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DENTAL CARIES IN 2 TO 5 YEAR OLD AUSTRALIAN CHILDREN:
REVIEW OF THE LITERATURE.

DIMITRIS VASILIOU NIKOLAOU
BDS (Thessaloniki)

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Department of Preventive Dentistry
Faculty of Dentistry
University of Sydney
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SUMMARY

Preschool children have become a group of great importance in Australia and overseas. This resulted from the following:

- the changing patterns of dental caries in the permanent dentition of schoolchildren in developed countries due to community and individual preventive measures;
- the application of principles of prevention;
- the considerations regarding the safe use of fluorides;
- the necessity to monitor disease trends and dental care delivery systems performance;
- the priority which has traditionally been given to children; and, finally,
- the role that accumulated disease plays in the attainment of oral health goals.

Yet, there is a lack of data on the oral health status of preschool children, who also exhibit relatively poor utilisation patterns.

Australian studies on the dental caries in preschoolers 2-5 years of age were collated, evaluated and discussed. Data drawn from radiographic examinations was not considered because of their limited efficiency and availability.

A variety of study designs, methods and indices used was found in the literature, thus affecting the comparability of the studies. Data for the majority of studies has been from the evaluation of preventive programmes (especially water fluoridation) and the School Dental Service (SDS).

There have been no studies reported on 2 year olds since 1962, and on 3 year olds since the early 1970s. Some data, of doubtful representativeness, exists on 4 year olds. Five year olds are the group studied in most detail.

Nevertheless, evidence consistently suggests that dental caries prevalence and experience have shown considerable improvements in the 4 year and, certainly, in the 5 year age groups and a "polarisation" of the disease at a regional, state and national level has therefore occurred. The state of Victoria has shown the greatest improvements over the past 12 years. Caries activity is the disease component which has shown greatest improvements. The teeth indicated for extraction in 4 and 5 year olds have been virtually eliminated.

The improvements in the oral health status of preschoolers had been more pronounced in the late 1960s, 1970s and early 1980s. Thus, it paralleled the trends in fluoride availability.

Disease trends do not appear to have been reversed in recent years. There has been some evidence that the polarisation of the disease has been accentuated in recent years as it is indicated by the continuing decline in caries prevalence and the levelling off of the caries experience.

Treatment received has also improved but this appears to have been due to the decreased activity of dental caries rather than the increased output of the service which has roughly remained unchanged. Teeth extracted due to caries have not quite followed the trends noted for teeth indicated for extraction. Three year olds appear to be the group with the first occurrence of treatment needs and targeting this age group appears necessary. Four year olds may be the group which receives relatively less care.

Factors responsible for this decline of dental caries in preschoolers cannot be readily identified by the available data, but water fluoridation, fluoride dentifrices, the availability of services and changing community attitudes appear to have played a major role in these trends.

There is an urgent need for representative basic, as well as analytic, epidemiological studies on Australian children younger than 5 years of age at a regional level.

The identification of high-carries and high-risk groups should be a high priority.

There is also a need to establish the representativeness of the SDS data, particularly at a regional and state level and for 4 year olds.

For the purpose of basic epidemiological studies, disease prevalence may be the only measurement necessary for 2 year olds because of the patterns of the disease.

Recording of missing teeth in preschool children has become feasible because of the disease patterns, and necessary for the purpose of evaluation and comparison at the regional, state and national levels.

Surface counts seem to have less sensitivity as an epidemiological index in the preschool age groups.

For evaluation purposes, treatments rendered to preschoolers other than those identified through the dimf index, particularly preventive services, should also be recorded and reported.

Australia has shown disease patterns in preschoolers which are similar to those in other developed countries. However, an improvement in terms of targeted provision of restorative and, especially, preventive care appears to be highly desirable particularly in the 3- and 4-year-old groups.

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ABBREVIATIONS

ABS	Australian Bureau of Statistics.
ACT	Australian Capital Territory.
ADA	Australian Dental Association.
AIH	Australian Institute of Health.
ComDeptHealth	Commonwealth Department of Health.
DeptHealth	Department of Health.
FDI	Federation Dentaire Internationale.
ICSMD	International Collaborative Study on Dental Manpower (Arnliot <i>et al.</i> 1985).
NSW	New South Wales.
NT	Northern Territory.
NZ	New Zealand.
Qld	Queensland.
SA	South Australia.
SDS	School Dental Service(s).
Tas.	Tasmania.
UK	United Kingdom.
USA	United States of America.
Vic.	Victoria.
WA	Western Australia.
WHO	World Health Organization.
WMHR	Western Metropolitan Health Region, Sydney, NSW.

1 INTRODUCTION

1.1 PRESCHOOL CHILDREN IN CONTEMPORARY DENTISTRY

The decline of dental caries in the permanent and deciduous dentition of schoolchildren in industrialised countries was first documented in the early 1980s (Glass 1982), and in 1985 a joint FDI/WHO working group further substantiated this trend (FDI/WHO 1985). The factors which led to this real decline in dental caries, and were common to the 9 countries reported (figure 1, page 2), were summarised by FDI/WHO (1985) as follows:

- a) availability of fluoride, especially widespread use of fluoride dentifrices;
- b) availability of dental resources;
- c) increased dental awareness coupled with greater utilisation of dental services (especially by children); and
- d) preventive approach by dental practitioners.

Factors not common to all of these 9 countries were:

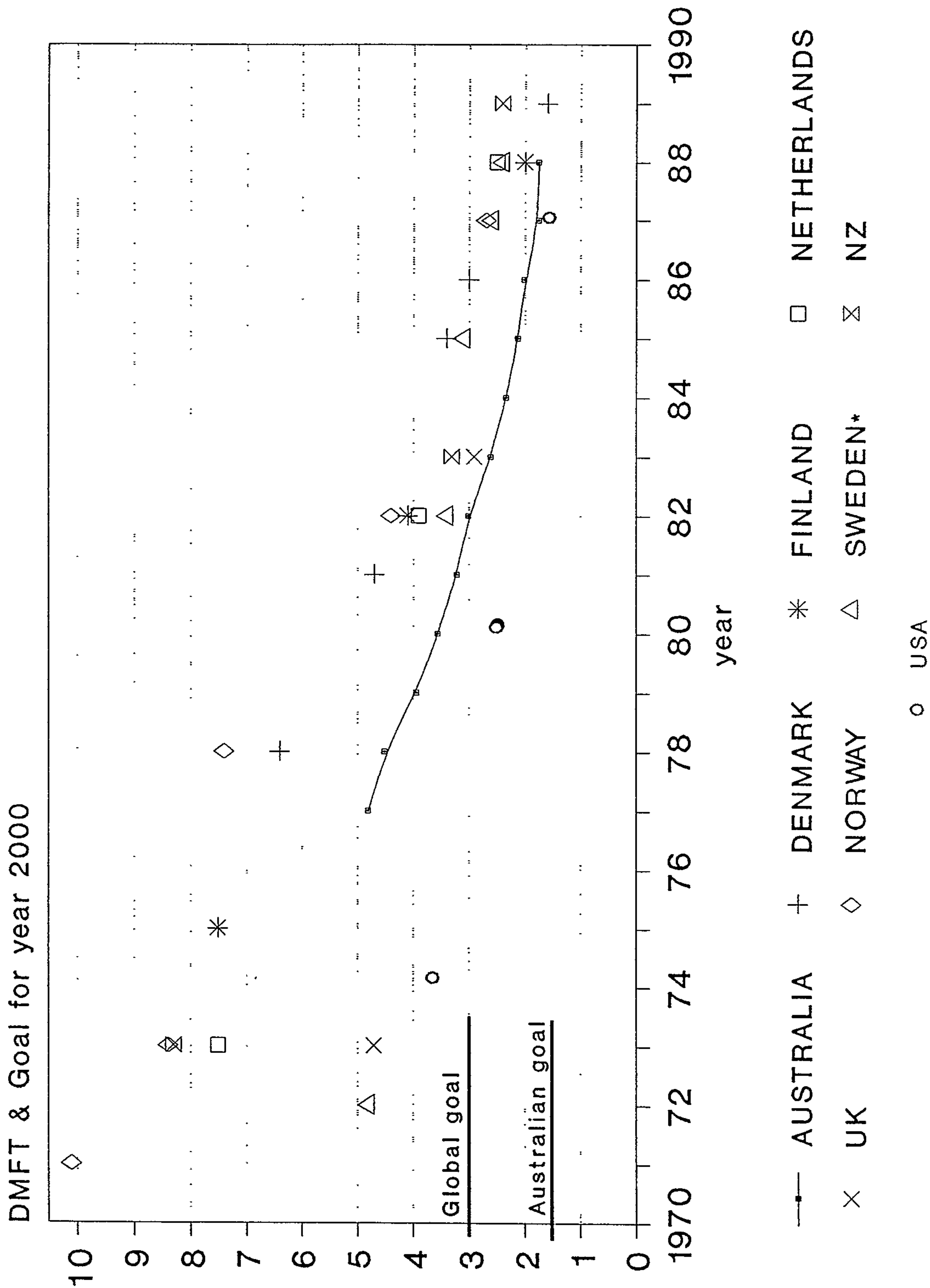
- e) fluoride mouthrinsing programmes (not widespread use in Australia, NZ and UK);
- f) fluoride tablets (Australia, Netherlands, Norway, Finland, and Sweden);
- g) water fluoridation (Australia, NZ, and USA); and
- h) reduction in sugar consumption (Denmark, Netherlands, Norway, USA, and UK).

This unexpectedly rapid decline occurred at a faster rate and earlier in time in countries employing water fluoridation extensively (ibid.), while the disease distribution by surface type lends support to the fluoride hypothesis (Brunelle, Carlos 1990).

The major change in sugar consumption has been a shift towards its use

Figure 1- Changes in caries experience at 12 years of age in some developed countries and goals for the year 2000.

Sources: FDI/WHO 1985; ComDeptHealth 1987; Barnard 1989; Moller 1990; FDI/WHO 1990.



* DFT but MT<0.05

in processed foods (FDI/WHO 1985) whereas it is not possible to establish a relationship between dental caries and total sugar consumption at an international level (European countries) due to either inadequately detailed data or the variance of fluoride availability (Honkala, Tala 1987).

The decline in dental caries experience has been paralleled by changes in the prevalence of the disease (table 1).

The combined effect of the changes in these two indices (prevalence and experience) has been a "polarisation" of the disease at an individual level, first described by Marthaler in 1975, with 20-25% of the children accounting for more than 50% of the disease (Winter 1990), and with pits and fissures (particularly those of first permanent molars) for as much as 75% of carious surfaces (Craig, Burton 1985; ComDeptHealth 1987; Brunelle, Carlos 1990).

Table 1- Changes in caries prevalence at 12 years of age in some developed countries.

Country	Year	%DMFT=0	Source
NSW	1955	1.0	Barnard 1956
	1984	37.0*	Barnard, Sivanewaran 1990
	1989	49.8*	AIH 1990
Australia	1977	10.4	ComDeptHealth 1987 Barnard 1989
	1985	34.6*	
	1988	50.3*	
England and Wales #	1973	5.0	Todd, Dodd 1985
	1983	20.0	
Finland	1975	1.0	FDI/WHO 1985
	1982	7.0	
Netherlands	1973	0.0	Kalsbeek 1982
	1982	23.0	
Norway	1970	0.0	von der Fehr 1982
	1987	10.0	
Sweden #	1980	5.0	Sundberg 1988
	1987	29.0	
USA	1980	26.9	Brunelle, Carlos 1990
	1987	41.7	

* Statistically significant difference ($p < 0.001$).

Data taken from figures.

These trends, along with the appraisal of the outcome of traditional approaches to oral health care (Holloway 1975; NZ DeptHealth 1978; Arnljot, Barmes, Cohen, Hunter, Ship 1985), led to the conclusion that dental disease, dental caries in particular, can most effectively and efficiently be addressed as a public health problem by means of prevention and health promotion (FDI 1984; WHO 1987a). A massive social improvement in health and economic benefit is then achievable with optimisation of disease-relevant factors in the environment and lifestyles (Mahler 1985).

However, the information available is disproportionately oriented towards schoolchildren, a phenomenon caused essentially by the recognition of dental caries in earlier years as mainly a problem of childhood (Dunning 1986) and, therefore, by the establishment of SDS to tackle this problem at a community level in many developed countries, including Australia and excluding the USA.

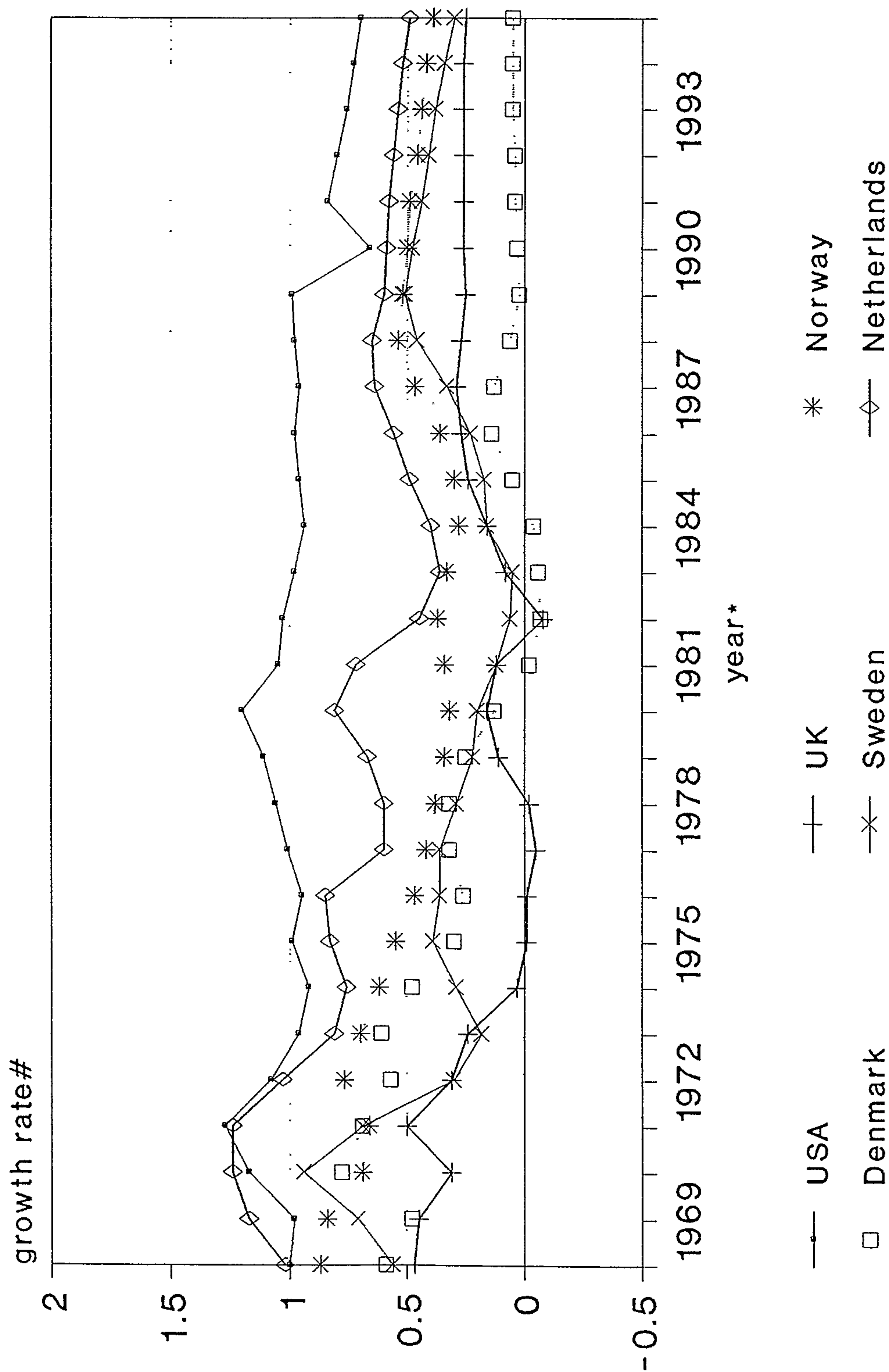
It has now become imperative to monitor the disease continuously (on a regular basis) and comprehensively (in terms of age groups examined and types of data gathered) in order to plan for adequate, appropriate, effective and efficient dental services, monitor their performance in quantity and quality, and introduce required alterations (WHO 1976; WHO 1977; FDI/WHO 1985; WHO/FDI 1989). Such information has not been made available for both adult, and, more so, preschool children populations' oral health in most developed countries (FDI/WHO 1985; Moller 1990; Waldman 1990; Holm 1990).

Currently, decreasing population growth rates (figure 2, page 5) have contributed in shifting the interest in the future direction of dental care delivery towards the aged people in developed countries, mainly due to the behavioral, organisational, economic and political implications of these demographic trends (Bailit 1987) rather than feasible oral health outcomes to be anticipated.

The latter is reflected in the oral health goals for the year 2000,

Figure 2- Population growth in some developed countries expressed as the annual percentage rate of growth (projections after 1985).

Source: Urban, Trueblood 1990.



* year ends on 30th June
annual, percent

global and Australian ones (FDI 1982; ComDeptHealth 1987), where the oral health indicator for older people is prevalence of edentulousness, the terminal stage of mainly dental caries (since periodontal disease has now been found to not constitute a major cause of tooth loss -Burt 1988), which can be improved only by the introduction and maintenance of preventive measures and conservative (as opposed to radical) treatment philosophies earlier in the life of the individual.

In contrast, the global oral health indicator and goal for the 5-6 years age group has been set in terms of disease-free prevalence (50% in this group should be caries-free by the year 2000) and the best way to achieve this is by making parents aware of the importance of dietary and other preventive measures applied from birth years (FDI 1982). A preliminary global oral health goal for the 5-6 years age group for the year 2025 is for 95% of children in this age group to be caries-free (Barnes 1989).

This approach (the earlier in life the introduction of preventive practices, the better) has been implemented in Scandinavian countries. In Norway, the aim of these programmes for preschool children has been to improve the eating and dietary habits, promote oral hygiene and use of fluoride tablets regularly (Heloe, Haugejorden, Heloe 1980). In Sweden, screening from the age of six months has also been a part of these programmes which were proved effective, judging by prevalence data of early and mid 1970s (Ahlberg 1978). In Denmark, general and individual preventive measures, regular dental examinations and treatment of oral diseases were to be made available to all 0-6 year old children as of 1981 (Schwarz, Hansen 1979). School Dental Services in Australia, NZ and UK have been covering these age groups (at least after the age of two and one half years) but mostly on a demand driven basis (NZ DeptHealth 1978; Lennon, Taylor 1980; NSW DeptHealth 1985).

In view of the decline of dental caries in schoolchildren, the polarised patterns of the disease at both the individual and the community level, the increased availability and use of fluorides, and,

finally, the issue of cost-containment combined with the questions on increased efficiency of preventive methods used (Burt 1989) and the resource allocation (Striffler 1985), preschool children have become even more important.

Firstly, concerns regarding the safety of the multiple use of fluoride vehicles have made the control of fluoride intake in early childhood a noteworthy issue (Anonymous 1990; James 1990; Woods 1991).

Secondly, the effectiveness of preventive measures and programmes and associated disease trends have been first tested and demonstrated in the early deciduous dentition (Finn 1947; Dean, Arnold, Jay, Knutson 1950; Lilienthal, Goldsworthy, Sullivan, Cameron 1953; Stephen, McCall, Tullis 1987; Attwood, Blinkhorn 1991).

Furthermore, methods for the identification of high-risk individuals and community groups have involved preschool children as subjects (Poulsen, Holm 1980; Schroder, Edwardsson 1987; Koch 1988).

Additionally, it has been shown that "past experience" of dental services utilisation, a component of service acceptability, has a definite impact on the regularity for seeking dental care later in life (Arnljot *et al.* 1985). To this end, dental disease in the primary dentition is most likely to initially be encountered and treated by dental providers (Moller 1963; Gray, Hawk 1967).

To these, the role deciduous teeth play in the development of the permanent dentition should be added.

In general, the setting of goals and the planning activities towards their attainment presume the existence of a database adequate for describing the problems, identifying achievements and weaknesses, and directing policy-makers into subsequent actions (WHO 1976; FDI/WHO 1985; WHO/FDI 1989). Global, national and local goals for the 5 years age cohort can be formulated and achieved on the basis of the

information available and programmes implemented on younger age groups because of the cumulative nature of dental caries.

However, preschool children have continuously been regarded to be among the dentally "neglected" groups (Gruebbel 1944; Moller 1963; Gray, Hawk 1967; Waldman 1990; Page, Davenport, Holt 1990).

1.2 PROBLEMS IN EPIDEMIOLOGICAL INVESTIGATIONS OF DENTAL CARIES IN PRESCHOOL CHILDREN

The priority which has been historically given to schoolchildren and the establishment of SDS made the access to these age groups for epidemiological purposes less of a problem and facilitated the collation of information on their dental caries status internationally.

As to preschool children, the accessibility problem was combined in various surveys with communication and management problems upon examination. Poor co-operation of children has been reported to have led to alterations of (Moller 1963), or compromises with some subjects on (Hennon, Stookey, Muhler 1969), the examination methods. In the case of the survey conducted by Hennon *et al.* (1969) some children did not co-operate for taking radiographs.

Additional time may be required for the above reason and for also obtaining the co-operation of the parents in an attempt to establish the communication necessary for solving probably the most serious epidemiological dilemma with preschool children, which is the recording of missing teeth (Moller 1963), for the recording of the demographic particulars of the children such as their age and residence (WHO 1971, 1977, 1987b), as well as for obtaining correct information on the oral health-related past history of the children's behaviour and environment in various types of investigations (Moller 1963; Hennon *et al.* 1969; Schroder, Edwardsson 1987; Koch 1988).

The "missing teeth" problem in the deciduous dentition necessitated the inventors of the DMF index for the permanent dentition, Klein and Palmer (1938), to point out that "an equivalent (to DMF for permanent teeth) measurement of the complete caries experience in the deciduous dentition is not possible since a definite decision may not be made as to whether a missing tooth has or has not been carious". They also suggested that "quantitative facts regarding dental caries in children should be presented separately, and in different ways, for the

deciduous and permanent dentitions" (ibid.).

To overcome this difficulty with the missing deciduous teeth, the American Association of Public Health Dentists introduced the "def" index (d:decayed; e:indicated for extraction; f:filled teeth) in 1943 (Gruebbel 1944). This index has been used in order to select information on the health status of the "almost universally neglected" deciduous teeth (ibid.), make national and international comparisons (Savara, Suher 1954; Hennon *et al.* 1969), and for experimental studies (Dean *et al.* 1950).

Jackson (1950b) suggested that the use of the DMFT index was the most appropriate for epidemiological purposes because of the "very high degree of accuracy, and its simplicity, clarity and logical appeal". Thus, Jackson proposed a modification of the DMFT index, the dmft index, to be used for all deciduous teeth up to the age of 4 years and for deciduous molars up to the age of 8 years. The d and D components of the dmft and DMFT indices were further analysed into d^1 , d^2 and D^1 , D^2 , respectively, where d^2 and D^2 meant the number of teeth indicated for extraction. Jackson noted, however, that the latter classification could not be considered to be absolute because it was made on a visual assessment (ibid.). Eventually, the dmft index was used for all deciduous teeth of 5 year old children as well (Jackson 1952).

In 1962, WHO adopted the df index as the best method of assessing caries experience in primary teeth but the Expert Committee noted that "for particular reasons it may be desirable to include an assessment of primary teeth lost because of caries" (WHO 1962).

In 1971, WHO adopted the dif index, with i being teeth indicated for extraction. Absent primary teeth should not be recorded as missing if a positive history of tooth loss because of caries could not be obtained. It was also noted that "the recording of the "i" component is a matter of clinical judgement and will vary in different areas" (WHO 1971). Shortly afterwards, SDS recording systems did not, for

example in Denmark (Schwarz, Hansen 1979), or did, like in Australia (ComDeptHealth 1987), adopt the dif index.

In 1977 and 1987 WHO suggested that the dmf index be used, with missing teeth recorded up to the age of 9 years (WHO 1977, 1987b). It is therefore expected that there is a variation in the epidemiological indices used in the literature with dif and dmf used alternatively or in combination.

The two indices, def (that is dif) and dmf, appear to have been used interchangeably. The dmf index has especially been used in cases where the education level of the population facilitated information to be gathered on the "m" component (Moller 1963), or even when such a facilitator was not reported but the recording of missing teeth was considered possible (Hewat, Eastcott, Bibby 1952; Cameron 1953; Barnard 1988). Overall, the dmf index is more versatile than the dif index.

The variation in epidemiological indices used in the literature may not only be due to the recording or not of the missing component. Epidemiological principles (prevalence is the primary interest), the variability with which dental caries affect different persons, types of teeth and tooth surfaces, and, finally, the variation with which this attack manifests itself upon examination because of the cumulative nature of the disease (decay; filling; or a combination of these; unoccupied space in the dental arch) led to the use of prevalence, tooth counts as well as tooth surface counts in order to increase epidemiological and research sensitivity, and planning accuracy (Klein, Palmer 1940; WHO 1979; Spencer 1980; Dunning 1986). The above-mentioned measurements have been cited in order of increased sensitivity when the level of the disease is increasing (Dunning 1986).

Thus, WHO (1979) suggested that the DMFS (DMF surfaces) index be used when more detailed information and the application of more rigorous methods are required as in the case of clinical trials and field testing of preventive agents. This Guide of WHO (1979) did not provide

for the recording of deciduous teeth by surface, an option which was left open for investigators conducting research with "special, clinical trial objectives" to use. However, "the different conventions as to the number of surfaces to be ascribed to a tooth missing because of caries can be an additional factor militating against comparability" (Downer 1990).

Disease prevalence data, experience expressed in tooth counts (dmft) and analysis of the dmft index in its components are suggested as minimal requirements for conducting and reporting basic oral health surveys (WHO 1971; WHO 1987b).

The criteria and methods for recording clinical caries have changed over time.

Sognnaes (1940) examined 309 deciduous and 449 permanent teeth in 32 children. Caries were detected by "the traditional catch of the explorer", and he questioned whether "superficial enamel lesions" (or "pre-caries") should be included in a caries record, although they should be recorded. Cleaning and drying of the teeth prior to the examination with mirror and explorer made for an additional 47% of carious lesions to be detected in the permanent teeth but this figure was only 9% in the primary teeth (ibid.).

Jackson (1950a) proposed a standardised, systematic method for recording clinical caries. The teeth should be clean and free from extrinsic stains and food debris. Each tooth should be dried thoroughly and each surface be examined. The examination should be carried out under good lighting conditions and proceed in a routine order. A mirror and sharp probes (Ash sickle-shaped probe No. 54 for pit and fissures, Ash No. 12 for approximal surfaces) should be used. The sickle probe should be sharpened lightly before each examination and should be used in all pits and fissures in several angles. A pit or fissure should be counted as carious if with a little pressure (variation of which should be accepted) the point stuck without doubt

and required a definite pull for its removal. An approximal surface was considered carious if Ash No. 12 probe caught a roughened surface or a definite cavity. Anything which was at all doubtful should not be recorded as carious. Stained pits and fissures, and stained or opaque light areas on other smooth surfaces should not be recorded as carious unless there was positive evidence of enamel dissolution (as suggested by Sognnaes in 1940). Arrested caries was counted as carious. Exposed dentine was counted as carious only if there was positive evidence of softening (Jackson 1950a). In field work, however, it was found that pre-cleaning of teeth and sharpening of the sickle probe before each examination were impractical. A new or freshly sharpened probe was used for every ten cases (Jackson 1952).

In 1962, WHO suggested that a lesion be recorded as carious if a cavity was diagnosed by mouth mirror and probe examination under good light (artificial or natural). White or chalky spots, discoloured or rough spots, as well as hard, stained pits and fissures which caught the explorer but did not have a detectably softened cavity floor, undermined enamel or a breakdown in the walls should not be recorded as carious. The residential history of the subjects and the number of teeth present (if it was desirable to obtain information on eruption patterns) should also be recorded (WHO 1962).

Moller (1963) gave a summary of the diagnostic criteria prevailing in the literature of the time. All "macroscopic defects of the enamel and dentine from which carious material could be readily excavated with an explorer were accepted as carious". "Softened dentine" was the criterion for recording pits and fissures as carious. No mention was made on enamel surface roughness while stains, opacities and translucencies were noted as sound teeth "unless positive evidence of enamel discontinuity could be detected". On approximal surfaces he used, when in doubt, dental floss (ibid.).

According to more recent WHO criteria for the diagnosis of clinical caries, "caries should be recorded as present when a lesion in a pit

or fissure, or on a smooth surface, has a detectably softened floor, undermined enamel or softened wall". Stained, "catchy" pits and fissures without any other of the above-mentioned characteristics, should be recorded as sound. On approximal surfaces, cavitation must be present for the tooth to be diagnosed as carious. Teeth with temporary fillings are also recorded as carious. When in doubt, caries should not be considered as present. Teeth with white or chalky, discoloured or rough spots are considered sound, too, in the absence of other positive criteria. Cleaning and drying of the teeth prior to examination have not been suggested (WHO 1971, 1977, 1987b).

