **The greatest challenge in the health field today is that of training and deploying the personnel required in a way that will make care less costly yet fully capable of meeting the stated goals (Mejia 1978).** *In order to fulfil oral health services needs in developing countries, the current and future role of oral health personnel will have to be a public health and prevention oriented one.*

With ideal use of auxiliaries, comprehensive dental care could be supplied to the all schoolchildren of the country up to the age of 17 (end of high school) to cover the teenage period of most rapid tooth decay, on a national health insurance basis. At this period of time in underdeveloped areas of the country, where dentists are often unavailable, oral health workers may best perform the job. School dental nurse are responsible for the early recognition, screening and much of the treatment of oral disease.

In order to obtain a comprehensive view of the prevalence of dental disease in schoolchildren, oral health status must be registered at least at the entry and exit from primary school. *Children should receive first priority in the development of preventive services, partly because of their increased caries-susceptibility, partly because they are more easily accessible, and partly because they are more teachable.*

Incremental dental care starts at the earliest available age (usually age six) when children enter the first grade of elementary school. The object is to bring all children up to date with needed dental care, so that only the increments of need occurring between visits will require care at the next periodic visit to the dentist. There is periodic recall of all children on a yearly basis. It is of interest to consider the demand priorities that exist when dental care is first made available in underdeveloped areas. Emergency care for relief of pain comes first of course.

A national health insurance policy that includes at the outset a dental component that gives priority to preventive and therapeutic services for children and emergency dental care for all (Dunning 1977) is recommended for Iran.

Philosophically, *ALL children should be entitled to receive maximal primary preventive dental care that includes the routine application of the five general methods for control of the plaque disease - use of fluorides, pit and fissure sealants, sugar discipline, plaque control, and education.* (Harris 1987)

The dental treatment of children must be started at the age of 3 years. It should be emphasised that regular examinations, and treatment when necessary, should be initiated between 3 and 4 years of age. There are some periods of human life which are considered of particular importance to the dentition such as the age of 6 and 24 months for eruption in the deciduous dentition and the 6th year for the permanent dentition. Hidasí (1962) concluded that the fourth year of life is of special importance and may be regarded as a critical year in the caries attack rate of the deciduous dentition, and prophylactic measures should be instituted early enough to mitigate the damage in this critical year.

Ideally the students should be screened at least once every school year for the presence of caries, periodontal problems, calculus, or other visible oral pathology. Dental caries and periodontal disease are theoretically preventable by regular and careful oral hygiene procedures to remove dental plaque.

The most efficient way to prevent caries and periodontal disease is to control them in childhood and in young adult life. It is especially important to take advantage of the school setting for it is possible to reach all schoolchildren with well-planned preventive measures. At the same time, most children have only mild form of disease that can be treated easily. If a systematic programme of preventive measures for schoolchildren, including regular check-ups, is carried out, it is to be expected that after some years the oral health of the entire population would be much improved.

Children can not wait until our economic obstacles and other constraints have been rectified, it is now that their minds and bodies are being formed and it is now that they need adequate food, health care, and education (UNICEF 1990).

THE AIMS OF SCHOOL BASED ORAL HEALTH PREVENTIVE PROGRAMS.**THESE SHOULD BE:**

- 1 *To help every child appreciate the importance of a healthy mouth.***
- 2 *To help every school child appreciate the relationship of oral health to general health and appearance.***
- 3 *To encourage the observances of dental health practices, including personal care, professional care, proper diet, and oral habits.***
- 4 *To enlist the aid of all groups and agencies interested in the promotion of school health.***
- 5 *To correlate dental health activities with the total school health program.***
- 6 *To stimulate the development of resources to make dental care available to all children and youths.***
- 7 *To stimulate dentists to perform adequate health services for children, in general and school age children in particular, as a major priority area.***

TO IMPROVE THE PRESENT SITUATION OF SCHOOLCHILDREN IN IRAN.**THE FOLLOWING MEASURES SHOULD BE TAKEN:**

- 1 *The use of preventive and therapeutic measures to combat periodontal disease, particularly in children and young adults, should be intensified.***
- 2 *A dental plaque control program should be carried out as widely as possible.***
- 3 *Efforts should be concentrated on the diagnosis and treatment of early periodontal disease.***
- 4 *A good recall system, especially for children and young adults should be organised.***
- 5 *The dental service network and the organisation of continuing education for all dental staff should be improved.***

6 REFERENCES

- Addy M, Dummer PMH (1986).
Prevalence of plaque, gingivitis and caries in 11-12-yr-old children in South Wales.
Community Dent Oral Epidemiol 14:115-118.
- Adler P, Tóth Á, Csémi L (1965).
A caries epidemiológiája a tejfogazatban II. Az egyes tejfogak caries-intenzitása és esendősége (Caries epidemiology in deciduous dentition II. Caries attack rate of individual milk teeth). Fogorv Szle 58:100-106.
Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary.
Budapest: Akadémiai Kiadó. p112.
- Adler P, Hradecky C (1966).
Caries prevalence and caries susceptibility of individual deciduous teeth.
Advance Fluor Res 4:107.
Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary.
Budapest: Akadémiai Kiadó. p112.
- Ainamo A, Ainamo J (1984).
The dentition is intended to last a lifetime.
Int Dent J 34:87-92.
- Ainamo J (1972).
Awareness of the presence of dental caries and gingival inflammation in young adult males.
Acta Odontol Scand 30:615.
- Ainamo J (1978).
The 'plaque principle' and its use for explanation of individual variation in susceptibility to periodontal disease. Odontostomatologia e implantoprotesi 1:8-?.
Cited by: Ainamo J (1984). Prevention of periodontal disease in the dental office. Int Dent J 34:56-61.
- Ainamo J (1982).
Assessment of periodontal treatment. A working paper for an EEC sponsored workshop. Public health aspects of periodontal disease.
Copenhagen. EEC.
- Ainamo J (1983).
Epidemiology of periodontal disease.
In: Lindhe J ed. Textbook of clinical periodontology.
Copenhagen: Munksgaard. p67.
- Ainamo J (1984).
Prevention of periodontal disease in the dental office.
Int Dent J 34:56-61.
- Ainamo J, Ainamo A (1981).
prevention of periodontal disease in the mixed dentition.
Int Dent J 31:125-132.
- Ainamo J, Ainamo A (1985).
Partial indices as indicators of the severity and prevalence of periodontal disease.
Int Dent J 35:322-326.

Ainamo J, Barmes DE, Beagrie G, Cutress T, Martin J, Sardo-Infirri J (1982).
Development of the World Health Organization (WHO) Community Periodontal Index of
Treatment Needs (CPITN).
Int Dent J 32:281-291.

Ainamo J, Nordblad A, Kallio P (1984).
Use of the CPITN in populations under 20 years of age.
Int Dent J 34:285-291.

Ainamo J, Paloheimo I, Nordblad A, Muntromaa H (1986).
Gingival recession in schoolchildren at 7, 12, and 17 years of age in Espoo, Finland.
Community Dent Oral Epidemiol 14:283-286.

Ainamo J, Tervonen T, Nordblad A, Kallio P (1987).
Use of CPITN cross-tabulations - a research perspective.
Int Dent J 37:173-178.

