

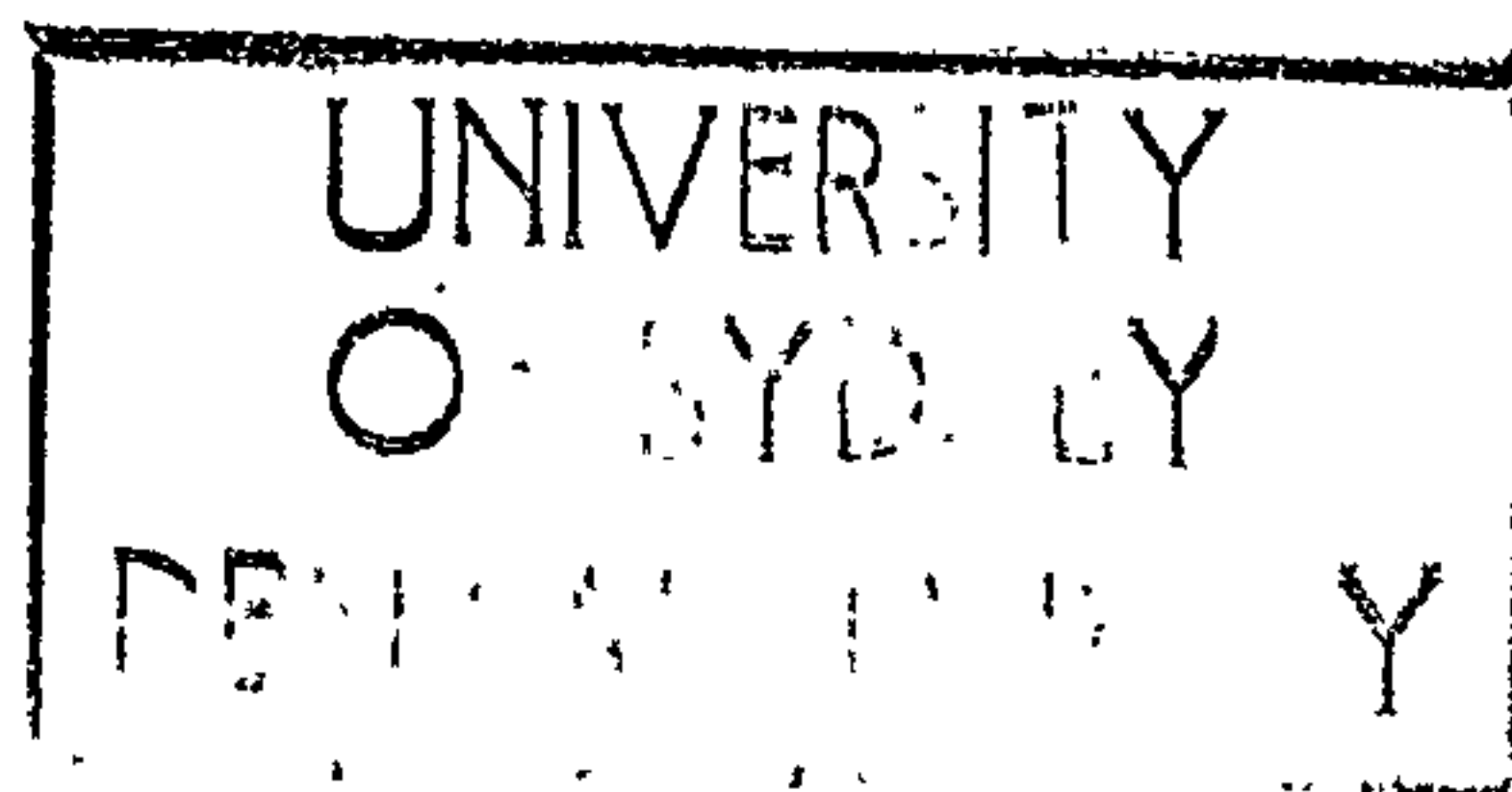
ORAL HEALTH STATUS OF PRIMARY SCHOOL CHILDREN
AND IMPLICATIONS FOR DENTAL CARE
- WESTERN HIGHLANDS PROVINCE, PAPUA NEW GUINEA

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A treatise submitted in partial requirement
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SUMMARY

A presentation is made of the methodology and findings of an oral health status survey of primary school children in Western Highlands Province, Papua New Guinea. Background information, regarding the province and of the country in general, is provided to facilitate discussion in the implications of the survey data for dental care delivery. This includes a review of the political system, pertinent demographic characteristics, economy, health status and health services infrastructure; and an analysis of the dental situation.

Survey methods and criteria were based on WHO protocol. While caries experience was found to be low, endemic levels of periodontal disease were recorded. Treatment needs of other conditions viz dentofacial anomalies, oral mucosal and bone conditions, and tooth defects and abnormalities, were assessed to be minimal. Survey data suggests that the provincial dental health services were not coping with the existing needs of the school population.

Statistical analysis of caries levels in the primary dentition, and of periodontal status, indicated that significant differences existed between population groups. Relevant factors to these findings may be variations in accessibility to services, and of cultural and lifestyle patterns related to diet and food habits. No significant differences in caries levels were apparent for the permanent dentition. The reasons are unclear.

Comparison of survey results suggests that the provincial caries experience may be higher than that in the coastal and island regions of the country; was lower than that of various South Pacific island states; and was low according to current global dental disease trends. Evidence also points to rising caries levels in developing nations. It has been suggested that this could be due to increasing urbanisation and the associated increased consumption of refined and fermentable carbohydrates. The high periodontal disease prevalence recorded would appear to be consistent with that of other developing nations. This is attributed to the general neglect of oral hygiene.

Several constraints affect the efficient delivery of dental care in Papua New Guinea. They are mainly the lack of epidemiological data; the low priority status of dental health services resulting in poor resource allocation; inappropriate dental workforce training; and transport and logistical difficulties due to inaccessible terrain. A rapidly expanding population, and increasing urbanisation may result in higher dental disease levels and greater demand for dental services. All these factors have profound implications for dental health services in the country.

Based on the survey's findings, several recommendations have been made for dental health services in Western Highlands Province and Papua New Guinea. Among them are a greater commitment to prevention such as the use of cost effective fluoride methods; the formulation of appropriate educational and promotional programmes directed at target groups and

devoted to changes of behaviour; the development of an appropriate training and role for dental care providers related to existing dental needs and resources; the training and utilisation of primary health care workers in the provision of dental health education, and dental clinical services based on simple technology; the use and continued research into the development of suitable dental delivery systems; the development of measurable goals for dental programmes; and the regular monitoring of dental disease patterns by improving data reporting systems, and by conducting relevant epidemiological studies.

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1 INTRODUCTION

1.1 PURPOSE OF THE TREATISE

There have been few dental epidemiological studies conducted in Papua New Guinea. Of these, most have been concentrated in coastal areas, the islands and eastern regions of the mainland. The highlands region, which comprises a large proportion of the population, has received little attention. The investigations, mostly dated, have been generally considered to be too limited, inadequate, or inaccurate to assess dental disease problems in the country (Barnes 1967; Dept of Public Health 1974). There is insufficient data on current disease patterns and trends, and for estimating treatment needs. This is especially pertinent, since current global observations suggest that developing countries are experiencing an increasing caries problem, and a high periodontal disease prevalence (WHO 1984).

Funding for public dental health services in Papua New Guinea is commensurate with its extremely low priority status in the relative importance of health problems. This has resulted in dental resource deficiencies such as workforce shortages, lack of logistical support and transport constraints for field services. Also, in a situation where the population is predominantly rural, the few staff and facilities available are usually based in urban centres. Together with the inhospitable terrain and poor transport systems contributing to difficult access to dental care, all the above factors have reduced the ability of the service to meet its goals and objectives. Hence appropriate oral health data is critical for the most effective delivery of dental care.

The provision of health services is inevitably linked to population characteristics. The annual population growth rate of Papua New Guinea is estimated to be 2.4% (National Statistical Office 1985). This rapidly expanding population is also associated with high internal migration from rural to urban areas, and from the less to the more affluent provinces. In these circumstances, rational planning is imperative for efficient provision of health services. Such planning will require epidemiological health data.

Given the above scenario, an oral health status survey of primary school children in Western Highlands Province, was conducted by this author in 1983. The study was regarded as having considerable value for several reasons. It would establish the prevalence of dental diseases and the treatment needs of the sample population. Baseline data would allow for subsequent evaluation of dental health programmes such as priority setting for preventive and treatment services; the extent to which oral health services are coping with the current need for treatment; the nature and extent of treatment needs; workforce estimates; and the costs in establishing, maintaining and expanding programmes. Data acquired may suggest areas of the most serious unmet needs, and assist in the choosing of alternative strategies to deal with dental disease problems. Comparison of the survey data with those of other regions of Papua New Guinea, and other countries, may help elucidate the causal relationships of dental diseases. Also, new knowledge of dental conditions may promote the identification of outstanding research opportunities.

Finally, in a country with limited resources, improved funding for dental care is unlikely. The appraisal of needs and demand for such care will enhance the rational planning of services, and facilitate appropriate deployment and concentration of scarce and costly resources. Data from oral health status studies is essential for the identification of areas and groups with the greatest need for care. This will in turn promote the maximal utilisation of services.

1.2 AIMS OF THE TREATISE

The aims of the treatise are:

1. To conduct an oral health epidemiological survey of primary school children, Western Highlands Province.
2. To establish the oral health status and treatment needs of the population surveyed.
3. To compare survey findings with:
 - a. Other regions of Papua New Guinea
 - b. Selected South Pacific nations
 - c. Current global oral disease trends and patterns
4. To provide data for discussion in their implications for the rational planning of dental care services.
5. To present recommendations.

2 GENERAL PROFILE

2.1 PAPUA NEW GUINEA

2.1.1 INTRODUCTION

Papua New Guinea (Figure 1) lies wholly within the tropics between the equator and 12 degrees S. Lat., and from 141 degrees E. Long., in the west to the 160 degrees E. Long., in the east (Hunter 1985). It consists of the eastern half of the world's second largest noncontinental island (the western half being part of Indonesia), and includes to the north and east some large islands; about 600 small scattered islands of the Bismarck and Louisiade archipelagoes; and the northern islands of the Solomons. The country occupies a land area of 463,840 sq kms.

The country contains a great diversity of topographical features - mountain ranges rising to 4500 metres, thick forests, vast swamps, seasonally swampy plains, broad upland valleys, large rivers, volcanoes and plateaus, and a large number of islands. These features represent formidable barriers to communication, transportation and human settlement. 70% of the land area cannot be used for arable purposes because of excessive slope or altitude (Dept of Health 1986).

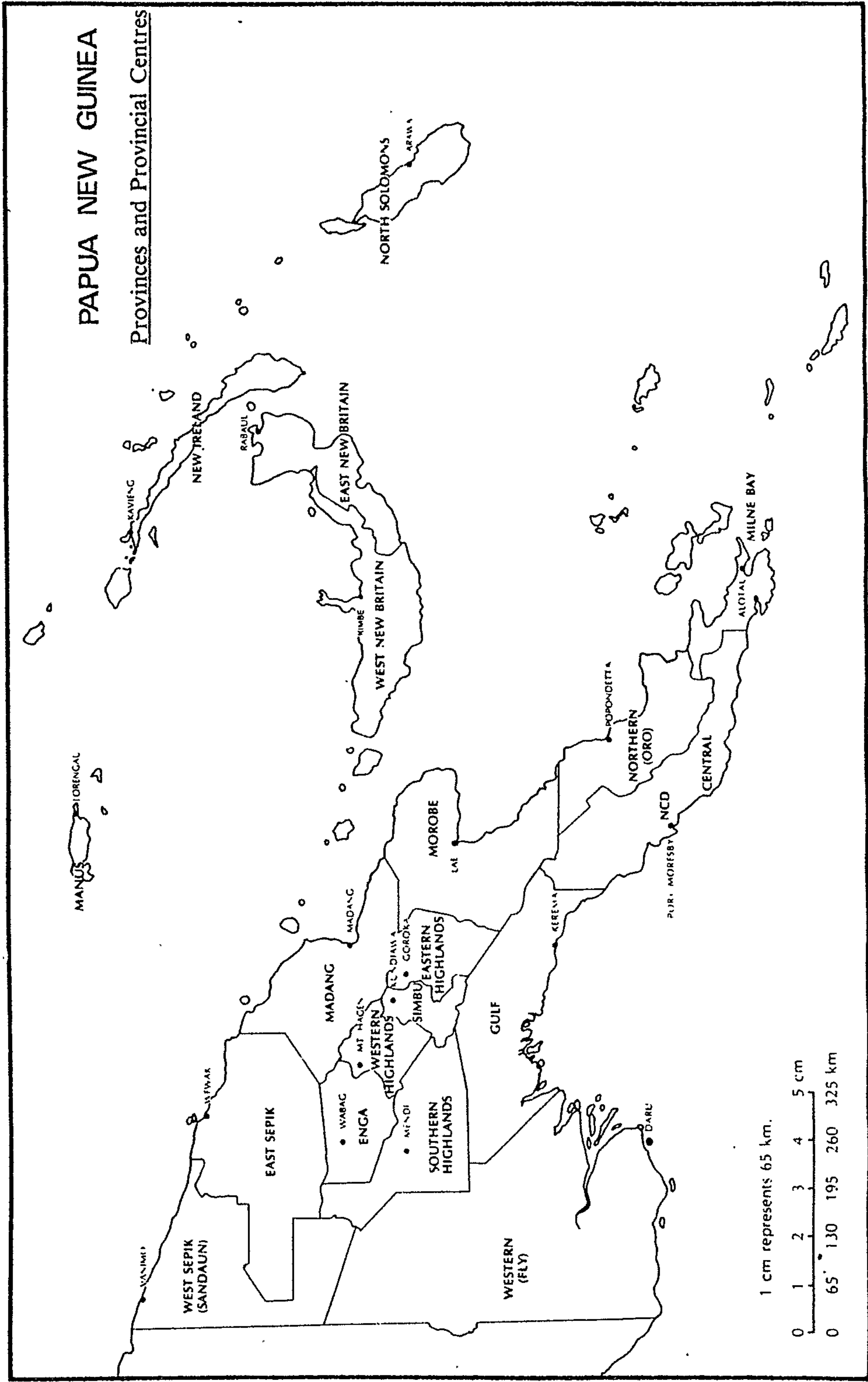
Apart from the Port Moresby area which has a dry climate, there is a regular and generally high annual rainfall in Papua New Guinea (Hunter 1985). The coastal regions have annual rainfalls varying from 1000 mm to 3000 mm. These areas are constantly warm and humid with monthly average temperatures of 22-30 degrees Celsius and humidity of 70-85%.