In 1971, WHO suggested that residual roots of primary teeth should be recorded as "i" teeth only when no permanent successor had erupted. Teeth restored for reasons other than caries (such as trauma and aesthetics), teeth used as bridge abutments, and teeth banded for orthodontic purposes should be recorded under the "excluded" category (WHO 1971).

In 1977, the use of a sickle-shaped probe along with consistent illumination was suggested by WHO. Primary and secondary recurrent caries should be recorded separately. "Exclusion" of teeth banded for orthodontic purposes was not suggested (WHO 1977).

In 1987, WHO did not suggest the use of a sickle-shaped probe, nor the separate recording of primary and secondary recurrent caries, that is categories by physical association of a lesion to an existing filling. Two new categories were introduced, those of "sealed" teeth and of teeth used as bridge abutments. The only teeth that should be recorded as "excluded" were those that could not be examined. In addition, dark, shiny, hard, pitted areas of enamel in a tooth showing signs of moderate or severe fluorosis should be considered sound. Teeth indicated for extraction are considered under the "treatment needs" coding (WHO 1987b).

The literature on diagnostic criteria and methods does not seem to

consider any differences between permanent and deciduous dentition.

However, it is obvious from the above review that the changes most relevant to the deciduous teeth have been those regarding the criteria of "catchy" pits or fissures, roughened enamel spots, and associated changes in treatment philosophies.

Radiographs are not considered essential because of the impracticability of using them and because they do not add efficiently to the accuracy of the data (WHO 1971; Dunning 1986; Downer 1989), especially in the case of deciduous teeth (Sognnaes 1940). Particularly in cases of some poorly co-operating preschoolers, x-rays may be impossible to use (Hennon *et al.* 1969).

Sognnaes (1940), along with cleaning and drying of the teeth, used radiographic examination on deciduous and permanent teeth, and it took him 90 minutes examining each child, to conclude that these methods in combination revealed 14% more tooth surfaces (not teeth) in the primary dentition to be carious compared with the clinical examination with mirror and explorer alone. Yet, radiographs, compared with all methods of clinical examination combined, did not detect more than 5% additional carious deciduous tooth surfaces (*ibid.*).

Chilton and Greenwald (1947) examined, both clinically and radiographically, a sub-sample of 729 children in a dental clinic, who had been randomly selected from a total sample of 2540 children 5 to 18 years of age. The latter ("master") sample had been examined clinically in school classrooms at North Arlington, New Jersey, USA, by means of mirror and explorer under ordinary school lighting "several months" before the radiographic examination of the sub-sample was conducted. They attributed the higher filled teeth component of the deft and DMFT scores of the sub-sample to this elapse of time. Only 12 children were included in the 5-year-old age group of the sub-sample. Their findings and inferences were based on the assumption that x-rays would certainly detect more carious teeth and, thus, the

def and DMFT scores recorded for the x-rays group would be higher than the respective scores of both the clinically detected caries in the sub-sample and the (also clinically detected) caries in the master sample. Thus, they did not report on all the statistical tests and derived confidence levels. Among other findings, they found statistically significant differences in both the def and DMFT indices between the sub-sample (radiographically examined) and the "master" sample except for the age groups of 5-6 year olds (sub-sample with n=200) and 13-15 year olds (sub-sample with n=618). They also found that the venue of the clinical examination (classroom versus clinic) did not alter the def and DMF scores which had been detected clinically in the sub-sample and the "master" sample. They concluded that "dental public health surveys to determine the dental needs of school populations or surveys to compare group dental status do not require roentgenographic examinations" but x-rays are required in dental surveys "conducted for research purposes" (ibid.).

Barnard (1956) found that roentgenograms detected 6.2% DMFS and 5.1% DMFT additional to the scores detected by clinical examination alone in 6-15 year old NSW children.

Burton and Rob (Burton, Rob, Craig, Lawson 1984), based on unpublished data, found a statistically not significant difference in 12 year olds in Sydney when using clinical examination alone (DMFT=1.31) compared with clinical examination in combination with radiographs (DMFT=1.38).

Carr (1966) reported a difference of 11% in the DMFT score detected by using mirror and explorer alone and radiographs supplementary to the clinical examination. He suggested that radiographs would be "very desirable" whenever the DMFS index is employed (Carr 1966).

Moreover, the younger the individual, the less the difference between clinical and radiographic examination appears to be (Barnard 1956; Moller 1963; Dunning 1986). It has also been found that the difference increases as the number of permanent teeth increases (Barnard 1956;

Moller 1963) but this relationship does not seem to be particularly important in the case of preschool children older than 2 years of age.

In Tamworth 1963 and 1979 surveys, a group of about 70 5-year-old children (one child every fifth in the total sample) was examined both clinically (mirror and explorer) and by means of radiographs. An increase of almost 30% in the scores of carious teeth (dt) and surfaces (ds) was detected by radiographs (5.5 and 9.3, respectively) when compared with the clinical examination (4.2 and 7.2) in 1963. In 1979, the difference was less; 21% for dt (1.5 with x-rays versus 1.3 teeth detected clinically), and 16% for ds (2.5 versus 2.1) (Barnard 1988). The total dmft scores are expected to change to less an extent because of some re-classification of filled teeth as carious teeth (Dunning 1986) but it should be noted that these Tamworth children had received little to very little restorative care (%f/dmft: 10% in 1963, 22% in 1979 -Barnard 1988) and, taking into account the young age of the fillings, the re-classification will not be as extended as reported by Dunning (1986). The latter connotes that, as a result of supplementary radiographic examination, the dmft figure would change relatively more than the DMFT score in teenagers, and that the less the disease at large, the less the efficiency of radiographs.

Although the above figures from Tamworth surveys indicate higher differences for deciduous than for permanent dentition produced by radiographic examinations, it appears that there has been little interest in this matter. Hennon *et al.* (1969) reported that without radiographs "three out of four interproximal lesions in the posterior region would have been missed". Thus, they proposed the use of diagnostic radiographs at the age of two and one half years when about 50% of second deciduous molars have been erupted.

Finally, various surveys have shown that, it is the analysis of data (frequency distribution of subjects/teeth/surfaces according to levels of caries experience) which becomes increasingly important for sensitivity purposes, if changing patterns of dental caries are to be

detected in a low-carries community (Burton *et al.* 1984; Craig, Burton 1985; Carr 1988; Hugoson, Koch, Hallonsten 1988; Brunelle, Carlos 1990) or more accurate planning and evaluation of services is to be conducted (Schwarz, Hansen 1979), rather than the index or examination method used.

With regard to comparisons between various surveys on comparable (which has implications for sampling methods) populations, Moller (1963) summarised the conditions which may produce artificial differences. These conditions are:

- a) variance in the definition of carious lesions;
- b) variance in interpretation by examiners;
- c) physical equipment used in the studies; and
- e) supplementation of the clinical examination by the cleaning and drying of the teeth, and radiographs.

1.3 PRESCHOOL CHILDREN AND AUSTRALIAN DENTISTRY

As early as 1907 the Australian dental community had already showed an interest in the dental status of children and some relatively raw statistics were available (in 3156 children with an average age of 12 years examined in Sydney, 16% of permanent teeth and 24.5% of temporary teeth were carious) but it was doubted whether "the children examined so far are a fair average" (Lever 1907). Thus, inadequate data existed to support the deputations of the NSW branch of the ADA to the NSW State government for the establishment of SDS in NSW, deputations which had started in 1904 (NSW DeptHealth 1985). Some actions were taken to this direction (first mobile school dental clinic in 1915; first action towards the introduction of operating auxiliaries for schoolchildren in 1925) in NSW (ibid.) but data at a population level was missing and it was only in 1954 when the first longitudinal dental health study was started in Melbourne with 2 year old children, in the Melbourne University Child Growth Study (Roche, Sunderland 1959), that is 7 years after the initiation of the classical study on the relationship between diet and dental caries at Hopewood House, Bowral, NSW (Lilienthal et al. 1953).

In 1963, the ADA made a submission on the establishment of a government funded scheme for dental care for children (ADA 1963). At the time of the submission, Barnard (1964b) reviewed the literature on dental caries in children, 2 to 5 year old inclusive. At that time dental caries status was reviewed for 3 studies of 2 year olds, 4 studies of 3 and 4 year olds, and 6 studies of 5 year olds. Interestingly, "the Scheme should apply in the first instance to children up to and including the age of 4 years" (Newton 1963). Before these studies, surveys had also been conducted on the dental status of aborigines' children and reviewed by Campbell (1939).

Developments since 1963 have been radical, particularly in the 1970s.

As to dental services for children, the Federal government decided in

early 1970s to undertake the financial responsibility for the development of the national SDS which was officially introduced in 1973 and practically commenced operating in 1976-77. The first objective of the national SDS was that, by 1982, free dental care would be offered to all children up to the age of 15 years, infants inclusive. The SDS in SA, Tas. and WA had been in operation before that time. In 1975, an evaluation programme was also introduced for the SDS and it practically started in 1977 (NSW DeptHealth 1985; ComDeptHealth 1981).

Workforce deployment followed the above-mentioned developments (table 2). It should be borne in mind that NSW and Vic. accounted for 34% and 27% of the target population (0-14 years) in 1975 (34% and 25% in 1985), respectively (Barnard 1971-1989).

Disease trends and fluoride availability changed dramatically. This has been most explicitly demonstrated in NSW, the most populated state of Australia which has been surveyed for more than 35 years and does not fall far from the national average figures (figure 3, page 21). Although there have been no national figures specifically for preschool

Table 2- Development of Australian SDS - School Dental Therapists; distribution by state and year 1969-1987.

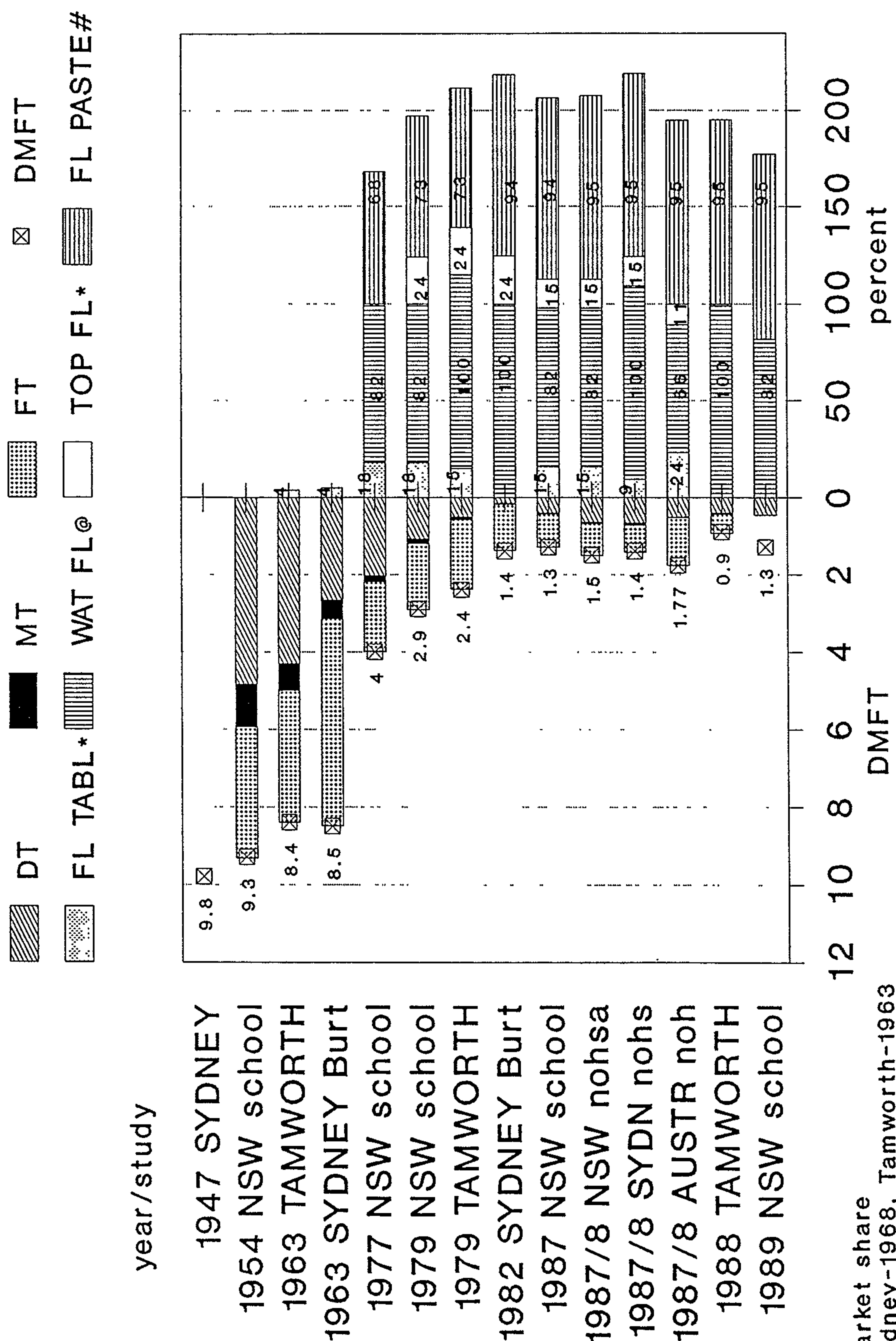
Source: Barnard 1971-1989.

Year	States								Australia
	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	
1969	8	-	-	14	-	24	-	7	53
1970	9	-	-	28	-	20	-	9	66
1971	9	-	-	37	-	25	-	12	83
1972	6	-	-	56	9	30	-	13	114
1973	10	-	-	59	9	31	1	13	123
1974	16	-	3	65	25	38	3	15	165
1975	20	7	8	75	28	55	12	21	226
1976	98	17	31	133	117	63	13	19	491
1977	134	18	31	147	132	79	15	24	580
1978	131	57	181	184	168	84	20	21	846
1979	172	104	122	210	211	89	21	23	952
1980	225	166	191	233	237	90	21	23	1186
1981	257	165	216	175	256	69	21	23	1182
1982	269	183	248	157	233	63	22	25	1200
1983	244	191	284	144	230	62	22	24	1201
1984	245	190	291	119	248	72	22	24?	1211
1985	246	165	289	114	248	84	17	25	1188
1986	240	170	287	113	248	75	21	23	1177
1987	258	141	270	139	190	72	19	20	*1109

* Total number; includes part-time school dental therapists:
25 in WA, 20 in Tas., 2 in NT, 1 in ACT.

Figure 3- Dental caries, treatment patterns and estimated availability and/or consumption of fluorides at 12 years of age in NSW, Australia.

Sources: Cameron 1953; Spencer 1986; NOHSA 1987-88; Barnard 1989; Barnard, Sivaneswaran 1990; AIH 1990.



Market share
@ Sydney-1968, Tamworth-1963
* If not indicated after 1977, not known

children, it was found in NOHSA (1987-88) that 15.3% of 5 year olds have used fluoride tablets (4.2% using "currently").

The availability of fluoride varies by state. In 1987, an estimated 82% of the population in NSW was covered by fluoridated water (with fluoride >0.5 ppm) mainly introduced since 1960s (Sydney in 1968), 72% in Vic. (Melbourne 1977), 6% in Qld (mainly since 1960s) where fluoride tablets is the only form of systemic fluoride promoted with about 34% of the primary schoolchildren taking tablets regularly (21% of the children were taking tablets in 1977), 73% in SA (Adelaide 1971), 87% in WA (Perth 1971), 100% in ACT (1964), 77% in Tasmania (Hobart 1964) and 78% in NT (Darwin started water fluoridation in 1972) (Barnard 1971-1989; ComDeptHealth 1985; Carr 1988; Barnard 1989).

Regular toothbrushing became universal and it was found to be exercised unexpectedly frequently by NSW teenagers in mid 1970s (Barnard, Clements 1976). Data on preschool children brushing habits is not available but in NOHSA (1987-88) 93% of 5 year olds claimed to brush their teeth at least once each day, without noteworthy fluctuations of this figure for 5-9 years of age group across States (95% of the toothpastes in the market are fluoridated -figure 3, page 21).

Sugar consumption has not changed quantitatively in the meantime, but there has been a shift towards processed sugar use, which is strongly associated ($r = -0.95$) with the trends of dental caries shown in figure 3 (page 21) for 12 year olds in NSW (Sivaneswaran, Barnard 1990). There is no reason to suggest that this change in sugar consumption patterns has not had an effect on preschoolers as well.

NSW dentists had been found to be relatively more preventively oriented in the ICSDM (Arnliot *et al.* 1985).

The demography of the population, as in other developed countries, is changing towards ageing but a growth rate higher than one per cent (roughly double the rate in other developed countries except USA; see

Figure 4- Annual per cent population growth, and 0-14 and 65+ years age groups as proportion of the total population; Australia 1970-1989.

Source: Barnard 1971-1989; ABS 1990.

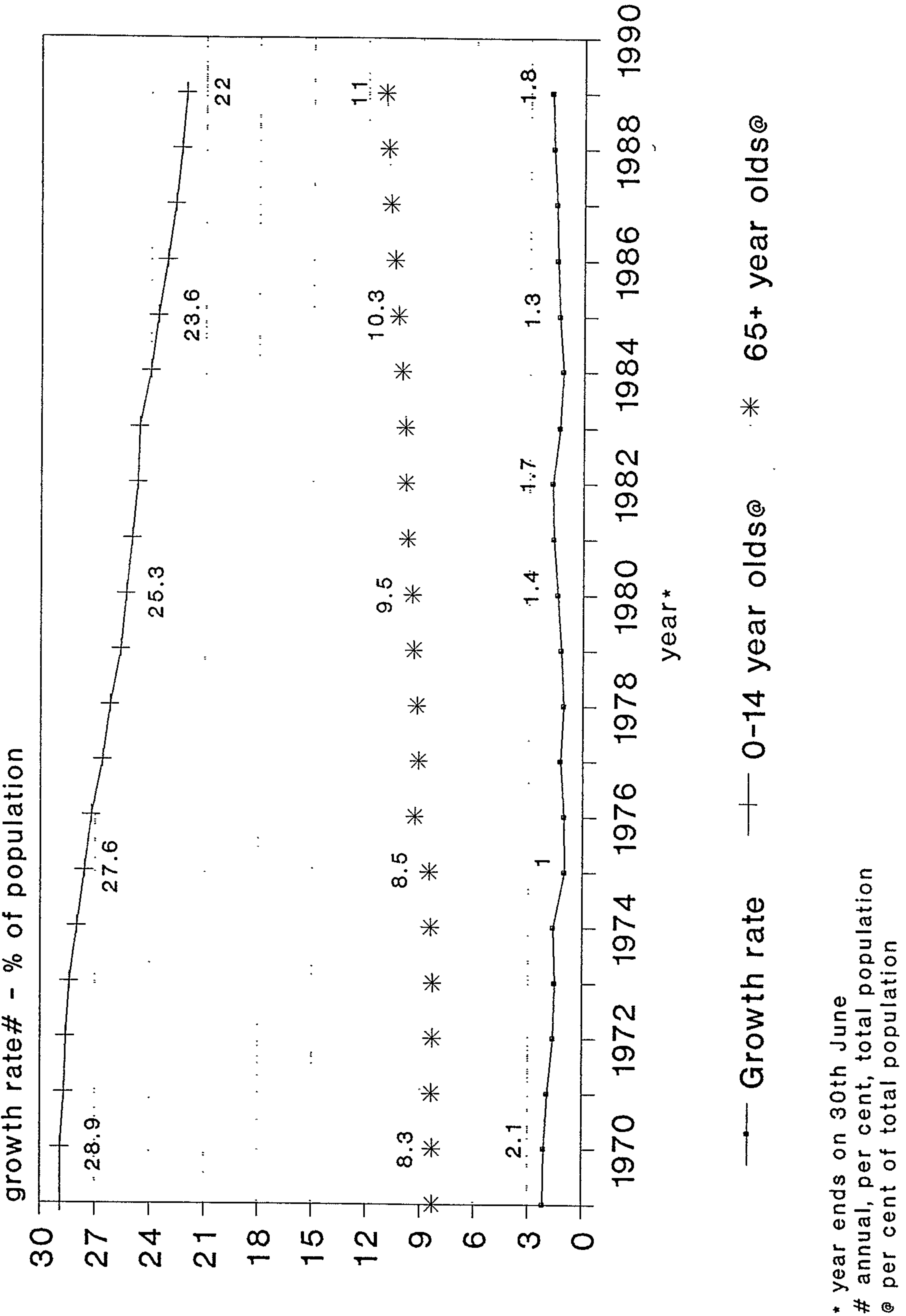


figure 2, page 5) has been maintained (figure 4, page 23). Thus, the 0-4 years age group increased about 8% between 1980 and 1987 -from 1,130,861 to 1,216,637, respectively (Barnard 1971-1989).

Adults' age groups present a disease pattern which is compatible to the before-prevention and, for older groups, before-maintenance ("blood and vulcanite") era of dentistry (figure 5, page 25). The latter figure has been produced by combining the expected DMFT projection throughout life, modelled by WHO/FDI (1989), with the results of NOHSA (1987-88) and Barnard (1956), and lends support to the argument on the feasibility for oral health outcomes in elderly people (see pages 4-6).

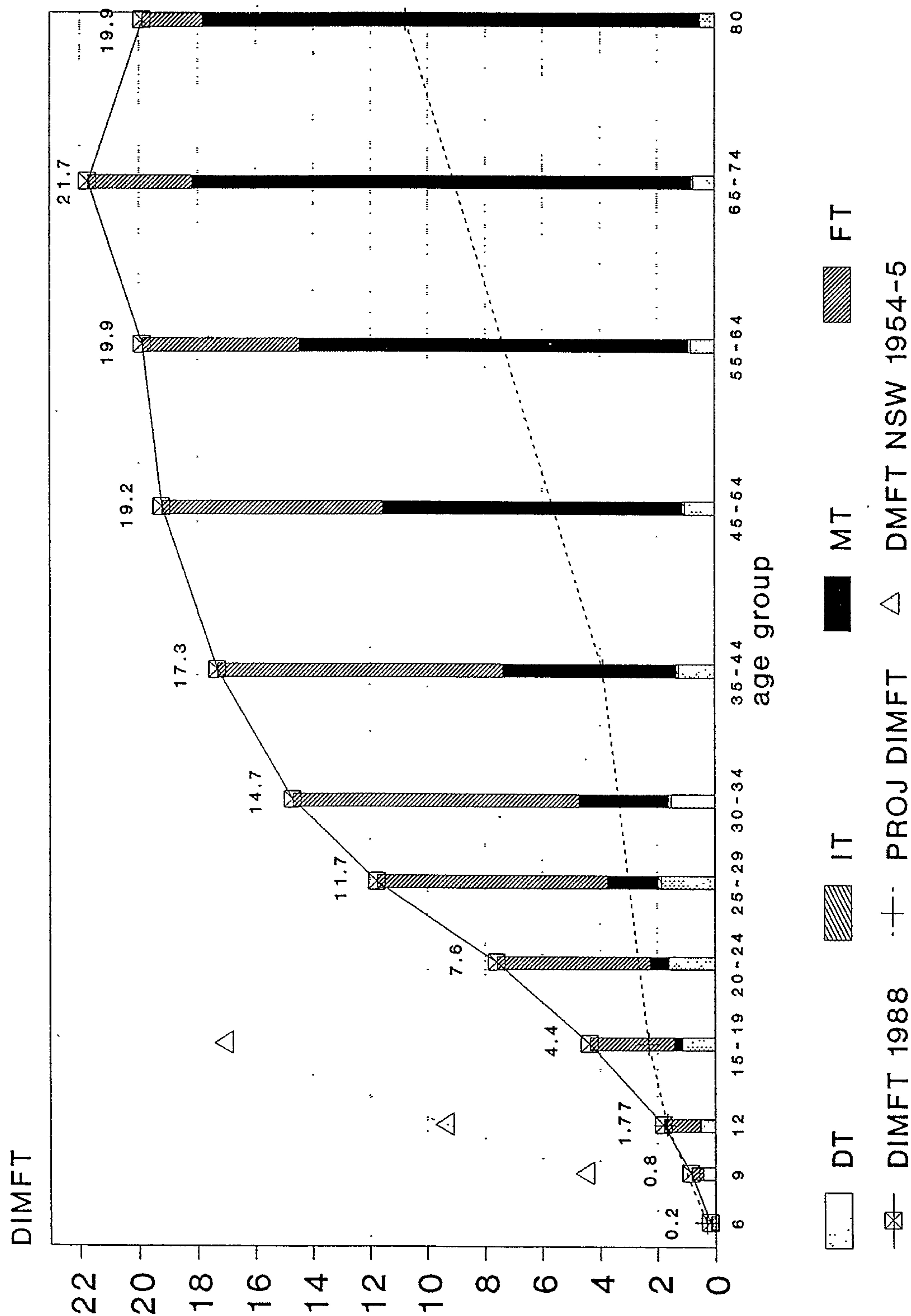
An indicator of "dental awareness", utilisation rate, has also been shown to have improved. In particular, 54% of the population claimed to have visited a dental provider in 1987-88 compared with 49% in 1979 (Barnard 1989). All age groups (except for preschool children who were not examined in NOHSA) appeared to have improved their regularity of use of dental services (ibid.).

The treatment mix received at last visit has also changed for all age groups, especially the younger ones, in the time period between 1979 and 1987-88. For the 5-9 years age group, examinations (25% of total treatments received in 1979; 47% in 1987-88), prophylaxis (18%; 16%), and fluorides (16%; 13%) constitute the bulk of the treatment received (ABS 1980; NOHSA 1987-88).

Taking into account the number of teeth present, it is noticeable that preschool children may have become the most deprived population group as far as the use of dental services is concerned. In 1979 and 1983 ABS surveys (ABS 1980, 1985), 63% and 69% of the 2-14 years old Australians had visited a dental provider in the year (fortnight for the 1983 survey) before the interview, respectively, but the corresponding figures for the 2-4 year olds had been 27% and 25% (Barnard 1986) while, in the ABS 1979 survey, 22% of the elderly (65+ year olds) had visited in the previous year and 36% of elderly persons

Figure 5- Expected dental caries projection and actual caries experience and treatment patterns by age group; NSW 1954-55 and Australia 1987-88.

Source: Barnard 1956; WHO/FDI 1989; Barnard 1989.



had in the NOHSA (1987-88). In the NOHSA, 5 year olds had least utilised the dental services during the year before the survey (59%) when compared with the other groups in the 5-9 years age cohort which averaged 79%. In that period of time, each 5-year-old Australian child had made 1.6 visits while the average number of visits per person per year had been 1.8 for the 5-9 year olds (NOHSA 1987-88).

Relatively low utilisation rates have also been reported for preschool children in other countries (Todd, Dodd 1985; Waldman 1990), especially for children of low socioeconomic background and/or with worse oral health status (Beautrais, Fergusson, Shannon 1982; Todd, Dodd 1985; Waldman 1990).

In general, the introduction of the overwhelming majority of the Australian population to the dental services occurs in the age of 5-9 years. Eleven per cent of this cohort had never visited a dental provider in 1987-88 while this figure for the same age group had been 17% in 1979 and 11% in 1983 (ABS 1980, 1985; NOHSA 1987-88). The role that SDS plays in utilisation is obvious. However, 71% of the 2-4 year olds in the 1983 ABS study (ABS 1985) and 30% of 5 year olds in the NOHSA (1987-88) had never visited a dental provider.

Two factors, among other possible factors, have been shown to be particularly associated with the above-discussed utilisation trends of these age groups, namely dental insurance coverage and the extent of the development of SDS locally.

Dental insurance developed rapidly in the second half of 1970s, peaked in 1982 (46% of the population were covered), and in 1988 an estimated 39% of the population were covered (Barnard 1971-1989). It was found in NOHSA (1987-88) that 47% of 5-year-old children had dental insurance coverage, while the figure for the 5-9 and 5-14 year olds was 47% and 50%, respectively. Of the total population, 46% were covered. In 1983, 53% of the 2-14 year olds and 56% of the 4-11 year olds had been found to have insurance coverage (ABS 1985).