Anderson GM (1960).
Practical orthodontics. 9th edn.
St. Louis: Mosby.

Anderson RJ (1988).
Has occlusal caries become more difficult to diagnose? (letter).
Br Dent J 165:9.

Ånerud Å, Löe H, Boysen H, Smith M (1979).
The natural history of periodontal disease in man: changes in gingival health and oral
hygiene before 40 years of age.
J Periodont Res 14:526-540.

Angel EH (1907).
Treatment of malocclusion of the teeth. 7th edn.
Philadelphia: SS White Dental Manufacturing Co.

Arnijot HA, Barmes DE, Cohen LK, Hunter PBV, Ship I (1985).
Oral health care systems.
London: Quintessence for WHO.

Ash MM, Gitlin BN, Smith WA (1964).
Correlation between plaque and gingivitis.
J Periodontol 35:424-429.

Ashly EP (1989).
Role of dental health education in preventive dentistry.
In: Murray JJ. The prevention of dental disease. 2nd edn.
New York: Oxford University Press. pp406-414.

Australian Community Health Association (1984).
A community health policy for Australia.
Australia: Australian Community Health Association.

Axelsson P, Lindhe J (1974).
The effect of preventive programme on dental plaque, gingivitis and caries in school
children. Results after one and two years.
J Clin Periodontol 1:126-138.

Baer PN (1971).
The case for periodontosis as a clinical entity.
J Periodontol 42:516-520.

- Baer PN (1974).
Periodontal disease in children and adolescents.
Philadelphia: Lippincott. p319.
- Bakdash MB (1986).
Minnesota Dental Association's television campaign.
(unpublished manuscript).
- Barnes DE (1983).
Indicators for oral health and their implications for developing countries.
Int Dent J 33:60-66.
- Barnes DE (1984).
Prevalence of periodontal disease.
In: Frandsen A. Public health aspects of periodontal disease.
Chicago: Quintessence. pp21-45.
- Barnes DE, Leous PA (1986).
Assessment of periodontal status by CPITN and its applicability to the development of long-term goals on periodontal health of the population.
Int Dent J 36:177-181.
- Barnard PD (1980).
Financing dental services.
New Doctor, J Doctors Reform Soc 18:24-27.
- Becker W, Berg L, Becker BE (1979).
Untreated periodontal disease. A longitudinal study.
J Periodontol 50:234-244.
- Berislav T (1990).
Classification of periodontal diseases.
Int Dent J 40:171-175.
- Berlin AJ (1979).
Classification of cleft lip and palate and related craniofacial disorders.
In: Bzoch KR. Communicative disorders related to cleft lip and palate. 2nd edn.
Boston: Little, Brown and Company.
- Berndorfer A (1962).
A 500-year-old skull with cleft lip.
Br J Plastic Surg 15:123-128.
- Bilimoria KF (1958).
Malocclusion - its role in the causation of periodontal disease.
J All-India Dent Assoc 35:293-300.
- Bille J, Thylstrup A (1982).
Radiographic diagnosis and clinical tissue changes in relation to treatment of approximal carious lesions.
Caries Res 16:1-6.
- Binder K, Driscoll WS, Schutzmannsky G (1978).
Caries preventive fluoride tablet programmes.
Caries Res 12 (Suppl 1):22-30.

Birkhed D, Edwardsson S, Hallonstan AL, håkansson C, Koch G, Lindvall AM, Mejäre I, Wendt LK (1987).

On prediction of caries in 5-year-old children. (Unpublished observations)

Cited by: Koch G (1988). Importance of early dentition of caries risk.

Int Dent J 38:203-210.

Blinkhorn AS (1978).

Influence of social norms on toothbrushing behaviour of preschool children.

Community Dent Oral Epidemiol 6:222-226.

Bonnet PH, Ruderman AP (1972).

Health care systems and financing.

In: Reinke WA. Health planning quantitative aspects and qualitative techniques.

Baltimore, Maryland: Johns Hopkins University. pp209-218.

Brady WF, Martinoff JT (1982).

A simplified examination, diagnosis, and treatment classification of periodontal disease.

J Am Dent Assoc 104:313-317.

Braybrooke D, Lindblom CE (1963).

A strategy of decision.

New York: Free Press. p71.

Brown Y (1983).

Your children's teeth.

Australia: Pitman.

Brucker M (1943).

Studies on the incidence and cause of dental defects in children. IV. Malocclusion.

J Dent Res 22:315-321.

Bureau of Economic and Behavioral Research (1979).

Dental habits and opinions of public: Results of a 1978 survey.

Chicago: American Dental Association.

Burt BA (1983) The epidemiology of oral disease.

In: Striffler DF, Young WO, Burt BA. Dentistry, dental practice, and the community. 3rd edn.

Philadelphia: Saunders. pp115-152.

Burt BA (1983). Financing for dental care services.

In: Striffler DF, Young WO, Burt BA. Dentistry, dental practice, and the community. 3rd edn.

Philadelphia: Saunders. pp378-417.

Burton JB, Rob MI, Craig GC, Lawson JS (1984).

Changes in the caries experience of 12 year old Sydney school children between 1963 and 1982.

Med J Aust 140:405-407.

Carranza FA jr ed (1979).

Gilckman's clinical periodontology.

Philadelphia: Saunders. p319.

Carter WJ, Wells JE (1960).

Epidemiology of gingival disease in Kansas City, Missouri school children.

Midwestern Dent 36:21-24.

- Caton J (1989).
Periodontal diagnosis and diagnostic aids.
Princeton, New Jersey: World Workshop in Clinical Periodontics. ppi-23-l-31.
- Clerehugh V, Lennon M A (1986).
A two-year longitudinal study of early periodontitis in 14- to 16-year-old schoolchildren.
Community Dental Health 3:135-141.
- Cormier PP, Levy JI (1981).
Community oral health. A systems approach for the dental health profession.
New York: Appleton-Century-Crofts. pp175-215.
- Corpron RE (1979).
Reaction to Dr Heifetz' paper.
In: Burt BA ed. The relative efficiency of methods of caries prevention in dental public health. Ann Arbor, Michigan: University of Michigan. pp105-109.
- Craft M, Croucher R, Dickinson J, James M, Clements M, Rodgers AI (1984).
Natural Nashers: a programme of dental health education for adolescents in schools.
Int Dent J 34:204-213.
- Crivelli MR, Aguas S, Quarracino C, Bazrque P (1988).
Influence of socioeconomic status on oral mucosa lesion prevalence in schoolchildren.
Community Dent Oral Epidemiol 16:58-60.
- Crossner CG, Unell L (1986).
A longitudinal study of dental health and treatment need in Swedish teenagers.
Community Dent Oral Epidemiol 14:10-14.
- Croxon LJ (1984).
A simplified periodontal screening examination: The Community Periodontal Index of Treatment Needs (WHO) in general practice.
Int Dent J 34:28-34.
- Cutress TW (1986).
Periodontal health and periodontal disease in young people: global epidemiology.
Int Dent J 36:146-151.
- Cutress TW, Ainamo J, Sardo-Infirri J (1987).
The Community Periodontal Index of Treatment Needs (CPITN) procedure for population groups and individuals.
Int Dent J 37:222-233.
- Cutress TW, Hunter PBV, Davis PB, Becck DJ, Croxson LJ (1979).
Adult oral health and attitudes to dentistry in New Zealand, 1976.
Wellington Medical Research Council of New Zealand. p197.
- Davies E, Ritchie HP (1922).
Classification of congenital clefts of the lip and palate.
J Am Med Assoc 79:1323-1327.
- Davies G, Wanna J, Warhurst J, Weller P (1988).
Public policy in Australia.
Sydney: Allen & Unwin.
- Davies GN (1968).
The different requirements of periodontal indices for prevalence studies and clinical trials.
Int Dent J 18:560-569.