The highlands region on the main land mass and the mountains on the islands are colder and wetter. The monthly average temperature is 10-23 Celsius and annual rainfall sometimes reaches over 6000 mm in some areas. Due to the influence of wind in enclosed valleys, some isolated locations may record over 10,000 mm of rain per year.

2.1.2 POLITICAL BACKGROUND

Papua New Guinea gained independence from Australia in 1975. The country's constitution provides for a Westminster style democracy with three branches of Government, i.e. executive, legislative and judiciary (Papua New Guinea Consulate General 1986). Although the original constitution had no provision for any form of provincial government, pressure for devolution and decentralisation of power became a political issue in the 1970's. As a consequence a policy of decentralisation was adopted in 1977, which aimed at handing over some political and administrative power from the national government to 19 provincial governments (Reilly 1985). Under this legislation, provincial governments have the authority to pass laws that override those of the national government in some areas; possess concurrent responsibilities in other areas such as health and education activities; and have powers devolved to them which include amongst others, health service administration.

FIGURE 1 PAPUA NEW GUINEA - MAP



2.1.3 DEMOGRAPHY

Papua New Guineans may be classified as Melanesians, although a wide variety of physical types are found (Hunter 1985). Loyalty is to a clan and the latter remains the basis for group identification. Clan size varies from a few hundred to several thousand.

Linguistically, the population is extremely heterogenous with more than 700 different languages spoken. Speech communities are very small, and a large number of languages are spoken by only a few hundred people. There are 3 principal lingua franca - Pidgin English, Hiri Motu and English. The latter is the introduced language of education and the official language of government.

According to census and school records (Dept of Health 1986), literacy is estimated to be only 33%. Primary education is not universal and 28% of children never enter school. Education figures in 1982 (Dept of Education 1983) suggested that 64% of the 7-12 years age group attended school, 46% of children completed primary schooling and only 16% went on to secondary education. However, such figures may overestimate school attendance since not all those enrolled attend.

2.1.3.1 POPULATION STATISTICS

The National Statistical Office (1985) estimated the country's population to be 3,398,000 in mid 1984, with a projected annual growth rate of 2.38%. The population density in the same period was 7

persons per sq km with the most densely populated areas found in the highlands. The latter accounted for 40% of the country's population with population groups scattered throughout the entire region in dispersed settlements.

Papua New Guinea's population is overwhelmingly rural (Goodman, Lepani, Morawetz 1985). 88% is classified as being resident in rural areas. Of the 12% living in the 63 centres classified as urban (settlements with a minimum population of 500), 9% live in the eight major towns of the country. Census reports (Dept of Health 1986) show that Papua New Guinea has a very young population with more than 43% under 15 years of age and 16% under 5 years. The same sources also reveal that life expectancy at birth increased from 40.4 years to 49.6 years between 1971 and 1980, and the median age rose from 17.8 to 18.5 years in the same period. The sex ratio of the population in 1980 was 109 males per 100 females.

Throughout the 1970s and at present, Papua New Guinea is experiencing declining infant and childhood mortality (Goodman, Lepani, Morawetz 1985). This is the result of improvements in nutrition and health care. The present high fertility rates are due to traditional practices such as long lactation periods and restrictions on postnatal intercourse being weakened through increased contact with Western influences. The country is passing through a time of demographic transition, and on present trends, it is estimated that the population will double in 30 years.

Although net migration at the national level is negligible, inter-provincial migration is extensive. The major reasons responsible for this are employment opportunities, changing clan ties and local tribal warfare.

Table 1 gives the country's population by province in the years 1974 and 1984 and the resultant percentage increase; and Table 2 gives a percentage population of various age groups in the same two years.

Table 1 PAPUA NEW GUINEA - POPULATION BY PROVINCE 1974 AND 1984

Population	1974	1984	% change
Papua New Guinea	2,726,900	3,252,400	19.3
Western Province	71,700	82,200	14.6
Gulf Province	58,500	68,900	17.8
Central Province	106,500	126,900	19.1
National Capital District	102,900	132,000	28.3
Milne Bay Province	117,000	142,500	21.8
Northern Province	70,600	85,700	21.4
Southern Highlands Province	215,500	251,000	16.5
Enga Province	150,400	173,700	15.5
Western Highlands Province	241,900	287,800	19.0
Chimbu Province	163,000	183,200	12.4
Eastern Highlands Province	251,400	295,100	17.4
Morobe Province	279,600	339,200	21.3
Madang Province	192,000	232,800	21.2
East Sepik Province	202,200	242,800	20.1
West Sepik Province	104,200	123,300	18.3
Manus Province	23,700	28,300	19.4
New Ireland Province	60,100	73,100	21.6
East New Britain Province	119,700	145,900	21.9
West New Britain Province	81,000	100,900	24.6
North Solomons Province	114,900	144,200	25.5

Source: National Statistical Office 1985
Papua New Guinea - 10 years in figures
Port Moresby: Papua New Guinea

Table 2 PAPUA NEW GUINEA - AGE GROUP PERCENTAGE DISTRIBUTION IN
POPULATION 1974 AND 1984

Age Groups	1974 (%)	1984 (%)
0 - 4 years	15.7	15.4
5 - 9 years	14.4	13.8
10 - 19 years	23.1	24.1
20 - 29 years	15.8	16.1
30 - 49 years	20.6	20.5
50 years and over	10.3	10.1

Source: National Statistical Office 1985
Papua New Guinea - 10 years in figures
Port Moresby: Papua New Guinea

2.1.4 ECONOMY

Papua New Guinea's economy as assessed by Goodman, Lepani and Morawetz (1985) will now be summarised, to be followed by a discussion of its implications for the health service.

2.1.4.1 ECONOMIC ACTIVITIES

The vast majority of the population live in private households which remain the dominant unit of production. With the establishment of colonial rule, the subsistence economy was transformed into a cash economy which includes activities such as wage labour, the production of commercial products, parting with property rights to land, timber or minerals etc. Only 16% of households contain a wage earner and 94% of the rural population rely on nonwage employment to sustain themselves. Nonwage employment consists of mainly agricultural activities which dominate economic life. Some 68% of the population over 10 years of age are directly engaged in agriculture.

Agricultural activities include the production of tree crops which account for over 30% of the country's export income. Crops include palm oil, copra, copra oil, coffee, tea and rubber. Other rural activities involve the production of food crops and spices; the exploitation of forest and fishery resources; and some expansion of poultry farming, pig rearing and cattle ranching for local production of meat.

The industrial economy is dominated by the exploitation of mineral deposits, primarily copper and gold, which has made the largest contribution to export earnings in the last decade. However, with the presently depressed prices for such commodities, revenue is well below that anticipated a short time ago.

2.1.4.2 TRANSPORT AND COMMUNICATION

The rugged terrain of the country has resulted in the scattering of population centres. Consequently, communication and transportation needed to link population groups are expensive, and difficult to install and maintain. The road network is limited. Of 14 mainland provinces, 5 have no all weather road connection with another province, and 2 have connections with each other only. Of 18,700 km of roads constructed 94% are unsealed. Other means of transport are by river; by coastal shipping which is served by mainly inefficient vessels; and by extensive but costly air transport. The telecommunications network is well developed and serves many areas. This usually involves the use of radio receivers and transceivers.

2.1.4.3 IMPLICATIONS FOR HEALTH SERVICES

The main factors that will determine Papua New Guinea's economic performance in the foreseeable future are mineral commodity prices; world prices for other primary exports and the volumes of production achieved; aid flows; volume of foreign investment; and the level of food and other agricultural production by small scale and subsistence

farmers. Such factors will determine the level of funding that will be made available to the health sector. However, unfavourable economic forecasts have already indicated that large increases in resource allocation will not be feasible. As a consequence, the National Dept of Health (1986) in its health plan 1986-1990, had implied that improved health services "will depend on increasing the quality of health service management and delivery by increasing efficiency, by reducing wastage (particularly of skilled manpower), and by educating the community to take a greater responsibility for its own health care."

2.1.5 HEALTH STATUS

The three most commonly used indicators for measuring health status are life expectancy, infant mortality and childhood mortality. Recent trends concerning these indicators suggest that there has been considerable health improvement in the population of Papua New Guinea since independence in 1975. Other indicators of health, disease indicators, relate to particular diseases. Morbidity and mortality statistics of diseases, if analysed over a period of time, do indicate trends in patterns of disease incidence and prevalence.

Patient admissions at health institutions in 1984 (Dept of Health 1986), suggested that 20% were for obstetric conditions; 40% for infectious diseases mainly pneumonia, malaria and diarrhoeal conditions; and that chronic and degenerative disease accounted for only a small proportion of conditions. Outpatient consultations

figures in 1984 also confirmed the predominance of infectious diseases, and the leading causes of death, excluding those due to perinatal conditions, were pneumonia and malaria.

2.1.5.1 MAIN HEALTH PROBLEMS

Taking into account morbidity and mortality patterns, preventability, and social and economic loss, major health concerns have been ranked by the National Department of Health (1986) in order of priority in its five year plan 1986-1990. They are:

1. Respiratory disease
2. Malaria
3. Gastrointestinal disease
4. Pregnancy and the complications of pregnancy
5. Malnutrition
6. Tuberculosis
7. Accidents and injuries
8. Sexually transmitted diseases
9. Leprosy
10. Skin conditions
11. Psychosocial problems
12. Dental problems
13. Neoplastic and degenerative diseases

2.1.5.2 HEALTH STATUS ANALYSIS

Although the health of the population has improved in recent years, there is recognition that formidable problems still exist (Dept of Health 1986). The extension of basic health services to 96% of the population has not resulted in any significant change in disease patterns, and the incidence of communicable disease e.g. tuberculosis, malaria and sexually transmitted diseases has actually increased. Immunisation coverage and the adoption of family planning methods remain low. Improved provision of rural water supplies and latrines has only slightly affected the incidence of childhood diarrhoea. Despite health education campaigns, malnutrition and disease related to smoking and excessive alcohol consumption remain major health problems.

2.1.6 HEALTH SERVICES

Health care delivery in Papua New Guinea is made up of 3, sometimes overlapping, systems (Dept of Health 1986). The traditional system consists of village healers, and experienced village women who give assistance in childbirth. Some support is provided by government in terms of village water supplies and nutrition projects. The private system consists largely of industrial developments such as mining corporations, companies, factories etc, which provide a full range of health care for their employees. Also the number of national medical and dental practitioners going into private practice is growing. This is evidenced by the fact that in the years 1974 and 1984, the percentage of registered national doctors in private practice had risen from 5.3% to 12.4%. Almost a quarter of registered national dentists were working in the private sector in 1984. The third system, the formal health care system, provides for the bulk of the population and addresses the main health problems of the community. The ensuing discussion of health services in Papua New Guinea will be concentrated on this system.

2.1.6.1 THE FORMAL HEALTH CARE SYSTEM

Health services are delivered at 3 levels (Dept of Health 1986). Primary health services involve the utilization of the most appropriate and least expensive workforce delivering the required services as close to the community as possible. Secondary health services which support the primary health services involve the more sophisticated diagnostic and treatment facilities available at hospitals. Tertiary health services provide more advanced care i.e. highly specialised clinical services. The latter is very limited in Papua New Guinea.

2.1.6.2 FUNDING

Department of Health figures (1986) indicate that throughout the period 1974-1984, the government maintained a health expenditure at about 8-9% of total government expenditure. This represented 2.6 to 3.6% of gross domestic product. It was estimated in 1984 that approximately 48% of health expenditure was allocated to rural and urban primary health services; 41% to hospitals (providing both primary and secondary services); 6% to training; and 5% to Department of Health administration. In recent years, health expenditure is double that of most Asian countries, but less than that of developed countries (Goodman, Lepani, Morawetz 1985).

2.1.6.3 FACILITIES

Health services are provided at various facilities including the aid post, health subcentres, health centres and hospitals. They are organised in the form of the health care pyramid with the aid post at the base and progressively fewer, more complex and costly facilities further up the pyramid, to the hospital at the apex. The abovementioned facilities will now be discussed briefly, based on information from Dept of Health sources (1981; 1982; 1986).

Hospitals

Hospitals are classified according to their workload, the size of referral populations they serve, and the complexity of services they offer. A provincial hospital provides comprehensive medical, diagnostic and nursing facilities; trains health workers; and supervises standards of health services in the province.

Health centres and health subcentres

A health centre is the base from which a comprehensive health service is delivered to the population of the health district. It serves a population between 5,000 to 20,000 depending upon the population density and the ease of communications. It provides inpatient and outpatient care; aid post supervision; maternal and child health clinics; family planning; disease control programmes; environmental improvement; and health education.

The officer in charge of a health centre is the health extension officer. This person is a high school graduate who has undergone general medical training for a period of 3 years. Below the health extension officer, other staff include nurses, nursing aides, aid post orderlies and hospital orderlies.

A health subcentre has similar but lesser responsibilities than those of a health centre. It normally serves a population of 2,000 to 10,000 and is staffed by a nurse and nurse aides or orderlies.

Aid posts

The aid post is a vital component of health services, and provides a wide coverage of health services for rural areas. It serves a population of 500 to 3,000 and is staffed by an aid post orderly. This person is usually an older male primary school leaver with 1 to 2 years general medical training. This "barefoot doctor" provides outpatient treatment including the prescription of drugs such as penicillin, chloroquine, quinine etc; health education; advice on environmental improvement; and cooperates with the health centre in disease control activities and community health nursing.

2.1.6.4 WORKFORCE

The health workforce, which includes a wide range of professional, skilled and semiskilled staff, has expanded over the last decade (Dept of Health 1986). Since this expansion rate has been faster than that of population growth, this has enabled the ratio of population to health workers to decrease.

The number and expansion of health facilities and major categories of the health workforce in the years 1974 and 1984 can be found in Table 3. Included in the table are pertinent health facility/population and health workforce/population ratios. The drop in the total number of hospitals evident in the table can be explained by the closure of some long stay special hospitals for tuberculosis and leprosy, and the redesignation of others as health centres.