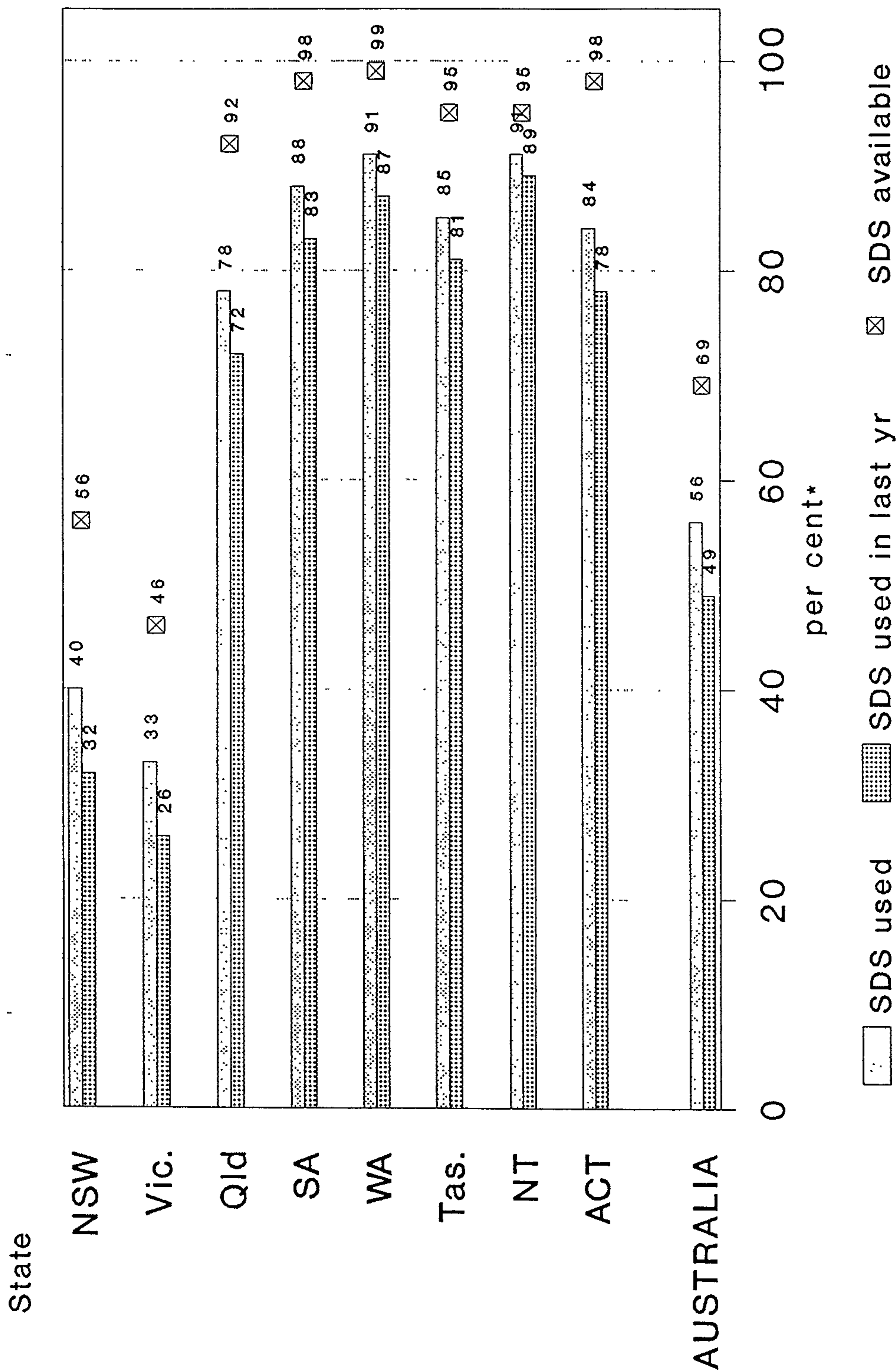
As to the extent of the development of SDS, the transition from a federal to a state government mode of financing the services (both for capital and recurrent expenditures) in 1981-82 led to a "freezing" of the development of the services and to the perpetuation of inequalities by state which had been established before 1980. Tas., SA, WA and Qld had much better developed SDS than NSW and Vic. in 1980 (given the distribution of the population by state -see page 20) so that they all had been close to the objective of total coverage, and the federal support to the states was made on a per capita basis (of children already covered). This change in the financing mechanism resulted in a situation where attainment of equality in coverage and service was not possible over time (Spencer 1983; NSW DeptHealth 1985; see table 2, page 20).

The impact of these two factors (dental insurance and SDS development) upon the utilisation patterns of children covered by SDS can be seen through the ABS 1983 survey (ABS 1985) -see page 26 for the proportion of children covered by dental insurance. The 1979 ABS study (ABS 1980) and NOHSA (1987-88) did not report suitably analysed data for a longitudinal assessment of this impact, although Spencer and Lewis (1988) showed the same impact of dental insurance coverage upon the place of visit for groups older than 12 years of age using data of the 1979 ABS survey.

Less than 40% of the 2-14 year olds in NSW and Vic. actually used the SDS in 1983, that is half the percentage of the same population group who used the service in all other states and territories (figure 6, page 28). Figure 6 also shows that, in NSW and Vic., less than one in every third child uses the SDS regularly ("used in last year" category). More importantly, 2-14 year old children with insurance coverage used SDS less than non-covered children (figure 7, page 29). Although the latter trend cannot be analysed by state and the age groups referred to in figures 6 and 7 are not identical, on the basis of the above-mentioned data on utilisation it could be assumed that this trend in the place of visit by insurance coverage for the younger

Figure 6- Availability of SDS for, and use of services by, Australian 4-11 year old children in 1983.

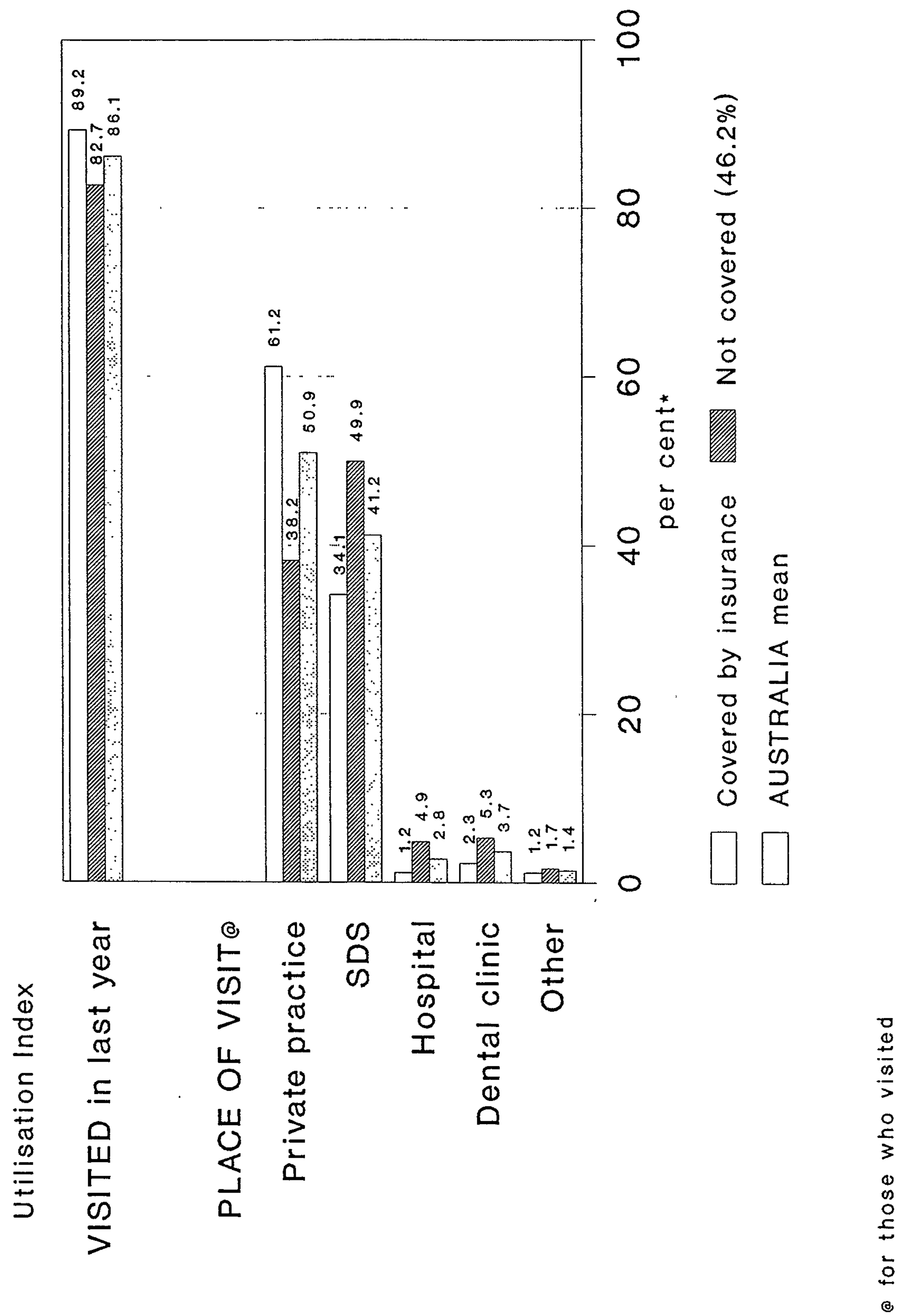
Source: ABS 1985.



* all figures have been rounded

Figure 7- Utilisation rate and place of last visit for Australian 2-14 year old children by insurance coverage in 1983.

Source: ABS 1985.



children is more so in states with less developed SDS (as shown in figures 6 and 7).

It is not known whether disease trends in Australian children play an additional role in the establishment of utilisation patterns such as the above. In UK, however, there have been reports based on records of the General Dental Service (GDS) and the Community Dental Service (CDS) which have indicated that children who visit the CDS have more severe disease than those utilising the GDS (Downer, Whittle, Teagle 1979; Lennon, Taylor 1980) although the assumption underlying this comment is that the treatment approach prevalent in both services is identical. Recent USA data further supports the argument that children (including preschoolers) with dental insurance coverage have better oral health status and more preventively oriented utilisation patterns (Waldman 1990).

To this end, it should be noted that perceived need(s) for dental care is a powerful factor in utilisation patterns (Barnard, Clements 1976; Arnljot *et al.* 1985). In NOHSA (1987-88), 69% of 5-year-old children did not perceive any need for treatment, compared with 63% of 5-9 year olds, 51% of the 10-14 years age group and 43% of the Australians older than 5 years of age.

Recent studies in Melbourne (Calache 1983; Spencer, Lewis 1986, 1988; Spencer, Wright, Brown, Brown 1989) and international reviews (Holm 1990) have shown that there is a lack of readily available Australian data for the purposes of making comparisons, identifying trends, evaluating services, and planning for the future.

One comprehensive source of information, SDS statistics (ComDeptHealth 1987), does not include any information on the oral health status of the 2- and 3-year old age groups, whereas the data made available from this source on 4 year olds derives from population samples that are relatively small (less than half) compared with older age groups examined by SDS personnel, especially when analyses are made by state.

The recently conducted NOHSA (1987-88) did not examine children younger than 5 years of age while the sample of 5 year olds examined was representative of the national but not large enough for state populations at this age, so that analysis by state for this age group cannot be conducted.

It is therefore clear that Australian preschool children constitute a dentally neglected population group as it is indicated by the above mentioned utilisation patterns and the availability of data on dental caries in this age group.

1.4 DEFINITION OF THE PROBLEM AND AIMS

The importance of the preschool children as a target group for the provision of dental services because of their vulnerability to dental caries, and for the introduction of preventive measures and the establishment of favourable dental-related behaviour has been widely recognised, and has attracted the attention of organised Australian dentistry, in particular, since its very early years. The need for monitoring of disease trends for setting goals, planning services, monitoring the attainment of these goals and the provision of services, evaluating the oral health outcome of the services and instituting necessary changes has become imperative. The possibility of identifying high-risk groups early in their lives and allocating resources more efficiently has been a high priority and challenge.

There is, however, a lack of comprehensive baseline data at both a national and state level, which has led to difficulties when some of the above tasks are undertaken in relation to Australian children younger than 5 years of age.

Hence, there is a need for collecting and collating information on dental caries in Australian preschool children in order to gain an insight into what information is available and what is missing, what is the quality of the information, what disease trends and treatment patterns are revealed through this information, and what needs there are for services and for research activities.

Therefore, the aims of this thesis are:

1. to collect and collate all the available information on the dental caries status of 2-5 year old preschool children in Australia; and
2. - to appraise the value of this information;
- to identify disease and treatment needs trends over time;

- to identify factors affecting these trends;
- to identify areas where further epidemiological evidence is necessary; and
- to discuss the advantages and disadvantages of using different indices in surveys and delivery system databases.

2 SUMMARY OF THE LITERATURE

2.1 MATERIALS AND METHODS

In order to collect as much information as possible, three sources of data were identified:

- the literature, government publications and university postgraduate theses;
- the departments of community and/or preventive dentistry of the Australian dental schools; and
- files kept by the Department of Preventive Dentistry of the University of Sydney containing mostly unpublished surveys and data of published ones involving preschool children in samples examined over the past 30 years.

Letters were written to:

- the AIH requesting updated information on the oral health status of children seen in SDS clinics and some additional data of certain years before 1986 (number of subjects in samples) not included in the 1987 publication of the ComDeptHealth;
- the librarians of the dental schools of the universities of Melbourne and Adelaide to obtain the tables of theses cited in the literature; and
- the faculty of the Australian dental schools in charge of community dentistry requesting any unpublished figures they might have.

The first and the latter of these requests did not eventually yield any additional information.

Some data on younger than 5 years age groups in studies conducted in NSW by the Department of Preventive Dentistry of the University of Sydney have been extracted from punch cards, some from survey summary

sheets, yet others have been taken from computer printouts. Certain figures were also obtained through correspondence included in the files kept by the Department.

For the purpose of standardisation, all indices used in the literature are adjusted to the contemporary index suggested by the WHO (1987b), that is:

- d: decayed;
- i: indicated for extraction, primarily due to caries;
- m: missing, as a result of caries; and
- f: filled, no decay.

When discussing disease trends, it is assumed that any changes in diagnostic criteria and methods that have occurred over time do not affect the trends identified (FDI/WHO 1985).

Student's t-test has been used for testing differences between percentages and means (Miller 1981). Differences are considered significant at the 5% level of confidence ($p < 0.05$).

It was expected that a variation in methods would be found in the literature. Thus, further methodological decisions were taken during the collation and evaluation of the literature. Therefore, the next two sections, along with the description regarding the collation and evaluation of the literature, include comments on the method which was followed in this review.

2.2 COLLATION OF DATA

The overwhelming majority of the studies collected, reported their results by age groups examined. Thus, all studies and all their respective figures were grouped by age cohorts (2-, 3-, 4-, and 5-year old children; tables 3, 4, 5, and 6; pages 36, 37, 38-39, and 41-43, respectively). Studies that did not categorise their observations into specific age groups, and/or did not provide for comparable or adjustable figures, and/or had dealt with special sample groups, were summarised separately (table 7, page 44).

In all tables the first column gives:

the author (only the main author in the case of multiple authors) and the year of the publication as cited in the references list / the period or year of the study / the

Table 3- Dental caries in 2-year-old Australian children; all available indices.

Reference / Year(s) of study / Area / Conditions	N	$\bar{x}$ dmft=0	mt	it	dt	ft	(d+f)t	dmft	dft	ds	fs	is	(d+f)s	difs	dmfs
Cameron (1953) / 1946-47 / Sydney / -	81	64.2%						1.60							
Jago (1963) / 1954-62 / Melbour./Chil.GrowthStudy	114	99.1%	0.00					0.04	0.04						0.04
Halikis (1963) / 1959 / Fremantle, WA / -	19	36.8%	0.00	0.47	3.32	0.00		3.80	3.80	3.90	0.00	0.53		4.42	4.42
Barnard (1964b) / Lit. rev. / NSW(est.) / -			0.00	0.00	0.30	0.00		0.30	0.30					0.50	
Martin (1965) / 1964 / Goulburn, NSW / Water Fl.															
ALL CHILDREN	9		0.00	0.00	0.22	0.00	0.00	0.22	0.22	0.22	0.00	0.00	0.00	0.22	
CONTIN. RESIDENTS	7		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Barnard (1988) / 1963-88 / Tamworth, NSW/															
ALL CHILDREN: 1963	24	83.3%	0.00	0.00	0.29	0.00	0.00	0.29	0.29	0.29			0.00	0.29	0.29
1965	19	94.7%	0.00	0.05	0.16	0.00	0.00	0.21	0.21	0.42			0.00	0.42	0.42
CONTIN. RESIDENTS: 1963	19	94.7%	0.00	0.00	0.11	0.00	0.00	0.11	0.11	0.11			0.00	0.11	0.11
Water Fl. 1965	11	90.9%	0.00	0.09	0.27	0.00	0.00	0.36	0.36	0.73			0.00	0.73	0.73

area where the survey was conducted / and the special conditions under which the study took place (ie. the children's group examined).

Table 4- Dental caries in 3-year-old Australian children; all available indices.

Reference / Year(s) of study / Area / Conditions	N	$\bar{x}$ dmft=0	mt	it	dt	ft	(d+f)t	dmft	dft	ds	fs	is	(d+f)s	difs	dmfs
Cameron (1953) / 1946-47 / Sydney / -	123	35.0%						3.40							
Kruger (1955) / 1954 / Brisbane / -	53	56.6%						2.70							
Jago (1963)/ 1954-62 / Melbour./Chil.GrowthStudy	113	75.2%	0.08					0.80	0.72						1.00
Halikis (1963) / 1959 / Fremantle, WA / -	55	1.8%	0.20	0.49	8.18	0.00		8.90	8.70	13.33	0.13	1.49		14.95	15.62
Barnard (1964b) / Lit.Rev. / NSW(est.) / -			0.00		3.60	0.00		3.60	3.60					4.50	
Kailis (1970) / 1963 / Carnarvon, WA / -	12	91.7%													
Martin (1965) / 1964 / Goulburn, NSW / Water Fl. ALL CHILDREN	49		0.04	0.00	0.94	0.04	0.00	1.02	0.98	1.18	0.04		0.00	1.22	
CONTIN. RESIDENTS	35		0.00	0.00	0.63	0.06	0.00	0.68	0.69	0.74	0.06		0.00	0.80	
Fanning (1975)/ 1970-72 / SA / F1. Tablets	89	88.0%						0.26							
No fluoride	90	69.0%						1.37							
Barnard (1975) / 1972 / Darwin / -	19	89.0%	0.00	0.00	0.30	0.00		0.30	0.30	0.30				0.30	
Fanning (1980) / 1970-76 / SA/ Water Fl.+F1. tablets	81	63.0%						---							
Fluor. water supply	339	80.0%						0.48							
Fluoride tablets	200	87.0%						0.35							
No fluoride	264	65.0%						1.36							
ComDeptHealth (1984) / 1983 / NSW / SDS	366	50.0%		0.05	2.18	0.16			2.41						
Barnard (1988) / 1963-88 / Tamworth, NSW /															
ALL CHILDREN: 1963	22	40.9%	0.00	0.00	3.64	0.00	0.00	3.64	3.64	4.77	0.00		0.00	4.77	4.77
1965	27	55.6%	0.04	0.11	1.85	0.11	0.04	2.11	2.07	3.15	0.15		0.04	3.30	3.30
Water Fl. 1969	11							1.73	1.73					1.73	
1972	17							0.35	0.35					0.59	
CONTIN. RESIDENTS: 1963	12	25.0%	0.00	0.00	4.50	0.00	0.00	4.50	4.50	5.92	0.00		0.00	5.92	5.92
1965	16	50.0%	0.00	0.12	2.19	0.19	0.06	2.50	2.50	3.38	0.25		0.06	3.62	3.62

Table 5- Dental caries in 4-year-old Australian children; all available indices.

Reference / Year(s) of study / Area / Conditions	N	$\bar{X}$ dmft=0	mt	it	dt	ft	(d+f)t	dmft	dft	ds	fs	is	(d+f)s	difs	dmfs
Cameron (1953) / 1946-47 / Sydney / -	97	12.4%							7.20						
Kruger (1955) / 1954 / Brisbane / -	164	23.7%							4.20						
Jago (1963)/ 1954-62 / Melbour./Chil.GrowthStudy	105	36.2%	0.13					3.35	3.22						4.40
Halikis (1963) / 1959 / Fremantle, WA / -	89	3.4%	0.31	1.29	8.60	0.25		10.45	10.14	14.01	0.49	5.00		19.50	20.52
Barnard (1964b) / Lit.rev. / NSW(est.) / -			1.00		4.90	0.60		6.00	5.00					8.50	
Kailis (1970) / 1963 / Carnarvon, WA / NoFl.	13	61.5%													
Martin (1965) / 1964 / Goulburn, NSW / Water Fl.															
ALL CHILDREN	46		0.00	0.04	1.92	0.09	0.00	2.04	2.04	2.46	0.11	0.15	0.00	2.72	
CONTIN. RESIDENTS	36		0.00	0.03	1.80	0.08	0.00	1.92	1.92	2.39	0.08	0.14	0.00	2.61	
Fanning (1975) / 1970-72 / SA / Fluoride tablets	504	81.0%						0.67							
No fluoride	1036	49.0%						2.12							
Barnard (1975) / 1972 / 1972 / Darwin / -	156	50.0%	0.11	0.04	1.96	0.30		2.41	2.30	2.90	0.50			3.40	
Barnard (1979a)/ 1962-78/ Yass, NSW /															
ALL CHILDREN: 1962	15		0.01	0.00	0.73	0.13		0.87	0.86	0.87	0.20			1.07	
Water Fl. 1967	33	61.0%	0.00	0.24	1.39	0.52		2.15	2.15	2.03	1.09			3.12	
1978	23	83.0%	0.01	0.00	0.35	0.22		0.57	0.56	0.35	0.25			0.60	
CONT. RESIDENTS: 1962	6		0.00	0.00	0.50	0.33		0.83	0.83	0.50	0.50			1.00	
Water Fl. 1967	21	71.0%	0.00	0.14	0.76	0.29		1.19	1.19	1.00	0.43			1.43	
1978	11	73.0%	0.00	0.00	0.64	0.18		0.82	0.82	0.60	0.20			0.80	
Fanning (1980) / 1970-76/ SA/Water Fl.+Fl. tablets	76	68.0%													
Fluor. water supply	3406	64.0%						1.19							
Fluoride tablets	877	74.0%						1.01							
No fluoride	1726	48.0%						2.23							
Calache (1983) / 1982 / Brunswick,Vic./ Water Fl.	202	62.4%				0.11		0.81						1.62	
ComDeptHealth(1981,1987)/ 1977-1986 /Australia/ SDS															
1977	4996	40.8%		0.16	2.34	0.36			2.86						
1978	10311	44.0%		0.14	2.25	0.37			2.75						
1979	14168	44.6%		0.14	2.28	0.43			2.86						
1980	17141	48.8%		0.12	1.95	0.35			2.42						
1981	21170	48.8%		0.10	1.92	0.38			2.41						
1982	20730	50.4%		0.05	1.83	0.35			2.24						
1983		52.2%		0.04	1.61	0.38			2.04						
1984		53.7%		0.04	1.58	0.37			2.00						
1985	25479	55.9%		0.03	1.51	0.33			1.88						
July 1986	9835	58.3%		0.01	1.43	0.28			1.73						
Barnard (1971-89)/ 1987 / Australia / SDS									1.69						

Table 5- continued.

Reference / Year(s) of study / Area / Conditions	N	$\bar{x}$ <u>dimft=0</u>	<u>mt</u>	<u>it</u>	<u>dt</u>	<u>ft</u>	<u>(d+f)t</u>	<u>dimft</u>	<u>dift</u>	<u>ds</u>	<u>fs</u>	<u>is</u>	<u>(d+f)s</u>	<u>difs</u>	<u>dmfs</u>
ComDeptHealth (1984) / 1983/ NSW / SDS	3156	51.8%		0.03	1.71	0.27			2.01						
AIH (1990) / 1989 / NSW / SDS	24	56.4%													
Barnard (1988) / 1963-88 / Tamworth, NSW/															
ALL CHILDREN: 1963	83	21.7%	0.39	0.28	4.61	0.24	0.13	5.52	5.13	7.99	0.51		0.08	8.90	10.42
1966	39	25.6%	0.33	0.10	3.02	0.31	0.15	3.77	3.44	5.13	0.41		0.13	5.54	
Water Fl. 1967	93	43.0%	0.28					3.23	2.95					4.82	
1970	47	57.4%	0.15	0.06				2.11	1.96	2.45				2.75	
1973	75	66.7%	0.20	0.05	0.73	0.12		1.10	0.90	0.99				1.16	
CONTIN. RESIDENTS: 1963	33	30.3%	0.61	0.30	4.52	0.15		5.58	4.97	8.76	0.18		0.00	8.94	11.97
1966	23	17.4%	0.48	0.17	3.47	0.40		4.52	4.04	6.39	0.48			6.87	
Water Fl. 1967	49	34.7%	0.35					3.69	3.34					5.79	
1970	25	48.0%	0.20	0.08				2.48	2.28	2.44				3.00	
1973	38	57.9%	0.34	0.11	0.84	0.05		1.34	1.00	1.37				1.47	

In the latter case (conditions or children's group), water fluoridation groups have been noted only when the measure has been implemented for a number of years which is equal to or greater than the age of the group under consideration. The year in which water fluoridation was commenced has been taken either from the respective studies or, where possible, from the relevant government publication (ComDeptHealth 1985).

All indices reported in the literature with adequate consistency have been included in tables 3 to 6 in order to give a more detailed summary of the literature. Indices which have been rarely reported in the literature as, for instance, number of teeth affected per 100 teeth present (Kruger 1955) or severity rate (Cooper, Schamschulla, Williams 1984), and could not be converted into a dif or dmf score have not been included in the tables.

Where appropriate and possible, the calculation of the components of the indices used have been done by the writer.

The dimf and dmf indices are numerically identical, and they are used

alternatively in this study.

In Tamworth studies conducted by Barnard (1988), the (d+f)t or (d+f)s index (teeth or surfaces filled and also decayed) is included in the d component of the dmfs scores. A number of additional indices from these studies (for example: percentage (%) of children with mt or ms=0, % with ft or fs=0) have not been included.

In all surveys, whenever the i component of the dmft/dift score is not given it is included in the d component of df and dmfs indices. If the i component is given, it is not included in the d component.

In any case, the sum of the components of dif/dmfs indices may not be equal to the dif/dmfs scores, respectively, due to rounding.

In the studies of Fanning and co-workers (1975, 1980) the age grouping into 3-4, 4-5 and 5-6 year olds was taken as 3, 4 and 5 year olds, respectively, and the figures cited in the tables 4, 5 and 6 (pages 37, 38, and 41-42, respectively) for fluoride tablets intake refer only to those children who had been taking tablets throughout their life.

Wright and Spencer (1980) examined 5-6 year old children at Brunswick, Vic., in 1977, while Spencer and co-workers (1989) reported on the dental caries status in 5 and 6 year old Brunswick children examined in 1985 (table 6, page 42). In the latter study, the age groups examined in 1977 and 1986 were treated as identical.

The oral health education programme conducted by Barnard at Canowindra (Barnard 1967) had Gilgandra children as the control group (Barnard 1966; see table 6, page 41).

The sample of children in the study conducted by Webb (1987) at WMHR, Sydney, in 1979 (table 6, page 43) comprised children born in 1973, and, thus, the results of this survey will not be considered in the discussion.

Table 6- Dental caries in 5-year-old Australian children;
all available indices.

Reference / Year(s) of study / Area / Conditions	N	Σ dmft=0	mt	it	dt	ft	(d+f)t	dmft	dift	ds	fs	is	(d+f)s	difs	dmfs
Cameron (1953) / 1946-47 / Sydney / -	91	6.6%						8.10							
Kruger (1955) / 1954 / Brisbane / -	128	14.8%						5.40							
Barnard (1959) / 1959 / Albury, NSW / -	82			0.50	2.70	0.69	0.15		3.89						
Jago (1963) / 1954-62 / Melbour./Chil.GrowthStudy	109	15.6%	0.30					5.70	5.40						9.00
Halikis (1963) / 1959 / Fremantle, WA / -	105	0.0%	0.87	1.03	8.42	0.63		11.00	10.13	14.10	1.66	3.53		19.29	22.10
Kailis (1970) / 1963 / Carnarvon, WA / -	11	54.5%													
Andrews (1964)/ 1963-64/ Vic. / -		24.0%	1.59					3.47	1.88						
Barnard (1964a) / 1963-64 / Sydney / 7th Day Adventists' children	25		0.24	0.12	1.76	0.96	0.04	3.08	2.84	2.60	1.40	0.28	0.04	4.28	5.45
Barnard (1964b) / Lit.rev. / NSW(est.) / -					4.60	1.10		7.00	6.00					11.00	
Carr (1966) / 1962-64 / Canberra/ Ch.Dent.Service															
1962	653								4.20						
1963	342								3.84						
Sept. 1964	201								5.02						
1964	660			0.46	3.24	0.51			4.21						
Barnard (1966) / 1965-66 / Gilgandra, NSW /															
1965	85		0.69	0.38	4.25	0.40	0.07	5.73	5.04	8.05	0.68		0.06	8.73	
1966	58		0.78	0.17	3.59	0.53	0.16	5.07	4.29	6.10	1.00		1.00	7.10	
Barnard (1967)/ 1965-66 / Canowindra, NSW /															
1965	52		0.25	0.37	4.78	1.23	0.19	6.63	6.38	9.10	2.58		0.10	11.67	
O.H.Educ. program 1966	26		0.46	0.31	4.46	0.81	0.04	6.04	5.58	8.19	1.38		0.04	9.58	
Martin (1965, 1979) / 1964-67 / Goulburn, NSW /															
1964 ALL CHILDREN	291		0.59	0.44	4.14	0.47	0.14	5.65	5.05	6.29	0.95	1.50	0.11	8.74	
CONTIN. RESIDENTS	206		0.60	0.46	4.57	0.31	0.08	5.94	5.34	6.31	0.56	1.67	0.06	8.54	
1967(Wat.Fl.)ALL CHILDREN								5.80							
CONTIN. RESIDENTS								4.70							
Roder (1971) / 1969-70/ SA,country/ Roder survey:	293		1.13		4.74	0.29		6.17	5.03						
1971 SA SDS :	100		1.00		4.65	0.09		5.74	4.74						
Fanning (1975) / 1970-72 / SA / Fluoride tablets	146	77.0%						0.71							
No fluoride	581	41.0%						2.75							
Barnard (1975) / 1972 / Darwin / -	171	34.0%	0.42	0.15	2.75	0.70		4.10	3.60	4.70				6.30	

Table 6- continued.