- Davies HC (1967).
A creative approach to teaching dental care.
Dental Health 6:3-8.
- Davis JS (1924).
The incidence of congenital clefts of lip and palate.
Annals Surg 80:363-374.
- de Muñiz BR (1985).
Epidemiologic oral health survey of Argentine children.
Community Dent Oral Epidemiol 13:328-33.
- Dental Division, Ministry of Health Malaysia (1981).
Dental services Malaysia.
Malaysia: Ministry of Health.
- Department of Community Medicine, The University of Adelaide (1989).
Legislation and the new public health: Introduction.
Community Health Studies XIII(4):397-402.
- Ditto WM, Hall DL (1954).
A survey of 143 periodontal cases in terms of age and malocclusion.
Am J Ortho 40:234 Abstr.
- Djukanovic D (1986).
The prevalence of periodontal disease in children and young adults in Yugoslavia.
Int Dent J 36:182-188.
- Dorn HF (1958).
The mortality of smokers and non-smokers. Proceeding of the social statistics section.
Am Statistical Assoc. pp34-71.
- Dorn HF, Cutler SJ (1958).
Morbidity from cancer in the United States.
Public Health Monograph 56:1-207.
- Dorrance GM (1933).
The operative story of cleft palate.
Philadelphia: Saunders.
- Dowell TB (1988).
The caries experience of 5-year-old children in England and Wales. A survey coordinated by the British Association for the study community dentistry in 1985-86.
Community Dent Health 5:185-197.
- Downer MC (1975).
Concurrent validity of an epidemiological system for caries with the histological appearance of extracted teeth as validating criterion.
Caries Res 9:231-246.
- Downer MC (1984).
Changing patterns of disease in the western world.
In: Guggenheim B ed. Cariology today. Zürich: Karger.
- Downer MC (1989).
Validation of methods used in dental caries diagnosis.
Int Dent J 39:241-246.

Downine RS, Fyfe C, Tannahill A (1990).
Health promotion models and values.
Oxford: Oxford University Press. pp27-48.

Driscoll WS (1974).
The use of fluoride tablets for the prevention of dental caries.
In: Forrester DJ, Schulz EM jr eds. International workshop on fluorides and dental caries reduction. Baltimore: University of Maryland.

Driscoll WS, Swango RA, Horowitz AM (1981).
Caries preventive effects of daily and weekly fluoride mouthrinsing in an optimally fluoridated community: findings after 18 months.
J Pediatr Dent 3:316-320.

Dunn JE Jr, Linden G, Breslow L (1960).
Lung cancer mortality experience of men in certain occupations in California.
Am J Public Health 50:1475-1487.

Dunning JM (1962).
Principles of dental public health.
Cambridge, Massachusetts: Harvard University Press.

Dunning JM (1976).
Dental care for every one: problems and proposals.
Cambridge, Massachusetts: Harvard University Press.

Dunning JM (1977).
Dental care for everyone. Problems and proposals.
Cambridge, Massachusetts: Harvard University Press.

Dunning JM (1986).
Principles of dental public health. 4th edn.
Cambridge, Massachusetts: Harvard University Press.

Dunning JM, Dunning N (1978).
An international look at school-based children's dental services.
Am J Public Health 68:664-668.

Durham G (1989).
Evaluation of "your pregnancy" a New Zealand health information booklet for pregnant women.
Community Health Studies XIII:281-288.

Easton D (1965a).
A systems analysis of political life.
New York: Wiley.

Easton D (1965b).
A framework for political analysis.
New York: Prentice Hall.

Edwards M, Watson ACH eds (1980).
Advances in the management of cleft palate.
London: Churchill Livingstone. pp37-42.

Eulau H, Prewitt K. p456, p481.
Cited by: Jones CO (1977). An introduction to the study of public policy. 2nd edn.
North Scituate, Massachusetts: Duxbury Press.

- Farmer RDT, Miller DL (1983).
Lecture notes on epidemiology and community medicine 2nd ed.
Oxford: Blackwall Scientific Publication.
- FDI (1987a).
Topical and systemic antimicrobial agents in the treatment of chronic gingivitis and periodontitis.
Int Dent J 37:52-62.
- FDI (1987b).
The impact of changing disease trends on dental education and practice.
Technical Report No. 30.
Int Dent J 37:127-130.
- FDI (1988).
Review of methods of identification of high caries risk groups and individuals.
Int Dent J 38:177-189.
- FDI (1990).
Factsheet on oral cancer.
London: International Dental Federation. pp14.1-14.5.
- FDI & WHO Joint Working Group (1985).
Changing patterns of oral health and implications for oral health manpower: part I.
Int Dent J 35:235-251.
- Field HM, Jong A (1971).
Cost-effectiveness of bussing pupils to a dental clinic.
HSMHA Health Reports 86:222-228.
- Finn SB (1982).
The epidemiology of dental caries.
In: Stallard RE. A textbook of preventive dentistry. 2nd edn.
Philadelphia: Saunders.
- Forward R ed (1974).
Public policy in Australia.
Melbourne: Cheshire.
- French J (1985).
To educate or promote health ?
Health Educ J 44:115-116.
- Frobelius ST (1965).
St. Petersburg Medicinische Zeitschrift 9:173.
Cited by: Moller P. Dentofacial deformities: Cleft lip and palate.
In: Pelton WJ, Dunbar JB, McMillan RS, Moller P, Wolff AE (1969). The epidemiology of oral health. Cambridge, Massachusetts: Harvard University Press.
- Garcia AI (1989).
Caries incidence and costs of prevention programs.
J Public Health Dent 49:259-271.
- Garcia-Godoy F, Cordero DA, Sanchez CM, Batista J (1986).
Periodontal treatment needs in 12-16-yr-old children from Santo Domingo.
Community Dent Oral Epidemiol 14:250-252.