Table 3 - PAPUA NEW GUINEA - HEALTH FACILITIES, HEALTH WORKFORCE; AND
HEALTH FACILITY/POPULATION AND HEALTH WORKFORCE/POPULATION
RATIOS - 1974 AND 1984

Description	1974	1984	% change
<u>Health facilities</u>			
Number of:			
Hospitals	27	19	- 29.6
Health centres/health subcentres	342	459	34.2
Aid posts	1575	2200	39.7
Number of persons per:			
Bed (all facilities)	231	215	- 6.9
Health centre/health subcentre	7973	7086	- 11.1
Aid post	1731	1478	- 14.6
<u>Health workforce</u>			
Number of:			
Doctors	226	283	25.2
Health extension officers	180	336	86.7
Nurses	1554	4481	188.4
Aid post orderlies	1547	2163	39.8
Number of persons per:			
Doctor	12066	11493	- 4.7
Health extension officer	15149	9680	- 36.1
Nurse	1755	726	- 58.6
Aid post orderly	1763	1504	- 14.7

Source: National Statistical Office 1985
Papua New Guinea - 10 years in figures
Port Moresby: Papua New Guinea

2.1.6.5 TRAINING

There are several institutions responsible for the training of all categories of health personnel in the country. The University of Papua New Guinea offers degree courses for both doctors and dentists. The College of Allied Health Sciences trains health extension officers and a vast range of health personnel such as those concerned with nursing specialities, medical laboratory technicians and radiographers. In addition, several schools are located throughout the country training nurses, nurse aides and aid post orderlies.

2.1.6.6 CONSTRAINTS

Although a considerable growth in health services has been achieved in the past decade, several constraints to the development of health services exist (Dept of Health 1986). With a high population growth and depressed commodity prices for its natural resources, government health expenditure for the foreseeable future is likely to be decreased. Workforce constraints consist of staff shortages; inequality in staff resource distribution; and insufficiently trained and poorly motivated staff. Allied to this is a lack of management skill among health personnel at all levels in the health services.

The rugged terrain of the country has always been a considerable logistical constraint to the delivery and supervision of health services and especially where the means of transportation are inadequate. Coupled with the cultural diversity and the vast number of languages spoken, there is inherent difficulty in the effective communication of health information.

Finally, although primary health care is the focus of the country's efforts to improve the health of the population, demands continue to be made for more highly visible symbols of health services e.g. hospitals instead of health centres; doctors instead of health extension officers. Also people are making increasing use of expensive curative services. They are much slower, however, in understanding the importance of pursuing healthier lifestyles and adopting preventive health measures.

2.2 WESTERN HIGHLANDS PROVINCE

2.2.1 INTRODUCTION

Western Highlands Province (Figure 2) forms part of the mountainous core found in mainland Papua New Guinea. The provincial centre is located at Mt Hagen town and the province is divided into 14 districts and subdistricts. The province occupies approximately an area of 8288 sq km (Hunter 1985).

The varied terrain includes the lower Jimi swamps at 366 m altitude and rises through undulating valleys to the wide expanse of the Wahgi plains. Above these valleys loom the Schrader and Bismarck ranges in the north, and the Kubor range in the south. A number of peaks rise to over 3660 m.

2.2.2 DEMOGRAPHY

Western Highlanders are generally small in stature with strong physiques, and they possess intense clan loyalty. Geographical barriers and warfare between neighbouring clans have restricted groups of people to particular river systems. This has produced a wide range of related but varied cultures and languages. Of the 60 indigenous languages found in the highlands (Millar 1983), several are spoken in the province. However, one of the big language groups, Melpa, is understood by more than half the provincial population. The lingua franca in the province is Pidgin English.

Although the literacy level is not known in Western Highlands Province, it is estimated to be low. 32% of children of primary school age were enrolled in primary schools in the province in 1983 whilst the corresponding enrolment figure for the secondary schools was 12% (Division of Education 1983).

The 1980 National Census (National Statistical Office 1982) estimated the population of Western Highlands Province to be 264129 with 94% of people considered to be residing in rural areas. The urban population is almost entirely within the confines of Mt Hagen town. Table 4 gives the percentages of the population by 5 yr age groups. It can be seen that the population is young with almost 40% under 14 years of age. The annual population growth rate is 2.1%, and there is considerable migration from less prosperous provinces into Western Highlands Province in search of work.

FIGURE 2 WESTERN HIGHLANDS PROVINCE - MAP

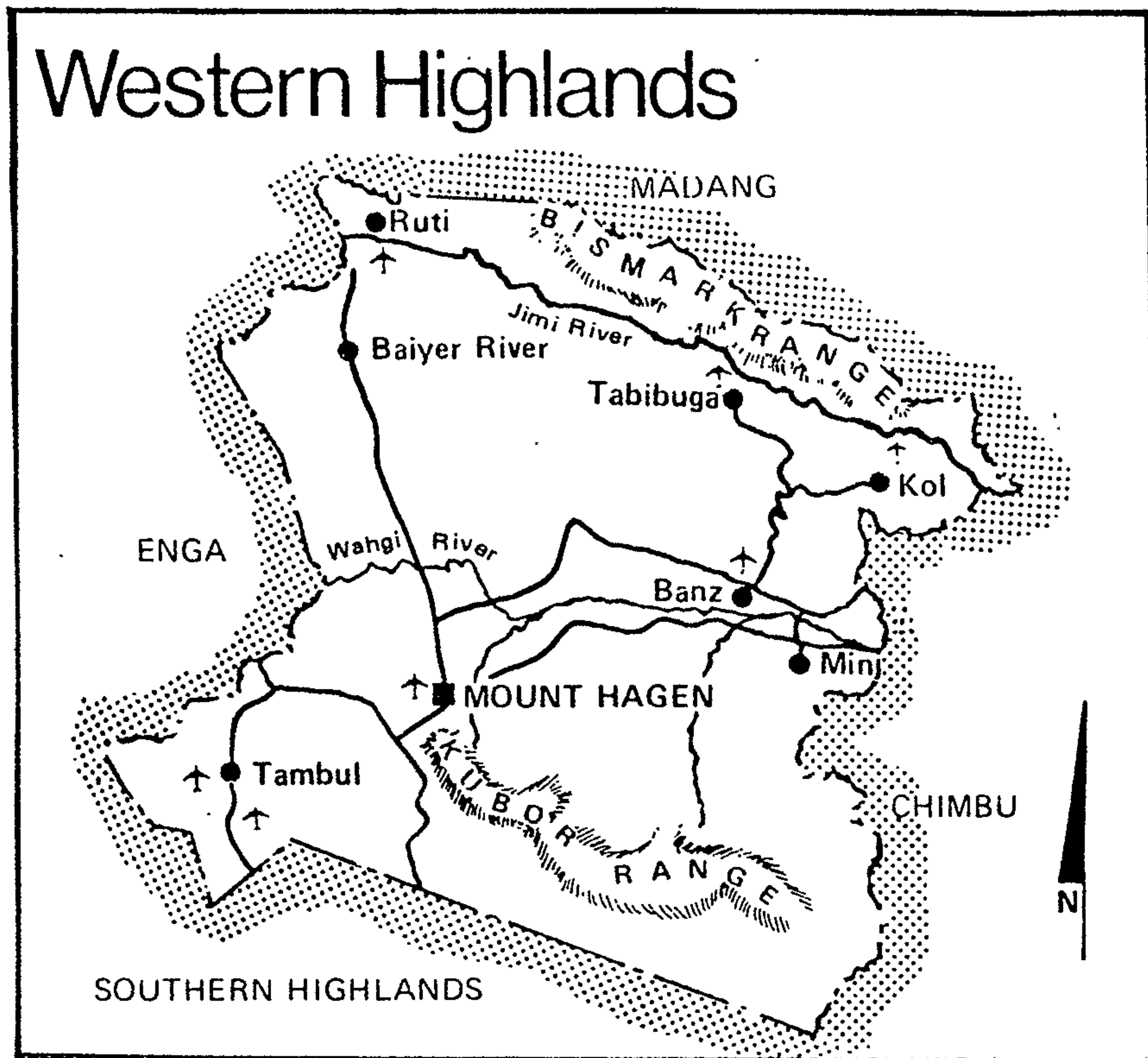


Table 4 - WESTERN HIGHLANDS PROVINCE -
POPULATION BY 5 YEAR AGE GROUPS

Age group (yrs)	Population	Percentage
0-1	8286	3.17
1-4	30612	11.59
5-9	36347	13.76
10-14	30120	11.41
15-19	22800	8.63
20-24	22423	8.49
25-29	21157	8.01
30-34	23571	8.92
35-39	14005	5.30
40-44	13275	5.02
45-49	10797	4.08
50-54	10814	4.09
55-59	8103	3.06
60-64	6362	2.40
65-69	3315	1.27
70-74	1703	0.64
75 +	419	0.16

Source: Department of Health 1986
Papua New Guinea National Health Plan 1986-1990
Department of Health Papua New Guinea

2.2.3 ECONOMY

Western Highlands Province is considered to be one of the more prosperous provinces in the country (Goodman, Lepani, Morawetz 1985). Of all coffee grown in Papua New Guinea, 37% is found in the province and the Wahgi valley is the main tea growing area in the country. These two tree crops constitute the province's most important export earnings. In addition, there is a significant market garden industry producing for local consumption, and the supply of a vast range of European vegetables to the coastal regions. Its forest resources in terms of timber production have been identified as having significant potential for development.

The road network system is extensive with the highlands highway providing a link to the coast as well as most of the other highland provinces. Of the total 1610 km of roads in the province, 75 km is classed as highway, 432 km as main roads with the rest as access roads (Hunter 1985). However, with only 11 km of roads sealed in the province, road transport is often difficult owing to rainfall, land slides and inadequate maintenance. Several airstrips capable of taking light aircraft are located in the province. These provide remote communities with a link to the urban centres.

2.2.4 HEALTH STATUS

As is seen nationally, Western Highlands Province is also experiencing an improving health picture in terms of an increasing life expectancy

and decreasing infant and childhood mortality rates (Table 5). However, several diseases are still of major concern in the province (Dept of Health 1986). Respiratory diseases like pneumonia remain a constant cause of serious illness and death particularly in rural areas. Despite improvements in access to health services, and the widespread use of antibiotics, pneumonia mortality has been increasing in the last 10 to 15 years. Chronic lung disease is common and in the highlands it is estimated that 20% of persons over 50 years are affected. Asthma, virtually unknown in traditional communities, is increasing in incidence, and influenza epidemics continue to be periodic problems. Poor ventilation of traditional houses with a low roof and an open fire place are regarded as highly contributory to respiratory and skin diseases. Due to the unsanitary disposal of excreta via pit latrines, and defaecation by humans and domestic pigs into streams, gastrointestinal disease and parasitic infestation are common. Also pigbel, a gastrointestinal disease thought to be caused by the ingestion of stale pork is a frequent source of death. Hookworm larvae are often transmitted via bare feet.

Increased economic activity resulting in considerable population movement in and out of the province has brought about undesirable consequences. Malaria outbreaks are now occurring in previously non malarious areas. Tuberculosis is increasing, and sexually transmitted diseases, especially gonorrhoea and syphilis, are highly endemic in the population. Finally, malnutrition is also widespread in the province.

Table 5 - PAPUA NEW GUINEA AND WESTERN HIGHLANDS PROVINCE -
HEALTH STATUS INDICATORS

Health status indicator	Year	Papua New Guinea	Western Highlands Province
1. Life expectancy (yrs)	1971	40.4	40.5
	1980	49.6	51.9
2. Infant mortality rates/1000 live births	1971	134	153
	1980	72	81
3. Childhood mortality rates/ 1000 live births	1971	79	83
	1980	42	42

Source: Department of Health 1986
Papua New Guinea National Health Plan 1986-1990
Department of Health Papua New Guinea

2.2.5 HEALTH SERVICES

Since decentralisation, provincial authorities have assumed control over several health functions. These include health institutions such as aid posts, health centres and health subcentres; family health services and supervision of disease control programmes. Nationally delegated functions are performed by the provincial health staff under the direction of the secretary for health, who in turn is responsible to the secretary of the department of the province. These include the provincial hospital; malaria control; and extension services such as tuberculosis, leprosy, sexually transmitted diseases, dental health and nutrition. In 1983, funding for nationally delegated functions was appropriated for the first time directly to provinces, and hence effectively completed the process of administrative and financial decentralisation.

Consistent with the expansion of health services throughout the country, health institutions such as health centres, health subcentres and aid posts, and various categories of the health workforce, have increased in numbers in the province in recent years. A summary of these figures and of their respective ratios in relation to the population in 1985 can be found in Table 6.

Table 6 - WESTERN HIGHLANDS PROVINCE - HEALTH FACILITIES, HEALTH WORKFORCE; AND HEALTH FACILITY/POPULATION AND HEALTH WORKFORCE/POPULATION RATIOS - 1985

Health facility	Number	Health facility/population ratio
Hospitals	1	1:264129
Health centres	11	1: 24012
Health subcentres	8	1: 33016
Aidposts	160	1: 1651
Beds (all facilities)	473	1: 559

Health workforce	Number	Health workforce/population ratio
Doctors	14	1:18866
Health extension officers	13	1:20317
Nurses	127	1: 2079
Nurse aides	106	1: 2491
Aid post orderlies	170	1: 1553

Source: Department of Health 1986
Papua New Guinea National Health Plan 1986-1990
Department of Health Papua New Guinea

3 DENTAL SITUATIONAL ANALYSIS

The analysis of the dental situation in Papua New Guinea will begin with a review of pertinent epidemiological literature. This will be followed by a resume of diet and oral health habits of the population. A discussion of the dental care delivery system of the country will then be undertaken, and considered in relation to Western Highlands Province.

3.1 ORAL HEALTH EPIDEMIOLOGICAL STUDIES - REVIEW OF LITERATURE

There have been few oral health epidemiological studies conducted in Papua New Guinea. Most of these were concentrated in coastal areas, islands and the eastern part of the mainland. This might have been because of the inaccessibility of large areas of the country, including most of the highlands, which until recent times were relatively unexplored.

In this review, the literature is divided into two groups for convenience: general epidemiological studies on oral health status and various dental conditions, and those concerned with specific investigations into caries aetiology.