Reference / Year(s) of study / Area / Conditions	N	$\bar{x}$ dmft=0	mt	it	dt	ft	(d+f)t	dmft	dift	ds	fs	is	(d+f)s	difs	dmfs
Fanning (1980) / 1970-76 / SA/ Water Fl.+Fl. tablets	55	84.0%						---							
Fluor. water supply	407	55.0%						1.83							
Fluoride tablets	80	72.0%						1.16							
No fluoride	395	40.0%						2.93							
Barnard (1979a)/ 1962-78/ Yass, NSW/															
ALL CHILDREN 1962	67	8.0%	0.40	0.64	3.69	0.84		5.57	5.17	8.01	1.48			9.49	16.20
Water Fl. 1967	100	40.0%	0.22	0.12	2.06	0.94		3.36	3.14	3.38	1.71			5.09	
1978	73	51.0%	0.01	0.00	1.18	0.67		1.86	1.85	1.70				2.80	
CONT. RESIDENTS 1962	24	38.0%	0.42	0.13	2.17	0.75		3.47	3.05	3.75	1.38			5.12	
Water Fl. 1967	59	46.0%	0.15	0.02	1.12	0.64		1.95	1.80	1.58	1.08			2.66	
1978	41	56.0%	0.02	0.00	1.20	0.46		1.68	1.66	1.60				2.30	
Barnard (1979b)/ 1970-78/ Boorowa, NSW /															
1970	56	30.4%	0.05					4.46	4.41					7.11	
Water Fl. 1972	37	29.7%	0.49					3.81	3.32					7.78	
1978	23	39.1%	0.61					3.39	2.78					7.82	
ComDeptHealth(1981,1987)/ 1977-1986 /Australia/ SDS															
1977	25413	38.7%		0.21	2.27	0.48			2.96						
1978	40602	39.8%		0.18	2.27	0.52			2.96						
1979	51076	42.2%		0.15	2.14	0.56			2.86						
1980	58924	44.2%		0.13	1.96	0.59			2.68						
1981	76245	48.3%		0.09	1.67	0.56			2.33						
1982	78514	48.6%		0.06	1.65	0.57			2.29						
1983		51.2%		0.04	1.47	0.56			2.07						
1984		51.5%		0.04	1.41	0.56			2.01						
1985	101574	55.0%		0.03	1.30	0.52			1.85						
1986	39828	56.3%		0.02	1.28	0.46			1.77						
ComDeptHealth (1984) / 1983 / NSW	17946	51.6%		0.03	1.54	0.43			2.01						
AIH (1990) / 1989 / NSW	295	48.2%			1.96			2.45							
Cooper (1984)/ 1981-82/ Orana & Far West Reg., NSW /															
No Fl. / All children:	208	33.3%	0.1		3.1	0.1		3.30							
Aborigines:	96	18.7%						4.60							
Caucasian children:	112	46.4%						2.40							
ComDeptHealth(1982a,1982b)/ 1982 / NSW / SDS / NoFl.								2.50							
Fluoride + NoFluoride:								2.00							
Spencer (1986) / 1984 / Vic. / SDS				0.05	1.54	0.45			2.05						
Spencer (1989)/ 1977-85 / Brunswick, Vic. /															
1977	103	10.7%				0.58		6.36							
Water Fl. 1985	174	46.6%						2.30							
Barnard (1971-89)/ 1987 / Australia / SDS									1.73						
NOHS Australia 1987-88 / Australia / -	373	60.5%	0.11	0.003	0.91	0.48	0.04	1.50	1.39						

Table 6- continued.

Reference / Year(s) of study / Area / Conditions		N	$\bar{x}$ dmft=0	mt	it	dt	ft	(d+f)t	dmft	dft	ds	fs	is	(d+f)s	difs	dmfs
Webb (1987) / 1979-86 / WMHR, NSW /Water Fl./ Child Dental Health Study																
	1981	2231			0.15	1.67	0.31			2.14						
	1982	2484			0.13	1.91	0.32			2.37						
	1983	3011			0.06	1.80	0.32			2.19						
	1984	2908			0.07	1.63	0.36			2.07						
	1985	2930			0.07	1.62	0.27			1.97						
	October 1986	2191			0.03	1.45	0.28			1.76						
	Webb's study 1979	380	45.5%		0.23	1.51	0.15			1.89						
Barnard (1988) / 1963-1988/ Tamworth, NSW/ ALL CHILDREN:																
	1963	351	16.5%	0.72	0.42	4.15	0.58	0.18	5.87	5.15	7.70	1.23		0.10	8.94	12.56
	1966	404	16.1%	0.43	0.29	4.83	0.50	0.25	6.05	5.62	8.53	1.03		0.14	9.55	
	Water Fl. 1967	470	27.4%	0.52					4.53	4.01					6.79	
	1970	409	42.5%	0.29	0.16				3.05	2.76	4.04				4.72	
	1973	426	43.4%	0.18	0.12	1.82	0.38		2.50	2.32	2.97				3.65	
	1979	352	51.4%	0.22	0.06	1.18	0.50	0.01	1.96	1.74	1.94	0.74	0.25		2.68	
	1988	216	64.4%	0.06	0.08	0.71	0.40	0.06	1.26	1.20	1.29	0.62	0.29		1.91	
CONTIN. RESIDENTS:	1963	157	16.6%	0.88	0.44	4.05	0.38	0.11	5.73	4.85	7.81	0.80		0.05	8.61	12.34
	1966	187	12.3%	0.55	0.33	5.25	0.58	0.31	6.72	6.16	9.10	1.24		0.17	10.36	
	Water Fl. 1967	243	26.3%	0.46					4.69	4.23					6.83	
	1970	199	44.2%	0.23	0.24				2.94	2.71	4.32				4.91	
	1973	207	38.2%	0.25	0.15	2.06	0.40		2.84	2.59	3.35				4.07	
	1979	169	49.1%	0.28	0.07	1.36	0.47		2.19	1.91	2.21			0.00	2.93	
	1988	110	63.6%	0.08	0.03	0.67	0.39		1.18	1.10	1.16	0.56			1.72	
Stockwell (1990) / 1987 / WA / Perth, Water Fl. # 412 63.8% 1.81 Bunbury-Busselton, Fl. tab1 376 57.3% 2.18																

Mean Fluor. Tablets Consumption Index: Perth-10; Bunbury/Busselton-257.

Figures from SDS evaluations have been taken from the government publications (ComDeptHealth 1981, 1984, 1987) which contained more detailed information than the papers of Carr (1982, 1983, 1988) which have also been listed in the references. This applies also to Tamworth figures which have been taken from the original computer printouts, punch cards, and/or survey summary sheets, and are more detailed and updated than those which have been published (Martin, Barnard 1970, 1972, 1973; Barnard 1980).

Wright and Spencer (1980) reported that 6% of Brunswick 5-6 year old children were caries-free in 1977, while Spencer and co-authors (1989) reported that 10.7% of those children were caries-free. The latter figure has been included in table 6 (page 42).

Very few studies included or reported radiographic examination of their samples or selected sub-groups. As was shown (pages 15-17) this method of examination is not considered to add substantial information to the clinical examination. Even if it did (in the age groups under consideration), there is very limited information in the literature

Table 7- Dental caries in 2-5 year old Australian children; unclassifiable studies.

Reference / Year(s) of study / Area / Conditions	Age	N	%dimft=0	dimft	dift	difs
Clements (1938) / 1937 / N.S.W. / -	0-5	118	39.8%(est.)			
Campbell (1939) / Lit. Rev. / Australia / Aborigines /	0-5	441	48.8%			
Carr (1953) / 1952 / Canberra / Mellanby Hypoplasia	3 & 4					
Mel.Hyp.-Roughness 1		26			0.50	
Mel.Hyp.-Roughness 2		71			3.70	
Mel.Hyp.-Roughness 3		50			4.80	
Mel.Hyp.-Roughness 4		23			7.20	
		=====			=====	
	Total=	170	(est.)	Mean=	4.05	(est.)
Lilienthal (1953) / 1947-52 / Bowral, NSW /	4	11	100.0%			
Anticaries diet	5	10	100.0%			
Barret (1953) / 1951-52 / Yuendumu, N.T./Aborigines	0-5	54	96.3%	0.40		
Sullivan (1958) / 1952-56 / Bowral, NSW /						
Anticaries diet	5			0.14		
	3-5			0.13		0.13
Willoughby (1963) / 1963 / Child Center, Adelaide/ -	3-5	66	33.3%	5.5		
Reade (1963) / 1963 / S.A. / -	1-4	112	12.5%	$\frac{d}{1.6}$ $\frac{i}{1.7}$ $\frac{f}{0.3}$		3.6
Reade (1965) / 1963-64 / Koonibba, SA / Aborigines	0-5	27	63.0%	1.7		
Barkla (1966) / 1954-64 / Melbourne/Ch.GrowthStudy/ Canines and Molars	2-3	116		Caries Increment		
	3-4	103		0.15		
	4-5	98		0.57		
				1.26		
Barrett (1972) / 1970 / Yuendumu, N.T./Aborigines	3-5	30	60.0%		1.10	
Stacey (1989) / 1988? / Melbourne / Water Fl. / (Diet study)ALL CHILDREN:	2-6	60	63.3%	$\frac{ds}{1.67}$ $\frac{ms}{0.50}$ $\frac{fs}{0.27}$	$\frac{dmfs}{2.43}$	
Anglo-saxon children:		34	76.5%	0.12 0.00 0.44	0.56	
Lebanese:		26	46.2%	3.65 1.15 0.04	4.88	

(for example, Tamworth 1963 and 1979 surveys -see page 17), which enables meaningful discussion and drawing of conclusions. Therefore, such data has not been included in the tables and will not be discussed in detail.

Kailis and Silva (1970) -tables 4, 5 and 6; pages 37, 38 and 41, respectively- used radiographs but not in preschoolers.

The figures reported by Roder (1971) -table 6, page 41- incorporated information derived from x-rays where available.

Some of the studies included in tables 3-7 (pages 36-44) reported their results by sex (Cameron 1953; Kruger 1955; Jago, King 1963; Halikis 1963; Carr 1966; Barkla, Roche, Jago, Maritz 1966; Roder 1971; ComDeptHealth 1984; Cooper *et al.* 1984; Calache, Wright 1987; ComDeptHealth 1987; Barnard 1988; NOHSA 1987-88).

Halikis (1963) and Cooper *et al.* (1984) found no statistically significant differences by sex.

Jago and King (1963) found boys to have significantly more decay than girls in the age groups of 4 and 5 years, but Barkla and co-authors (1966) attributed this finding to the "semi-longitudinal" nature of the data of the study and deficiencies in the statistical method employed by Jago and King. Barkla and co-authors (1966) also noted that the difference in disease level by sex could not be explained on the basis of the eruption patterns of deciduous teeth alone because it had been found that in children of British ancestry living at Brunswick, Vic., the eruption of primary teeth did not differ in males compared with females (Roche, Barkla, Maritz 1964).

Calache and Wright (1987) reported statistically significant differences between males and females (with males having higher dmfs than females) but this matter was not pursued further by the authors.

The SDS evaluation data (ComDeptHealth 1987) showed that in the period 1977-1986 males had consistently more (approximately 10%) teeth affected (dift) than females in the age groups of 4 and 5 years with "only a very negligible difference" between males and females as to the number of deciduous teeth present. The latter, number of teeth present, could not be pursued due to the non-recording of missing teeth (ComDeptHealth 1987).

Although the remaining studies reporting dif or dmf scores by sex tend to roughly indicate that males have more disease than females, the trends have not been consistent throughout the age groups under consideration (Cameron 1953; ComDeptHealth 1984), the reported differences seem negligible (Carr 1966; Roder 1971; NOHSA 1987-88; Barnard 1988), and many of the surveys have not provided for testing the statistical significance of their findings (Cameron 1953; Kruger 1955; Carr 1966; Roder 1971; ComDeptHealth 1984).

Furthermore, particularly for studies involving children younger than 5 years of age, the samples of children examined are not adequately large and, thus, an analysis by sex would further detract from the validity of the data.

Finally, an analysis of the data by sex does not appear to be of practical value in the context of this review.

Therefore, it was decided that such an analysis should not be included in tables 3 to 7, nor further comments be made with regard to disease levels by sex. For studies which reported their results by sex and did not provide a mean value for the total sample, the weighted mean dmft or dift value of the pooled data was included in the tables.

For the purposes of discussion, it will be assumed that the eruption patterns of deciduous teeth in all the studies included in tables 3 to 7 closely follow those reported in the Australian and international literature (Roche *et al.* 1964; Graber 1972; Hagg, Taranger 1986) and

that no difference in emergence patterns exists between males and females (Roche *et al.* 1964; Hagg, Taranger 1986).

2.3 EVALUATION OF DATA

As expected, there has been a diversity of epidemiological indices and criteria used in the literature. This has been brought about by both the multiplicity of purposes for which studies were conducted (falling in all three categories of epidemiological studies -descriptive, analytic and experimental- as defined by Dunning in 1986) and, thereof, by the use of the appropriate methods and indices to satisfy the requirements of the design of each study. Therefore, as a first step, all comparable indices used with adequate consistency in the studies reviewed have been included in tables 3 to 7 (pages 36-39, 41-44).

Certain aspects with regard to evaluation (age groups; radiographical data; analysis by sex) have already been examined in the previous section in order to decide on the summarisation of the studies.

Some studies did not report the diagnostic criteria for recording caries as present. In studies which reported the criteria used, investigators have generally followed the criteria proposed in the literature of the time (see pages 12-14). This is particularly important with regard to the "sticky" pits and fissures. The SDS examinations have followed the WHO (1977) criteria (Carr 1988).

Not all of the studies provided for surface counts and, in those (mostly unpublished) studies which did, the information collected on the components of the difs/dmfs indices could not be completely analysed into their constituents and, more importantly, cannot be compared with other studies due to the inconsistency with which the index appears to have been used in the literature (tables 3 to 7).

Furthermore, it has been suggested that surface counts be used when rigorous epidemiological methods are desirable. The criteria proposed for recording decayed surfaces (initial, enamel, dentine caries and caries with pulpal involvement) (WHO 1979) indicate that such methods, particularly the use of the difs/dmfs indices, should probably be

accompanied by radiographic examinations as it has been suggested earlier (Carr 1966) and followed by investigators (Hennon *et al.* 1969; Hugoson *et al.* 1988). It has already been shown that only one of the collated studies employed x-rays and incorporated radiographical findings in the reported data. However, radiographs were not used systematically, while the dmft score was used for reporting the results (Roder 1971).

Additionally, it is obvious that, in 2 and 3 year olds, surface counts are almost identical to tooth counts even in studies conducted on high-carries population groups.

Finally, the dmfs scores appear to be less reliable for the purpose of comparing different studies (Downer 1990).

These observations, along with the fact that the level of dental disease in these young age groups does not necessitate the use of surface counts for increased epidemiological sensitivity, led to the decision that surfaces data will not be further analysed. Some comments regarding surface counts will be made where appropriate.

There have been studies which have examined very small, non-representative samples, especially in younger age groups. Data drawn from such samples should not be included in further analyses and it is not taken into consideration if the sample examined did not comprise 45 subjects in 4 year olds (so that several studies will not be excluded) or 50 subjects in the 5 years' cohort, unless part of a survey covering more than one age groups (e.g. 3 year olds in the study conducted by Kailis and Silva (1970); table 4, page 37). However, in younger age groups the use of studies involving small samples seems unavoidable. In the discussion, it is indicated whether use is made of all or selected (with adequate sample size as described above) studies.

A serious shortcoming, especially for the purposes of comparison and

identification of trends, is that the sampling methods vary from random, stratified selection of subjects (NOHSA 1987-88), to examination of all children attending a clinic or school or kindergarten (for example: Halikis 1963; ComDeptHealth 1987; young age groups in Barnard 1988). However, repeatedly surveyed age groups (for example, Tamworth children -Barnard 1988) have been drawn through consistent methods.

Demographic changes in the populations examined over an extended period of time are not known.

In the case of the studies conducted in Brunswick, Vic., the children's sample had been weighted toward children of migrant parents in 1977 but not in 1985. The cross-sectional samples were treated in the 1989 paper as being similar (Wright, Spencer 1980; Spencer *et al.* 1989).

All (except x-rays) conditions inducing errors when comparisons are made that were identified by Moller (1963; see page 18) appear to be present. Probable variation in the interpretation of radiographs is the case only for Roder's (1971) study -table 6, page 41.

All surveys have been conducted by dentists, except for SDS examinations which are performed by School Dental Therapists (ComDeptHealth 1987). Thus, the number of examiners varies from one (for example, Kruger 1955) to about 1,300 in SDS (for a more exact number of examiners in SDS by year, see table 2, page 20). The examiners in SDS have not been calibrated but their recordings are considered reliable because it was found that variation is minimised by the similar training they have received and the similar conditions (equipment and supervision) under which they examine the children (ComDeptHealth 1987), while the use of a large number of examiners with each examiner handling a small portion of the cross-sectional sample has produced accurate and consistent results (*ibid.*; Carr 1982).

Roder (1971) reported the use of 9 non-calibrated examiners. In all

the other surveys with small numbers of examiners, calibration does not appear to be deficient.

There is a noticeable difference regarding the physical equipment used in various surveys. It was not possible to determine the venue where examinations took place for all studies, but SDS examinations (ComDeptHealth 1987), as well as the studies of Cameron (1953), Halikis (1963), Jago and King (1963), Roder (1971), Barnard (1975), and Cooper *et al.* (1984) were conducted under "dental clinic" conditions. The results of Chilton and Greenwald (1947) -see page 16- indicate that the venue of examination may not be particularly important.

Generally, the use of (various types of) probe and plane mouth mirror under various lighting conditions without drying and cleaning of the teeth has been the predominant method of examination. Kruger (1955) used a headlamp along with natural light and reported that drying and cleaning of the teeth was not always possible. Jago and King (1963) dried but did not clean the teeth before each examination. Kailis and Silva (1970) examined the children under natural light. Calache and Wright (1987) conducted their examinations at the residences of the children. All investigators reported using adequate and standardised illumination.

The data on the "continuing residents" in fluoridated areas (Tamworth, Goulbourn, Yass -tables 3, 4, 5, and 6; pages 36, 37, 38-39, 41-43) lies beyond the scope of this review and naturally comprise less subjects in their respective samples than the "all children" groups. Only the 5 year olds' group examined in the Tamworth studies (Barnard 1988) comprise a consistently adequate sample of "continuous residents" children. The small samples involved in the other surveys would compromise the validity of any conclusions drawn, especially with regard to younger age groups. A detailed history of fluoride intake for the "non-continuing residents" groups, which were examined in these surveys, could not be obtained and, thus, fluoride intake could not be quantified following a proposed index (for example, see Stockwell,

Medcalf, Rutledge, Holman, Roberts 1990) while the conclusions drawn may be misleading. Furthermore, the usefulness of these data is also compromised by the fact that it is not possible to differentiate between fluoridated and non-fluoridated areas at a national or state level (see pages 20-22) in a manner that would allow meaningful comparisons because of the nature of the data provided by surveys not involving fluoridation outcomes, at least directly.

Frequency distributions of dental caries (by tooth or surface) and of the subjects examined (by levels of caries experience or severity) have not been reported for primary teeth.

"Unclassifiable" studies in table 7 (page 44) cannot be used in any analysis by age group.

On the basis of the points raised above, tables 8, 9, 10 and 11 (pages 53, 54, 55-56, and 57-60, respectively) include the "working information" relevant to this review.

In these tables, figures cited in brackets have been derived from very small samples and should be treated with caution (see page 49).

For many studies the figures included in the tabulation of d/, f/dimft and d/, f/dift ratios (per cent) have been calculated by the writer (last four columns in tables 8 to 11). In these ratios, and for the purposes of uniformity and comparing the studies, the d component always includes the i component.

Some differences in the sequencing of the studies between the tables 10 and 11 (pages 55-60) of this section and tables 5 and 6 in section 2.1 (pages 38-39, 41-43) have been due to formatting purposes.

Two studies, those of Halikis (1963) in all preschool age groups, and Jago and King (1963) except for 5 year olds, do not appear to follow the trend shown from other studies with regard to the caries experience

Table 8- Dental caries and treatment patterns in 2-year-old Australian children.

Reference / Year(s) of study / Area / Group	N	% d _{imft} =0	mt	it	dt	ft	(d+f)t	d _{imft}	d _{ift}	% d/ d _{imft}	% f/ d _{imft}	% d/ d _{ift}	% f/ d _{ift}
Cameron (1953) / 1946-47 / Sydney / -	81	64.2%						1.60					
Jago (1963)/ 1954-62 / Melbour./Chil.GrowthStudy	114	99.1%	0.00					0.04	0.04				
Halikis (1963) / 1959 / Fremantle, WA / -	19	[36.8%	0.00	0.47	3.32	0.00		3.80	3.80	99.7%	0.0%	99.7%	0.0%
Barnard (1964b) / Lit. Rev. / NSW(est.) / -			0.00	0.00	0.30	0.00		0.30	0.30	100.0%	0.0%	100.0%	0.0%
Martin (1965) / 1964 / Goulburn, NSW / Water Fl.	9	[	0.00	0.00	0.22	0.00	0.00	0.22	0.22	100.0%	0.0%	100.0%	0.0%
Barnard (1988) / 1963-1988 / Tamworth / ALL CHILDREN: 1963 Water Fl. 1965	24 19	[83.3% [94.7%	0.00 0.00	0.00 0.05	0.29 0.16	0.00 0.00	0.00 0.00	0.29 0.21	0.29 0.21	100.0% 100.0%	0.0% 0.0%	100.0% 100.0%	0.0% 0.0%

Table 9- Dental caries and treatment patterns in 3-year-old Australian children.

Reference / Year(s) of study / Area / Group	N	% dimft=0	mt	it	dt	ft	(d+f)t	dimft	dft	% d/ dimft	% f/ dimft	% d/ dft	% f/ dft
Cameron (1953) / 1946-47 / Sydney / -	123	35.0%						3.40					
Kruger (1955) / 1954 / Brisbane / -	53	56.6%						2.70					
Jago (1963) / 1954-62 / Melbour./Chil.GrowthStudy	113	75.2%	0.08					0.80	0.72				
Halikis (1963) / 1959 / Fremantle, WA / -	55	1.80%	0.20	0.49	8.18	0.00		8.90	8.70	97.4%	0.0%	99.7%	0.0%
Barnard (1964b) / Lit.Rev. / NSW(est.) / -			0.00	0.00	3.60	0.00		3.60	3.60	100.0%	0.0%		
Kailis (1970) / 1963 / Carnarvon, WA / -	12 [91.7%]												
Martin (1965) / 1964 / Goulburn, NSW / Water Fl.	49		0.04	0.00	0.94	0.04	0.00	1.02	0.98	92.2%	3.9%	95.9%	4.1%
Fanning (1975) / 1970-72 / SA / Fl. Tablets No Fluor.	89 90	88.0% 69.0%						0.26 1.37					
Barnard (1975) / 1972 / Darwin / -	19 [89.0%	0.00	0.00	0.30	0.30	0.00		0.30	0.30	100.0%	0.0%	100.0%	0.0%]
Fanning (1980) / 1970-76 / SA / Water Fl.+ Fl.Tablets Water Fl. Fl. Tablets No Fluor.	81 339 200 264	63.0% 80.0% 87.0% 65.0%						--- 0.48 0.35 1.36					
ComDeptHealth (1984) / 1983 / NSW / SDS	366	50.0%	0.05	2.18	0.16				2.41			92.5%	6.6%
Barnard (1988) / 1963-88 / Tamworth, NSW / ALL CHILDREN: 1963 Water Fl. 1965 1972	22 [40.9% 27 [55.6% 17	0.00 0.00 0.00	0.00 0.11 0.04	3.64 1.85 [0.35	0.00 0.11 0.04	0.00 0.11 0.35		3.64 2.11 0.35	3.64 2.07 0.35	100.0% 92.9% [	0.0% 5.2%]	100.0% 94.7%]	0.0% 5.3%]

Table 10- Dental caries and treatment patterns in 4-year-old Australian children.

Reference / Year(s) of study / Area / Group	N	% dimft=0	mt	it	dt	ft	(d+f)t	dimft	dift	% d/ dimft	% f/ dimft	% d/ dift	% f/ dift
Cameron (1953) / 1946-47 / Sydney / -	97	12.4%						7.20					
Kruger (1955) / 1954 / Brisbane / -	164	23.7%						4.20					
Jago (1963) / 1954-62 / Melbour./Chil.GrowthStudy	105	36.2%	0.13					3.35	3.22				
Halikis (1963) / 1959 / Fremantle, WA / -	89	3.40%	0.31	1.29	8.60	0.25		10.45	10.14	94.6%	2.4%	97.5%	2.5%
Barnard (1964b) / Lit.Rev. / NSW(est.) / -					4.90	0.60		6.00	5.00	81.7%	10.0%	98.0%	12.0%
Kailis (1970) / 1963 / Carnarvon, WA / -	13	[61.5%]											
Martin (1965) / 1964 / Goulburn, NSW / Water Fl.	46	[	0.00	0.04	1.92	0.09	0.00	2.04	2.04	96.1%	4.4%	96.1%	4.4%]
Fanning (1975) / 1970-72 / SA / Fl. Tablets No Fluor.	504 1036	81.0% 49.0%						0.67 2.12					
Barnard (1975) / 1972 / Darwin / -	156	50.0%	0.11	0.04	1.96	0.30		2.41	2.30	83.0%	12.4%	87.0%	13.0%
Barnard (1979a) / 1962-78 / Yass, NSW / Water Fl.	15 33 23	[61.0% 83.0%	0.01 0.00 0.00	0.00 0.24 0.00	0.73 1.39 0.35	0.13 0.52 0.22		0.87 2.15 0.57	0.86 2.15 0.56	83.9% 75.8% 61.4%	14.9% 24.2% 38.6%	84.9% 75.8% 62.5%	15.1% 24.2% 39.3%]

Table 11- Dental caries and treatment patterns in 5-year-old Australian children.

Reference / Year(s) of study / Area / Group	N	$\frac{Z}{\text{dimft}=0}$	mt	it	dt	ft	$\frac{(d+f)t}{\text{dimft}}$	$\frac{\text{dimft}}{\text{dift}}$	$\frac{\% \text{ d/}}{\text{dimft}}$	$\frac{\% \text{ f/}}{\text{dift}}$	$\frac{\% \text{ d/}}{\text{dift}}$	$\frac{\% \text{ f/}}{\text{dift}}$
Cameron (1953) / 1946-47 / Sydney / -	91	6.6%					8.10					
Kruger (1955) / 1954 / Brisbane / -	128	14.8%					5.40					
Barnard (1959) / 1959 / Albury, NSW / -	82			0.50	2.70	0.69	0.15	3.89			82.3%	17.7%
Jago (1963) / 1954-62 / Melbour./Chil.GrowthStudy	109	15.6%	0.30				5.70	5.40				
Halikis (1963) / 1959 / Fremantle, WA / -	105	0.0%	0.87	1.03	8.42	0.63	11.00	10.13	85.9%	5.7%	93.3%	6.2%
Kailis (1970) / 1963 / Carnarvon, WA / -	11	[54.5%]										
Andrews (1964) / 1963-64 / Vic. / -		24.0%	1.59				3.47	1.88				
Barnard (1964a) / 1963-64 / Sydney / 7th Day Adventists' children	25	[	0.24	0.12	1.76	0.96	0.04	2.84	61.0%	31.2%	66.2%	33.8%]
Barnard (1964b) / Lit.rev. / NSW(est.) / -					4.60	1.10	7.00	6.00	65.7%	15.7%	76.7%	18.3%
Carr (1966) / 1962-64 / Canberra/ Ch.Dent.Service	653							4.20				
	1962							3.84				
	1963							5.02				
	Sept. 1964			0.46	3.24	0.51					87.9%	12.1%
	1964							4.21				

Table 11- continued.