- Gardiner JH (1956).
Survey of malocclusion and some aetiological factors in 1000 sheffield school children.
Dental Practitioner Dent Record 6:187-198.
- Gardner H ed (1989).
The politics of health. The Australian experience.
Melbourne: Churchill Livingstone.
- Garn SM, Rowe NH, Cole PE (1977).
Husband-wife similarities in dental caries experience.
J Dent Res 56:186.
- Genco RJ, Christersson LA, Zambon J (1986).
Juvenile periodontitis.
Int Dent J 36:168-176.
- Gibson RM, Fisher CR (1978).
National health expenditures, fiscal year 1977.
Soc Security Bul 41:3-20.
- Gift HC (1986b).
Qualitative evaluation of oral hygiene aids. (unpublished manuscript).
Cited by: Gift HC (1988). Awareness and assessment of periodontal problems among dentists and the public. Int Dent J 38:147-153.
- Gift HC (1986a).
Current utilisation patterns of oral hygiene practices.
In: Loe H, Kleinman DV eds. Dental plaque control measures and oral hygiene practices.
Oxford: IRL Press.
- Gift HC (1984a).
Qualitative evaluation of a new antimicrobial therapy for periodontal disease. (unpublished manuscript). Cited by: Gift HC (1988). Awareness and assessment of periodontal problems among dentists and the public. Int Dent J 38:147-153.
- Gift HC (1988).
Awareness and assessment of periodontal problems among dentists and the public.
Int Dent J 38:147-153.
- Gift HC (1984b).
Utilisation of professional dental services.
In: Cohen LK, Bryant PS eds. Social sciences and dentistry. London: Quintessence.
- Gjerimo P (1982).
Goals for periodontal health and acceptable levels of disease. Means and methods in community strategies. Working paper for an EEC sponsored workshop. Public health aspects of periodontal disease.
Copenhagen: EEC.
- Glickman I (1964).
Clinical periodontology. 3rd edn.
Philadelphia: Saunders.
- Glickman I (1972).
Clinical periodontology. 4th edn.
London: Saunders.

Glickman I (1984).
Clinical periodontology. 6th edn.
London: Saunders.

Goose DE, Hartles RL (1964a).
Aetiology and prevention of periodontal disease in children.
In: Principles of preventive dentistry.
Oxford: Pergamon Press. pp42-51.

Goose DH, Hartles RL (1964b).
Principles of preventive dentistry.
Oxford: Pergamon Press.

Grant JP (UNICEF) (1990).
The state of the world's children.
United Kingdom: Oxford University Press. Published for UNICEF.

Graves RC, Burt BA (1975).
The pattern of the carious attack in children as a consideration in use of fissure sealants.
J Prev Dent 2:28-32.

Gray PG, Todd JE, Slack GL, Bulman JS (1970).
Adult dental health in England and Wales, 1968.
London: Her Majesty's Stationery Office.

Gröndhal HG (1979).
Radiographic caries diagnosis and treatment decisions.
Swed Dent J 3:109-117.

Gunther WO (1931).
Über die Häufigkeit der totalen Gesichtsspalten. University of Leipzig, dissertation.
Cited by: Moller P (1969). Dentofacial deformities: cleft lip and cleft palate.
In: Pelton JW, Dunbar JB, Russel S, Macmillan S, Moller P, Wolfe AE eds. The Epidemiology of oral health. Cambridge, Massachusetts: Harvard University Press. pp94-123.

Haefner DP (1967).
Preventive action in general disease, tuberculosis and cancer.
Public Health Rep 82,45:1-9.

Ham C, Hill M (1984).
The policy process in the modern capitalist state.
Sussex: Harvester Press.

Harris NO (1987a).
Water fluoridation.
In: Harris NO, Christen AG. Primary Preventive Dentistry. 2nd edn.
Los Altos, California : Appleton & Lange. pp159-187.

Harris NO (1987b).
School-based dental health programs.
In: Harris NO, Christen AG. Primary preventive dentistry. 2nd edn.
Los Altos, California: Appleton & Lange. pp453-469.

Harris NO, Simonsen RJ (1987).
Pit and fissure sealants.
In: Harris NO, Christen AG eds. Primary preventive dentistry. 2nd edn.
Los Altos, California: Appleton & Lange.

- Hayes RL (1963).
Oral cancer and occupational health.
J Occupational Medicine 5:342-347.
- Heclo HH (??).
Br J Political Science. p85.
Cited by: Jones CO (1977). An introduction to the study of public policy. 2nd edn.
North Scituate, Massachusetts: Duxbury Press.
- Hidasi GY (1962).
Az alsó és felső tejmolarisok szuvasodásának megoszlása (Distribution of caries among the lower and upper deciduous molars). Fogorv Szle 55:149-150.
Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary.
Budapest: Akadémiai Kiadó. p112.
- Hoch G (1988).
Importance of early detection of caries risk.
Int Dent J 38:203-210.
- Hold RD, Winter GB, Fox B, Askew R (1985).
Effects of dental health education for mothers with young children in London.
Community Dent Oral Epidemiol 13:145-151.
- Horowitz AM (1980).
Oral hygiene measures.
J Can Dent Assoc 46:43-46.
- Horowitz HS (1973).
School fluoridation for the prevention of dental caries.
Int Dent J 23:346-353.
- Horowitz HS, Heifetz SB (1975).
The current status of topically applied fluorides in preventive dentistry.
In: Newbrun E ed. Fluoride and dental caries. 2nd edn.
Springfield, Illinois: Thomas. pp46-80.
- Horowitz HS, Heifetz SB, McClendon BJ, Vegas AR, Guimaraes LOC, Lopes ES (1974).
Evaluation of self-administered prophylaxis and supervised toothbrushing with acidulated phosphate fluoride.
Caries Res 8:39-51.
- Hugoson A, Koch G, Reylander H (1981).
Prevalence and distribution of gingivitis-periodontitis in children and adolescents.
Swed Dent J 5:91-103.
- Jacob MC, Plamping D (1989).
The practice of primary dental care.
Cambridge: University Press.
- Jamison HC (1960).
Prevalence and severity of periodontal disease in a sample of population.
PhD Thesis. University of Michigan.
- Johnson NW (1988).
Detection of high-risk groups and individuals for periodontal diseases.
Int Dent J 39:33-47.

- Jones CO (1977).
An introduction to the study of public policy. 2nd edn.
North Scituate, Massachusetts: Duxbury Press.
- Jones M, Larsen NP, Pritchard GP (1930).
Dental disease in Hawaii.
Dent Cosmos 72:439-450, 574-577.
- Jones RG (1982).
Introduction to preventive dentistry.
In: Stallard RE. A textbook of preventive dentistry. 2nd edn. Philadelphia: Saunders. pp1-17.
- Kay EJ, Watts A, Patterson RC, Blinkhorn AS (1988).
Preliminary investigation into the validity of dentists' decisions to restore occlusal surfaces of permanent teeth.
Community Dent Oral Epidemiol 16:91-94.
- Kerosuo E, Kerosuo H, Kallio P, Nyandini U (1986).
Oral health status among teenage schoolchildren in Dar es salaam, Tanzania.
Community Dent Oral Epidemiol 14:338-340.
- Kernahan DA, Stark RB (1958).
A new classification for cleft lip and cleft palate.
Plastic Reconstructive Surgery 22:435.
- Kimberley JR, Zajac EJ (1985).
Strategic adaptation in health care organisations: implications for theory and research.
Medical Care Review 42:267-302.
- King JM (1978).
Patterns of sugar consumption in early infancy.
Community Dent Oral Epidemiol 6:47-52.
- Kjome RL (1975).
Effects of tooth sample selection on the periodontal disease index.
Ann Arbor: University of Michigan. PhD thesis.
- Klein H, Palmer CE (1938).
Studies on dental caries. V. Familial resemblance in the caries experience of siblings.
Public Health Rep 53:1353-1364.
- Klein H, Shimizu T (1945).
The family and dental disease. I. DMF experience among husbands and wives.
J Am Dent Assoc 32:945-955.
- Klock B, Krasse B (1979).
A comparison between different methods for prediction of caries activity.
Scand J Dent Res 87:129-139.
- Knutson JW (1949).
Surveys and the evaluation of dental programs.
In: Pelton WJ, Wisan JM eds. Dentistry in public health. Philadelphia: Saunders. pp65-91.
- Konrádi D (1905).
A fogak egészségtani jelentősége (Hygienic role of teeth).
Egészség 19:333-337. Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary. Budapest: Akadémiai Kiadó. p111.