3.1.1 GENERAL ORAL HEALTH EPIDEMIOLOGICAL STUDIES

3.1.1.1 EARLY STUDIES

Early studies consisted of those undertaken on Manus Island (Kirkpatrick 1935; 1937); and on island, mainland and highland populations (Sinclair, Cameron, Goldsworthy 1950a; 1950b; Williams 1958). Common findings from these investigations include the presence of odontoclasia, a form of enamel hypoplasia, in young children; a low caries prevalence; and normal occlusion among most subjects. In addition, Sinclair et al found that people generally possessed dentitions larger than "civilised races"; had few aberrations in third molar regions; exhibited high rates of attrition; and that occlusal attrition at times actually overtook the carious process.

Whilst contending that the above studies remain to be considered as sources of data on unaltered dental conditions in primitive peoples, Barmes (1967) cited several inadequacies which have resulted in reducing the validity of any general comparison with them. Failure to calibrate examiners and to specify precise criteria for measurements used; disregard for age distributions except for gross divisions; and haphazard sampling were considered major weaknesses of the studies.

3.1.1.2 THE 1960s

This period marked the advent of elaborate and more scientifically sound dental investigations. A comparative study of dental

conditions, primarily caries, as found in populations existing on 6 virtually unaltered traditional diets, was undertaken by Barmes (1962). Findings strongly indicated that caries prevalence was highest amongst groups existing on an unvaried sweet potato staple diet, and lowest in groups with a varied sago staple diet. The former was exclusively found in highlands regions, and the latter was common to villages situated on plains and along rivers. The age adjusted mean dmf/DMF score of 3.4 per subject was recorded for the whole survey. Barmes suggested that a distinct caries pattern existed for each dietary type. Higher caries prevalence at higher altitudes than that at low altitudes was also confirmed by Vines (1968). Barmes' study will be considered more fully under "dietary considerations" in a later section.

Two separate island studies, (Bailit, Ogan, Leigh 1968; Anderson 1970), on New Ireland, New Britain and the North Solomons, reported the following. A low caries prevalence in both primary and permanent dentitions was associated with the highest frequency of attack in the occlusal and buccal surfaces of the first and second molars. Although a high prevalence of leukoplakia was recorded especially in the cheek and buccal mucosa there was a low prevalence of oral cancer. High levels of oral pigmentation were evident especially in the North Solomons.

Finally, common findings of the investigations in the 1960s included the high prevalence of periodontal disease (estimated by Barmes to be affecting 43.5 to 63.7% of the total population for periodontitis, and

56.1 to 91.6% for periodontitis together with gingivitis); the difficulty in ascertaining the reasons for tooth loss; and the presence of odontoclasia in young children; and the low prevalence of malocclusion, with simple Class I malocclusion the most common condition.

3.1.1.3 BEYOND THE 1960s

The first national dental survey (Humphreys 1977) was conducted utilising standard WHO methods. The sample, some 8000 primary school children, was drawn from all but 4 provinces. The children were divided into a younger and an older age grouping according to physiologic dental development. General findings included a low prevalence of oral mucosal conditions, bone conditions, tooth defects and dentofacial anomalies. Of the latter two measurements, enamel hypoplasia and crowding were the two most common features respectively.

Periodontal disease was reported to be common, with over 60% of the sample exhibiting soft deposits. However, as might be expected, advanced disease levels were low in a young population. Negligible differences in periodontal disease prevalence were recorded when groups with different diets were compared.

Caries measurements suggested that the percentage of persons affected by caries in the primary dentition was 42.2% with a mean dft score of 1.0. For the permanent dentition, this ranged from 18.5% (mean DMFT

0.3) in the younger age group and 33.4% (mean DMFT 0.8) in the older children. Caries prevalence was consistent with those of earlier studies in that it was highest in the highlands, and in those children existing primarily on a sweet potato diet. Measurements also reflected a large discrepancy between decay rate and dental treatment. Results indicated that 90% of untreated decay occurred in the primary dentition; and 75% and 42% of the permanent dentition in the younger and older age groups respectively. When urban and rural groups were compared, caries prevalence was slightly higher in the former, whereas little difference was recorded for periodontal disease.

A remote community existing predominantly on traditional diets in the Eastern Highlands Province was the subject for 2 investigations into root surface caries (Schamschula, Keyes, Hornabrook 1972; Schamschula, Barmes, Keyes, Gulbinat 1974). The studies revealed that the prevalence of root surface caries was much higher than that of coronal caries in persons 30-39 years; that there was a statistically strong association between periodontal disease and root surface caries; and that there was a significant positive correlation between age (i.e. duration of exposure to irreversible destructive disease) and dental condition.

Finally, Malden (1983) reported that of a small sample of children examined in a remote area of the Southern Highlands Province, 32% had untreated caries, almost half of whom were suffering with chronic dental sepsis often with a history of pain. The latter, he suggested,

might give some indication of the extent of the levels of untreated decay associated with pain.

3.1.2 STUDIES ON CARIES AETIOLOGY

A number of population groups, known to represent sharply contrasting levels of caries experiences and which included a substantial proportion of caries free persons, were the subject of a large series of related investigations into caries aetiology. Located along the Sepik and Fly rivers and their tributaries, the remote villages in the studies were isolated from each other due to the several languages present creating a barrier to communication. Persons examined were lifelong residents in the region, and they existed on virtually unchanged traditional dietary patterns exhibiting a lack of refined carbohydrates. The findings of these studies will now be discussed.

It was suggested (Barnes 1969; Barnes, Adkins, Schamschula 1970; Adkins, Barnes, Schamschula 1974) that caries prevalence was associated with trace elements, micronutrients and macronutrients of soils, food and water. Findings (Schamschula, Adkins, Barnes, Charlton, Davey 1978) indicated that a high concentration of minerals in plaque and saliva had a beneficial effect on caries, whereas the opposite was true for trace elements extraneous to hydroxyapatite in surface enamel. This same study reported that caries was associated with plaque quantity; that the acid producing capacity of plaque was as great or greater than that observed in populations with high sucrose consumption; that a high exposure to environmental fluoride

and lithium resulted in reduced caries experience; and that water borne fluoride levels had no demonstrable contribution to caries distribution patterns.

Other studies on these population groups revealed that betel chewing conferred a degree of protection from caries (Schamschula, Adkins, Barmes, Charlton 1977); increased lactobacilli and streptococcal counts in plaque and saliva were accompanied by increased caries prevalence (Schamschula, Barmes 1970a; 1970b); and that significant positive associations were found between dental arch width, and the buccolingual and mesiodistal diameters of second permanent molars with caries (Schamschula, Barmes, Adkins 1972). Finally, Schamschula et al (1978) found no association between caries and age. It was suggested that this might be the result of the slow progress of lesions, and the rate of attrition eradicating these lesions.

3.1.3 SUMMARY

Important findings of the above studies related to oral health status may be summarised as follows:

1. Caries prevalence was low throughout the county.
2. Caries prevalence was highest in the highlands where the inhabitants exist on an unvaried sweet potato diet.
3. High rates of untreated dental decay were present in both primary and permanent dentitions.
4. Periodontal disease prevalence was high throughout the country with severe disease levels common in older persons.
5. A low prevalence of malocclusion was evident with simple Class I malocclusion and crowding the most common conditions.
6. A high prevalence of leuokoplakia existed in island populations.
7. Enamel hypoplasia, including odontoclasia, was common.

3.2 DIETARY CONSIDERATIONS

The Papua New Guinean villager lives to a very great extent on the produce of village gardens, and to a lesser extent on animal life in the surrounding jungle, or marine life in rivers or seas. Racial diversity has resulted in differences in types of food grown and eaten, cooking methods, meal patterns, types of first foods given to babies, and even the use of cooking utensils (Clark 1978). Staple foods grown are taro (*Araceae* family), yam (*Dioscorea* spp.), banana (*Musa* spp.), sweet potato (*Ipomoea batatas*) and sago (*Metroxylon* spp.). Such staples are extremely high in carbohydrate content but extremely low in protein. Whilst all are found in coastal areas and the lowlands, sweet potato is virtually the only staple grown in the highlands.

There are 4 basic cooking methods (May 1984) namely, boiling in clay pots or metal saucepans; baking on coals, with skins of vegetables or leaves for protection, and where bamboo is often used for placing food; roasting over flames with coconut milk as grease; and finally "mumu", a method involving an oven prepared in the ground with the use of stones, coconut shells and leaves, and heated by a fire built over it. Generally meals are restricted to a large meal at night, one small meal in the morning, and irregular snacks during the day.

3.2.1 CARIES AND DIET

Barmes (1962; 1968a; 1968b) in his elaborate investigations on the

relationship between caries and diet, classified 6 traditional dietary groups.

Dietary group 1 - Taro, Yam or Banana staple, supplemented with fruits, nuts, leaf foods, small mammals and fish. This dietary range is typical for coastal and all lowlands dwellers, but is superceded by sago diets in swamps, river and plain regions.

Dietary group 2 - Mixed diets which may be Taro, Yam or Sweet Potato staple, supplemented with banana and most of the subsidiary foods of group 1, except for fish. This dietary complex represents the transition from lowland to highland diets. There may be a slight dominance of either sweet potato on one hand, or taro and yam on the other. It is common to inland village groups at about 2000 to 3000 ft above sea level.

Dietary group 3 - Sweet potato staple. This food is eaten in "boiled" form and supplemented with some pig meat, and to an even smaller extent also with the subsidiary foods of group 2. This is the most unvaried diet and is exclusively found in the true highlands regions i.e. over 3000 ft above sea level.

Dietary group 4 - Sweet potato staple - eaten in the "baked" form and supplemented by the same subsidiary foods as group 3. Apart from the cooking method, this group is identical to group 3 and can be regarded as a subgroup of 3.

Dietary group 5 - Unvaried sago staple. Other lowland foods are very restricted because of seasonal flooding and lack of suitable land for cultivation. This diet is common to villages totally surrounded by swamps. This group can be regarded as a subgroup of 6.

Dietary group 6 - Varied sago staple. This diet is common to villages situated on plains and near rivers. Most other crops are also cultivated, and there is an abundance of fish, small mammals, crocodiles etc. This group has a higher protein intake than all the others, and their diet is perhaps the best in the country in terms of nutrition.

Barnes' findings showed distinct differences between the 6 groups both in terms of caries prevalence (Table 7) and distribution by tooth surface. Groups 3 and 4 showed a predominance of smooth surface caries; group 5 proximal caries; and pit and fissure caries in the remaining groups. These results led Barnes to hypothesise that a distinct caries pattern existed for different dietary groups. He added that since such high carbohydrate diets were associated with low

caries prevalence, this suggested that the difference in caries prevalence between "civilised" and "primitive" people might be one of refining (including cooking and preparation) more than one of content. Finally the tooth attrition found in these groups was attributed to the cooking modes which allowed for the inclusion of much soil and sand.

Whilst Barmes' classification may still be applicable, social and economic changes have taken place in the intervening years due to urbanisation, establishment of trade stores, even in isolated villages, and rural development. These changes have resulted in new diets, which include foods such as rice, wheat, flour, bread, canned fish and canned meat, together with other foods which reflect the original diet of the group. It may be inevitable that dietary changes will be undoubtedly towards refined foods and increased frequency of intake. For the urban dweller in particular, economic factors predispose to and almost compel the selection of inexpensive refined foods of carbohydrate nature. Hence, the distinct possibility of a rise in caries prevalence.

Table 7 - CARIES PREVALENCE BY DIETARY GROUPS

Dietary Group	Primary dentition		Permanent dentition	
	% persons affected	mean df/ 100 teeth	% persons affected	mean DMF/ 100 teeth
1	41	10	25	2
2	57	13	50	5
3	78	26	86	25
4	24	10	62	8
5	55	16	82	26
6	0	0	1.5	0.06

Source: Barmes 1962
Dental disease patterns related to dietary patterns in
primitive peoples of the Territory of Papua and New Guinea
D.D.Sc thesis, University of Queensland

3.3 ORAL HEALTH HABITS

3.3.1 BETEL CHEWING AND RELATED HABITS

The outstanding oral habit in Papua New Guinea with implications for oral health is betel chewing. This addictive habit, traditionally the domain of the lowlands and hill country less than 400-600 metres, is spreading rapidly to the highlands as a consequence of economic development. It is practised by both sexes, and betel chewing may start at the age of five years (Bailit et al 1968). Lactating mothers have been observed to prechew the betel bolus for young infants (Schamschula et al 1977). Humphreys (1977) estimated that with the exception of rural highlands children, 40% of the children in his study were chewing betel nut regularly by the age of 13 years. Betel chewing is intoxicating. It is said to depress sensations of thirst and hunger, help sustain physical exertion, and create a feeling of well being.

The habit involves the mastication of a bolus comprising the shelled nut of the betel palm, *Areca catechu*; leaves of the plant *Piper betel* or a variety of aromatic tree barks; and a hydrated mixture of calcium oxide and carbonate usually prepared by heating and powdering calcined shells. Application of the lime involves the use of a stick or loop vine.

Mastication of the bolus stimulates a copious flow of saliva which is coloured bright red on contact with the constituents. Prolonged practice of the habit results in the deposition on teeth of a strongly

adherent dark red to black substance which finally covers the whole crown areas of teeth.

Betel chewing in Papua New Guinea has been described as having a beneficial effect on caries prevalence by Schamschula et al (1977) and Howden (1984). Although the exact reason for this is not known, the latter suggested that deposits on teeth resulting from the habit actually served as a direct barrier against acid attack. However, there is evidence that suggests that the habit is associated with leukoplakia (Bailet et al 1968) and oral cancer (Atkinson, Chester, Smyth, Seldam 1964). Oral cancer is thought to be associated with the practice of wiping a lime coated stick against the buccal mucosa, which often results in lime burns in the latter. It is the commonest cancer in men, and the fourth highest in women in the country (Dept of Health 1986). Statistics show that this cancer comprised 10.4 to 17.8% of all cancers in the period 1979-1983, and its frequency is regarded to be one of the highest in the world.

Anderson (1970) also reported on the widespread chewing and smoking of native tobacco, a habit which may begin in children of 5 years. Where wooden pipes are used, characteristic wear patterns and diastemas were observed. The above studies also suggested that the use of tobacco may have contributed to the leukoplakia found in the country.