Reference / Year(s) of study / Area / Group	N	Σ dimft=0	mt	it	dt	ft	(d+f)t	dimft	dift	Σ d/ dimft	Σ f/ dimft	Σ d/ dift	Σ f/ dift
Barnard (1966) / 1965-66 / Gilgandra, NSW / -													
1965	85		0.69	0.38	4.25	0.40	0.07	5.73	5.04	80.7%	7.0%	91.8%	7.9%
1966	58		0.78	0.17	3.59	0.53	0.16	5.07	4.29	74.2%	10.5%	87.7%	12.4%
Barnard (1967) / 1965-66 / Canowindra, NSW /													
1965	52		0.25	0.37	4.78	1.23	0.19	6.63	6.38	77.6%	18.6%	80.6%	19.3%
O.H.Educat. program 1966	26	[	0.46	0.31	4.46	0.81	0.04	6.04	5.58	78.9%	13.4%	85.4%	14.5%]
Martin (1965) / 1964 / Goulburn, NSW / -													
ALL 1964	291		0.59	0.44	4.14	0.47	0.14	5.65	5.05	81.1%	8.3%	90.7%	9.3%
CONTIN. RESIDENTS 1964	206		0.60	0.46	4.57	0.31	0.08	5.94	5.34	84.7%	5.2%	94.2%	5.8%
Roder (1971) / 1969-70 / SA, country/ Roder survey: 1971 SA SDS:	293 100		1.13 1.00		4.74 4.65	0.29 0.09		6.17 5.74	5.03 4.74	76.8% 81.0%	4.7% 1.6%	94.2% 98.1%	5.8% 1.9%
Fanning (1975) / 1970-72 / SA / Fl. Tablets No fluor.	146 581	77.0% 41.0%						0.71 2.75					
Barnard (1975) / 1972 / Darwin / -	171	34.0%	0.42	0.15	2.75	0.70		4.10	3.60	70.7%	17.1%	80.6%	19.4%
Fanning (1980) / 1970-76 / SA / Water Fl.+ Fl. Tablets Water Fl. Fl. Tablets No fluor.	55 407 80 395	84.0% 55.0% 72.0% 40.0%						--- 1.83 1.16 2.93					
Barnard (1979a) / 1962-78 / Yass, NSW / Water Fl. ALL CHILDREN	67 100 73	8.0% 40.0% 51.0%	0.40 0.22 0.01	0.64 0.12 0.00	3.69 2.06 1.18	0.84 0.94 0.67		5.57 3.36 1.86	5.17 3.14 1.85	77.8% 64.9% 63.4%	15.1% 28.0% 36.0%	83.8% 69.4% 63.8%	16.2% 29.9% 36.2%

Table 11- continued.

Reference / Year(s) of study / Area / Group	N	Σ dimft=0	mt	it	dt	ft	(d+f)t	dimft	dift	Σ d/ dimft	Σ f/ dimft	Σ d/ dift	Σ f/ dift
Barnard (1979b) / 1970-78 / Boorowa, NSW /													
1970	56	30.4%	0.05					4.46	4.41				
Water Fl. 1972 [	37	29.7%	0.49					3.81	3.32				
1978 [	23	39.1%	0.61					3.39	2.78				
Cooper (1984) / 1981-82 / Orana & Far West Reg., NSW/ Schools / No Fl. / ALL:	208	33.3%	0.10		3.10	0.10		3.30	3.20	93.9%	3.0%		
Aborigines:	96	18.7%						4.60					
Caucasian children:	112	46.4%						2.40					
Spencer (1986) / 1984 / Vic. / SDS				0.05	1.54	0.45			2.05			77.6%	22.0%
Spencer (1989) / 1977-85 / Brunswick, Vic. / 1977	103	10.7%				0.58		6.36			9.1%		
Water Fl. 1985	174	46.6%						2.30					
ComDeptHealth (1981,1987) / 1977-1986 /Australia/ SDS													
1977	25413	38.7%		0.21	2.27	0.48			2.96			83.8%	16.2%
1978	40602	39.8%		0.18	2.27	0.52			2.96			82.8%	17.6%
1979	51076	42.2%		0.15	2.14	0.56			2.86			80.1%	19.6%
1980	58924	44.2%		0.13	1.96	0.59			2.68			78.0%	22.0%
1981	76245	48.3%		0.09	1.67	0.56			2.33			75.5%	24.0%
1982	78514	48.6%		0.06	1.65	0.57			2.29			74.7%	24.9%
1983		51.2%		0.04	1.47	0.56			2.07			72.9%	27.1%
1984		51.5%		0.04	1.41	0.56			2.01			72.1%	27.9%
1985	101574	55.0%		0.03	1.30	0.52			1.85			71.9%	28.1%
1986	39828	56.3%		0.02	1.28	0.46			1.77			73.4%	26.0%
Barnard (1971-89) / 1987 / Australia / SDS													
NOHSA 1987-88/Australia/-	373	60.5%	0.11	0.003	0.91	0.48	0.04	1.50	1.39	61.1%	31.9%	65.8%	34.3%
ComDeptHealth(1982a,1982b) / 1982/ NSW/SDS / No Fluor.:								2.50					
Fluor. + No Fluor.:								2.00					

Table 11- continued.

Reference / Year(s) of study / Area / Group	N	$\frac{\Sigma}{d+imft=0}$	mt	it	dt	ft	$\frac{(d+f)t}{d+imft}$	$\frac{d}{d+imft}$	$\frac{f}{d+imft}$	$\frac{d}{d+imft}$	$\frac{f}{d+imft}$	
ComDeptHealth(1984)/ 1983/ NSW / SDS	17946	51.6%		0.03	1.54	0.43				78.1%	21.4%	
AIH (1990) / 1989 / NSW / SDS	295	48.2%			1.96		2.45	80.0%				
Webb (1987) / 1979-86 / WMHR, NSW / Child Dental Health Study	2231 2484 3011 2908 2930 2191			0.15 0.13 0.06 0.07 0.07 0.03	1.67 1.91 1.80 1.63 1.62 1.45	0.31 0.32 0.32 0.36 0.27 0.28		2.14 2.37 2.19 2.07 1.97 1.76		85.0% 86.1% 84.9% 82.1% 85.8% 84.1%	14.5% 13.5% 14.6% 17.4% 13.7% 15.9%	
Barnard (1988) / 1963-88 / Tamworth, NSW / ALL CHILDREN:	351 404 470 409 426 352 216 157 187 243 199 207 169 110	16.5% 16.1% 27.4% 42.5% 43.4% 51.4% 64.4% 16.6% 12.3% 26.3% 44.2% 38.2% 49.1% 63.6%	0.72 0.43 0.52 0.29 0.18 0.22 0.06 0.88 0.55 0.55 0.23 0.25 0.28 0.08	0.42 0.29 0.16 0.12 0.06 0.08 0.44 0.33 0.24 0.15 0.07 0.03	4.15 4.83 1.82 1.18 0.71 4.05 5.25	0.58 0.50 0.38 0.50 0.40 0.38 0.58	0.18 0.25	5.87 6.05 4.53 3.05 2.50 1.96 1.26 5.73 6.62 4.69 2.94 2.84 2.19 1.18	77.9% 84.5% 77.6% 63.3% 62.7% 78.3% 84.2%	9.9% 8.3% 15.2% 25.4% 31.7% 6.6% 8.7%	88.7% 91.0% 83.6% 71.1% 65.8% 92.6% 90.5%	11.2% 8.9% 16.4% 28.6% 33.3% 7.8% 9.4%
CONTIN. RESIDENTS: Water Fl.												
Stockwell (1990) / 1987 / WA / Perth, Water Fl. Bunbury-Busseton, NoFl. @	412 376	63.8% 57.3%			2.06 1.36 0.67	0.40 0.47 0.39		77.6% 65.3% 59.3%	14.1% 21.6% 33.1%	85.1% 74.9% 63.6%	15.4% 24.8% 35.5%	

@ Mean Fluor. Tabl. Consumption per child = (No. of tablets taken per day * reported interval): Perth-10; Bunbury/Busseton-257.

in the children's groups examined.

Halikis' study (1963) (tables 8, 9, 10, 11 -pages 53, 54, 55, 57) involved children ("representing the lower socioeconomic groups" -Jago, King 1963) who visited the Gustafson Dental Clinic, Fremantle, WA, in a period of about six months (Halikis 1963). These, combined with the lower caries prevalence in the 4 years age group than in the 3 year olds, indicate that the patients of this clinic were not a representative sample and it was more likely to have attended because of high dental caries' level.

The study of Jago and King (1963) on the other hand (tables 8, 9, 10, 11 -pages 53, 54, 55, 57) involved children who visited the Melbourne University Child Growth Study Unit four times a year up to the age of 4 years, and twice a year subsequently. The relatively low figures recorded for children up to and including the age group of 4 years (the period with the more frequent recall regimen) may have constituted an early indication of the importance of the recall system in the prevention of the disease.

The relatively low figures recorded in the Goulbourn dental survey (Martin, Barnard 1965 -tables 8, 9, 10, 11; pages 53, 54, 55, 57) for the age groups younger than 5 years may be attributed to the effect of water fluoridation in combination with the small (probably unrepresentative of the town's population) numbers of subjects examined.

From the studies of Fanning and co-workers (1975, 1980) and given the fluoridation status of the SA population in the period 1970 to 1976 (Adelaide started fluoridation in 1971; see page 22), the control ("no fluoride") groups' caries status will be taken as the more possible to be representative of the SA population in that period of time (tables 9, 10 and 11; pages 54, 55-56, 58, respectively).

Calache (1983) -table 10, page 56- reported on dental caries in a

Melbourne sample comprising 4 year olds. Table 3.5, page 70, in that study provided information on dmfs of males and females from which the weighted pooled value (1.62) for the total sample was estimated by the writer. Subsequently, probably faced with the lack of data in the literature, Calache compared these findings with those of the 1977 Brunswick survey (Wright, Spencer 1980) by converting the dmfs value of 1.62 into an "approximation of dmft from dmfs" of 0.32 (table 4.1, page 133, in the thesis of Calache). The literature available on this age group reveals a maximum dmfs/dmft ratio of 2 (Halikis 1963; Barnard 1988 -Tamworth 1963 data; table 5, pages 38-39). Thus, it was decided to cite a figure of 0.81 in the dmft column for this study, although it may still be a somewhat low estimate.

The data drawn from the SDS evaluation studies in the period 1977-1989

Table 12- Dental caries in 4- and 5-year-old Australian children by state, by year; SDS evaluation data.

Source: AIH 1990; ComDeptHealth 1987; Barnard 1971-89; Stockwell 1990.

STATE	AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
=====														
NSW	4	2.39	2.24	2.18	1.99	2.01	2.01	2.01	2.00	1.93	1.90			
	5	2.49	2.35	2.25	2.22	2.01	2.06	2.01	1.97	1.90	1.85			
													2.45	(dmft)
Vic.	4	3.94	3.92	4.19	3.29	3.10	2.59	2.03	2.03	1.59	1.32			
	5	4.10	4.44	4.27	3.81	3.07	2.82	2.18	2.05	1.83	1.61			
Qld	4	2.89	2.98	3.44	2.92	3.14	2.89	2.61	2.66	2.87	2.52			
	5	2.88	2.71	2.69	2.67	2.45	2.46	2.40	2.40	2.20	2.19			
SA	4	2.66	2.28	2.13	1.85	1.79	1.74	1.64	1.56	1.50	1.60			
	5	2.59	2.38	2.20	2.05	2.01	1.95	1.84	1.95	1.72	1.79			
WA	4	1.78	1.72	1.54	1.48	1.56	1.52	1.52	1.30	1.10	1.06			
	5	2.15	2.36	2.18	1.98	1.78	1.90	1.78	1.59	1.40	1.31	1.38		
Tas.	4	2.32	2.26	2.18	1.92	1.75	1.62	1.79	1.52	1.51	1.45			
	5	2.94	2.75	2.54	2.35	2.10	1.92	1.89	1.91	1.72	1.59			
NT	4		2.17	1.92	1.75	1.40	1.66	1.55	1.60	1.44	1.28			
	5		2.42	2.40	2.39	1.78	1.97	1.94	1.88	1.74	1.67			
ACT	4	2.97	2.35	2.27	2.05	2.54	2.20	2.80	2.25	2.57	2.21			
	5	1.75	1.90	1.64	1.66	1.47	1.43	1.48	1.34	1.22	1.16			
=====														
Austr.	4	2.86	2.75	2.86	2.42	2.41	2.24	2.04	2.00	1.88	1.73	1.69		
	5	2.96	2.96	2.86	2.68	2.33	2.29	2.07	2.01	1.85	1.77	1.73		

by state and age group has been cited in table 12 (page 62). These data should be considered in the context of utilisation patterns and factors associated with these patterns, as they have already been discussed in pages 24 to 30.

One could add to these behavioral trends that the SDS data from ACT and Qld constantly shows the 4 year olds to have worse oral health status than the 5 year olds, that, at a national level, 4 and 5 year olds do not show any difference in disease experience especially in the 1980s (table 12, page 62), that a group of 3 year olds examined by the NSW SDS in 1983 had more disease than the 4-year-old group (ComDeptHealth 1984), and, finally, that SDS data gave a national average dft of 1.73 for 5 year olds in 1987, while NOHSA (1987-88) gave a figure of 1.39 (a 25% difference which could not be tested for significance because the number of children in the SDS sample was not available).

The difference between dft in 5 year olds as reported by SDS in 1985 (1.85) and by NOHSA in 1987-88 (1.39) was statistically significant ($p < 0.003$).

It appears appropriate that any discussion on trends of dental caries in preschool age groups (especially 4 and 5 year olds) should take into consideration the question whether SDS data is representative of the Australian population at these ages and, more precisely, whether any of the preschool age groups eligible to and using the SDS differ, and to what extent, from their respective population in each state.

3 DISCUSSION

3.1 GENERAL CONSIDERATIONS

The following discussion and accompanying figures is based on the tables presented and evaluation made in the previous sections (pages 48 to 63, and tables 8 to 12). Both disease trends and treatment patterns will be commented on.

Disease trends have been noted on the plotted dft/dmft data to gain some insight into changes over time but their validity may be questionable due to the data available, as has been previously indicated.

Treatment patterns should be viewed in the light of the availability of technology which has proven effective in conservative (as opposed to radical), chemical control of caries. It can also be assumed that the rate of progression of dental caries is now slower than it used to be 30 years ago (Craig, Powell, Cooper 1981; Ekanayake, Sheiham 1987) because of the increased availability of fluorides from extensive sources and probably favourable changes in the vehicles and patterns of sugar consumption. The collated data can, of course, give information only on restorative and surgical (extraction) treatments rendered.

In general, the fact that most surveys have been conducted after 1960 (only 3 studies of those in the tables 7 to 10 inclusive had been published before and in the 1950s) indicates the change that occurred in the Australian dental community's approach to dental care after the 2nd World War. In this context, the role of the SDS introduction in early 1970s must also be recognised.

Furthermore, the impact that fluoridation, other preventive programmes, and SDS evaluation surveys have had on the availability of data is well demonstrated throughout the collated data.

The discussion on the collated literature could not but be affected by the availability of data. Thus, both disease trends and treatment patterns on the one hand, and epidemiological/evaluation implications on the other, will be discussed for the 2- and 3-year-old children collectively. Disease trends, treatment patterns, and considerations on epidemiological/evaluation approaches will be commented upon in a more analytical manner for the 4- and 5-year olds.

In this discussion, comments regarding indices do not refer to experimental study designs where the requirements are different to those in basic epidemiological and delivery system evaluation studies.

In instances of poor availability of data for certain age groups and disease indices, maximum values have been cited in the text for minimising the possibility of creating a misleadingly "low" disease level profile.

An attempt has been made for the figures presented in the following discussion to be as uniform as possible.

3.2 DENTAL CARIES, TREATMENT PATTERNS AND IMPLICATIONS FOR EPIDEMIOLOGICAL AND EVALUATION METHODS IN 2- AND 3-YEAR-OLD AUSTRALIAN CHILDREN

3.2.1 Studies On 2-Year-Old Australian Children

It is evident that there is a dramatic lack of information on dental caries in 2-year-old children nationally. There have been no studies reporting on the dental health status in this age group since 1965.

All studies available are depicted in figure 8 (page 67; from table 8, page 53), although the most recent study involving an adequate sample size was conducted in the period 1954 to 1962 (Jago, King 1963) and, as already discussed (page 52), it can hardly be taken as representative of the population of Melbourne.

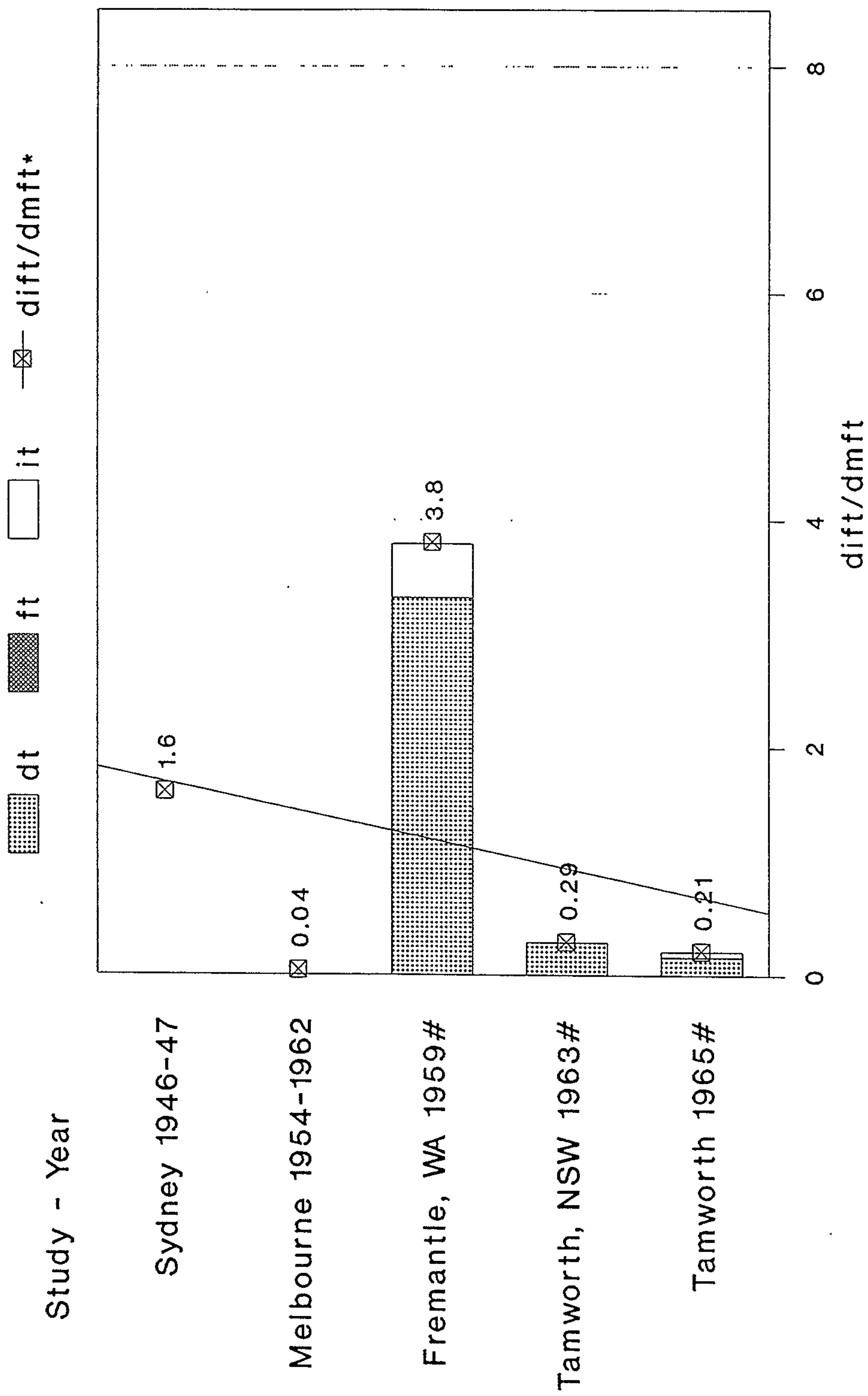
In this age group, tooth and surface counts were identical in the 1960s but this observation is made on the basis of mainly non-representative samples. With the exception of Halikis' study, the prevalence of the disease did not exceed 36% (Cameron 1953) of the children examined in the period from 1947 to 1965.

Judging by the availability of data, it can be said that very little, if anything, has been done with regard to this age group in terms of dental care, although it appears that selective preventive services should be the method of choice in the 2 year olds.

Given these limited and early observations and the eruption patterns of deciduous teeth, a broad and tentative assumption can be made that there has been an improvement of unknown extent in the oral health status, and nowadays there is a low level of dental caries in the 2-year-old Australians, with "bottle caries" representing the major threat to the dentition of certain individuals.

It is therefore appropriate to consider the use of the simplest index

Figure 8- Dental caries and treatment patterns in 2-year-old Australian children; all available studies.



* mt=0 in all studies
18<n<25

available, prevalence, or the preferable dichotomy approach suggested by WHO (1978), as being sensitive enough in this age group for epidemiological and screening purposes. It should be noted that caries prevalence can be markedly affected by even light changes in the diagnostic criteria (Murray 1991).

Tooth counts may also be easier, though not absolutely necessary, to use today if no restorative treatment rendered to these children is the (desirable and feasible) norm, which implies that secondary caries, differential diagnosis for missing teeth, and conventional evaluation indices (d/dmf, f/dmf), may not be applicable to this age group.

Surface counts would not add much to the information required for planning and evaluation purposes, not only because of their (tentatively shown) coincidence with tooth counts but also because, as with tooth counts, the expectedly low level of disease and the preferably non-invasive treatment of caries in this age group make prevalence of the disease the index of choice for dental public health purposes.

3.2.2 Studies On 3-Year-Old Australian Children

Some data exists on dental caries in 3 year olds but it suffers, once again, from problems regarding representativeness of the samples.

All available studies have been included in figure 9 (page 70; from table 9, page 54).

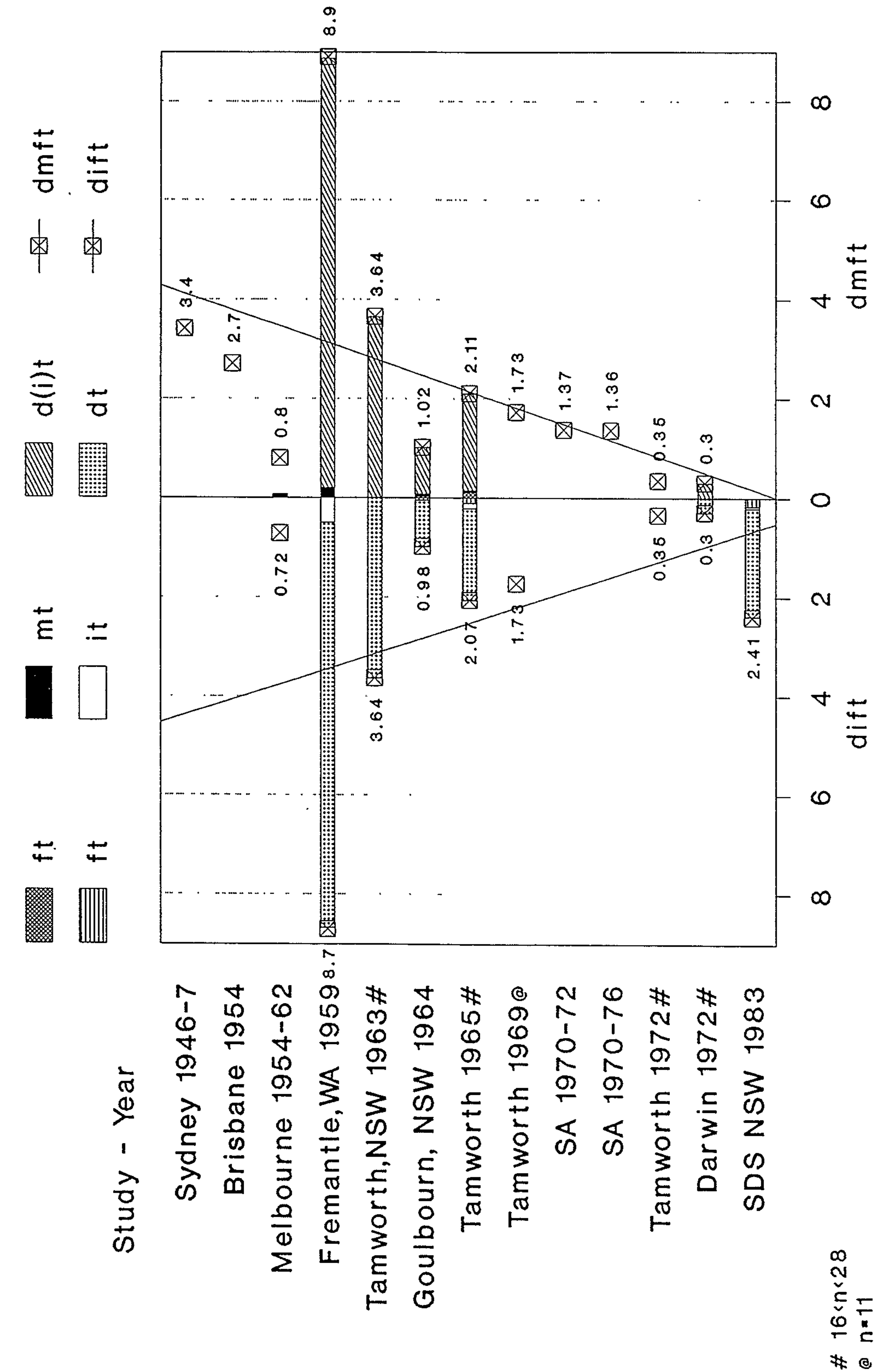
With the eruption of primary molars before the age of 3 years, the caries attack scene is established and by the third year of age (especially the susceptible) individuals will suffer the sequelae of the disease. Thus, the prevalence of the disease increases and the maximum recording in the period 1947 to 1965 (with the exception of Halikis' study) was 65% (Cameron 1953). However, in the period between 1965 and 1983 the maximum score recorded has been that of NSW's SDS of 50% (one should recall here that this was not a representative sample; see page 63).

An improvement in the oral health status over the years can be expected to have occurred but, again, its extent is not known.

It appears safe enough to assume that nowadays this is the age when the first treatment needs occur in certain groups of children. However, as it is indicated by the NSW's SDS data of 1983, high-caries groups may not receive any restorative or other care. Hence, the discussion on epidemiological indices to be used for 2 year olds (pages 66 and 68) is of value for this age group as well, with tooth counts appearing to be a sensitive enough index for use in disease levels expected to prevail at the present time.

As to the comparability between dmft and dift values yielded by different surveys, it has been argued that the omission of the m component "produces only a very minor discrepancy" (Carr 1983) which allows for comparisons to be made between the dift and dimft index (Cooper *et al.* 1984). These arguments appear to be acceptable with regard to these young age groups provided that the studies being compared are at least representative of their respective populations.

Figure 9- Dental caries and treatment patterns in 3-year-old Australian children; all available studies.



3.3 DENTAL CARIES, TREATMENT PATTERNS AND IMPLICATIONS FOR EPIDEMIOLOGICAL AND EVALUATION METHODS IN 4- AND 5-YEAR-OLD AUSTRALIAN CHILDREN

3.3.1 Dental Caries In 4- and 5-Year-Old Australian Children

The variation in methodology (especially indices used) and the question of representativeness of samples examined create greatest problems in these age groups when analysing the information on dental caries.

With all deciduous molars in the oral cavity for at least one year, sufficient time exists for dental caries to spread in terms of both prevalence and experience.

3.3.1.1 Dental caries in 4-year-old Australian children

All data available on disease experience (dmft and dft) in 4-year-old Australian children has been plotted in figure 10 (page 72; from table 10, pages 55-56), while figure 11 (page 73; from table 10) illustrates both dental caries experience and non-prevalence (caries-free children) reported by studies in which adequate numbers of children ($n > 45$) were examined.

In these figures, both the dmft and dft indices, when reported by the same study, have been plotted.

In figure 11 (page 73), the best-fitting trend depicted by dmft values for 4 year olds has not been drawn because it did not appear rational even after the correction of the dmft value given by Calache (1983) - see page 62- and/or when data from Halikis' study (1963) was not plotted.

Figure 10- Dental caries experience in 4-year-old Australian children; all available studies.