- Koch G (1988).
Importance of early dentition of caries risk.
Int Dent J 38:203-210.
- Korkhaus G (1928).
The frequency of orthodontic anomalies at various ages.
Int J Ortho Surg 14:120-135.
- Lamb MW, Ford E (1960).
Dental health of children in the fourth grade of four elementary schools in Lubbock, Texas.
Dent Abstr 5:688-689.
- Lange DE (1984).
Attitudes and behaviour with respect to oral hygiene and periodontal treatment needs in selected groups in West Germany.
In: Frandsen A ed. Public health aspects of periodontal disease. London: Quintessence.
- Larmas M (1985).
Simple tests for caries susceptibility.
Int Dent J 35:109-117.
- Leatherman GH (1982).
Oral hygiene for children: a look at what we must have and what we should do.
Int Dent J 32:253-258.
- Leclercq MH, Barmes DE, Sardo-Infirri J (1987).
Oral health: Global trends and projections.
World Health Statistics Quarterly 40:116-128.
- Lindblom CE (1968).
The policy-making process.
Eaglewood Cliffs, NJ: Prentice-Hall. p13.
- Lindhe J, Hamps SE, Löe H (1975).
Plaque induced periodontal disease in Beagle dogs.
J Periodont Res 10:243-255.
- Lindhe J, Westfelt E, Nayman S, Socransky SS, Heijl L, Bratthall G. (1982).
Healing following surgical/non-surgical treatment of periodontal disease.
J Clin Periodontol 9:115-128.
- Listgarten MA (1976).
Structure of the microbial flora associated with periodontal disease and health in man. A light and electron-microscope study.
J Clin Periodont 10:100-112.
- Listgarten MA, Mayo HE, Tremblay R (1975).
Development of dental plaque on epoxy resin crowns in man. A light and electron-microscope study.
J Periodontol 46:10-26.
- Löe H, Ånerud Å, Boysen H, Smith M (1978a).
The natural history of periodontal disease in man. Study design and baseline data.
J Periodontol Res 13:550-562.
- Löe H, Ånerud Å, Boysen H, Smith M (1978b).
The natural history of periodontal disease in man. Tooth mortality rates before 40 years of age.
J Periodontol Res 13:563-572.

- Löe H, Ånerud Å, Boysen H, Smith M (1978c).
The natural history of periodontal disease. The rate of periodontal destruction before 40 years of age.
J Periodontol 49:607-620.
- Löe H, Morrison E (1986).
Periodontal health and disease in young people: screening for priority care.
Int Dent J 36:162-167.
- Löe H, Theilade E, Jensen SB (1965).
Experimental gingivitis in man.
J Periodontol 36:177-187.
- Lövdal A, Arno A, Schei O, WÆrhau GJ (1961).
Combined effect of subgingival scaling and controlled oral hygiene on the incidence of gingivitis.
Acta Odontol Scand 19:537-555.
- Lowi T (1964).
American business, public policy, case-studies and political therapy
World Politics 16:677-715.
- Lundstrom A ed (1960).
Introduction to orthodontics.
New York: McGraw-Hill.
- McCall JO (1944).
Study of malocclusion in preschool and school children.
Dental Items Interest 66:131-133.
- McDonald RE (1974).
Gingivitis and periodontal disease in children.
In: Dentistry for the child and adolescent. 2nd edn. Saint Louis: Mosby.
- McIntyre J, Wight G, Blinkhorn AS (1985).
A reassessment of Lothian health board's dental health education programme for primary schoolchildren.
Community Dent Health 2:99-108.
- McMillan RS, Wolfe AE (1969).
Periodontal disease.
In: Pelton WJ, Dunbar JB, McMillan RS, Moller P, Wolfe AE eds. The epidemiology of oral health. Cambridge, Massachusetts: Harvard University Press.
- Mahler H (1985).
Oral health care systems. (forward)
In: Arnlijot HA, Barmes DE, Cohen LK eds. Oral health care systems.
London: Quintessence for World Health Organization.
- Mandell RL, Socransky S (1981).
A selective medium for actinobacillus actinomycetemcomitans and the incidence of the organism in juvenile periodontitis.
J Periodontol 52:593-598.
- Mahler H (1988).
Keynote Address.
Health Promotion 3:133-138.

- Manji F, Sheiham A (1986).
CPITN findings and the manpower implications of periodontal treatment needs for Keyan children.
Community Dent Health 3:143-151.
- Marrula J, Murtomaa H, Ainamo J (1977).
Conceptions of Finnish people about the ethology and prevention of dental caries and periodontal disorders.
Community Dent Oral Epidemiol 5:108-115.
- Marthaler TM (1966).
A standardised system of recording dental conditions.
Helv Odont Acta 10:1-18.
- Massler M, Frankel JM (1951).
Prevalence of malocclusion in children aged 14-18 years.
Am J Orthodon 37:751-768.
- Massler M, Schour I (1949).
The P-M-A index of gingivitis.
J Dent Res 28:634.
- Massler M, Schour I, Chopra B (1951).
Relations of malnutrition, endemic dental fluorosis and oral hygiene to the prevalence and severity of gingivitis.
J Periodont 22:205-211.
- Mejia A, Fülöp T (1987).
Health manpower planning: an overview.
In: TL Hall, Menjia A eds. Health manpower principles, methods, issues.
Geneva: World Health Organization.
- Milemane PA, Purdell-Lewis DJ, Weele LT (1983).
Effect of variation in caries diagnosis and degree of caries on treatment decisions by dental teachers using bitewing radiographs.
Community Dent Oral Epidemiol 11:356-362.
- Milemane PA, Vissers T, Purdell-Lewis DJ (1986).
The application of decision making analysis to the diagnosis of approximal caries.
Community Dent Health 3:65-81.
- Milio N (1988).
Making policy: a mozaic of Australian community health policy development.
Canberra: Commonwealth Department of Community Services and Health.
- Miller N, Benamghar (1985).
Enquete sur le temps consacre a la motivation, a l'hygiene et au detarage par les chirurgiens-dentistes de lorraine dans le cadre de l'exercise omnipratique.
Colloque National de Parodontie: Lyon.
- Miller J, Hobson P (1961).
Relationship between malocclusion, oral cleanliness, gingival conditions and dental caries, in schoolchildren.
Br Dent J 111:43-52.
- Mistry KM (1980).
Dental health in India. Prepared for a Symposium on Assisting Dental Education and Dental Public Health in Developing Countries.
Bombay: New Age Printing Press. pp1-2.