3.3.2 OTHER HABITS

Although tooth cleaning methods using sand, betel husks, vines, twigs, sticks etc have been observed (Barmes 1968a), no oral hygiene procedures are practised by the vast majority of the population. Attempts by dental and other health staff in promoting the benefits of good oral hygiene have met with little response. Some reasons for this are advanced by this author. It would seem that little social stigma is associated with the loss of teeth, particularly by the rural population. Soft traditional diets appear to be managed adequately by the edentulous. The inaccessibility and relatively high cost of toothbrushes, in a predominantly rural population where cash earners are few, represent factors that are not conducive to oral hygiene practices. The above scenario may also be partly explained by the chronic, and in the main, non life threatening nature of common dental disease.

Finally, traditional methods of treating dental disease have been reported by Bailit et al (1968). These included the draining of abscesses by insertion with bamboo slivers; manual extraction of loose teeth; and the use of a "citrus like" fruit for chemotherapeutic purposes.

3.4 THE DENTAL CARE DELIVERY SYSTEM IN PAPUA NEW GUINEA

Dental care for the great majority of the population is provided largely by government or church run services. The private sector consists of a very limited number of dentists based in some urban centres, and large industrial developments. Dental care for the armed forces, though government funded, operates as a separate entity to the rest of the public dental health service.

Decentralisation of dental health services, and the attendant transfer of responsibilities to the provinces in 1983, has resulted in changes to the dental care delivery system. Whilst previously having assumed total control of dental care in the country, the present role of the National Health Department has been redefined. Functions of the latter now focus primarily on the coordination of epidemiological research; promotional activities; the monitoring of provincial dental activities; the coordination of dental personnel training; the appointment of dental personnel; the provision of training for other health personnel on matters related to dental health promotion; the liaison with other government departments on matters of mutual concern e.g. fluoridation of water supplies, dental health education in schools etc; and finally, the provision of specialist services and dental equipment (Dept of Health 1986).

The delivery of dental health services falls within the decentralised responsibilities of the provincial Divisions of Health. Services are provided by main provincial dental clinics, and a limited number of

rural dental clinics. Dental personnel in a province are supervised by the provincial dental officer, who is in turn responsible to the provincial health secretary.

3.4.1 GOALS AND PRIORITIES

The goals of dental health services as defined by the National Health Department (1986) are as follows:

1. To reduce the incidence of dental disease through preventive strategies and programmes of oral health education.
2. To detect and treat dental diseases in school children and adults.

Methods through which these goals are to be achieved include the formulation and dissemination of dental health information to the general population; the provision of school dental services; the monitoring of dental disease status; the improved training of non dental health staff in dental health promotion; and the standardisation of oral health equipment.

Dental treatment priorities have also been identified. They are in descending order:

1. Relief of pain, treatment of infections, trauma, and conditions endangering life and well being.
2. Early detection, treatment and prevention of dental disease in children and adolescents.
3. Provision of dentures and prosthetic appliances.
4. Limited treatment of conditions such as malocclusion and those requiring complex and expensive care.

3.4.2 FUNDING

Dental care is rated 12th out of a total of 13 in the relative importance of health problems in the country (Dept of Public Health 1974; Dept of Health 1986). This low priority status has resulted in the correspondingly low allocation of funds to the service, a major constraint to dental care delivery. As an indication, funding prior to decentralisation, e.g. in the period 1976-1982, was in the region of 3 to 4.5% of the total health budget of the country (Vele 1987a). Approximately 60% of the dental budget is allocated for salaries and wages of dental personnel (Dept of Health 1980a).

With the delegation of financial authority to the provinces, funding allocation rested primarily with the health priorities of the individual provinces. In this author's experience, in provinces where dental programmes had assumed a high profile previously, funding of a similar nature to the above has been maintained or even increased. However, in other provinces, funds for dental programmes have been drastically reduced.

3.4.3 THE PROVISION OF DENTAL CARE

3.4.3.1 DENTAL CARE SERVICES

A basic dental service was in existence in Papua New Guinea prior to 1958, where treatment was provided by few staff, mainly on demand, in the larger centres (Schamschula, Barmes 1966). However, the formulation of a public dental service by Williams (1958) resulted in

the setting up of formal programmes for dental care delivery with a consequent increase in staff numbers and facilities. There are at present basically two modes for dental care provision, namely the school dental service, and services for the general population. The former is given priority in terms of funding and workforce allocation (Dept of Public Health 1977). Most of the services provided are by means of dental "patrols" to rural communities utilising air or boat transport, or by foot.

The school dental service (Dept of Health 1980a; 1980b; 1980c; 1984), covering both primary and secondary schools, is manned almost entirely by dental therapists who operate under the general supervision of dental officers. Some 90% of the working hours of a dental therapist are assigned to treating school children. Emphasis is placed on the early detection of dental disease and subsequent treatment; the dissemination of oral health education and oral hygiene practices; and the encouragement of parental participation whenever possible. Recipients of this service receive free dental treatment.

Due to several constraints arising from low resource allocation, the range of clinical services in the school dental service is limited. This normally includes the provision of simple restorations, usually amalgams; extraction of painful teeth; and prophylaxis. As a necessity, priority is often focussed on dental care for the permanent dentition at the expense of the primary dentition. Treatment for cases of malocclusion is rarely a viable option.

Services for the general population are provided by a whole range of staff categories which include dental officers, dental therapists, dental technicians and dental orderlies. Whereas dental officers are responsible for more complex care, dental therapists, unlike their Western counterparts, are trained to provide adult services similar to those in the school dental service. This latter development is imperative since the majority of provinces are mostly only staffed by one dental officer each, whilst in some cases none. Dental therapists also work with family health services providing dental health education to prenatal and postnatal mothers.

Treatment for the general public is provided for a nominal fee (Dept of Public Health 1977). It suffers from similar constraints as the school dental service. Despite the wide range of services offered, advanced conservative and prosthodontic treatment, and root canal therapy are rare occurrences. Oral surgery, especially in the highlands and urban areas, often involves treating injuries resulting from dentofacial trauma. The increasing frequency of such injuries is associated with road accidents, contact sports, domestic violence, and tribal conflicts, with alcohol abuse a common factor (Dept of Health 1986). Table 8 illustrates the type of clinical services provided by the school dental service and those of the general dental services.

Finally, the water supplies of Port Moresby, the national capital, and various armed forces barracks were fluoridated following the passing of the Fluoridation of Public Water Supplies Act in 1965 (Dept of Public Health 1977). It is estimated that this covers approximately 3.77% of the total population in 1980 (Dept of Health 1986).

Table 8 - PAPUA NEW GUINEA - SELECTED DENTAL CLINICAL SERVICES STATISTICS - 1980 TO 1984

Description of dental service	School Dental Service					General Dental Service				
	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984
1. Restorations:										
Permanent dentition										
Simple amalgam	11023	13297	9111	10041	11814	8367	8948	9051	10878	9753
Compound amalgam	965	1054	653	904	1182	2556	2603	2861	3523	3734
Composite	232	377	665	602	1463	2623	3598	4225	3687	4615
Inlay	-	10	60	-	60	20	12	41	27	9
Crown	-	43	70	-	26	49	86	114	94	119
Primary dentition										
Simple amalgam	3673	3891	1843	2325	2424	802	807	857	970	763
Compound amalgam	789	995	532	869	699	342	328	323	341	363
Total	16682	19667	12934	14741	18668	14775	16382	17484	19520	19356
2. Extractions:										
Permanent dentition	2324	3794	2945	3223	3772	48599	51632	52312	51046	53461
Primary dentition	4724	5570	3590	4446	4090	4199	5161	5832	6588	6542
Total	7048	9364	6535	7669	7862	52798	56793	58144	57634	80003
3. Miscellaneous:										
Prophylaxis	5174	5149	3803	2524	3151	4309	4612	5830	6422	4703
Root therapy	-	7	-	5	-	403	273	384	432	477
Oral surgery	-	-	-	2	-	1491	517	493	371	522
Radiographs	-	10	-	6	6	-	1575	2199	2021	2551
4. Prosthetics:										
Acrylic, full	-	-	-	-	-	1145	1184	971	1198	857
Acrylic, partial	-	-	-	-	-	1069	1234	1314	1489	1640
Orthodontic appliance	-	-	-	-	-	20	41	42	40	36
Total	-	-	-	-	-	2234	2459	2327	2727	2533

Source: Vele AA 1987b
 Review of dental workforce development and utilisation in Papua New Guinea
 MDS thesis University of Sydney

3.4.3.2 UTILISATION AND COVERAGE

Demand for dental health services amongst the adult population is low. This may be expected since the vast majority have not been exposed to the benefits of dental care. Dental resource deficiencies resulting in difficult access to dental care are no doubt major contributing factors. Also better coverage is made difficult with a rapidly increasing population. As an indication of the above, the utilisation rate was approximately 5-7% of the whole population in the period 1980-1985 (Dental Health Services 1987).

Treatment for adults is often only prescribed on demand, where the extraction of painful periodontically involved teeth is a common occurrence for the rural population. The urban dweller and the educated, with their increasing dental awareness, however, are often recipients of more advanced care. A large proportion of general dental attendances is found in the densely populated highlands (Dept of Health 1980a; 1980b).

There is wide provincial variation in coverage by the school dental service. For example, in 1983, this ranged from 0.4% of the total school population in Oro Province to 75.5% in West New Britain (Dept of Health 1984). Such discrepancies are explained by the amount of dental resources available in terms of staff, facilities, and equipment. School children located in areas with difficult access may only be treated on a most irregular basis, or not at all, whilst schools in more accessible areas may be visited once every 12-24 months. However, coverage by the school dental service has improved

since the 1970s. In the period 1980-1985, approximately 30% coverage of the total school population in each individual year was achieved (Dental Health Services 1987). This is compared to 13% covered in the period 1976-1977 (Dept of Health 1980b).

Studies previously reviewed (Humphreys 1977; Malden 1983) showed that a large amount of untreated decay, in both dentitions, was present in school age children. Since 40% of Humphreys' study sample was drawn from urban schools - a group normally receiving regular dental care - this suggests that coverage alone may not be sufficient to meet the dental needs of school children.

Finally, utilisation rates and coverage by general adult services and the school dental service in the period from 1980 to 1985 can be found in Table 9. Table 10 shows the provincial variation in school dental service coverage from 1980 to 1983.

Table 9 - PAPUA NEW GUINEA - DENTAL HEALTH SERVICES - UTILISATION AND COVERAGE - 1980 TO 1985

Year	Total population	Total school population	Total school population covered	% of school population covered	Total adult attendance	Total attendance (school + adults)	% of Total population covered
1980	3006799	285150	87733	30.76	81185	168918	5.62
1981	3042500	299588	97641	32.59	82563	180204	5.92
1982	3113300	318996	90838	28.47	88343	179181	5.76
1983	3187300	372918	109310	29.31	93036	202346	6.35
1984	3264700	388990	117468	30.19	97012	214480	6.57
1985	3343000	403046	129388	32.10	97867	227225	6.80

Source: Dental Health Services 1987
Annual dental statistics 1980-1986
Department of Health
Papua New Guinea

Table 10 - PAPUA NEW GUINEA - COVERAGE IN SCHOOL DENTAL SERVICE BY PROVINCE - 1980 TO 1983

Province	% coverage of total school population			
	1980	1981	1982	1983
Western	11.4	16.8	14.7	8.5
Gulf	14.5	16.6	5	21.5
National Capital	16.4	69	47	49.6
Central	38	38	17	43.9
Milne Bay	43	61	32	43.8
Oro	20	26	12.3	0.4
Southern Highlands	26.8	1.4	9.7	5.4
Eastern Highlands	5.6	10.3	24.6	4.8
Chimbu	8.4	10.4	N/A	N/A
Western Highlands	14.5	71	89	70.7
Enga	60	27.9	5.7	3.8
Morobe	22.4	29	22.2	10.8
Madang	47.5	44.4	47.2	23.2
West Sepik	5.3	6	8.2	14.7
East Sepik	37.8	26.6	22.7	37
Manus	37.5	27.2	N/A	N/A
New Ireland	88.6	94.5	96	65.7
East New Britain	21.2	9.5	22.7	29.6
West New Britain	65.7	83.6	47.4	75.5
North Solomons	32	14.6	20	19.2

N/A - not available

Source: Department of Health 1984
1983 Annual report (covering 1980-1983)
Papua New Guinea
Government Printer
Konedobu

3.4.3.3 FACILITIES AND EQUIPMENT

Dental health services are provided by two main types of facilities i.e. provincial dental clinics and rural dental clinics, both located in provincial hospitals and health centres respectively. These facilities and the oral health equipment situation, will be discussed based on information from Department of Health sources (1977; 1982; 1986), and this author's experience of dental health services in the country.

The provincial dental clinic

This facility serves as the main dental referral centre for a province. The standard of equipment, and the type and number of dental personnel present depend on its workload; the size of the referral population it serves; and since decentralisation, the priority status of dental health services in a province. Provincial dental clinics located in base hospitals usually consist of a number of surgeries, and may possess modern equipment. It is the base for the dental officer; a varying number of dental therapists, dental technicians and dental orderlies; and often resident dental officers completing pre-registration requirements. In less developed provinces, such a facility may lack a dental officer amongst its staff, and the equipment is usually basic.

The provincial dental clinic provides advisory services, and clinical supervision of all aspects of dental care in a province. Field

extension functions involve rural dental clinic supervision; aid post supervision where base level health workers provide dental relief of pain procedures; and dental visits to rural areas providing general and school dental services. It is also responsible for inservice training for provincial dental staff; and the liaison with other sections e.g. family health services, nutrition services etc on matters of dental health promotion.

The rural dental clinic

The rural dental clinic is responsible for the dental care of an assigned population group in a district or districts. It is normally a single chair surgery where the equipment is basic and at times antiquated. The latter is usually of the portable variety, suitable for rural patrols, and where high speed equipment is mostly absent. It is staffed by a dental therapist, and may be complimented in some cases by a dental orderly. Its prime function is the provision of school dental services. Other functions include the provision of basic adult dental services; dental health education for other health staff and the general population; and where appropriate, aid post supervision. In 1985, there were 36 rural dental clinics throughout the country.

Other facilities

Other facilities include 5 dental caravans present in three coastal and island locations. Their function is the provision of school

dental services. Specialist services offered to the provinces by the Dental School, University of Papua New Guinea, are seldom utilised. This is mainly due to funding constraints resulting in the inability to meet patient transfer costs to this facility. With the exception of oral cancer, a condition usually treated in the national capital or by visiting specialists, almost all dental conditions including complicated jaw fractures are managed by dental and other health staff in a province.