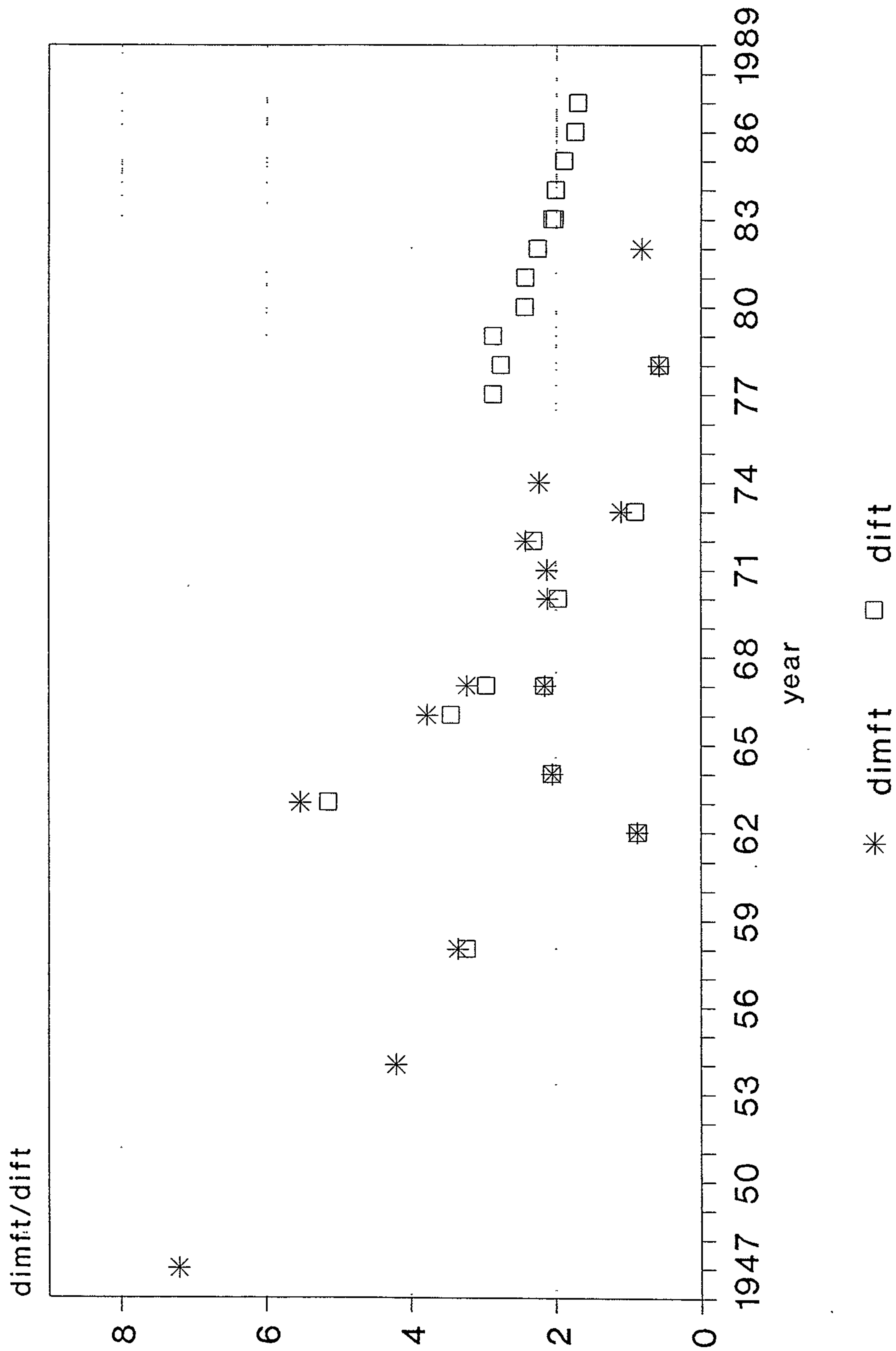
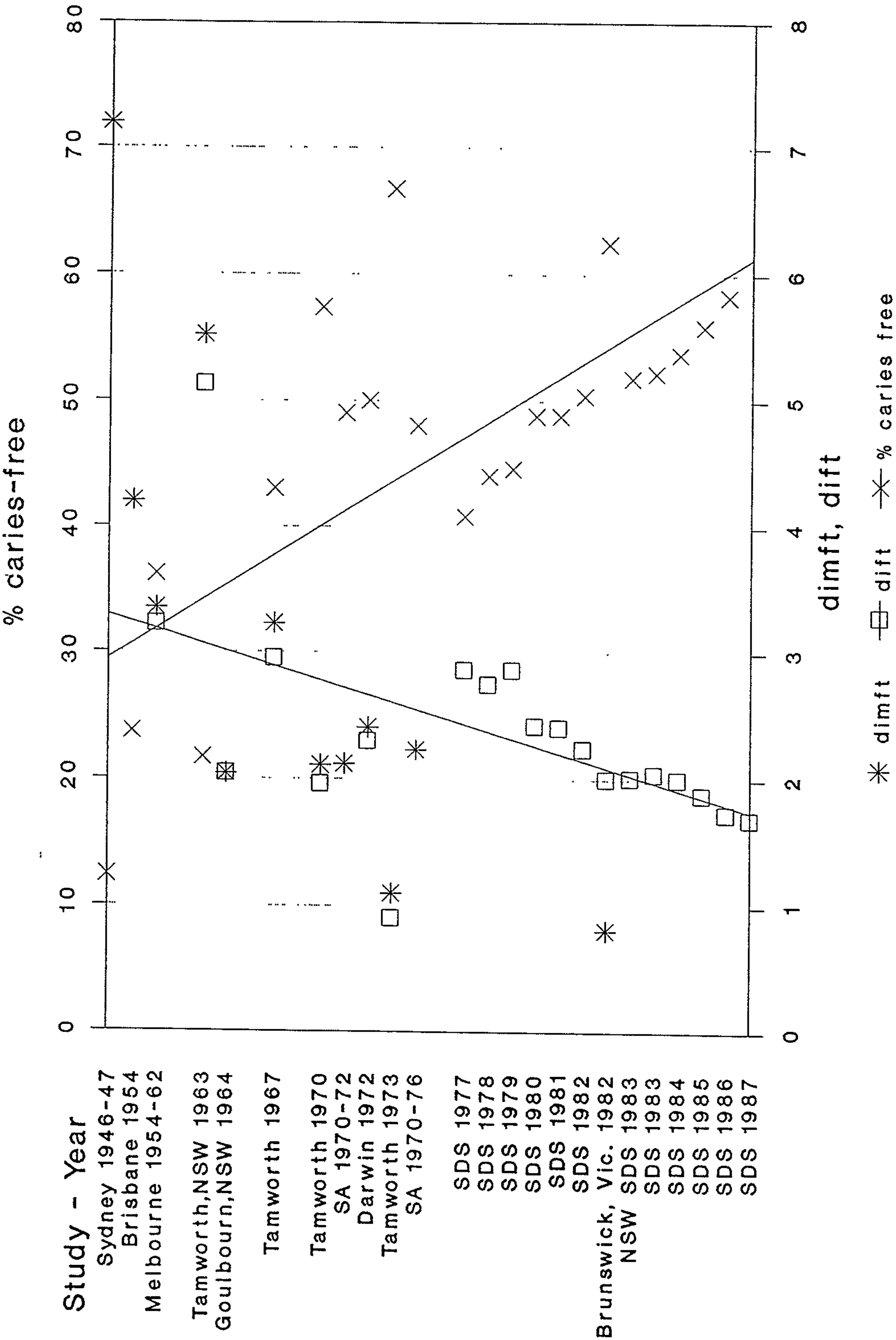


Figure 11- Dental caries experience and prevalence in 4-year-old Australian children; selected studies (n>45).



The last unquestionable recording of missing teeth was that of Tamworth by Barnard (1988) in 1973. Hence, the available dmft data on this age group does not appear to be as adequate for depicting trends as the dft scores are. This is mainly due to the recent SDS evaluation data on 4 year olds.

A trend towards decreasing disease prevalence and experience over the years is obvious (figures 10 and 11).

Surface counts, in the limited number of studies they are reported, do differ from tooth counts. Although this difference tentatively (due to the lack of adequate data) describes the spreading of caries attack, the fact that the surface to tooth counts ratio has always been found to be less than 2 (Halikis 1963) or less than 1.5 (Barnard 1988) -see table 5, pages 38 and 39- and that the missing due to caries teeth have never been found to be more than 0.5 (except in Halikis' study) lend support to the discussion on indices to be used nowadays in basic epidemiological surveys of preschool children.

The case of the estimate of the dmft value from the findings on dmfs by Calache (see page 62) is an example of the caution which should be exercised in this kind of conversions in preschool age groups.

The maximum reported value of disease prevalence in the period 1947 to 1966 was 88% (Cameron 1953). In the 1970s the maximum prevalence was reported by SDS in 1977 (ComDeptHealth 1987) -59%, and in 1980s again by SDS in 1980 (ComDeptHealth 1987) -52% (see table 10, pages 55-56).

There apparently is a difference between the dft recordings reported by SDS and the dft scores given by studies conducted in the period from 1963 to 1976. This difference suggests that either most of the studies conducted before 1974 involved low-carries population groups or poorly drawn samples, or that SDS data is not representative of the Australian and/or state population, or that there is a difference in the diagnostic criteria, and/or clinical interpretation, and/or methods

used, or a combination of the above.

In either case, both groups of studies show improvements in oral health status of the 4 year olds in their respective time periods.

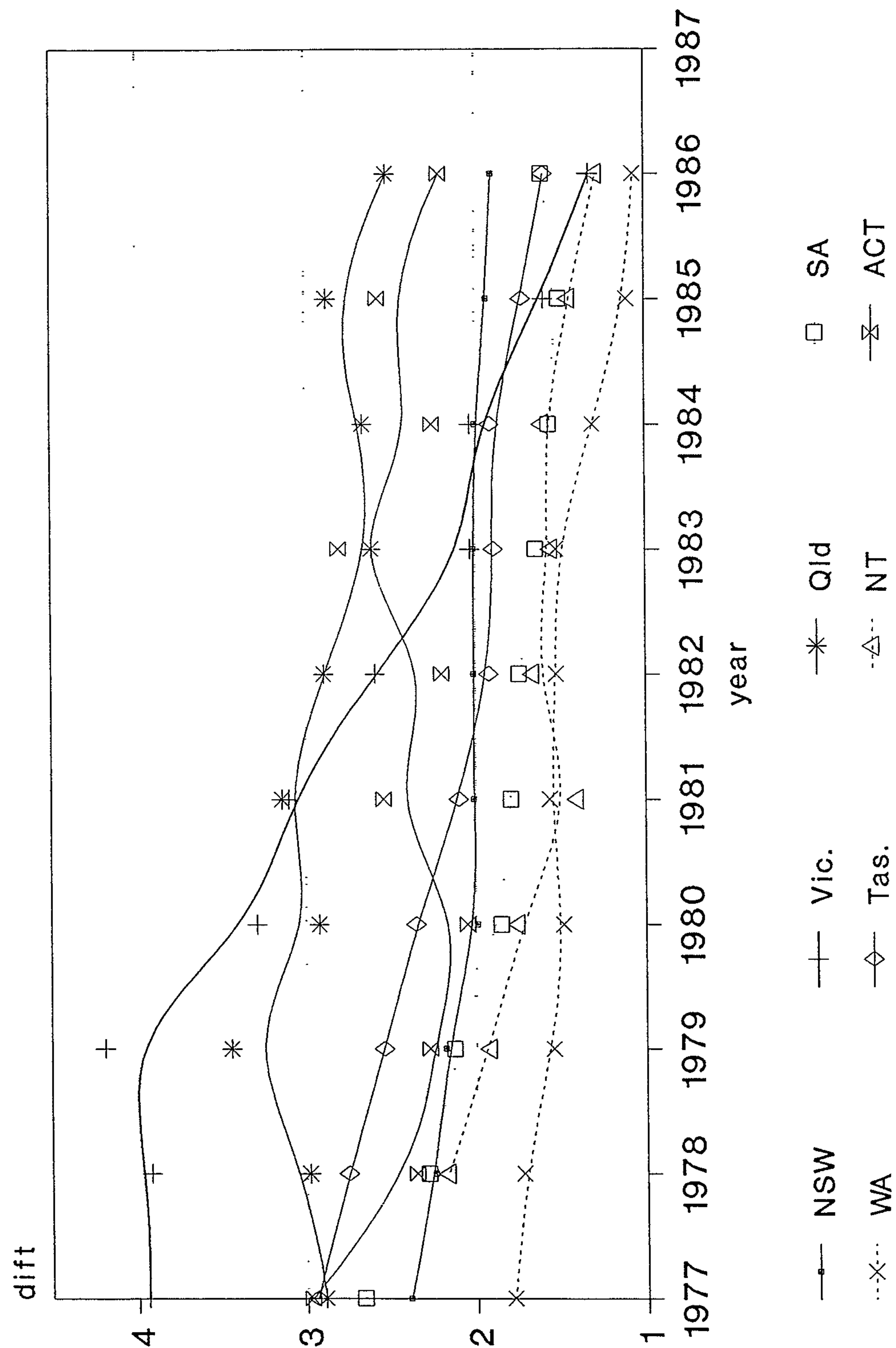
In the case of SDS national data, the improvement in the period 1977 to 1986 has been statistically significant ($p < 0.001$). Problems arise however from the lack of data when one tries to identify whether these trends have continued in recent years or not.

An interesting trend depicted in figure 11 (page 73) is that the experience of the disease in 4 year olds may be levelling off while its prevalence continues to drop (or the number of caries-free children continues to increase). Apart from the dental public health implications of this trend, it may be considered as an additional indication that the SDS data on 4 year olds includes high-caries "pockets" of children.

Figure 12 (page 76; from table 12, page 62) illustrates trends in the dift scores of 4 year olds examined by SDS, by State. The lowest figures have been consistently reported by WA in the period 1977 to 1986, but Vic. has shown the most impressive improvement (66.5% decrease in dift between 1977 and 1986; $p < 0.001$) over the first 10 years of SDS evaluation surveys.

Qld ($p < 0.32$) and ACT ($p < 0.06$) have been the only states whose SDS 4-year-old children have failed to exhibit significant decreases in dift scores in the period 1977-1986. However, the data has been drawn from relatively small samples which, more importantly, have been showing consistently higher caries experience than the 5-year-old groups examined in each year in the period 1977-86. For ACT children, the dift score in 4 year olds was significantly higher than in the 5 year olds in both 1977 and 1986 ($p < 0.001$). In Qld, this difference was not significant in either of the years 1977 and 1986 ($p < 0.25$).

Figure 12- Dental caries experience in 4-year-old children examined by SDS, by state; Australia 1977-1986.



WA ($p < 0.01$) and Tas. ($p < 0.001$) in 1977, and WA ($p < 0.001$), SA ($p < 0.02$) and NT ($p < 0.001$) in 1986, were the states which showed the 4 year olds examined in SDS to have dft scores significantly lower than the 5 year olds. The number of children examined in SDS of NT in 1978 was not available and the difference in dft scores between 4 and 5 year olds could not be tested for significance.

3.3.1.2 Dental caries in 5-year-old Australian children

The preschool age group which has been studied in most detail is the 5 year olds. Figures 13, 14 and 15 (pages 78, 79 and 82; from table 11, pages 57-60, and table 12, page 62, respectively) illustrate the information on dental caries trends corresponding to those presented for the 4 year olds. Again, both dmft and dft (drawn from the same study) have been plotted in figures 13 and 14.

It is possible that in this age group, depending on the eruption patterns of permanent incisors, the highest level of dental caries in the primary dentition's lifespan can occur.

Any treatment received in previous years is a factor affecting the disease trends (Arnliot *et al.* 1985).

It is made clear by the best-fitting trends in figures 13 (page 78) and 14 (page 79) that both the experience and prevalence of the disease in this age group have decreased substantially over the last 40 years.

It should be stressed here that the trends of dft and dmft shown on figure 14 do not correspond to any changes in the mt component because the trend for the dft scores is affected by the data from studies not reporting the missing teeth component.

The maximum disease prevalence reported before 1965 was 93% in Sydney

Figure 13- Dental caries experience in 5-year-old Australian children; all available studies.

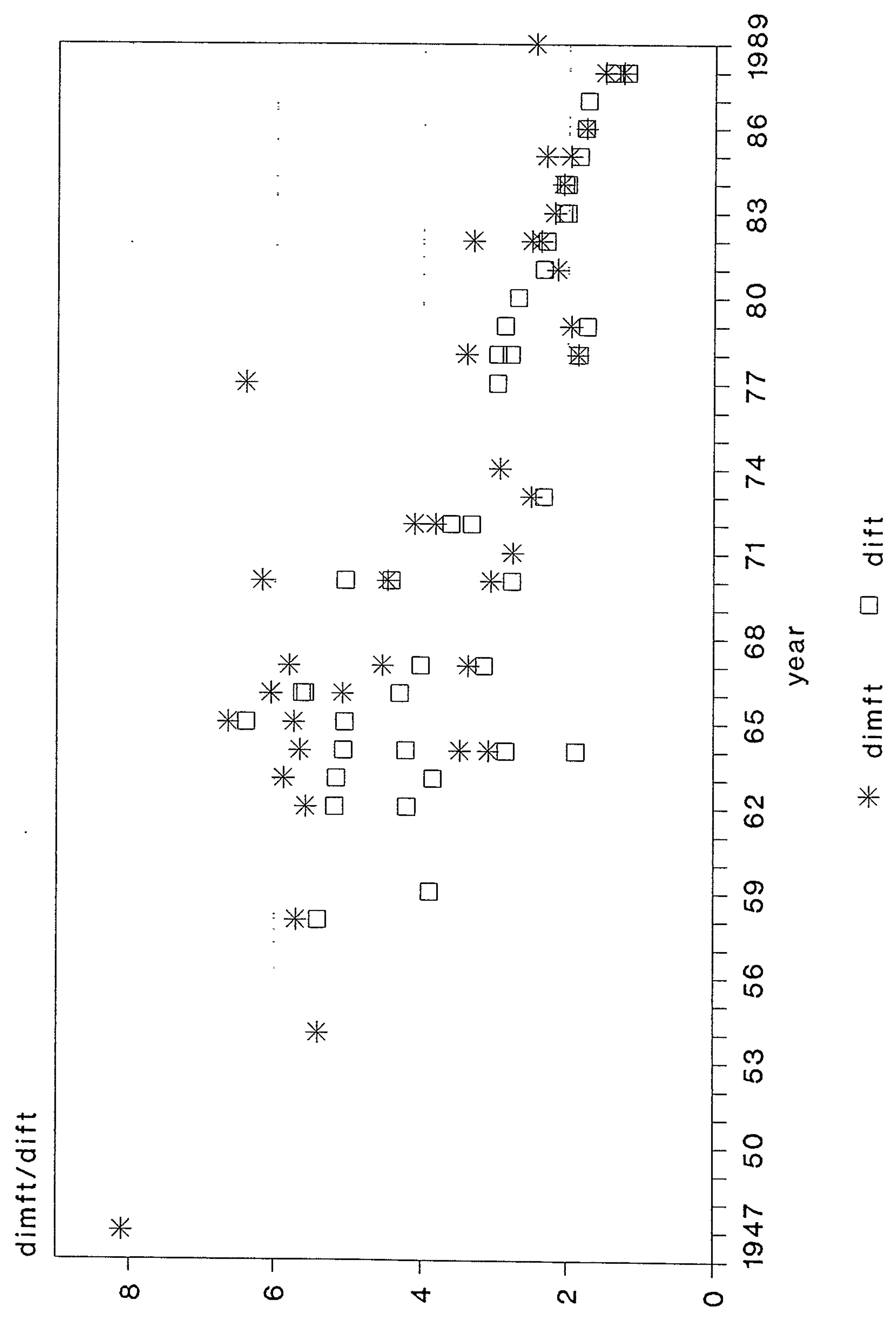
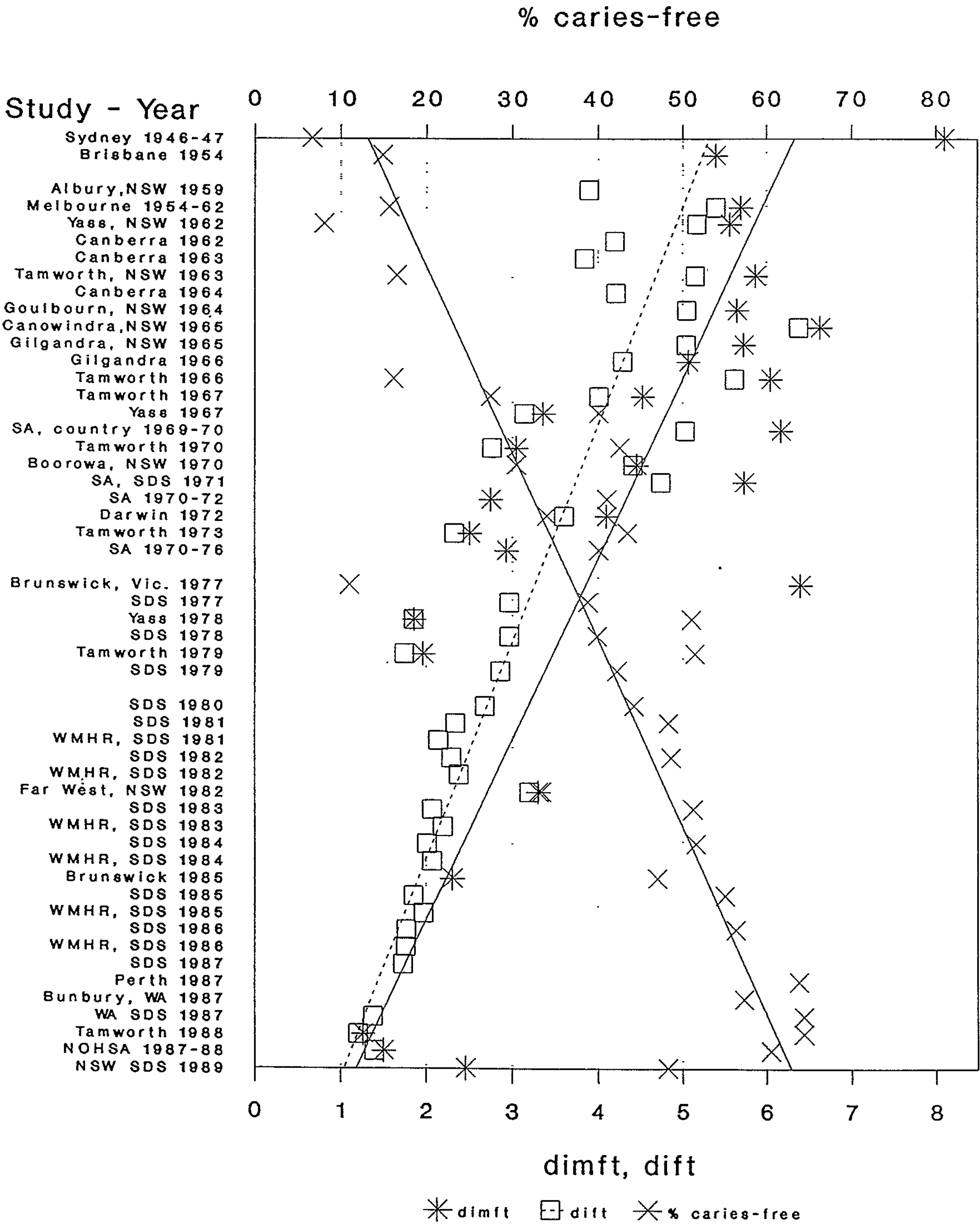


Figure 14- Dental caries experience and prevalence in 5-year-old Australian children; selected studies (n>50).



(Cameron 1953), in the 1970s was 89% in Brunswick, Vic. (Spencer *et al.* 1989) -second maximum in the 1970s was 70% in Boorowa, NSW (Barnard 1979b), and in 1980s was 67% in Far West, NSW (Cooper *et al.* 1984). The SDS national figure was 56% in 1986 (ComDeptHealth 1987) -see table 11, pages 57-60.

The global goal for the year 2000 (50% of the children 5-6 years of age will be caries-free -FDI 1982) has been attained since 1983 (51% of 5 year olds examined in SDS were caries-free). The Australian goal for the year 2000 (65% caries-free -ComDeptHealth 1987) seems attainable (60.5% of the 5-year-old children were caries-free in the NOHSA 1987-88), and in some areas it has almost been achieved (64% of the children were caries-free: in Tamworth in 1988 -Barnard 1988; and in Perth in 1987 -Stockwell *et al.* 1990).

As to the proposed goal for the year 2025 (95% of the 5-6 year olds should be caries-free -Barnes 1989), SDS evaluation data shows that the percentage of caries-free children increased by about 30% in the period between 1977 and 1986 (from 39% in 1977 to 56% in 1986). Fifty one per cent of Tamworth ("all" group) children were caries-free in 1979, while this figure increased to 64% in 1988 (a 25% increase) -see table 11, pages 59 and 60. Additional information is required before any prediction can be made regarding the feasibility of the above-mentioned goal but, if the above-discussed trends continue at a similar rate, it seems feasible.

The surface over tooth counts ratio, once again, has never been found to be more than two. Thus, taking into consideration that this was the case in the 4 year olds as well, disease increments appear to be possible to be described sensitively enough by using tooth counts.

Additionally, the above finding on the dmft/dmfs ratio logically implies that either the caries attack involves new teeth rather than surfaces of the same tooth, or that the incidence of the disease levels off between the age of 4 and 5 years. The latter appears to be the

case with the SDS data, while the former hypothesis is the case in most of the other studies. However, it should be noted here that SDS data on 4 year olds has been questioned for representativeness so that any conclusions on disease incidence may be misleading. Furthermore, eruption patterns indicate that there is a time interval of about one year between the average time of emergence of the first primary molars and that of the second primary molars (Roche *et al.* 1964; Hagg, Taranger 1986), which implies that diminished caries incidence between the ages of 4 and 5 years may be taken as indicative of a high caries incidence earlier in life.

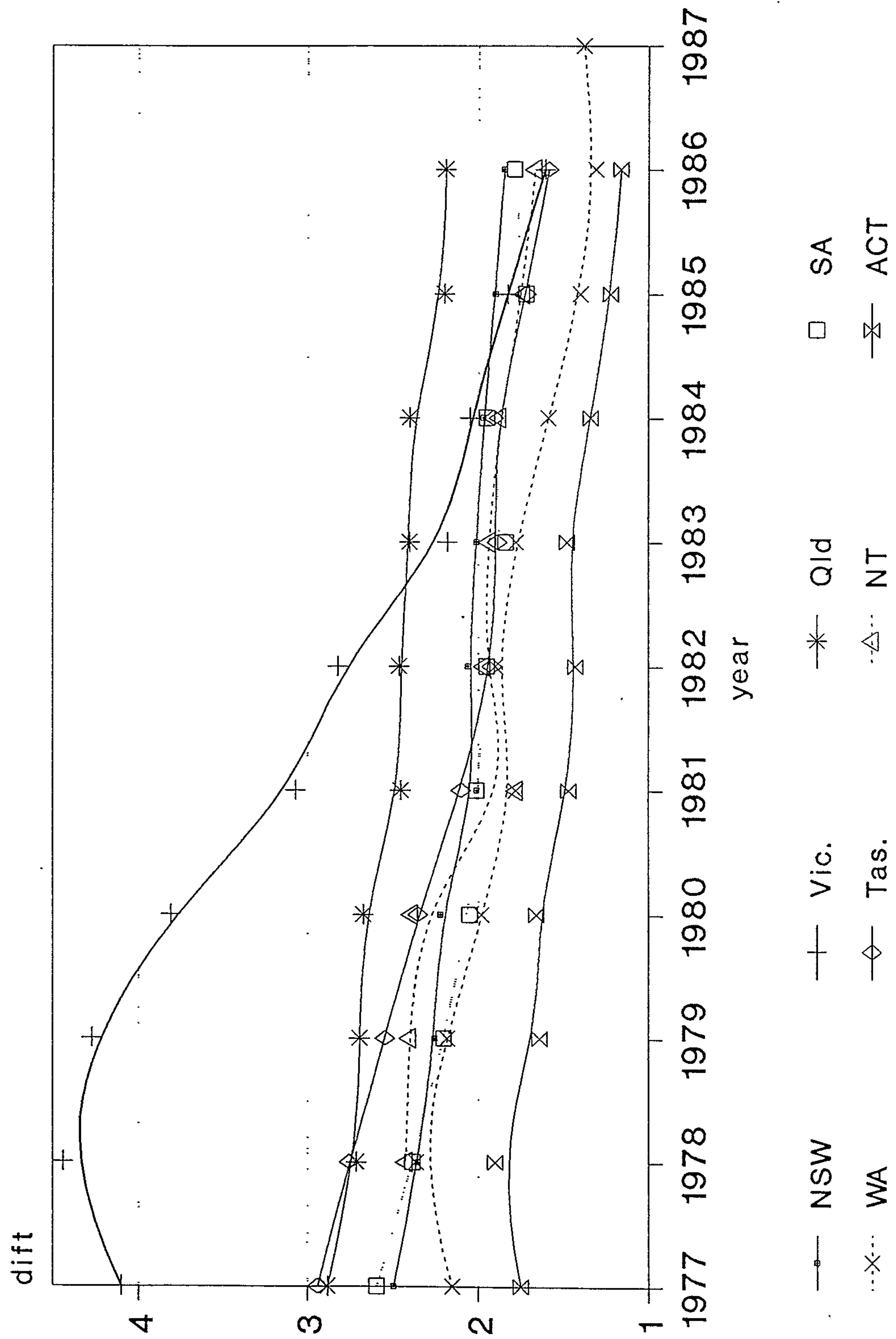
There again appears to be a difference between SDS data and other surveys in both the dft scores and the prevalence percentage.