- Mitropoulos CM (1985).
A comparison of fiber-optic transillumination with bitewing radiographs.
Br Dent J 159:21-23.
- Mitropoulos CM, Downer MC (1987).
Inter-examiner agreement in diagnosis of dental caries among officers of the reference service.
Br Dent J 162:227-228.
- Mitropoulos CM, Worthington HV (1984).
The effect of different light sources on measuring the prevalence of dental caries.
Community Dent Health 1:111-114.
- Møller H (1989).
Changing incidence of cancer of the tongue, oral cavity and pharynx in Denmark.
J Oral Pathol Med 18:224-229.
- Møller IJ, Poulsen S (1973).
A standardised system for diagnosis, recording and analysing caries data.
Scand J Dent Res 81:1-11.
- Møller P (1969).
Dentofacial deformities: cleft lip and cleft palate.
In: Pelton JW, Dunbar JB, Russel S, Macmillan S, Møller P, Wolfe AE eds. The Epidemiology of oral health.
Cambridge, Massachusetts: Harvard University Press. pp94-123.
- Moore GR (1948).
The orthodontic programs of the Michigan State Department of Health with a new classification of occlusion for survey purposes.
Am J Orthodon 34:335-361.
- Moore WEC (1987).
Microbiology of periodontal disease.
J Periodontol Res 22:335-341.
- Moore WEC, Holdeman LV, Cato EP (1985).
Comparative bacteriology of juvenile periodontitis.
Infect Immun 48:507-519.
- Moore WEC, Holdeman LV, Cato EP, Good IJ, Smith EP, Ranney RR, Palcanis KG (1984).
Variation in periodontal floras.
Infect Immun 46:720-726.
- Moore WEC, Holdeman LV, Simbert RM, Good IJ, Burmeister JA, Palcanis KG, Ranney RR (1982).
Bacteriology of experimental gingivitis in young adult humans.
Infect Immun 38:651-667.
- Moyers RE, Jay P eds (1959).
Orthodontics in mid-century.
St. Louis: Mosby. Reprinted from Workshop in Orthodontics, University of Michigan.
- Muñiz B, Crivelli MR, Paronic HC (1981).
Estudio clínico de las lesiones en tejidos blandos en niños de una comunidad.
Rev AOA 69:405-408.
Cited by: Crivelli MR, Aguas S, Adler I, Quarracino C, Bazerque P (1988).
Influence of socioeconomic status on oral mucosa lesion prevalence in schoolchildren.
Community Dent Oral Epidemiol 16:58-60.

- Murray JJ (1989).
The prevention of dental disease. 2nd edn.
Oxford: Oxford University Press.
- Murtomaa H, Ainamo J (1977).
Conceptions of Finnish people about their periodontal situation.
Community Dent Oral Epidemiol 5:195-199.
- Murtomaa H, Masalin K (1984).
Effects of a national dental health campaign in Finland.
Acta Odontol Scand 42:297-303.
- Nancy M (1986).
Health and the media in Australia - an uneasy relationship.
Community Health Studies X:419-422.
- National Institute of Dental Research (1987).
National survey of oral health of employed adults and older Americans.
(unpublished data). Cited by: Gift HC (1988). Awareness and assessment of periodontal problems among dentists and the public. Int Dent J 38:147-153.
- Neel JV (1958).
A study of major congenital defects in Japanese infants.
Am J Human Genetics 10:398-445.
- Nevins M, Becker W, Kornman K eds (1989).
Consensus report discussion section I.
Princeton, New Jersey: World Workshop in Clinical Periodontics. pp23-31
- Newbrun E (1987).
Epidemiology of caries - Worldwide.
Dtsch Zahnärztl Z 42:8-15.
- Newbrun E (1980).
Achievements of the seventies: community and school fluoridation.
J Public Health Dent 40:234-247.
- Newbrun E (1989).
Cariology. 3rd edn.
Chicago: Quintessence.
- Newman M, Socransky S, Savitt ED, Propas DA (1976).
Studies of the microbiology of periodontitis.
J Periodontol 47:373-379.
- O'Leary TJ (1964).
A study of periodontal examination systems. Abstr.
J Dent Res 43:794.
- Oral cancer (1989).
Lancet, August 5:311-312.
- Oravec P (1935).
Cariesvizsgálatok 3-6 éves gyermekeknél (Examinations on dental caries in children aged 3-6 years). Iskolaorvosi Továbbképző Tanfolyam előadásaiából Budapest.
Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary.
Budapest: Akadémiai Kiadó. p104.

Oravecz P (1959).

A táplálkozás és a szájhygiene szerepe baranyamegyei óvodáskorú gyermekek caries frekvenciájának alakulásában (The role of nutrition and oral hygiene in the frequency of dental caries of preschool children, in the country of Baranya). Fogorv Szle 52:34-42.

Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary. Budapest: Akadémiai Kiadó. p103.

Page RC (1986).

Current understanding of the aetiology and progression of periodontal disease. Int Dent J 36:153-161.

Page RC Schroeder HE (1981).

Current status of the host response in chronic marginal periodontitis. J Periodontol 52:477-491.

Page RC, Schroeder HE (1982).

Periodontitis in man and other animals. Basel: Karger.

Page RC, Bowen T, Alman L, Vandesten E, Ochs H, Mackenzie P, Osterberg S, Engel LD, Williams BL (1983).

Prepubertal periodontitis. I. Definition of a clinical disease entity. J Periodontol 54:257-271.

Palmer GR, Short SD (1989).

Health care & public policy. An Australian analysis. Bangalore: Macmillan India.

Peron R (1929).

Frequence des fissures congenitales de la levre et du palais. Paris, dissertation.

Cited by: Moller P. Dentofacial deformities: Cleft lip and palate.

In; Pelton WJ, Dunbar JB, McMillan RS, Moller P, Wolff AE (1969). The epidemiology of oral health. Cambridge, Massachusetts: Harvard University Press.

Petersen PE (1983).

Dental visits and self assessment of dental status in the Danish population. Community Dent Oral Epidemiol 11:162-168.

Piaget J, Inhelder B (1969).

The psychology of the child. New York: Basic Books.

Picton DCA (1986).

Basis for the use of topical and systemic fluorides in caries prevention. J Royal Soc Med 79 (Suppl 14:18.

Pilot T, Barmes DE (1987).

An update on periodontal conditions in adults, measured by CPITN. Int Dent J 37:169-172.

Plater WR (1949).

Caries control: Its influence and effect on malocclusion. Am J Orthodont 35:790-796.

Poulsen S, Moller I, Naerum J, Pederson PO (1972).

Periodontal disease and oral hygiene in 2383 Moroccan schoolchildren aged eight and twelve years.

Arch Oral Biol 17:1513-1518.