The basic and at times antiquated equipment present in several dental facilities is a major constraint in providing adequate restorative services for the bulk of the population. This may be evidenced by the large number of tooth extractions performed over that of restorative services (Table 8). In recognition of this, attempts to upgrade and standardise oral health equipment considered to be appropriate for the country, were undertaken in 1983 by the National Health Department. However, with provinces assuming full financial authority, some of the more affluent provinces have begun purchasing capital equipment outside national recommended guidelines. In a country suffering from acute maintenance and repair problems involving health equipment, such a development may be unfortunate.

3.4.3.4 WORKFORCE

There are 4 main categories of dental personnel whose functions and responsibilities vary according to the tasks they perform (Dept of Public Health 1974; Dept of Health 1986).

The provincial dental officer (in most cases the only dentist in a province), assumes primarily managerial functions. This person is responsible for the organisation of provincial dental health services, and is involved in planning, evaluation, inservice training and supervision of other dental staff. Other functions include the promotion of dental health within the community, and the integration of dental health services within general health services. Clinical duties involve mainly the provision of those services beyond the scope of dental therapists.

The dental therapist forms the backbone of dental health services in the country. This category of staff is trained in a range of common dental procedures such as prevention techniques, simple restorations, tooth extractions, dental health education etc. The dental technician, apart from constructing prosthetic appliances, is also at times responsible for dental health education, and simple clinical procedures such as impression taking. Finally, the dental orderly, who normally assumes chairside duties, often performs relief of pain procedures, e.g. tooth extractions. Such skills are usually learnt through on the job training.

Situation

The expansion of health services in Papua New Guinea in the last decade has resulted in an increase in workforce numbers in almost all health activities. However, due to its low priority status, workforce numbers for dental health services remain small. From the 1970s to the present (Table 11), the dentist:population ratio is in the region of 1:90000-80000. Although the clinical operator (dentist and dental therapist):population ratio is a more accurate indicator of the workforce situation, the improved figures recorded in the same period are still unfavourable in terms of dental care delivery. Workforce shortages are even more acute when considering the 1986 figures in the table. Of the 40 dentists registered in the country, almost half were engaged in private practice, administration or training, leaving only 21 actually involved in the delivery of field services (Vele 1987b).

It is anticipated that the above situation is unlikely to improve in the near future (Dept of Health 1986). This is due to the few dentists and dental therapists being trained at present; and the difficulty in recruiting expatriate dentists, who traditionally form a sizeable proportion of those engaged in field services.

Finally, the private sector has to date consisted almost entirely of expatriate dentists. However the inherent possibility of more national dentists going into private practice, has resulted in the likely introduction of a system of bonding after graduation.

Table 11 - PAPUA NEW GUINEA - DENTAL HEALTH SERVICES WORKFORCE AND WORKFORCE/POPULATION RATIOS

Source	Year	Population	Number of dentists	Dentist/ population ratio	Number of dental therapists	Dentist - dental therapist/ population ratio
1. Schamschula, Barnes 1966	1965	2,200,000	14	1:157100	28	1:52400
2. Vele 1987b	1972	2,276,900	28	1: 97400	60	1:31000
3. Humphreys 1977	1977	2,750,000	31	1: 87000	56	1:31600
4. Vele 1987b	1986	3,252,400	40	1: 81300	102	1:22900

3.4.3.5 TRAINING

Informal dental training in Papua New Guinea began in 1956 and eventually culminated in the setting up of the Dental College in Port Moresby in the early 1960s (Schamschula, Barmes 1966). Although its original function was the training of dental therapists and dental technicians, it undertook responsibilities for dental officer training briefly in the early 1970s. Prior to this period, dental officer candidates were sent for training in the Fiji School of Medicine. Finally, the training of dental officers and dental therapists was transferred to the Dental School, University of Papua New Guinea, in 1976 and 1983 respectively (Vele 1987b).

The present educational standard for entry into the dental officer course is high and is equivalent to that of the medical course. The former is of 5 years' duration together with an additional year of residency prior to registration. This has resulted in the failure to recruit the intended intake of 8 students per year, and a failure rate of 50% (Dept of Health 1986). Only 8 dental officers graduated between 1981-1985. The low intake rate is also attributed to the ignorance of dentistry as a career amongst school leavers.

Suggestions (Dept of Health 1986) put forward as means of rectifying the problem include a reduction in training time; increased efforts to publicise dentistry as a career amongst well qualified school leavers; and because of the high costs in training, a reversal to overseas training for potential dental officers. However, the latter

suggestion raises the possibility of inappropriate teaching for the Papua New Guinean situation, and a higher failure/attrition rate.

Prior to the transfer of dental therapy training to its present premises, entrance requirements included the completion of 4 years of secondary school (Barnes, Schamschula 1967). In the period 1958-1983, 175 dental therapists graduated (Vele 1987b). However, since this period, and with the raising of minimum entrance requirements to completion of 6 years of secondary school, there has been only 1 recruit for the course up to 1986. Hence, not surprisingly, the University has now decided to revert to the previous entry requirement.

Finally between 1965 and 1978, 35 dental technicians were trained. The course was suspended following a perceived surplus and underutilisation of technicians.

3.4.3.6 CONSTRAINTS

Dental health services face similar constraints to improving dental health that all other health services experience i.e. difficulties with transport and terrain, staff and finance shortages, and problems with equipment and maintenance. However, outstanding features that are seen to impede efficient dental care delivery are as follows (Dept of Public Health 1974; Dept of Health 1986):

1. The maintenance of oral hygiene is given a low priority by the general community. This is influenced by lack of knowledge and understanding of dental diseases, and of activities to prevent them.

2. Demand for dental health services is usually for curative care which results in the diversion of resources from more widely based preventive and promotive programmes.
3. There is a lack of quality and quantity of supervision of field services. Associated with this may be the lack of adequate support and interest by the provincial health authorities since decentralisation.
4. A high loss of dental therapists within a few years of graduation together with the present negligible intake of students has severe implications for workforce planning in the near and interim future. It has been suggested that such a high rate of attrition is due to the lack of a viable career structure.
5. The bias towards technical and scientific dental education and training at the expense of community health dentistry in the dental officer's course may result in inappropriate training for the Papua New Guinean situation.
6. The lack of relevant epidemiological data has hindered rational planning and improvements in dental care delivery.

3.5 THE DENTAL SITUATION IN WESTERN HIGHLANDS PROVINCE

In Western Highlands Province, dental care delivery in the period leading up to 1980 was very poor. There was an acute lack of equipment, a run down provincial dental clinic, and low morale amongst the few dental staff. Tooth extractions were often the only service provided.

Provincial funding of dental health services - 3 to 4% of the total provincial health budget in 1983 and 1984 (Division of Health 1983-1984; Dept of Finance 1984) - was similar to that of the country in general. However, enormous support from the National Health Department between 1981 and 1984, brought about a dramatic improvement in the infrastructure of the service. This included the building of a multisurgery provincial dental clinic equipped with modern facilities;

the establishment of 4 rural dental clinics; and an increase in the number of dental staff. Following this increase, total staff numbers consisted of the provincial dental officer, 7 dental therapists, 2 dental technicians, 5 dental orderlies and from 1982 onwards, a resident dental officer undergoing preregistration training on an annual basis. Also, a vehicle was made available full time for rural dental visits.

The above changes resulted in vast improvements in dental care in the province. Coverage by the school dental service has become consistently one of the highest in the country, and is well above the national average (Tables 9, 10 and 12). These tables also illustrate an improving trend in the number of adults receiving treatment, so that in recent years, attendances were twice that of the national average.

However, despite the above improvements, and bearing in mind the constraints to improving dental care delivery, Table 12 shows that almost 90% of the provincial population do not receive dental care annually. As a result, a dental training programme involving the aid post orderly was set up in the province in 1982.

Table 12 - WESTERN HIGHLANDS PROVINCE - DENTAL HEALTH SERVICES - UTILISATION AND COVERAGE - 1980-1985

Year	Population	Total school population	Total school population covered	% of school population covered	Total adult attendance	Total attendance (children + adults)	% of population covered
1980	264129	18121	2607	14.39	3808	6415	2.49
1981	269500	19129	13579	70.99	8219	21798	8.09
1982	275400	20436	18343	89.76	10644	28987	10.53
1983	281500	27029	19116	70.72	12380	31496	11.19
1984	287800	27879	18994	68.13	11205	30199	10.49
1985	294200	26310	23838	90.60	14026	37864	12.87

Source: Dental Health Services 1987
Annual dental statistics 1980-1986
Department of Health
Papua New Guinea

3.5.1 THE DENTALLY TRAINED AID POST ORDERLY

The rurally based aid post orderly serves as a frontline health worker, capable of offering primary health care. This person, usually male, and indigenous to the community he serves, is seen to be able to relate to his own people in an appropriate manner. Health habits and concepts can thus be explained in a fashion that the community can understand and accept. This scenario was the basis for the dental training of the aid post orderly in Western Highlands Province.

The purpose of the training programme was twofold; to maximise the number of health staff actively involved in dental health education and promotion; and to provide relief of pain services in rural and inaccessible areas. Training consisted of the teaching of oral health concepts and practices; and tooth extraction techniques. Those deemed competent were provided with a basic set of extraction forceps and local anaesthetic equipment. Follow up training, supervision and evaluation was conducted during routine visits to the aid posts concerned at two monthly intervals. 20 aid post orderlies were considered to be successfully trained in the province between 1982 and 1984. In the same period, provincial dental statistics showed that although figures varied considerably between individual aid post orderlies, the annual number of tooth extractions performed by each was approximately 34 teeth.

Finally, for similar reasons, dental training for aid post orderlies was also conducted in 3 other highland provinces (Soo 1979; Malden 1983; Sheen 1985).

4 CLINICAL SURVEY

4.1 INTRODUCTION

4.1.1 SELECTION OF TYPE OF STUDY

A descriptive epidemiological dental survey was planned and executed in Western Highlands Province in 1983. Since there was little or no existing information on the dental health of the population, baseline data resulting from the study was considered critical for efficient dental care delivery. Primary school children, being the most accessible group in the population, formed the survey sample. Given the constraints facing dental health services in general, an advantage of such a sample was that a large part of the study could be conducted during the routine delivery of the school dental services.

The protocol and format of the study was based on the WHO Combined Oral Health and Treatment Needs Assessment (with CPITN) (WHO 1977;198?). Minor additions and modifications were made to the latter after local considerations were taken into account. The decision to adopt a WHO protocol allowed for a systematic approach to the collection and reporting of data; international uniformity; and data comparison with other countries.

The subsequent evaluation of dental health services with the survey's data was seen to be in accordance with the research priorities of the Medical Research Advisory Committee, the ultimate body responsible for health research projects in Papua New Guinea (Dept of Health 1979).

Envisaged benefits of the survey would also reflect important aims of the National Development Strategy, namely those of increasing rural welfare; helping less developed areas; increasing general welfare; and improving nutrition (Dept of Health 1974).

4.1.2 PLANNING

As a result of decentralisation, permission in principle for the survey first had to be sought from the provincial health and education authorities. Planning consisted of several bodies being consulted for technical and financial assistance. Discussions were held with the National Health Department and the Institute of Medical Research (Papua New Guinea) as regards the appropriateness of the study. Correspondence with the Oral Health Unit of WHO helped elucidate the type of study to be conducted; the choice of clinical variables to be measured, and their assessment methods; sampling methodology; and the statistical analysis of data. Finally, the Preventive Dentistry Department of Sydney University assisted by providing photographic prints and slides, and various literature on dental conditions, to facilitate diagnosis.

Following the above, a subsequently successful proposal for the survey was submitted to the Medical Research Advisory Committee, for approval and funding.

4.1.3 BUDGET

The following were responsible for both direct and indirect funding for the survey:

1. Medical Research Advisory Committee - A grant of K1700 was allocated for the printing of half the required number of survey forms; travelling allowances and food supplies for survey personnel; and photographic materials, other incidentals etc.
2. WHO - This organisation was responsible for the statistical analysis of survey data; the provision of half the required number of survey forms; and the loan of 20 No. 621 probes for periodontal assessment.
3. Division of Health, Western Highlands Province - K1500 was allocated for transport costs, food supplies and incidentals. Indirect funding consisted of the permission to utilise the provincial designated dental vehicle for survey purposes.
4. Dental Health Services, National Health Department - This body was responsible for the provision of various new dental equipment e.g. explorers and mouth mirrors etc.

4.2 SAMPLE

4.2.1 POPULATION

According to the 1980 population census (National Statistical Office 1982), primary school children i.e. those between 6 and 14 years of age, comprised approximately 25% of the population of Western Highlands Province (see Table 4). Figures (Division of Education 1983) suggested that in 1983, 32% of these children attended the 108 primary schools located throughout the province.

Although age considerations are important in evaluating health data, recording correct ages is difficult in Papua New Guinea. Birth registration is often impractical, and birth cards are only issued to the small percentage of the population born in health institutions. Recorded ages in school enrolment books consist mainly of a combination of inaccurate guesswork of parents' memory, the physical development of the child, and the ages of siblings. Rural village registers are usually difficult to locate, and the task is often complicated by associated name changes.

After consultation with the WHO (Barnes 1983), it was decided to survey primary school children falling into the following age/tooth eruption categories:

1. 6-7 year olds - one or more first permanent molars erupted, and not more than two permanent lateral incisors erupted
2. 8-10 year olds - four first permanent molars and four permanent lateral incisors erupted, but no second permanent molars erupted
3. 11-14 year olds - those with any second permanent molars erupted

4.2.2 SAMPLE SIZE

It is recognised that a survey sample should be large enough to yield sufficiently precise estimates of disease frequency with an acceptable sampling error, and offer an acceptable chance of detecting epidemiological differences between population groups (WHO 1972). However, various constraints rendered strict sampling routines in the survey difficult. They were in the main the predominantly rural and scattered population; inaccurate school enrolment figures; considerable nonattendance in schools during the coffee harvesting season, and in areas affected by tribal conflict; and ignorance of the expected levels of variations of the oral conditions being assessed.