Five year olds in NOHSA (1987-88) showed a dft score (1.39) significantly lower than the SDS 1986 national recording (1.77) ($p < 0.0003$) which, noticeably, is due to the difference in the dt component (0.9 versus 1.46, respectively; $p < 0.0003$).

The most recent data available from SDS is the 1989 NSW data (AIH 1990) which shows a significant increase in both the experience and prevalence of the disease in NSW's 5 year olds when compared with 1986 SDS data for NSW. It appears that there has been a statistically significant increase in dental caries experience (assumed $SD=3$; $p < 0.003$) which is, again, due to the dt component (1.96 in 1989 versus 1.28 in 1986; $p < 0.003$), a finding which lends support to either the non-representativeness of the SDS sample or the different diagnostic criteria and methods employed in the SDS clinics. Compared with the national 1987-88 figure (NOHSA), this 1989 SDS dmft score of NSW is also significantly different ($p < 0.003$).

SDS data on 5-year-old children, by state, is shown in figure 15 (page 82). The improvement in dft scores in the period 1977 to 1986 at a national level has been statistically significant ($p < 0.001$). ACT is the state with the lowest dft scores consistently. As was the case

Figure 15- Dental caries experience in 5-year-old children examined by SDS, by state; Australia 1977-1987.



with 4 year olds, Vic. has shown the greatest improvement of caries experience in this age group (61%), and Qld the least (24%). The second smallest improvement of caries experience has been shown in NSW (26%) but in both 1977 and 1986 NSW children had significantly less caries experience than Qld children ($p < 0.001$). All states have shown statistically significant improvements in the period 1977-1986 ($p < 0.001$).

It does not appear to be the case that there has been a reversal of disease trends in the late 1980s. It is more probable that the 5-year-old children who receive care from SDS have more severe and prevalent disease and probably more teeth are extracted in this group of the 5-year-old population, or that these teeth had already been extracted at the age of 4 years.

Another possibility, drawn from the combination of the hypothetically different SDS and non-SDS children, is that the prevalence of the disease continues to drop at a national or state level but its experience does not. The latter possibility signifies the noteworthy trend of an increase in the disease activity and severity (and dental neglect) among susceptible groups of individuals in recent years, or aggressive treatment of 4 and 5 year olds received by SDS, or both of these.

Thus, recording of missing teeth is important in order to test the above hypotheses and meaningfully monitor disease and treatment trends. Therefore, the suggestion that it is acceptable to compare dift with dimft scores (Carr 1983; Cooper *et al.* 1984) does not appear an error-free exercise, at least at a regional or interstate level, if the question of either the representativeness of the population of groups examined or the reliability and accuracy of the scoring in SDS compared with that of other populations is not resolved. This is particularly important if one has in mind that NSW and Vic. children are least covered by, and make use of, SDS (figures 6 and 7, pages 28 and 29, respectively).

3.3.2 Dental Treatment Patterns In 4- and 5-Year-Old Australian Children

As has been already said, non-invasive treatments rendered cannot be shown by the available data.

Although surface counts are more reliable than tooth counts in measuring treatment needs (Sardo-Infirri, Barmes 1979; Spencer 1980) we have already seen that surface counts give only limited information additional to that provided by tooth counts and, at any case, none of the two counts differentiates between possible radical and conservative treatments for the purposes of more accurate planning.

Furthermore, the relative lack of data on dmfs makes tooth counts the only available alternative to discuss.

The discussion and figures in the next sections are based on the last 4 columns of tables 10 and 11 (pages 55-56, and 57-60, respectively). It should be recalled here that the numerator (d) of the d/dift and d/dimft ratios in tables 8 to 11 includes the i component, where available. In the figures cited in this section, the i component, if available, is depicted separately for the dift scores but not for the dimft scores.

Analysis of the dift data drawn from SDS examinations into its components by state has not been reported in the literature, except for individual states and years.

3.3.2.1 Treatment patterns in 4-year-old Australian children

The analysis of the dmft and/or dft scores into their components as reported by selected studies is illustrated in figure 16 (page 86; from table 10, pages 55-56). Halikis' study, although non-representative, has been included because this is the "baseline" data on treatment patterns in 4 year olds attending a clinic in the late 1950s.

Individual scores (such as dt, it, ft, mt, and dft/dmft), used in this section of the discussion, have also been taken from table 10, unless stated otherwise.

In general, the available data is dominated by SDS recordings. It is obvious that 4 year olds have noticeable quantities of treatment needs.

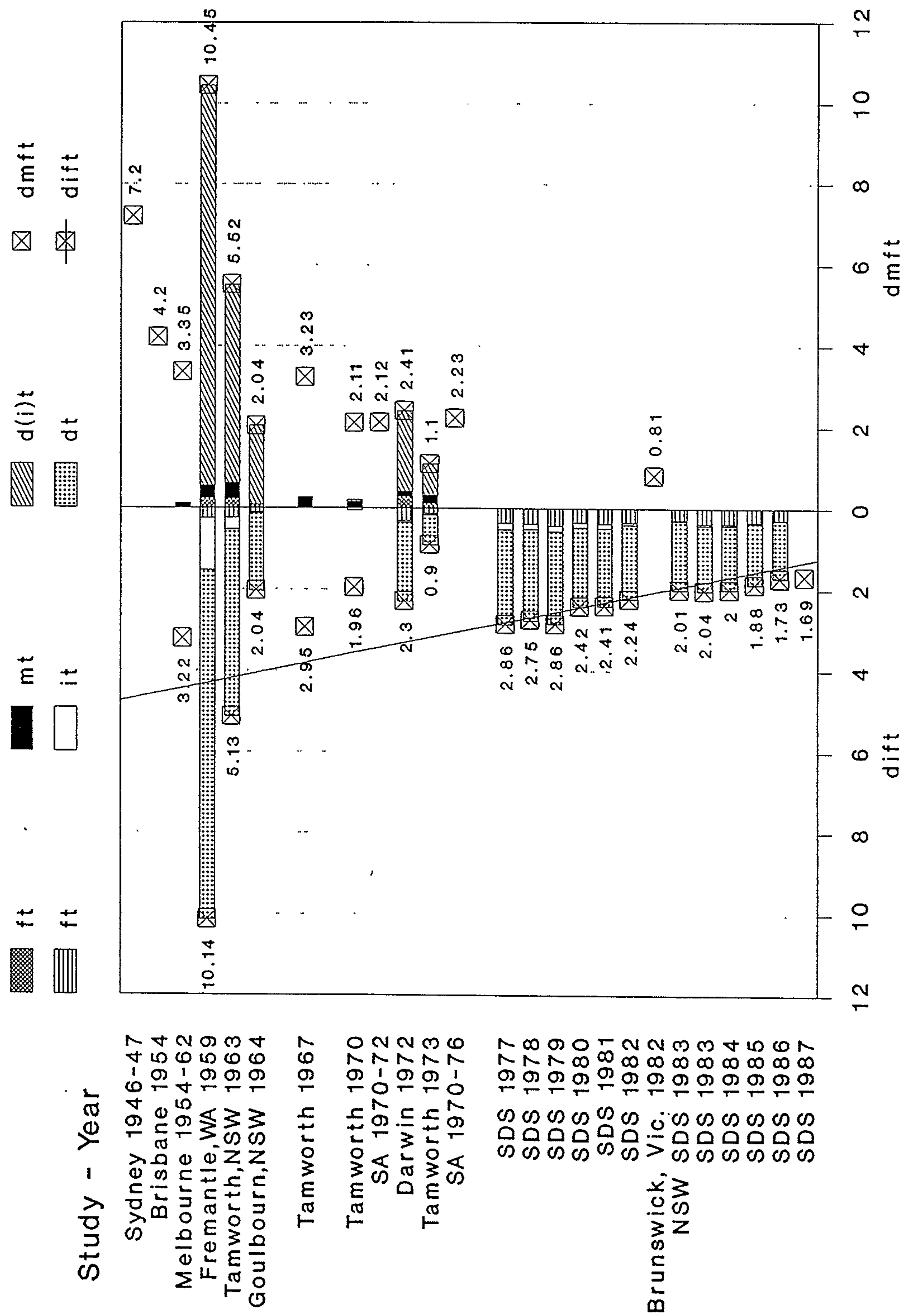
In absolute terms, there appears to have been a relatively small improvement in restorative treatment rendered. For example, 4-year-old children examined by SDS had 0.28 teeth filled in 1986, Halikis' sample had 0.25 teeth filled in 1963, while the ratio of the dft scores given by these two surveys is almost 1:6. Tamworth children had an ft score of 0.24 in 1963 (SDS 1986 dft : Tamworth 1963 dft = 3.3).

This indicates, on the other hand, an improvement in the ft/di(m)ft ratio over the years since disease activity decreased at the same time. However, the quantity of non-invasive treatment probably rendered by the SDS is not known.

The it component has diminished. This implies that the mt component has also followed a similar trend. In general, as the disease level decreases and the availability of service increases, missing teeth are expected to decrease (Carr 1982). It is important, therefore, that the it component in SDS data did not change significantly in the period 1977 to 1986 ($p < 0.1$).

Moreover, Tamworth 4-year-old children in 1973 (the latest mt score

Figure 16- Treatment patterns in 4-year-old Australian children; selected studies (n>45).



available; water fluoridation had been available for 10 years) had received more extractions (0.2) than fillings (0.12), and the extractions accounted for 18% of the total dmft score. This indicates, again, the importance of recording the mt component in order to make regional comparisons and evaluations possible. The lack of adequate, recent data on the mt component excludes further arguments in this regard of treatment patterns in 4-year-old children.

In view of the declined caries experience, the virtually unchanged restorative care rendered, and the presumably very young age of fillings present in 4 year olds' teeth, recurrent caries (table 10, pages 55-56) do not seem to constitute a problem, although conclusive data is missing.

SDS data on 4 year olds shows an average ft/dift ratio of about 16% in the period between 1977 and 1986. There appeared to be a favourable trend in the ft/dift ratio up to 1983-1984 when the ratio reached its maximum (18.5%). This trend appears to have followed the trends of the development of workforce in SDS (see table 2, page 20). Approximately 85% of the caries recorded by SDS in mid 1980s might have been untreated caries.

It is clear that most of the improvement in the oral health status has resulted from the decline in active caries, whereas a treatment backlog of around one decayed tooth per child appears to exist. However, taking into consideration that 58% of the 4 year olds examined by SDS in 1986 were caries-free (a figure which is apparently conservative), the treatment needs per child affected by dental caries are obviously much more than one tooth per child.

Treatment needs do not appear to be met in the Australian 4-year-old children.

3.3.2.2 Treatment patterns in 5-year-old Australian children

Figure 17 (page 89; from table 11, pages 57-60) illustrates the analysis of the dmft/dift scores drawn from selected studies (with $n > 50$) on 5 year olds into their components. Halikis' results are not included in this figure.

Studies on samples drawn from NSW regions (Far West -Cooper *et al.* 1984; WMHR -Webb 1987) are also included in this figure.

Individual scores (such as dt, it, ft, mt, and dift/dmft), used in this discussion, have been taken from table 11 as well.

Again, changes in dental caries experience have been the result of decreases in caries activity, with relatively minor changes in the ft component of dimft or dift index in absolute terms. The 5 year olds examined by Halikis (1963; not depicted in figure 17), for example, had had as many fillings (0.63) as the SDS children in 1980 (0.59) or Yass children in 1978 (0.67).

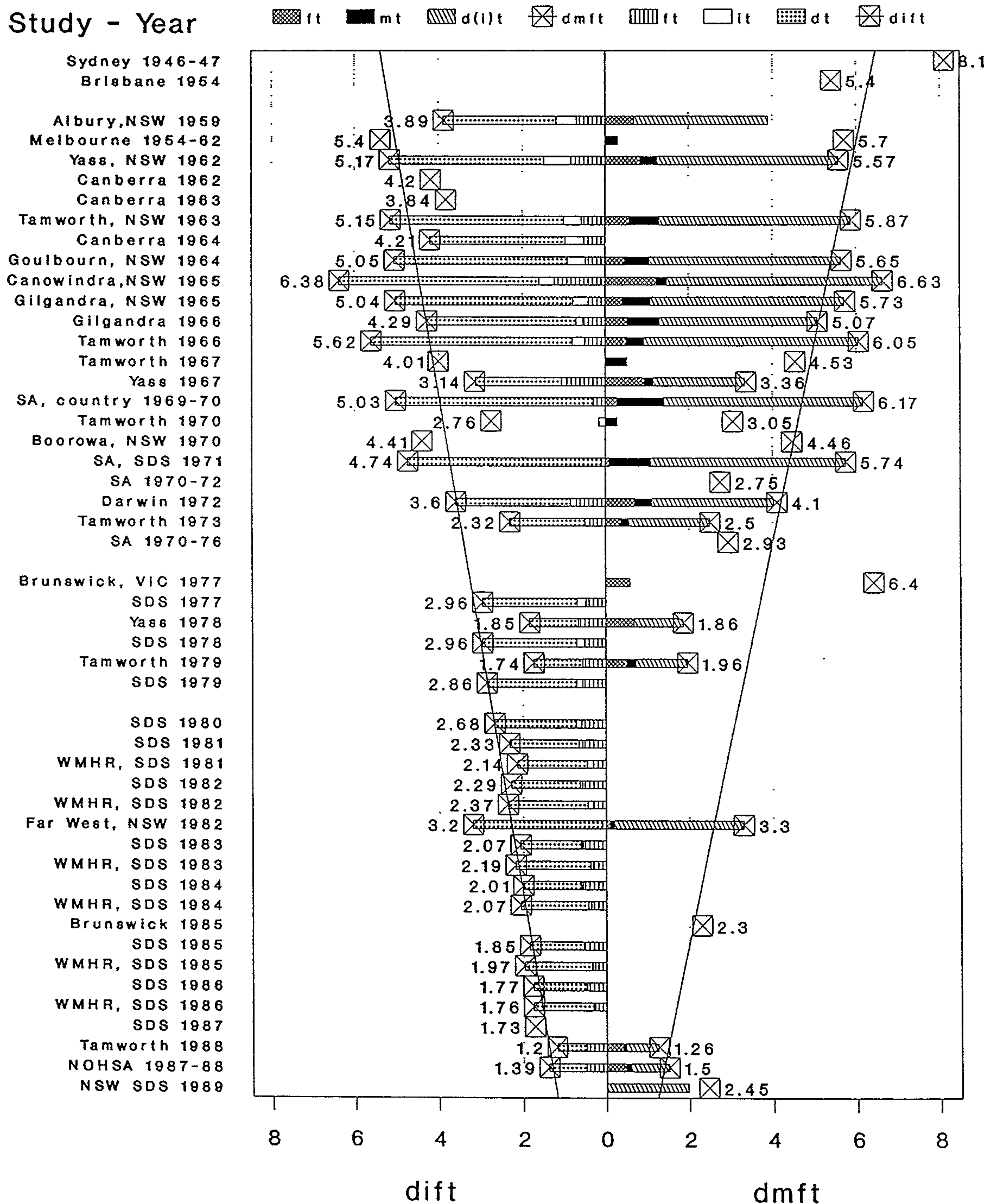
This indicates, like in 4 year olds, substantial improvements in the ft/di(m)ft ratio in 5 year olds over the years especially in groups showing a low level of disease. Although the non-invasive treatments rendered are missing, it is apparent that the 5 year olds is the group receiving some dental care when compared with younger age cohorts. Yet, an average of at least one tooth per child appears to remain untreated.

The it component has been virtually eliminated (0.03 in SDS 1985; 0.003 in NOHSA 1987-88; not significant difference: $p > 0.32$). Unlike 4 year olds (see page 85), the it component has decreased significantly between 1977 and 1986 for children examined by SDS ($p < 0.003$).

Although it would be expected that the mt component has also decreased substantially due to the decreased dental caries level, better service

Figure 17- Treatment patterns in 5-year-old Australian children; selected studies (n>50).

Study - Year



availability (Carr 1982) and, finally, the virtual elimination of the i component, NOHSA (1987-88) reported as many teeth missing due to dental caries (0.11) as had been recorded in NSW's Far West region in 1982 (0.1) with no water fluoridation, and in Tamworth in 1973 (0.18; $p > 0.32$) after 10 years with fluoridated water supply. In addition, country areas in SA with its SDS operating even before 1973, showed in 1969-70 and in 1971 (Roder 1971) the highest mt scores ever recorded in Australian 5 year olds, either by SDS or by epidemiological surveys. Thus, the importance of recording the mt becomes obvious yet another time.

Recurrent caries do not appear to be noteworthy.

Five-year-old children examined by the SDS showed an average ft/dift ratio of around 23% in the period 1977-1986, with its maximum (28%) in the 1984. Overall, the ratio increased from 16% in 1977 to 26% in 1986 but this increase was due to the lower level of active caries rather than increased productivity of SDS. This (lower caries activity) was the main reason for which NOHSA showed a higher -than the SDS in 1986-ft/dift ratio in 1987-88 (34%) because, firstly, the ft component in NOHSA (0.48) did not differ from that of SDS in 1986 (0.46) and, secondly, the it component reported by each survey were practically nil (see page 88). As in the case of 4 year olds, there appears to be a relationship between workforce and restorative treatment rendered by SDS.

Children of the WMHR SDS at Sydney had consistently lower ft/dift ratios than their state equivalent throughout the period 1981-1986, without any relevant consistency in dift scores themselves. Far West region of NSW showed virtually no treatment received in 1982. Finally, NSW SDS data for 1989 indicated a dt component which alone is higher than the SDS dift national score of 1987, and the dmft figure reported by NOHSA in 1987-88.

Therefore, apart from the regional variations in SDS in NSW, SDS data

from NSW does not appear to be representative of the state population. It is not known what variation exists by state but Vic. is very similar to NSW in terms of SDS development and, thus, the data from the SDS in Vic. may also be non-representative.

In order to tentatively quantify the importance of recording the mt component and its potential impact on the SDS data, studies on dental caries in 5-year-old children which provided sample size, mt and dift scores in table 11 (pages 57-60) were pooled for the periods 1954-1967, and 1977-1988.

"Fatality" refers to the number of deaths caused by a disease over the number of cases of the disease. "Tooth fatality" is defined as the MT/DMFT ratio (Dunning 1986). Thus, for deciduous teeth, the m/dift ratio can be considered a modified "tooth fatality" ratio. Such a pooling could not be undertaken for 4 year olds due to the lack of suitable, recent data.

It was found that the weighted pooled mean value of the m/dift ratio (per cent) for 5 year olds in the period 1954-1967 was 9.6%, ranging from 3.9% to 18.2%. In the period 1978-88 the m/dift ratio was calculated to be 7.75%, ranging from 3.1% to 12.6%. The decrease in the mean values of mt/dift% between 1954-1967 and 1978-1988 is probably not significant ($p < 0.07$).

One should recall here that the it component in the SDS data on 4 year olds had not decreased significantly in the period 1977-1986 but it had in 5 year olds seen by SDS (see pages 85 and 88).

Additionally, the weighted mean m/dift% in the period 1978-1988 equals almost 1/3 of the average ft/dift ratio in SDS for 5 year olds up to the year 1986. It should be noted that the studies that met the criteria in order to draw the mt/dift ratio, reported dift values generally lower than the scores given by SDS in the period 1977-1986. In NOHSA, the mt/dift ratio was 7.9%, but the mt accounted for 19% of previous treatment (mft).

Finally, if SDS children are not representative of the general population, then the maximum values of the mt/dift ratio might be applicable to SDS data.

Thus, recording and reporting of the mt component is desirable for assessing quantitatively a service.

Table 13 (page 93) summarises the findings of NOHSA (1987-88) on some behavioral aspects and treatment needs of 5, 9 and 5-9 years cohorts. Some of these findings have already been discussed in the introduction (pages 24, 26-30).

As expected, the 5 year olds (or their parents/family environment) indicated relatively less perceived treatment needs in NOHSA (69% thought there was no need for treatment) and, compared with the 5-9 year old children, they used the service least (59% visited a dental care provider 1.7 times a year -NOHSA 1987-88).

On the other hand, taking into account the "none" and "not know" categories of perceived needs and the examinations (treatment received) (table 13, page 93), it should also be noted that most of those children who visited in 1987-88 did so for a check-up, a finding in agreement with previous national surveys, although the different age grouping does not allow straightforward comparisons (Barnard 1986).

The limited care provided for preschool children younger than 5 years of age has resulted in relatively high unmet treatment needs in terms of pulp care and fillings/crowns needed by 5-year-old children. However, their perceived needs for fillings and extractions appear to be adequately met (table 13, page 93).

As to non-radical treatments rendered, topical fluoride applications and cleaning/polishing of the teeth in 5 year olds were, again, the lowest compared with other groups in the 5-9 years age cohort.

Table 13- Normative and perceived needs, treatment received at last visit and some behavioral variables; primary dentition[@], Australia 1987-88.

Source: NOHSA 1987-88.

Category/ Age group/ Treatment	Normative need&			Perceived need			Treatment received*		
	5	9	5-9	5	9	5-9	5	9	5-9
Examinat.							34.3	35.6	37.2
Clean/Pol.							5.9	14.5	12.4
Fluoride							6.2	11.7	10.2
X-ray							0.5	1.4	0.6
Sealant	1.9	1.7	1.3						
Fill/Crown	26.0	19.8	22.6	6.2	8.5	6.6	10.3	12.5	13.1
Pulp care	2.6	0.3	1.4						
Extrac.- # for caries	0.3 0.3	8.5 2.8	2.9 1.0	0.8	3.5	2.0	1.6	5.5	3.1
Orthodon.				0.8	11.0	7.0	---	3.0	1.1
Other	---	---	0.5	2.6	5.6	5.2	0.4	1.3	1.3
None				69.2	57.6	63.4	40.9	14.6	20.9
Not know				19.5	12.8	14.4			

Behavioral Variable	Age group		
	5	9	5-9
UR (%)	59	85	79
Vis/Per/Yr	1.6	2.0	1.8
Place -SDS	57	58	61
-Priv. Pr.	36	37	34
Insured (%)	47	52	47

@ Refers to normative needs only.
& Per cent of persons with one or more.
* Treatment most recently ("at last visit") received by all persons: the product of the treatment (percent of total treatment) received by those who visited in the previous 12 months times the UR.
Blank cell indicates figure not recorded.
Due to any reason.
--- Figure not given.
UR: Utilisation rate (% visited last year).
Vis/Per/Yr: Visits per Person per Year (all persons).
Place: per cent of those who visited.

These trends indicate, firstly, that care should be taken for the preschoolers before the age of 5 years and, secondly, that it may well be the case that children who use the service are not those with the higher disease levels, a finding in agreement with studies conducted in Australia (Wright, Spencer 1980) and overseas (see pages 24, 26-30).

The latter becomes particularly important if the assumption that the disease experience is stable while the prevalence continues to drop holds true.

3.3.3 Epidemiological Implications

Apart from recording the prevalence of the disease, it is desirable, for reasons of efficiency and accuracy, to record the disease's experience using the dmft index in 4 and 5 years age groups.

The missing component in particular, was found to represent as much as 20% of the total "invasive" treatment received (mft) and it was shown to be especially important when making regional and inter-state comparisons because it might constitute up to 12% of the dft score.

Surface counts are not considered necessary because the tooth counts have been shown to be sensitive enough for an index. Attention should be given when conversions of surface counts into tooth counts, and vice versa, are made. When surface counts are used for maximum sensitivity in a study design, it is considered to be worthwhile to report on the dmft scores as well (for example: Hennon *et al.* 1969; Barnard 1975).

Any inferences drawn from the SDS data at an inter-state level are susceptible to errors due to the non-representativeness of the data in several, the most populated though, states, that is NSW and probably Vic. This limitation of SDS data regarding its comparability at a state level has been broadly indicated by the ComDeptHealth (1987).

There is therefore a need to establish the relationship between SDS data and other valid data at a national, state and regional level, if this data is to be used interchangeably, where available, for planning purposes.

3.4 SUMMARY OF DENTAL CARIES IN 2-5 YEAR OLD AUSTRALIAN CHILDREN.

It is certain that age and number of teeth present affect the dental caries patterns, utilisation of dental services (treatment received inclusive) and the availability of data.

There is a dramatic lack of information on both the 2 and 3 year olds.

Only two, non-representative, studies on 2 year olds were identified in the literature after the review of Barnard (1964b). The most recent study on the caries status of 2 year olds comprising an adequate sample size was conducted in the period 1954-62 (Jago, King 1963), whereas the most recent representative study on the caries status of three year olds was conducted in 1970-76 in SA (Fanning, Cellier, Somerville 1980).

There apparently is more data on 4 year olds, but the issue of representativeness questions the validity of the surveys' findings. SDS data was repeatedly shown throughout this study to not describe the 4-year-old population accurately, in terms of disease prevalence, experience as well as activity, especially at a state level. This may be due to either different diagnostic criteria and/or treatment philosophies, or the population served by SDS is a relatively high-caries one. The latter is supported by behavioral and disease data from both overseas and from the Australian literature reviewed here but the former cannot be excluded.

Five year olds are the group examined in most detail. For the reasons outlined above, SDS data should be treated with caution but they are the only national figures prior to 1988.

In 4 and 5 year olds, a noticeable change has occurred in the literature after 1973 with regard to the index most commonly used, from the dmft towards the dift index. This was brought about mainly by the adoption of the dift by the SDS evaluation programme after the 1971

recommendation of WHO (1971), as well as by the conducting of surveys other than SDS ones in 1970s less frequently than in 1960s.

The SDS evaluation programme did not adopt the dmft index suggested by WHO in 1977 because of the magnitude of the Australian study (which had already commenced) and associated administrative complexities (ComDeptHealth 1987; Carr 1988).

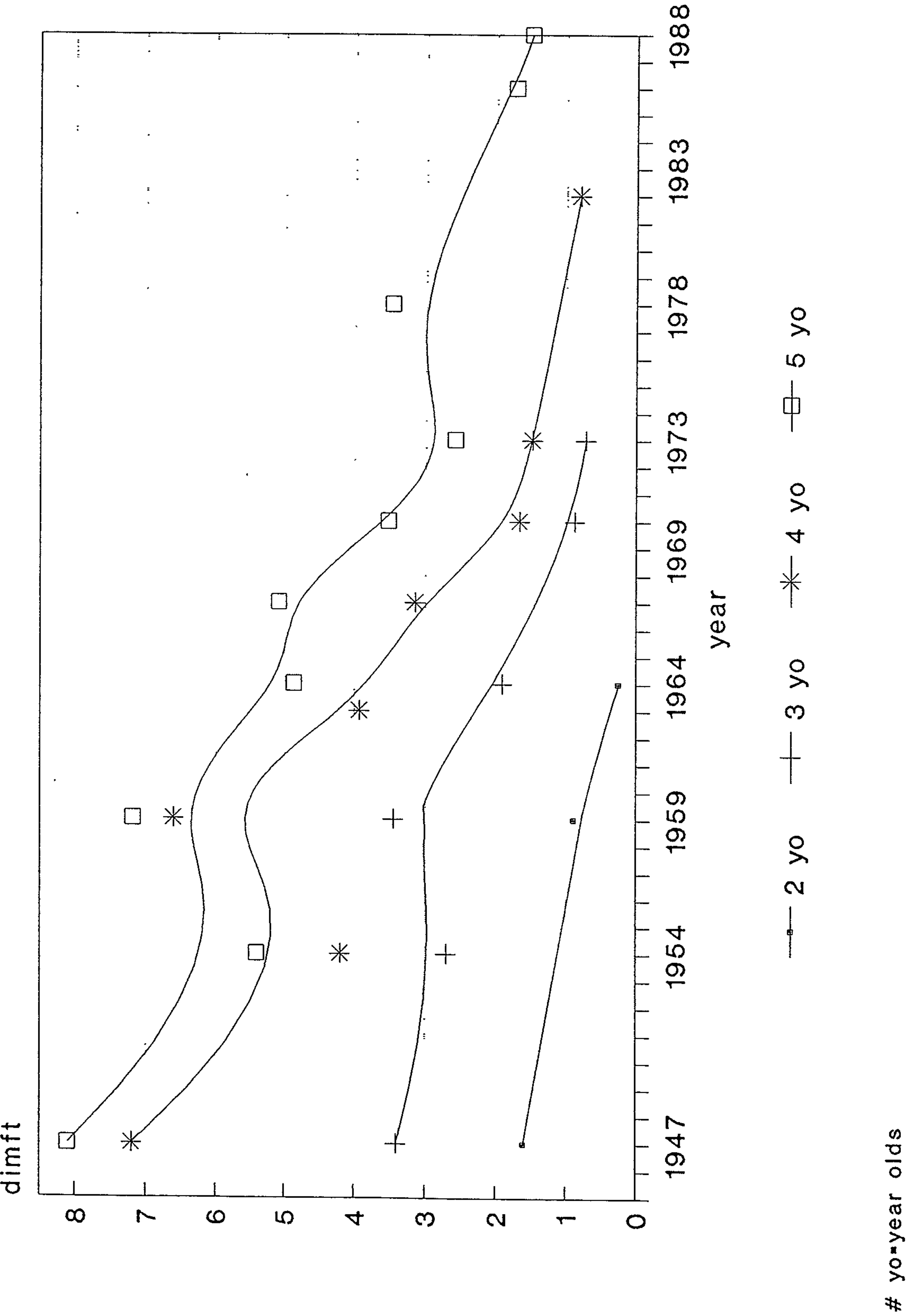
Although the oral health status of 2 and 3 year olds is expected to have been improved over the last four decades, available information indicates this to have been the case for 4 and 5 year olds, regardless of the validity of individual studies, for it was shown that different series of data consistently reveal improvements in both caries experience and prevalence in these (4 and 5 years) age groups.