- Poulton DR, Aaronson SA (1961).
The relationship between occlusion and periodontal status.
Am J Orthodont 47:690-699.
- Powell RN, Gilhooly JT, McKenna ER (1986).
Prevalence and distribution of gingivitis and dental caries in children aged 6-12 years in
Brisbane primary schools.
Community Dent Oral Epidemiol 14:110-114.
- Radike AW, Gish CW, Peterson JK (1973).
Clinical evaluation of stannous fluoride as an anticaries mouthrinse.
J Am Dent Assoc 86:404-408.
- Ramfjord SP (1959).
Indices for prevalence and incidence of periodontal disease.
J Periodontol 30:51-59.
- Ramfjord SP (1969).
Methodology for determining periodontal treatment needs.
J Periodontol 40:524-528.
- Ranney RR (1981).
Pathogenesis of periodontal disease.
In: International Conference on Research in the Biology of Periodontal Disease.
Chicago: University of Illinois.
- Rayner JF (1970).
Socioeconomic status and factors influencing the dental health practices of mothers.
Am J Public Health 60:1250-1258.
- Renson CE (1984).
Changing patterns and concepts of oral disease: the effects on future manpower needs.
Dentistry Today 1 No.3:1-8.
- Renson CE, Crielaers JA, Lbikunle SAJ, Pinto VG, Ross CB, Sardo-Infirri J, Takazoe I, Tala H (1985).
Changing patterns of oral health and implications for oral health manpower: part I.
Int Dent J 35:235-251.
- Report of panel discussion on dental public health (1979).
Delivery of dental services in countries of the Asian Pacific region.
Penang, Malaysia: Dental training school.
- Reynolds C (1989).
Legislation and the new public health: Introduction.
Community Health Studies XIII:397-402.
- Ringelberge ML, Matonski GM, Kimball AW (1974).
Dental caries-experience in three generations of families.
J Public Health Dent 34:174-180.
- Ripa LW (1980).
Occlusal sealants: Rationale and review of clinical trials.
Int Dent J 30:127-129.
- Ripa LW (1981).
Professionally applied topical fluoride therapy: a critique.
Int Dent J 31:105-120.

Rivilin (??), p 119.

Cited by: Jones CO. An introduction to the study of public policy. 2nd edn.
North Scituate, Massachusetts: Duxbury Press.

Ruderman AP (1972).

General economic considerations.

In: Reinke WA, Health planning quantitative aspects and qualitative techniques.
Baltimore, Maryland: Johns Hopkins University. pp96-137.

Rugg-Gunn AJ (1989).

Diet and dental caries.

In: Murray JJ ed. The prevention of dental disease. 2nd edn.
Oxford: Oxford University Press. pp4-114.

Rugg-Gunn AJ, Holloway PJ (1974).

Methods of measuring the reliability of caries prevalence and incremental data.
Community Dent Oral Epidemiol 2:287-294.

Russell AL (1963).

International nutrition surveys: a summary of preliminary dental findings.
J Dent Res 42:233-244.

Russell AL (1969).

Epidemiology and the rational bases of dental public health and dental practice.

In: Young WO, Striffer DF eds. The dentist, his practice, and his community. 2nd edn.
Philadelphia: Saunders.

Salisbury R, Heilinz J (1970).

A theory of policy analysis and some preliminary applications.

In: Sharkansky I ed. Policy analysis in political science. Chicago: Markham.

Salzman JA (1957).

Orthodontics: Principles and prevention.

Philadelphia: JB Lippincott.

Savara BS, Suher T (1954).

Incidence of dental caries in children 1 to 6 years of age.
J Dent Res 33:808-823.

Sawle RF, Andlaw RJ (1988).

Has occlusal caries become more difficult to diagnose?
Br Dent J 164:209-211.

Saxén L (1980).

Juvenile periodontitis.

J Clin Periodontol 7:1-19.

Schaub RMH (1984).

Barriers to effective periodontal care.

Thesis, Department of Social Sciences in Dentistry.
Holland: University of Groningen. pp1-282.

Scully C, Malamos D, Levers BGH, Porter SR, Prime SS (1986).

Sources and patterns of referrals of oral cancer: role of general practitioners.
Br Med J 293:599-601.

- Shanley DB, Ahern FM (1984).
Periodontal disease and the influence of socio-educational factors in adolescents.
In: Frandsen A ed. Public health aspects of periodontal disease.
London: Quintessence.
- Shapiro L, Stallard RE (1982).
Ethology of periodontal disease.
In: Stallard RE. A textbook of preventive dentistry. 2nd edn.
Philadelphia: Saunders. pp61-69.
- Shaw (1982).
Ethology of dental caries.
In: Stallard RE. A textbook of preventive dentistry. 2nd edn.
Philadelphia: Saunders. pp33-49.
- Sheiham A (1969).
The prevalence and severity of periodontal disease in British populations.
Br Dent J 126:115-122.
- Sheiham A (1983).
Promoting periodontal health-effective programmes of education and promotion.
Int Dent J 33:182-187.
- Sidi AD, Naylor MN (1988).
Comparison of bitewing radiography and interdental transillumination as adjuncts to the clinical identification of approximal caries in posterior teeth.
Br Dent J 164:15-18.
- Silverstone LM (1978).
Preventive dentistry.
Fakenham, Norfolk: Cox & Wyman.
- Sivaneswaran S (1985).
The community periodontal index of treatment needs: Patient assessment at westmead hospital dental clinical school.
Westmead, Australia. Department of Preventive Dentistry, Westmead Hospital.
- Slots J (1977a).
The microflora in the healthy gingival sulcus in man.
Scand J Dent Res 85: 247-254.
- Slots J (1977b).
The predominant cultivatable microflora of advanced periodontitis.
Scand J Dent Res 85:114-121.
- Slots J (1979).
Subgingival microflora and periodontal disease.
J Clin Periodontol 6:351-382.
- Slots JS, Reynolds HS, Genco RL (1980).
Actinobacillus actinomycetemcomitans in human periodontal disease: a cross sectional microbiological investigation.
Infect Immun 29:1013-1020.
- Slots J, Zambon J, Rosling BG et al (1982).
Actinobacillus actinomycetemcomitans in human periodontal disease. Association, serology, leukotoxicity and treatment.
J Periodont Res 17:447-448.

- Smith (1968).
Cost-effectiveness and cost-benefit analysis for public health programs.
Public Health Rep 83:899-906.
- Socransky SS, Haffajee AD, Goodson JM, Lindhe J (1984).
New concepts of destructive periodontal disease.
J Clin Periodontol 11:21-32.
- Socransky SS, Manganiello AD, Propas D, Oram V, Van Houte J (1977).
Bacteriological studies of developing supragingival dental plaque.
J Periodont Res 12:90-106.
- Sogaard AJ (1985).
Present stage of dental health knowledge, attitudes and behaviour and development trends in Scandinavia. (unpublished manuscript).
Cited by: Gift HC (1988).
Awareness and assessment of periodontal problems among dentists and the public.
Int Dent J 38:147-153.
- Sós J (1936).
Iskolásgyermek vizsgálatok az Orosháza községhez tartozó monori tanyákon (Surveys of school children living on small farms in the neighbourhood of Orosháza). Népegészségügy 17:124-30. Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary.
Budapest: Akadémiai Kiadó. p166.
- Stanley FJ, Williams HE (1989). Morbidity and mortality patterns.
In: Graham V, Trevor P eds. Community child health: an Australian perspective.
Melbourne: Churchill Livingstone.
- Stjernsward J.
Cost-benefit in Sri Lanka. (Personal communication).
Cited by: FDI (1990). Factsheet on oral cancer. London: FDI. p14.5.
- Stone HG (1984).
School fluorides. Letter to the editor.
Chicago Ill: ADA News. American Dental Association.
- Stookey GK (1978).
Topical fluoride therapy.
In: Harris NO, Christen AG eds. Primary preventive dentistry. 2nd edn.
Los Altos, California: Appleton & Lange.
- Storey E (1983).
In: Brown Y, Crack D, Hall R, Jayasekera T, Lucas J, Rio AD, Wilde J, Wright C, Wright J eds. Foreword. Your children's teeth.
Hong Kong: Savage.
- Suomi JD, Smith LW, McClendon BJ, Spolsky VW, Horwitz HA (1971).
Oral calculus in children.
J Periodont 42:341-345.
- Survey of dentistry (1961).
The final report of the commission on the survey of dentistry in the United States.
Washington: American Council on Education.
- Tala H (1987).
Community periodontal index of treatment needs in Finland.
Int Dent J 37:179-182.