Given the above, the survey sample was determined based on the following factors: the funds available; the length of the survey period; possible disruption to routine dental health services; the location of the individual schools; modes of transport; and the amount of travelling time. A trial survey was undertaken to ascertain the number of subjects that could be examined daily. Physical and psychological factors likely to affect survey personnel such as fatigue, and fluctuations in interest in the investigation, were also considered.

Having evaluated the above factors, it was anticipated that approximately 5000 subjects would be examined by two examiners in a period of 5 months. 10% of the sample would undergo duplicate examinations for the purpose of assessing interexaminer variability.

On the basis of 10 "examination" days per month, and an equal number of examinations for each examiner, this would constitute approximately 55 daily examinations per examiner.

Finally, the sample size of 5000 subjects represented approximately 7.5% of the 6-14 years age group population of the province, or 23.5% of the official primary school enrolment.

4.2.3 SAMPLE SELECTION

In Western Highlands Province, there are numerous tribal groups all exhibiting their own customs and beliefs. Different dietary patterns are present amongst these groups who live at altitudes ranging from 366 metres to 3000 metres (Hunter 1985). Lifestyle differences are also associated with the urban and rural populations. The latter exists mainly on traditional diets, whereas the former has greater accessibility to tradestores selling refined Western foods, and to other government and general services.

Hence, to ensure some degree of representativeness of the sample, an attempt at stratification was made. A certain percentage from each of the several strata represented in the population was selected for the sample.

4.2.3.1 STRATIFICATION

Stratification was done in 2 stages:

Stage 1

As a general rule, the different major tribal groups reside in different districts of the province. To ensure proportional representation of such groups, the sample was first stratified by means of population distribution among the 14 districts in the province. Table 13 shows each district's population as a percentage of the total provincial population; and the proportional district sample size from the anticipated total sample size of 5000.

Stage 2

Further stratification of a district's sample in terms of school selection was made with regard to altitude level; and the location of a school in relation to its accessibility to services. The latter would indicate to a certain degree whether a school was located in an urban or rural environment. The variables of "altitude" and "access" were introduced after consultation with the WHO (Barnes 1983).

3 categories of altitude were created, namely < 1500 metres, 1501-1900 metres, and > 1900 metres. As for access, 5 categories were introduced - highway access (HW), mainroad access (MR), access road access (AR), no road access (NR) and no road and air access (NRA) - in descending order of accessibility to services.

From the above it can be seen that the various categories of altitude (3) and access (5) would combine to give a maximum of 15 cells.

However, several factors preclude the inclusion of all 15 cells in each district. They were the predetermined district sample size calculated from population distribution; the number of schools present in individual districts which ranged from 1 to 16; and the fact that no district "possesses" the range of characteristics that cover all the various access and altitude categories. Hence, schools in individual districts were selected on the basis of including as many of the 15 cells as possible.

Due to high nonattendance and inaccurate school enrolment figures, it was decided to select as many schools as possible within the survey framework to cover for contingencies. Similarly, the predetermined number of subjects for each school only served as a guide for survey personnel. These figures were reached after taking into account general representational and statistical considerations. Table 14 lists each district's selected schools; their official enrolment figures; altitude status; access status; and the intended sample size.

Table 13 - SAMPLE SELECTION - DISTRICT POPULATION DISTRIBUTION AND
DISTRICT SAMPLE SIZE

District	District population*	% of total provincial population (264,129)	Sample size
Hagen Central	46375	17.56	878
South Wahgi	32856	12.44	622
North Wahgi	31921	12.08	604
Dei	30318	11.48	574
Anglimp	20714	7.84	392
Tambul	19831	7.51	376
Nebilyer	18421	6.97	349
Mul	17833	6.75	338
Baiyer	13261	5.02	251
Upper Jimi	10019	3.79	190
Middle Jimi	8341	3.16	158
Lower Jimi	7377	2.79	140
Lumis	5703	2.16	108
East Kambia	1159	0.44	22

Source: *National Statistical Office 1982
1980 National population census final figures:
Census unit population, Western Highlands Province, Papua New
Guinea
Port Moresby: Papua New Guinea

Table 14 - SAMPLE SELECTION - BY SCHOOL

District and district sample size	School code	School	*School enrolment	Altitude code	Access code	Intended sample size
Hagen Central 878	32	Togoba	123	2	1	80
	33	Arawagai	273	2	3	120
	34	Rebiamul	582	2	1	130
	35	Kokglamp	199	2	2	100
	36	Mt Hagen	774	2	1	130
	37	Anga	194	2	3	100
	38	Minimp	202	2	3	100
	50	Holy Trinity	444	2	1	120
South Wahgi 622	21	St John Bosco	325	2	1	190
	22	Kugark	324	2	2	190
	23	Kurumul	146	2	2	100
	24	Piltange	145	2	3	90
	25	Dama	98	2	3	60
North Wahgi 604	16	Fatima	451	2	2	150
	17	St Anselm	370	2	2	150
	18	Nondugl St Marys	150	2	2	90
	19	Ambang	172	2	3	110
	20	Millep	178	2	3	110
Dei 574	26	Muglamp	348	2	2	300
	27	Nunga	205	2	2	180
	28	Golge	128	2	3	100
Anglimp 392	29	Kindeng	500	2	1	180
	30	Kuli	264	2	3	130
	31	Kaip	140	2	3	90
Tambul 376	42	Tambul	444	3	2	150
	43	Yano	210	3	3	60
	44	Tomba	58	3	1	40
	45	Alkena	204	3	3	60
	46	Kiripia	279	3	3	70

Table 14 is continued overleaf

Table 14 - continued

District and district sample size	School code	School	*School enrolment	Altitude code	Access code	Intended sample size
Nebilyer 349	12	Paraka	150	1	3	40
	13	Alimp	147	1	3	40
	14	Nebilyer	265	1	1	90
	15	Kuga	293	2	1	90
	49	Ulga	265	2	2	90
Mul 338	39	Malbuga	183	1	2	110
	40	Kelengha	142	2	3	110
	41	Bukapena	234	3	2	120
Baiyer 251	03	Tskisa	82	1	3	60
	04	Kwinkya	171	1	2	70
	05	Tapiakama	122	2	5	60
	06	Kingaringa	142	3	5	70
Upper Jimi 190	08	Gobo	155	1	5	50
	09	Ambullua	223	3	4	90
	47	Kosap	164	1	5	50
Middle Jimi 158	10	Tabibuga	206	1	2	80
	48	Tsingaropa	144	1	3	80
Lower Jimi 140	01	Koinambe	126	1	4	70
	11	Togban	144	1	5	70
Lumis 108	07	Lumis	168	2	3	110
East Kambia 22	02	Mt Au	150	1	4	100**

Altitude code 1 - 1500 metres	Access Code 1 - highway access
2 - 1501-1900 metres	2 - mainroad access
3 - 1900 metres	3 - access road access
	4 - no road access
	5 - no road and air access

**For statistical considerations, it was decided to examine as many school children as possible who were present during the visit.

Source: * Division of Education 1983
School enrolment figures
Dept of Western Highlands
Papua New Guinea

4.2.3.2 SELECTION OF SCHOOL CHILDREN

General guidelines were drawn up for the selection of children for examination.

1. As far as possible, all classes in a selected school were included for examination to ensure that the sample covered all 3 age groups. The number of examinations for each class depended on the predetermined sample size for the school. As near equal number of examinations were conducted from each class.
2. Every other child on a school class list was examined until the required number was reached. Absentees were replaced by the next available child on the list. This procedure was not possible in smaller schools, and where there were low attendance rates. In such instances, every available child was examined.
3. The presence of separate columns for girls and boys in the class list facilitated examination of equal numbers of both sexes.

4.3 CLINICAL ASSESSMENT

4.3.1 CLINICAL VARIABLES - STATUS, TREATMENT NEEDS AND EXAMINATION CRITERIA

The most useful and significant assessments of oral conditions - their status and treatment needs - were recorded. Assessments were made on caries; periodontal disease; dentofacial anomalies; conditions of oral mucosa; defects and abnormalities of teeth; enamel hypoplasia (including fluorosis); fluorosis; and bone abnormalities.

The following publications were used for criteria adoption and reference during examination of subjects:

1. Oral Health Surveys Basic Methods 2nd Edition (WHO 1977)
2. Application of the International Classification of Diseases to Dentistry and Stomatology ICD-DA 2nd Edition (WHO 1978a)
3. Leaflet for field use with the WHO pathfinder oral health and treatment assessment form with CPITN (WHO 198?)
4. A guide to oral health epidemiological investigations (WHO 1979)
5. Guide to epidemiology and diagnosis of oral mucosal disease and conditions (WHO 1980a)
6. An epidemiological index of developmental defects of dental enamel (DDE Index) (Commission on Oral Health, Research and Epidemiology 1982)

All survey subjects were examined at their respective schools.

Assessments were conducted with plane mouth mirrors and sickle shaped explorers. In the case of the Community Periodontal Index and Treatment Needs (CPITN) assessment, the WHO No. 621 probe was used. Mucosal or facial tissues that appeared to be abnormal, and the submandibular, sublingual and cervical lymph nodes, were also palpated digitally.

4.3.1.1 CRIES

The method used for assessing caries status was clinical examination involving the DMFT (decayed, missing and filled teeth) index for permanent teeth, and the dmft index for primary teeth. Due to its impracticality, radiographic diagnosis was not used. It was recognised however, that this might constitute an underestimation of the need for restorative care (Dunning 1980).

Assessment consisted of a systematic approach involving the examination of the most posteriorly placed tooth on the right side of the maxilla proceeding on to the most posteriorly placed tooth on the left. The sequence was repeated from left to right for the lower teeth. All teeth were examined. A tooth was considered present in the mouth when any part of it was visible or when it could be touched with the tip of the explorer without having unduly displaced soft tissues. If a permanent and primary tooth occupied the same tooth space, only the status of the permanent tooth was recorded.

4.3.1.1.1 ASSESSMENT CRITERIA FOR STATUS

The following criteria and codes were used for scoring:

Letters were used for primary teeth, numbers for permanent teeth.

A or 0 = Sound Tooth. No evidence of treated or untreated caries.

B or 1 = Decayed. A lesion with detectably softened floor, undermined enamel or a softened wall. On approximal surfaces the explorer point must have entered the lesion with certainty.

Defects not counted as caries:

- white and/or chalky spots
- discoloured or rough spots
- stained pits or fissures which caught the explorer but did not have a detectably softened floor, undermined enamel, or softening of the walls.

C or 2 = Filled tooth with no decay. There was one or more permanent restoration(s) but no secondary caries (in contact with the restoration), or other area of the tooth with primary decay.

D or 3 = Filled tooth with primary decay. A tooth had one or more permanent restoration(s) and also one or more decayed areas that had no physical association with the restoration(s). A tooth with a temporary filling was coded as decayed B or 1.

E or 4 = Filled tooth with secondary decay. A tooth had one or more permanent restoration(s) and there was secondary decay (in physical contact with restoration(s)). If a tooth was filled and contained both primary and secondary decay, it was coded in this category.

M = Primary tooth missing owing to caries (under 9 years only). This score was used for primary teeth missing at an age when normal exfoliation would not be a sufficient explanation for absence.

5 = Permanent tooth missing owing to caries (under 30 years). This was only used for permanent teeth and for persons under

30 years of age, where a clear history was available to establish that the tooth was extracted because of caries.

- 6 = Permanent tooth missing for reasons other than caries (under 30 years). This was used for permanent teeth judged to be absent congenitally or extracted because of orthodontic reasons.
- 8 = Unerupted tooth. Restricted to permanent dentition, used only for a tooth space with an unerupted permanent tooth and no primary tooth present.
- X or 9 = Excluded tooth. A primary or permanent tooth which had been restored for reasons other than caries, e.g. trauma, cosmetic purposes etc.

The WHO criteria for Code 7 - Permanent tooth missing for any reasons (30 years and over) - was not applicable since the survey was conducted on primary school children.

4.3.1.1.2 ASSESSMENT CRITERIA FOR TREATMENT NEEDS OF TEETH

Treatment requirements were recorded for each tooth immediately after caries status had been assessed. The following criteria and codes were used for scoring:

- 0 = None - tooth sound, no treatment required
- 1 = One-surface restoration
- 2 = Two-surface restoration
- 3 = Three-surface restoration

4 = More than 3-surface restorations or crown

These codes were used to designate treatment required to remove primary or secondary caries, repair damage due to trauma, or replace unsatisfactory fillings. Replacement of a filling was recorded when there was one or more signs of:

- deficient margins to a restoration which was likely to permit leakage into dentine
- overhanging margin causing local irritation to the gingivae
- fracture which had caused a filling to be loose or to permit leaking into dentine

5 = Extraction due to caries. When:

- caries had so destroyed the crown that it could not be restored
- caries had proceeded to an extent that there was an obvious and open exposure of the pulp
- only the roots remained

6 = Extraction because of periodontal disease. When periodontal disease had proceeded so far that the tooth was loose or functionless and could not be restored to a firm and functional state by periodontal therapy

8 = Extraction for other reasons. When treatment was required for orthodontic reasons, developmental defect, impaction or trauma

9 = Other. Any other treatment not specifically covered by codes 1-8, e.g. removal of gross overhangs, splints for loose teeth, removal of occlusal interferences on restorations.

When a single tooth was indicated for extraction for more than one reason, only the major reason for such treatment was coded. The WHO

code 7 and criteria was not included in the assessment criteria since school children were unlikely to require full dentures.

4.3.1.2. PERIODONTAL DISEASE

The CPITN index was used as the assessment method with the recognition that it was designed primarily to assess periodontal treatment needs rather than status, i.e. past disease experience (Ainamo, Barmes, Beagrie, Cutress, Martin, Sardo Infirri 1982). Its advantages were the rapid assessment of mean disease status of a population group and prevalences of various grades of periodontal involvement; and the facilitation of treatment time to be calculated for various types of treatment categories.

Although the CPITN index was not originally designed for periodontal assessment in the mixed dentition period (Sardo-Infirri 1983), it was used in this survey after Barmes (1983) suggested that the index would produce useful data on periodontal health related to oral hygiene for younger age groups.

4.3.1.2.1 ASSESSMENT CRITERIA

The standard CPITN assessment format was used with certain modifications after consultation with the WHO. Measurements were made of gingival bleeding, presence of calculus and pocket formation. The presence of plaque, gingival recession and tooth mobility were not recorded.