The lack of data on 2 and 3 year olds and the heterogeneity of the surveys conducted with 4- and 5-year-old subjects do not allow for an accurate identification of disease trends throughout the age cohort of 2 to 5 years of age during the last 4 decades in order to draw conclusions on changes in the incidence of the disease. Figure 18 (page 97) depicts such a trend very tentatively. It appears that caries increments would now be expected to have been more evenly dispersed between the age of 2 and 5 years. The following comments will focus primarily on the older age groups (4 and 5 year olds).

The collated information indicates that the "polarisation" phenomenon has occurred in the 4 and 5 year olds, as it has at 12 years of age. In particular, Australian data on preschool children confirmed the finding that there is a close relationship between the prevalence and the experience of the disease (WHO 1962), at least in the case of 4 and 5 year olds (figures 11 and 14; pages 73 and 79, respectively).

The decrease in caries experience appears to have started before the 1970s (Carr 1988) but this may be attributed to the fact that many surveys conducted in the 1960s were of the pre-, post- fluoridation

Figure 18- Dental caries experience in 2-5 year old Australian children; summary of all available studies.



type. It is evident, however, that in early 1970s the downward trend was in operation.

Tooth age has been shown to strongly influence the dental caries incidence, particularly in the 2-5 years age cohort. Early studies, conducted on relatively high-carries preschool population groups, have shown that there appears to be a spurt in the caries' prevalence and experience at the age of 3 and 4 years. After a rapid increase in the 3rd as well as in the 3rd to 4th year of age the dental caries incidence levels off in the 4th to 5th year of age (Hewat *et al.* 1952; Savara, Suher 1954; Gray, Hawk 1967; Hennon *et al.* 1969).

Although the Australian data supports the findings on the relationship between tooth age and dental caries, the levelling off of caries activity between the ages of 4 and 5 years can be seen only in the case of SDS data. In both 1977 and 1986, the Australian mean dft scores in 4 year olds examined by SDS personnel were not significantly different from those in 5 year olds ($p < 0.06$ in 1977; $p < 0.13$ in 1986). This change from "probably not significant" to "not significant" a difference between the two age groups is also depicted on figure 19 (page 100). The difference in dft scores between the age groups of 4 and 5 years in each state have been discussed in pages 75 and 77.

As we saw, SDS data shows inconsistencies between and within age groups at a regional and state level and their representativeness can be questioned, at least in the case of 4 year olds. The latter can be reversed: SDS data depicts caries activity trends which are characteristic of high-carries populations. It is difficult to find any other explanation for the inconsistencies such as the above-discussed which are also depicted in figure 19 (page 100), that is the rate of improvement in oral health is somewhat faster in the 5 than in the 4 years age groups, especially if we take into account the expected decrease in caries progression due to the availability of fluorides. The latter is supported by the data drawn from 4 and 5 year olds of Tamworth before 1974 (figure 19).

Thus, by extrapolation and having in mind early studies (Hewat *et al.* 1952; Savara, Suher 1954; Gray, Hawk 1967; Hennon *et al.* 1969), what can be said with certainty is that the 3 year olds is the key-age group in caries initiation and, therefore, prevention. However, if caries progression has been delayed and the assumption that the SDS is not representative of the population holds true, there may have been a change in the caries' incidence with its peak at a later age.

Figure 19 (page 100; from table 11, pages 57-60) illustrates the best series of data available on dental caries in the age groups of 4 and 5 years, that is data from SDS (1977-1986) and Tamworth (1963-1988), as well as the data from Yass (1962-1978) and NOHSA (1987-88). The 1989 dmft score of NSW SDS has also been included. The figure includes annual data from Tamworth surveys not cited in table 11 (page 60). Tamworth studies found a clearly significant decrease in the dmft scores in 5 year olds between 1979 and 1988 ($SE=0.16$; $p<0.003$).

Tamworth started fluoridation in 1963, Yass in 1958 (ComDeptHealth 1985).

The possible scenarios on dental caries trends in recent years have already been discussed (page 83). From figures 11 (page 73), 14 (page 79), and 19 (page 100), it does not seem to be the case that the trend of declining dental caries has been reversed. A levelling off of the decline in caries experience may be the case. Thus, the most interesting and challenging scenario is that the prevalence of the disease continues to drop at a time when the caries experience has levelled off. This is particularly shown in figure 11 (page 73) for the presumably high-carries SDS 4-year-old children but it is also supported by Tamworth figures.

A difference of roughly 20% between the dmft values given by Tamworth-Yass surveys and those of SDS for 5 year olds can be detected on figure 19 (page 100). This difference may be explained by the water fluoridation and differences in fluoride availability at large (French,

Figure 19- Dental caries in 4- and 5-year-old Australian children.

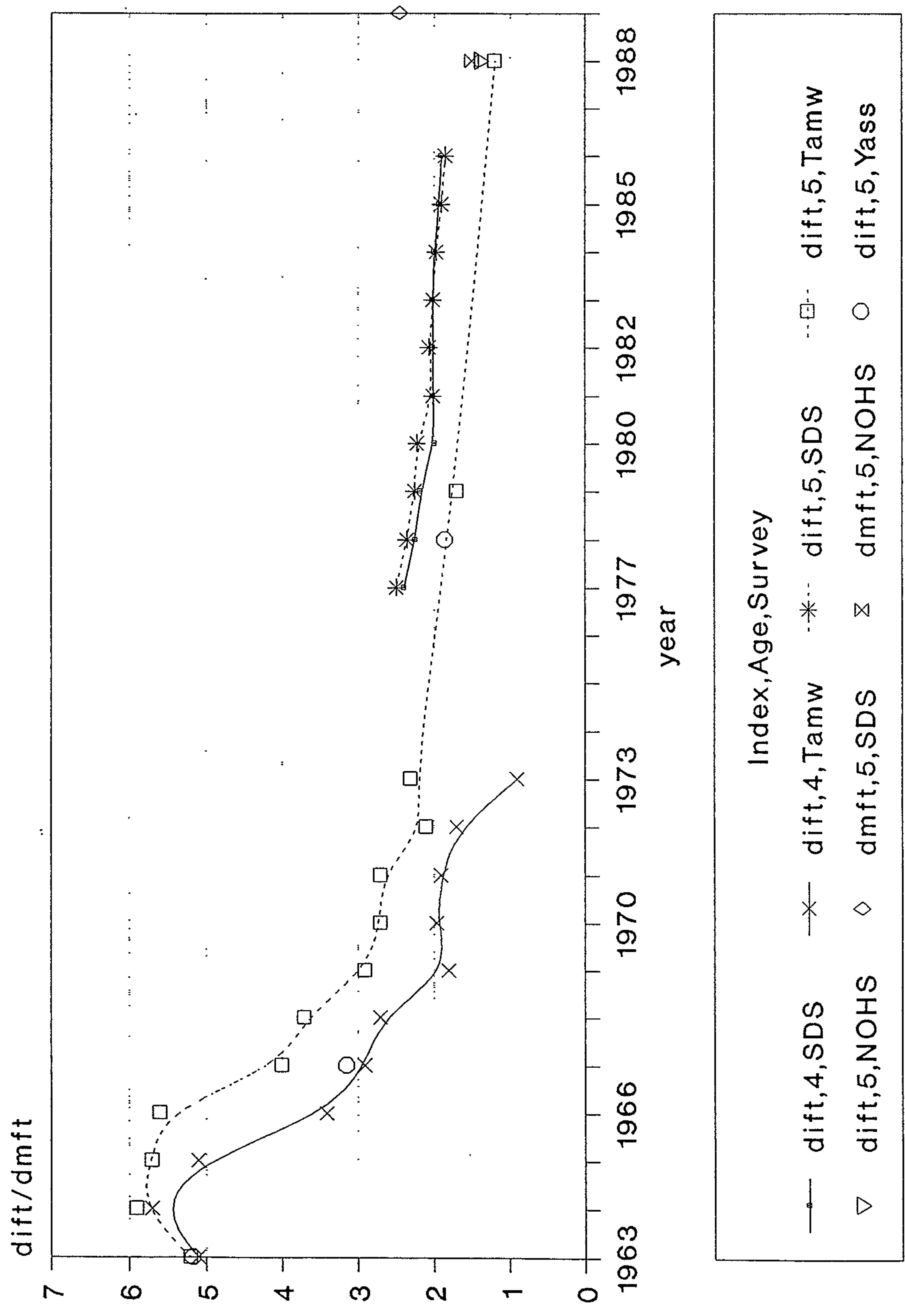
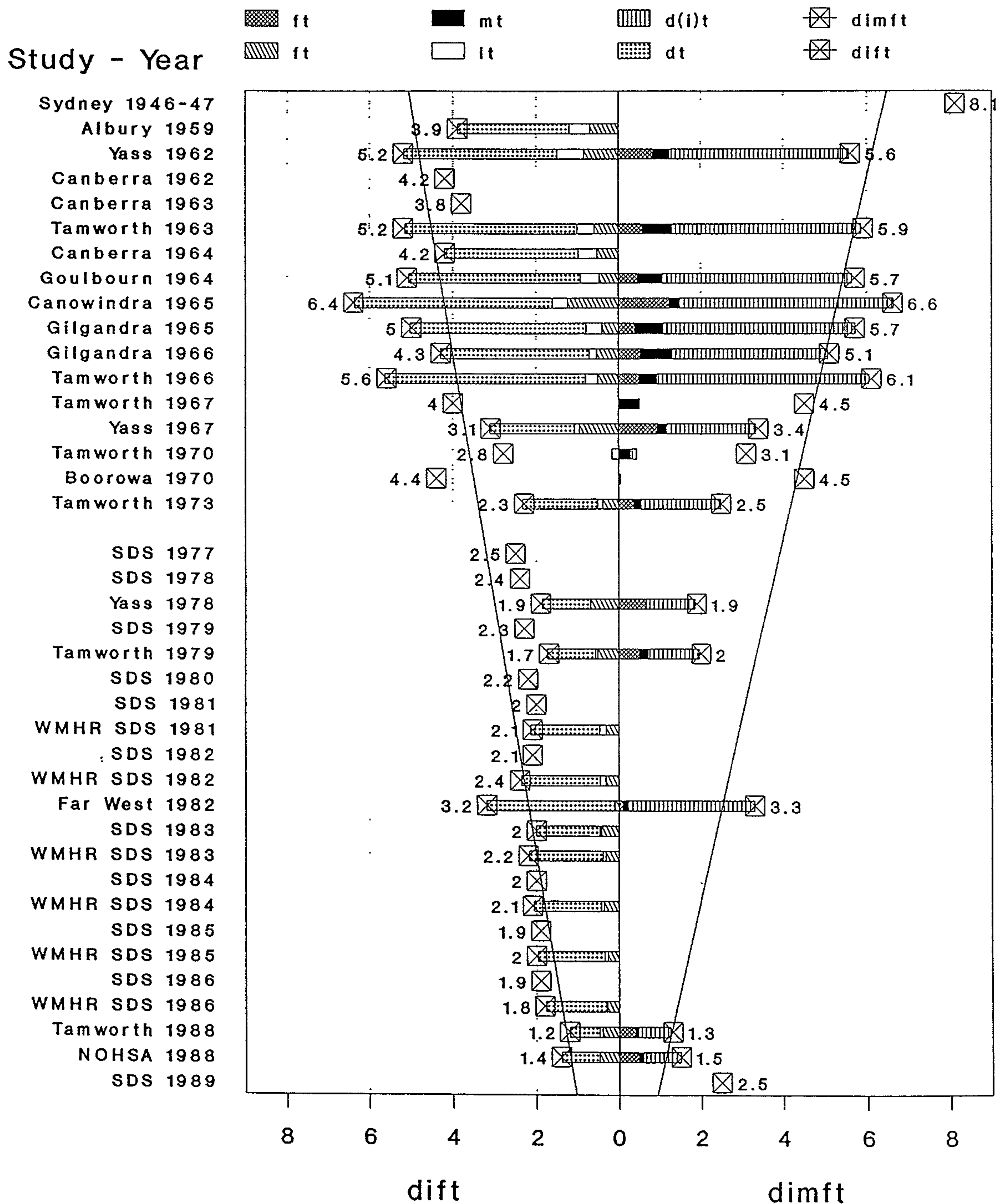


Figure 20- Dental caries trends and treatment patterns in 5-year-old NSW children; 1947-1989.



Carmichael, Rugg-Gunn, Furness 1984; see also figure 3, page 21), although differences in diagnostic criteria may also be a factor.

Figure 20 (page 101) summarises the information on dental caries and treatment patterns in the most surveyed age group and state, 5 year olds and NSW. It is obvious that the data available for Australia is largely those of NSW. It appears that five years of age has been the start-off point of conducting epidemiological surveys and, thus, they have been examined in much more detail than the younger age groups. The relative lack of data from other states precluded such a summarisation by state.

Treatment patterns have been, in absolute terms, more stable than disease trends.

As it has been demonstrated from early studies on the impact of water fluoridation on the dental market (Douglas, Wallace, Lerner, Coppersmith 1972), it is not necessary to increase the productivity of the dental workforce in order to increase the f/dmf ratio, provided that effective preventive measures are implemented. Thus, the apparent increase in the service's adequacy has resulted from the decrease in the caries' activity.

However, the increase in the provision of services provided by SDS in early 1980s (when it peaked in absolute and relative terms) appears to have halted, and this seems to be associated with the levelled-off workforce development and the decreased allocation of resources.

There is a necessity to record regularly non-invasive treatments rendered. The younger the age group, the greater this necessity appears to be.

Although the 3 year olds seem to be the group with the first occurrence of treatment needs, it can be said, by extrapolating from older age groups (four year olds have been consistently shown to have more active

disease than 5 year olds), that they receive very little, if any, service. It is certain that some groups of the population, particularly in NSW and Vic., are more deprived of dental care, and these groups appear to be the more susceptible ones (Cooper *et al.* 1984; Spencer *et al.* 1989).

The necessity for recording the mt component emerges at this point. Analysis of the available data indicated that the omission of mt may not preclude international comparisons, especially in low caries situations and younger age groups (such a comparison has been done with DMF at 12 years of age -Moller 1990; see and figure 1, page 2) but at a state, regional and local level it may be quite misleading. The AIH introduced the dmf index in SDS evaluation data in 1989 (AIH 1990).

There is no data on the distribution of the population by dental caries status in these age groups. SDS evaluation data (ComDeptHealth 1987), which has been reported by Carr (1988), has not included frequency distributions of children by disease experience for deciduous teeth. Thus, although such an analysis is considered essential for sensitivity and planning purposes (Schwarz, Hansen 1979; Hugoson *et al.* 1988), the Australian literature has been lacking suitable data on deciduous teeth.

It is necessary to specifically identify the extent of how different SDS data is compared with their respective populations, if this data is to be used meaningfully for interstate comparisons, monitoring and planning purposes.

Finally, the tentative indication drawn from the Australian data presented, that caries experience is not decreasing at a rate comparable with that of caries prevalence, accentuates the priority which should be given to the identification of high-risk groups.

3.5 FACTORS ASSOCIATED WITH DENTAL CARIES TRENDS IN 2-5 YEAR OLD AUSTRALIAN CHILDREN.

Factors responsible for the trends in dental caries in Australian preschool children cannot be easily identified from the available data.

Logically, most of the factors responsible for the decline of dental caries in the permanent dentition of Australian schoolchildren (figure 3, page 21) have been operating in the case of preschoolers as well. Carr (1982) suggested that, for Australian schoolchildren, the work of the SDS in preventive dentistry, dental health education and dental health promotion, the use of fluoridated water, fluoride supplements and fluoridated toothpastes, the growing emphasis placed on prevention by the dental profession, and, finally, the (impossible to substantiate) increasing appreciation by the community of the desirability for good dental health, have all contributed to the improvement in oral health status.

To these, changing patterns of sugar consumption should be added (Barnard, Sivanewaran 1990).

It is beyond any doubt that fluorides, mainly in the form of fluoridated water and fluoride dentifrices, have been the major factor in this decline of dental caries in preschoolers. The information on fluoride availability (figure 3, page 21) is matched well by all the figures and tables presented heretofore for preschool children. A differentiation between fluoridated and non-fluoridated areas could not be made but data for 5 year olds presented in figure 19 (page 100) may be taken as an indication of the importance of water fluoridation with regard to dental caries in preschool age groups. The results reported by Fanning *et al.* (1980) and the trends illustrated in figure 19 (page 100) lend support to the fluoride hypothesis. SDS data from Qld gives an indication on the importance of compliance to the use of fluoride supplements (see pages 81 and 83). The results reported by SDS examinations (pages 81, 83) and by Spencer *et al.* (1989) from Vic., as

well as those of Stockwell and co-workers (1990) from WA, add value to the known effectiveness of water fluoridation. The increased consumption of fluoride through the food chain appears to have played a role in the caries decline, especially in non-fluoridated areas, as well (ibid.).

However, professionally applied fluorides seem to have played a less significant role in caries patterns in these age groups than in older children (table 13, page 93). The treatment approach by the dental providers may vary by the type of service (SDS versus private practice) but this, in turn, may be the result of different population groups served. There is no data on preschoolers suitable for testing the latter hypothesis. The unchanged patterns of fillings rendered may be an indication of the preventive approaches adopted by the dental care providers but the relatively stable pattern of tooth extractions does not indicate so. The impact that dental health education activities have had on the attitudes of the public is difficult to measure and some results have been disappointing (FDI/WHO 1985). Taking into consideration the utilisation patterns of the preschoolers and the, roughly, unchanged restorative treatment provided to these groups, it could be said that the provision of service does not seem to have played as an important role in the decline of caries in preschoolers as is the case for older age groups. This has also been argued by Hunter (1984) for NZ 5 year olds.

Studies conducted mainly in Vic. in the 1980s, have shown a close association between demographic/socioeconomic variables, dietary patterns and dental caries in preschool children, and have also indicated high-risk groups such as children of families in low socioeconomic categories, of certain ethnic groups, with their mothers' having poor English-speaking ability and low educational level (Calache 1983; Wright, Spencer 1980; Spencer *et al.* 1989; Stacey 1989), results that do appear to be supported by the international literature (Davenport 1990; Waldman 1990).

Table 14- Oral debris in, and debris-free (%), 4- and 5-year-old Australian children; SDS evaluation data 1977, 1981, 1985.

Source: ComDeptHealth 1987.

Year \ Age	Debris index		% debris-free	
	4	5	4	5
1977	1.9	1.9	41.9	41.7
1981	1.5	1.5	52.0	49.3
1985	1.3	1.4	52.8	49.7

Additionally, SDS data has indicated changes in the oral debris scores in both 4- and 5-year-old children (table 14) with which both the changing prevalence and experience of dental caries (ComDeptHealth 1988) and the reported improvement in toothbrushing habits (see page 22) are closely associated. However, as it has been explained above, it is not known how much of this improvement could be attributed to the efforts of the SDS personnel.

Therefore, changing attitudes and oral health-related practices of the public should be considered as an important factor in the decline of dental caries in Australian preschoolers. The availability of services may have been a factor in these changing attitudes.

Data on the frequency distribution of children and/or teeth and/or surfaces by caries status appears to be particularly important in making some well-substantiated points with regard to factors associated with disease patterns.

3.6 INTERNATIONAL TRENDS IN DENTAL CARIES IN, AND TREATMENT PROVIDED TO, PRESCHOOL CHILDREN

There has been a lack of information on dental caries in preschool children at an international level. Table 15 (page 108) summarises data from some developed countries and areas in order to put the Australian data into an international perspective.

From table 15 (page 108), it is obvious that preschool children in developed countries have showed substantial improvements of the dental caries status in a variety of service (see page 6) and disease-prevention environments. In NZ, for example, fluoridated water supplies covered 54% of the population (FDI/WHO 1985). In Scandinavian countries, increasing emphasis has been put on the work at health centers and kindergartens since mid 1970s. The target groups of these programmes have been expectant and nursing mothers, and infants who are seen at regular intervals and are eligible for free-of-charge, comprehensive treatment. The purposes of the preventive programmes for the preschool children are the establishment of good eating and dietary habits, the promotion of good oral hygiene, and, finally, the motivation for regular use of some fluoride vehicle (Ahlberg 1978; Schwarz, Hansen 1979; Heloe *et al.* 1980; Heloe 1982). In Hague, there had been an oral health campaign in the period 1969-1978 but, alone, it could not explain the caries decline (Truin, Plasschaert, Konig, Vogels 1981).

The data in table 15 indicates that a decline of the caries experience in preschool children has occurred, especially in the 1970s. This decline appears to be levelling off or slowing down, with the exception of Glasgow, Scotland, where Attwood, Blinkhorn and MacMillan (1990) found a statistically significant decrease in the dmft score of 5 year olds between 1984 and 1987.

As to the prevalence of the disease, Swedish (Hugoson *et al.* 1988; Stecksen-Blicks, Holm, Mayanagi 1989) and British data (Hargreaves,

Table 15- Changes in caries experience*, prevalence, and treatment patterns in preschool children in some developed countries.

COUNTRY/ Area	Age	Year	Caries- free (%)	dmft, (dift)	dmfs, (difs)	d/d(m)ft, d/d(m)fs(%)	Source
DENMARK	2 3 4 5	1977-8 1977-8 1988 1989	76# 63# 43# 28#	 1.3 1.3	1.2 2.1 4.1 7.3	63# 51# 40# 33# 46	Schwarz, Hansen 1979 Møller 1990
ENGLAND & WALES	5	1973 1983 1985-6	28 51	(3.3) (1.8) (1.6)		(69) (69)	Todd, Dodd 1985 Møller 1990
Camden	2-3 3-4	1968 1980-1 1968 1980-1	82 89 64 78	0.8 0.4 1.4 0.7			Holt et al. 1982
Hertford- shire	3	1973 1981	67 83	(1.4) (0.5)		(85) (80)	Silver 1982
SCOTLAND Isle of Lewis	5	1971 1981 1984 1987	7 21 25 25	7.3 4.6 5.0 4.4	(12.1) (7.9) (7.9) (5.7)	(96) (95) (92) (84)	Hargreaves, Cleaton- Jones 1990
Glasgow	5	1984 1987	23 36	4.9 4.1		63 66	Attwood et al. 1990
FINLAND	3 3-5 5	1975 1981 1974 1976 1979 1975 1981 1982 1988	 24 40 57 13 47	1.5 0.5 3.7 2.7 1.7 5.0 1.2 1.6		 61@ 46@ 32@ 58	Downer 1984 Milen et al. 1981 Downer 1984 FDI/WHO 1985 Møller 1990
NZ	5	1977 1982	34 44	3.7 2.6		14 27	Hunter 1984
NETHERLANDS The Hague	5	1969 1972 1978	1 3 28		12.2 13.2 6.8	81 84 79	Truin et al. 1981
SWEDEN	3-5	1974 1980 1987	32# 55# 74#				Sundberg 1988
Jonkoping	3 5	1973 1978 1983 1973 1978 1983	35 62 70 9 25 29		(3.9) (2.0) (2.3) (11.2) (6.3) (5.9)	(95) (91) (92) (59)	Hugoson et al. 1988
Umea	4	1967 1976 1980-1 1987	17 36 50 58	5.3 2.4 2.0 1.6	7.8 2.9 2.0 2.0		Stecksen- Blicks et al. 1989

* Parentheses indicate dift or difs scores and thereof ratios.
Figures taken from graphs.
@ Proportion of children in need of restorative dental care.

Cleaton-Jones 1990; for the period 1981-1984) indicates that the levelling off of the caries experience may be accompanied by continual improvements in the percentage of caries-free children. This trend has not been shown consistently in the literature (French *et al.* 1984; Rugg-Gunn, Carmichael, Ferrell 1988; Murray 1991).

Overall, these trends in caries experience and prevalence depict the polarisation of the disease which has occurred in many developed countries.

It also appears from table 15 (page 108) that, the younger the children are, the more untreated dental caries they have (for USA data, see Waldman 1987, 1990). With the noticeable exception of 5 year olds in NZ, it seems that (despite the decrease in the $d/d(m)f$ ratio) approximately half of the disease remains untreated, even in Scandinavian preschoolers, but data on the quantity of non-invasive treatments rendered to these age groups appears to be missing. The apparent increase in the $dt/dmft$ ratio in NZ in the period 1977-1982, which was due to a slight increase in the dt component (from 0.5 in 1977 to 0.7 in 1982) and a decrease in the ft component (from 3.1 to 1.7, respectively -Hunter 1984), may be an indication of the changed diagnostic criteria and treatment approach in the NZ SDS (NZ DeptHealth 1978).

Danish SDS data (Schwarz, Hansen 1979) supports the argument that the incidence of dental caries in preschoolers increases evenly throughout the ages of 2 to 5 years. Table 15 also shows that 3-4 year olds are apparently the key-age group in clinical caries initiation.

Hugoson *et al.* (1988) found that the proportion of caries with involvement of the dentine in deciduous teeth in the period 1973-1983 had declined significantly less than it had in permanent teeth where enamel caries prevailed, a finding which "accentuates the importance of increased prophylactic measures early in the primary dentition" (*ibid.*).

The assumption that the dmfs/dmft ratio is not higher than two in 4-year-old children appears to hold true, particularly when caries experience has declined (Stecksen-Blicks *et al.* 1989).

Hargreaves and Cleaton-Jones (1990) found, in 5 year olds, a dmfs/dmft ratio higher than two in all the surveys conducted on the Isle of Lewis, Scotland. However, the "et" (that is the mt -Hargreaves, Wagg, Thompson 1987) component of dmft was found to be high and increased in the period 1971-1987 (the mt/dmft ratio was 19%, 17%, 18% and 28% in 1971, 1981, 1984 and 1987, respectively -Hargreaves, Cleaton-Jones 1990). The latter depicts the effect which dental services can have upon the oral health status in these young age groups.

Finally, the data presented in table 15 (page 108) indicates that Australian preschool children have shown improvements in their caries status paralleling or exceeding those in other developed countries, despite the lack of organised, systematic preventive programmes, except water fluoridation, in Australia. However, it appears that some improvement in the provision of restorative and preventive dental care to Australian preschoolers would be desirable.

4 CONCLUSIONS

The collated information on dental caries in 2-5 year old Australian children indicated that there is a dramatic lack of data on the younger age groups (2 and 3 year olds), some data of doubtful representativeness exists on the 4 year olds, while 5 year olds is the age group best-surveyed.

Despite the deficiencies of individual studies and the problems with comparability, evidence suggests that dental caries experience and prevalence in 4-5 year old and, by extrapolation, in 2 and 3 year old, Australian children have declined substantially over the past 25 years. This decline was primarily due to the reduced activity of dental caries.

The decline of dental caries experience and prevalence appears to have been more pronounced in the late 1960s, in the 1970s and early 1980s. A levelling off of this trend in caries experience may have occurred in recent years but a significant finding was that the levelling off may not involve the prevalence of the disease. High-caries and high-risk groups must, therefore, be a high priority.

This change in the dental caries status has made for the provision of services to appear relatively improved. Four-year-old children appear to be under-served compared with 5 year olds, who, in turn, are least served when compared with older age groups. More than one tooth per child affected by dental caries appears to require care.

There is some evidence that groups with more disease receive less care. Targeting resources to the preschool children with the higher dental care needs is highly desirable.

Comparisons at a regional and inter-state level and planning activities should not be based on data which has not previously been validated.

Availability of fluoride through multiple vehicles (water fluoridation, dentifrices, supplements), changing public attitudes, and increased availability of service, appear to have been the factors associated with these trends.

It is necessary to conduct surveys at a national, state and regional level on these age groups in order to identify and monitor disease trends and treatment (including utilisation) patterns (especially in children younger than 5 years of age), validate data collected regularly from SDS or other sources, and identify high-risk population groups.

In order to conduct epidemiological surveys for planning and evaluation purposes, the prevalence of the disease, especially in younger age groups, and tooth counts appear to be sufficient measurements for the purpose of such studies in Australian preschool children. Teeth missing due to caries should also be recorded. Tooth surface counts do not appear to be more sensitive an index than tooth counts in surveys involving these age groups.

It has been shown to be important to analyse and report the data adequately, particularly in terms of the numbers of individuals and teeth according to their caries status.

Finally, for evaluation purposes, it is considered necessary to record preventive treatments rendered.

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