Tanner AC, Haffer C, Bratthall GT, Visconti RA, Socransky SS (1979).
A study of the bacteria associated with advancing periodontitis in man.
J Clin Periodontol 6:278-307.

Taylor CE (1972).
Stages of the planning process.
In: Reinke WA, Health planning qualitative aspects and quantitative techniques. Baltimore, Maryland: Johns Hopkins University.

The Australian Dental Association (NSW branch) (1969).
A long-term policy for the provision of dental services in NSW.
Sydney: Australian Dental Association (NSW branch).

Thoma KH (1917).
Oral disease of ancient nations and tribes.
J Allied Dent Soc 12:327-334.
Cited by: Tóth K (1970). The epidemiology of dental caries in Hungary.
Hungary: Akadémiai Kiadó.

Thystrup A, Fejerkov O, Bruun C (1979).
Enamel changes and dental caries in 7-year-old children given fluoride tablets from shortly after birth.
Caries Res 13:265-276.

Todd JE, Dodd T (1985).
Children's dental health in the United Kingdom 1983.
London: Her Majesty's Stationery Office.

Todd JE, Whitworth A (1974).
Adult dental health in Scotland, 1972.
London: Her Majesty's Stationery Office.

Topic B (1990).
Classification of periodontal diseases.
Int Dent J 40:171-175.

Tóth Á, Csémi L, Adler P (1965).
A caries epidemiológiája a tejfogazatban I. Iskoláskor előtti gyermekek caries intenzitása (Caries epidemiology in deciduous dentition I. Caries intensity in preschool children). Cited by: Fogorv Szle 58:42-48. Tóth K (1970). The epidemiology of dental caries in Hungary.
Hungary: Akadémiai Kiadó.

Tóth K (1970).
The epidemiology of dental caries in Hungary.
Hungary: Akadémiai Kiadó.

Toth K, Szabó I (1960).
Dental condition of preschool children (one to six years of age in Szeged, Hungary).
J Dent Res 38:451-463.

Truin GJ, Plasschaert AJM, König KG, Vogels ALM (1981).
Dental caries in 5-, 7-, 9-, and 11-year-old schoolchildren during a 9-year dental health campaign in The Hague.
Community Dent Oral Epidemiol 9:55-60.

U.S. Public Health Service, National Center for Health Statistics (1974).
Edentulous persons, United States, 1971.
DHEW publ No.(HRA) 74-1516-Ser 10-No. 89.
Washington DC: Government Printing Office.

- Valanis B (1986).
Epidemiology in nursing and health care.
Norwalk, Connecticut: Appleton-Century-Crofts.
- Veau V (1931).
Division palatine.
Paris: Masson.
- Waerhaug J (1966).
Epidemiology of periodontal disease.
In: World Workshop on Periodontics.
Ann Arbor, Michigan: University of Michigan. pp181-211.
- Wald N, Kiryluk S (1988).
UK smoking statistics.
Oxford: Oxford University Press.
- Waldrop TC, Anderson DC, Hallmon WW, Schmalstieg FC, Jacobs RL (1987).
Periodontal manifestations of the heritable Mac1, LFA-1, deficiency system. Clinical, histologic and molecular characteristics.
J Periodontol 58:400-416.
- Walsh M (1985).
Effects of school-based dental health education on knowledge, attitudes and behavior of adolescents in San Francisco.
Community Dent Oral Epidemiol 13:143-147.
- Warnakulasuriya KAAS, Ekanayake AN, Sivayoham S, Stjernsward J, Pindborg JJ, Sobin LH, Perera KS (1984).
Utilisation of primary health workers for early detection of oral cancer and precancer in Sri Lanka. WHO Bulletin 62:243-250.
- Weinberger BW (1948).
An introduction to the history of dentistry in America.
St. Louis: Mosby.
- Weller P, Grattan M (1981).
Can ministers cope? Australian federal ministers at work.
Melbourne: Hutchinson.
- WHO (1961).
Periodontal disease.
Technical Report Series No. 207.
Geneva: World Health Organization.
- WHO (1970).
Dental health education.
Technical Report Series No. 449.
Geneva: World Health Organization.
- WHO (1978a).
Application of the international classification of diseases to dentistry and stomatology (ICD-DA). 2nd edn.
Geneva: World Health Organization. pp28-35.
- WHO (1978b).
Epidemiology, ethology, and prevention of periodontal diseases.
Technical Report Series No. 621.
Geneva: World Health Organization.

- WHO (1979).
Formulating strategies for health for all by the year 2000.
Geneva: World Health Organization.
- WHO (1980).
Planning oral health services.
WHO Offset Publication No. 53.
Geneva: World Health Organization.
- WHO (1981a).
Global strategy for health for all by the year 2000.
Geneva: World Health Organization.
- WHO (1981b).
Development of indicators for monitoring progress towards health for all by the year 2000.
Geneva: World Health Organization.
- WHO (1983).
New approaches to health education in primary health care.
Technical Report Series No. 690.
Geneva: World Health Organization.
- WHO (1984).
Prevention methods and programs for oral diseases.
Technical Report Series No. 713.
Geneva: World Health Organization.
- WHO (1987a).
Oral Health Surveys basic methods. 3rd edn.
Geneva: World Health Organization.
- WHO (1987b).
Alternative systems of oral care delivery.
Technical Report Series No. 750.
Geneva: World Health Organization.
- WHO (1988).
Responsibilities and institutional relationships in economic support for health for all.
In: Economic support for national health for all strategies.
Geneva: World Health Organization. pp97-109.
- WHO (1990).
Presentation at seventh annual international conference of chief dental officers.
Singapore: World Dental Congress.
- WHO/UNICEF (1978).
Primary health care (Alma-Ata declaration).
Geneva and New York.
- Williams BL, Ebersole JE, Spektor MD, et al. (1985).
Assessment of serum antibody patterns and analysis of subgingival microflora of members of a family with a high prevalence of early-onset periodontitis.
Infect Immun 49:742-750.
- Winter GB, Fox B, Holt RD (1981).
Dental health education of mothers with young children in the Borough of Hillingdon.
London: General Dental Council.

Winter GB (1988).
Prediction of high caries risk-diet, hygiene and medication.
Int Dent J 38:227-230.

World Workshop in Periodontics (1966).
Ann Arbor: University of Michigan. pp118-124.

Young WO, Striffler DF (1964).
What is public health?
In: The dentist, his practice, and his community.
Philadelphia: Saunders. pp20-29.

Young WO, Striffler DF (1969).
Dental health education.
In: The dentist, his practice, and his community. 2nd edn.
Philadelphia: Saunders.

Zambon J, Christersson LA, Slots J (1983).
Actinobacillus actinomycetemcomitans in human periodontal disease. Prevalence in patient groups and distribution of biotypes and serotypes within families.
J Periodontol 54:707-711.