Sextants

The total of 6 sextants were defined by teeth number 17-14, 13-23, 24-27, 37-34, 33-43 and 44-47. The rule that "a sextant will be examined only if there are two or more teeth present and not indicated for extraction" was disregarded when dealing with children in the mixed dentition stage. The presence of only one permanent tooth - index tooth or otherwise, and not indicated for extraction - qualified a sextant for assessment. The assessment of whether a tooth was indicated for extraction was determined by the resources and facilities in the different areas of the province.

Index teeth

1. For subjects in the mixed dentition stage, and where the second permanent molars were unerupted, index teeth measured were number 16, 11, 26, 36, 31, 46 when present. The standard CPITN assessment which included all the latter teeth plus the four second permanent molars was utilised for older subjects.
2. The second permanent molar was scored when the first permanent molar was missing prematurely.
3. In the absence of the index tooth and the second permanent molar in a posterior sextant, all remaining permanent teeth were scored. The same applied to an anterior sextant when the index tooth was missing.

4. No recording was made when there were only primary teeth present in a sextant.

5. Only one recording was made for each sextant - the worst finding from surfaces recorded in a sextant examined.

Probing

Probing was conducted using the WHO No. 621 probe. The index tooth was probed to determine pocket depth and to detect calculus and bleeding response. Probing force was no more than 25 grams - a practical test for establishing this force was to place the probe point under the thumb nail until blanching occurred. To detect subgingival calculus, the lightest possible force which allowed movement of the probe ball point along the tooth surface was used.

When inserting the probe, the ball point followed the anatomic configuration of the surface on the tooth root. Pain noted by the subject was indicative of the use of too heavy a probing force.

There was no rule specifying the number of separate probings to be made. This depended on the condition of the tissues surrounding the tooth. However, seldom were four probings exceeded.

Examination and recording

After probing, the most severe condition found for an index tooth was recorded. Codes in descending order of priority were:

4 = pocket $\geq$ 6 mm - black area of probe was not visible

3 = pocket 4 or 5 mm - gingival margin situated on black area of probe

2 = any calculus felt during probing

1 = bleeding observed directly or by using mouth mirror after probing was complete

0 = healthy, no signs of disease

Where no index tooth was examined, the most severe condition found in the sextant was recorded.

The gingivae of a designated tooth was inspected for the presence or absence of bleeding before the subject was allowed to swallow or close his/her mouth. It was recognised that bleeding might be delayed 10-30 seconds after probing.

A diagonal line was placed across the appropriate box where a sextant did not qualify for assessment.

4.3.1.3 DENTOFACIAL ANOMALIES

The criteria used and methods of recording were as follows:

0 = Dentofacial anomaly absent

1 = Dentofacial anomaly present

A dentofacial anomaly was recorded as present if:

- a) it caused a significant and unacceptable effect on facial appearance, or
- b) it caused a significant reduction in masticatory function or resulted in a significant impairment of speech, or
- c) there was a gross defect such as cleft lip, cleft palate, or pathological or surgical injury, or
- d) it constituted an occlusion that predisposed to tissue destruction in the form of periodontal disease or caries

2 = Treatment of dentofacial anomaly recommended

For the purposes of the study, which was a baseline data survey of oral health, other anomalies not included in the above criteria, such as some anomalies of tooth position etc, were also recorded. When present, the nature of the dentofacial anomaly was recorded beside the appropriate box using the ICD-DA code (WHO 1978a) for subsequent analysis.

4.3.1.4 CONDITIONS OF ORAL MUCOSA

A thorough and systematic examination of the oral mucosa and soft tissues in and around the mouth was performed on all survey subjects. This was conducted prior to the examination of teeth and periodontal tissues using two plane mouth mirrors for retraction and inspection, and where necessary digital palpation. The lips, buccal and labial mucosa, palatal and lingual mucosa, sulcus and retromolar areas, surface and margins of the tongue, tongue mobility and floor of the mouth were all examined for pathology. Nonpathological conditions deemed of note were also recorded.

As for dentofacial anomalies, Codes of 0, 1 or 2 were used for absence, presence of conditions and for the recommendation for treatment. ICD-DA Codes were used to specify the nature of the condition.

4.3.1.5 DEFECTS AND ABNORMALITIES OF TEETH

The purpose of this assessment was the recording of defects and abnormalities of teeth excluding caries, and enamel hypoplasia. The entire dentition was screened for tooth defects, abnormalities and evidence of trauma. Recording codes were again those of 0, 1 or 2, with the ICD-DA classification used to specify type of condition.

4.3.1.6 ENAMEL HYPOPLASIA

Due to the high prevalence of enamel hypoplasia observed in the province, a decision was made to record this condition as a separate entity. Definitions proposed by the Commission on Oral Health, Research and Epidemiology (1982) for enamel hypoplasia and opacities were used as guidelines for assessment. Hypoplasia was defined "as a qualitative defect of enamel visually and morphologically identified as involving the surface of the enamel (an external defect) and associated with a reduced thickness of enamel." Opacity was defined "as a qualitative defect of enamel identified visually as an abnormality in the translucency of enamel."

The dentition of every subject was assessed for hypoplasia and/or opacities. Teeth were examined in the "wet and unclean" state. When in doubt, a tooth was assessed as being normal. Defects not having a functional or disease problem were not identified as requiring treatment. This was particularly so since dental aesthetics are not as yet a concern amongst the great majority of the provincial population.

A subject was judged to be affected if any one of the following existed (Barnard 1983):

1. White/cream opacity (W)
2. Yellow/brown opacity (B)
3. Hypoplasia (H)
4. Hypoplasia with white/cream opacities (HW)
5. Hypoplasia with yellow/brown opacities (HB)

Observations were recorded 0, 1 or 2 in the appropriate box as in preceding assessments. Also the codes of W, B, H, HW or HB were inserted outside the appropriate "caries status" boxes of individual teeth for further statistical analysis.

4.3.1.7 FLUOROSIS

A separate assessment of dental fluorosis (as opposed to hypoplasia of other origins) was also conducted as part of the standard WHO basic oral health survey format. With no fluoridated water supply in the

province, and a total ignorance of natural fluoride levels in soils and water, it was appreciated that clinical assessment of this condition was difficult.

All teeth were examined and the worst affected tooth was scored. The codes and criteria used for assessment were as follows:

Code	Category	Criteria
0	Normal	The enamel presented the usual translucent, semi-vitriform type of structure. The surface was smooth, glossy and usually of a pale creamy white colour.
1	Questionable	The enamel disclosed slight aberrations from the translucency of normal enamel, ranging from a few white flecks to occasional white spots. This classification was utilized in those instances where a classification of "normal" was not justified.
2	Very mild	Small, opaque, paper-white areas scattered irregularly over the tooth but not involving as much as approximately 25 percent of the tooth surface. Frequently included in this classification were teeth showing no more than about 1-2 mm of white opacity at the tip of the summit of the cusps of the bicuspids or second molars.

- | | | |
|---|----------|--|
| 3 | Mild | The white opacity in the enamel of the teeth was more extensive but did not involve as much as 50 per cent of the tooth. |
| 4 | Moderate | All enamel surfaces of the teeth were affected, and surfaces subject to attrition showed marked wear. Brown stain was frequently a disfiguring feature. |
| 5 | Severe | All enamel surfaces were affected and hypoplasia was so marked that the general form of the tooth might be affected. The major diagnostic sign of this classification was the discrete or confluent pitting. Brown stains were widespread and teeth often presented a corroded appearance. |

4.3.1.8 BONE ABNORMALITIES

A thorough examination was conducted on all hard tissues in and around the mouth for bone disorders and abnormalities. Recordings of 0, 1 or 2, and ICD-DA codes were used for assessment.

4.3.2 SURVEY FORM

The survey form (Figure 3) was designed utilizing the format of the WHO Oral Health and Treatment Needs Assessment (with CPITN) with the following amendments:-

Boxes 14-15

Codes of AA (6-7 years), BB (8-10 years) or CC (11-14 years) were used for the three age groups examined for the survey.

Box 16

Instead of "Ethnic Group" on the original WHO form, Access codes of 1 (highway access), 2 (mainroad access), 3 (access road access), 4 (no road access) or 5 (no road and air access) were recorded.

Box 17

Altitude codes of 1 (< 1500 metres), 2 (1501-1900 metres) or 3 (> 1900 metres) were used in place of "Occupation" in the original WHO form.

Boxes 18-19

Codes of 01-50 were used to indicate the fifty individual selected schools where subjects were surveyed.

Boxes 21, 23, 25, 26, 27

Oral mucosal disease (conditions of oral mucosa), Disorders involving bones (bone abnormalities), Hypoplasia (enamel hypoplasia), Defect of Teeth (defects and abnormalities of teeth) and Dentofacial Anomalies were recorded in the above boxes respectively. Codes of 0 (Absent), 1 (Present) or 2 (Treatment Recommended) were used. ICD-DA codes specifying a condition observed, were recorded on the dotted lines next to the appropriate boxes.

Box 24

Fluorosis codes of 0 (Normal), 1 (Questionable), 2 (Very mild), 3 (Mild), 4 (Moderate) or 5 (Severe) were recorded.

FIGURE 3 - SURVEY FORM

MODIFIED WHO ORAL HEALTH AND TREATMENT NEEDS ASSESSMENT FORM (with CPITN) (PNG)

Note: 1. No codes to be changed. 2. Unused sections to be cancelled by diagonal lines

(1) (5) Date 19 (6) (7) Registration Number (8) (11) Examination Number (12) (for duplicates)

Study Number

PERSONAL AND DEMOGRAPHIC INFORMATION

Sex M=1 F=2 (13) Name family other

Age in years (14) (15) Geographic location..... (18) (19)

Access (16) Examiner (20)

Altitude (17)

Oral Mucosal disease (21) Hypoplasia (25)

Disorders involving bones (23) Defect of teeth..... (26)

Fluorosis (24) Dentofacial Anomalies (27)

COMMUNITY PERIODONTAL INDEX OF TREATMENT NEEDS

CODES: 0 = healthy
1 = bleeding
2 = calculus
3 = pocket 4 or 5 mm
black band partially visible
4 = pocket $\geq$ 6 mm
black band not visible

17/16 11 26/27
(42) (44)
(45) (47)
47/46 31 36/37

There must be 2 or more teeth present and not indicated for extraction in a sextant.

DENTAL CARIES STATUS AND TREATMENT OF TEETH

	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
CARIES (13)																	(28)
TREATMENT R (29)																	(44)

	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	
CARIES (45)																	(60)
TREATMENT (61)																	(76)

DENTAL CARIES

	Primary	Perm.	TREATMENT	
SOUND	A	0	NONE	0
DECAYED	B	1	RESTORATIONS	
FILLED & CARIES FREE	C	2	1 surface	1
FILLED WITH PRIMARY DECAY	D	3	2 surface	2
FILLED WITH SECONDARY DECAY	E	4	3 surface	3
PRIMARY TEETH MISSING DUE CARIES $\leq$ 9 yrs	M	-	$>$ 3 surface or crown	4
PERMANENT TEETH MISSING DUE CARIES (UNDER 30 YEARS ONLY)	-	5	EXTRACTION FOR	
PERMANENT TEETH MISSING ANY REASON OTHER THAN CARIES (UNDER 30 YEARS ONLY)	-	6	caries	5
PERMANENT TEETH MISSING ANY REASON (30 YEARS & OLDER)	-	7	periodontal disease	6
UNERUPTED TOOTH	-	8	dentures	7
EXCLUDED TOOTH	X	9	other reason	8
			OTHER (specify)	9

CARD No. (80)

4.3.3 EQUIPMENT

Each examining team was provided with a set of the following instruments and accessories:-

Sharp explorers of the sickle shaped type

Plane mouth mirrors with extra mirror heads

WHO No. 621 probes (Morita)

Metal tumblers, kidney dishes and bottles of 40% Cetrimide solution for cold sterilization

Sterilizing pots (boiling)

Gauze squares and cotton rolls

Portable chair (Kinsman) with adjustable height, and head rest

Equipment for dental emergency treatment.

Examination instruments were boiled for half an hour at the end of each day. Cold sterilization of instruments between subjects was effected by wiping and immersing in 1:1000 Cetrimide Solution. Due to the delicate nature of the WHO No. 621 probe, these were wrapped in towels and packed in boxes during transit to and from schools. Cold sterilization procedures were used only for these probes, involving horizontal immersion in large kidney dishes.

4.3.4 SURVEY PERSONNEL

Two teams, each comprising of an examiner and a recorder, were responsible for conducting the survey. The provincial dental officer and a nursing aide formed one team as examiner and recorder

respectively. The other included the resident dental officer as examiner and a dental technician as recorder. It was planned for the 2 teams to conduct approximately equal numbers of examinations.

4.3.5 TRAINING

Utilising trial subjects, extensive calibration of the 2 examiners in their examination techniques was undertaken. Training consisted of achieving better recognition of conditions; assessing early caries diagnosis criteria; achieving the correct probing force required for CPITN assessment; evaluating gingival bleeding response and calculus detection; learning the terms and coding systems of assessments; evolving a common standard of the criteria used; establishing a systematic approach to examining; and assessing the average time of a single examination. Simulated examinations were employed to evaluate the recorders' competence and alertness.

4.3.6 PILOT SURVEY

A pilot survey involving 100 school children was conducted shortly before the official survey. This enabled survey personnel to gain regular survey experience in working together, and provided opportunities to resolve difficulties arising in implementation of survey instructions. Methods employed for the survey, selection of children, procedures, organization of examinations etc. were all tested and subsequently accepted, altered or amended. The pilot survey also served as an opportunity for evaluating levels of

variation of oral conditions likely to be assessed. Both intra and inter examiner variations which arose from this survey were also discussed and resolved. The results from this pilot study were not included in final data analysis.

4.4 INTEREXAMINER VARIABILITY AND DUPLICATE EXAMINATIONS

Although examiners should be in close agreement in assessing disease status of population groups, variations between them inevitably occur in assessments of oral health status of individuals (Striffler, Young, Burt 1983). This in part is due to the difficulties encountered in early caries diagnosis and the often reversible nature of periodontal disease. Such conditions may be undetectable, easily missed or inconsistently detected.

Physical and psychological factors affecting examiners may also contribute to assessment variations (WHO 1977). Fatigue; fluctuations in interest in the study; variations in visual acuity and tactile sense, are all factors which affect judgement from time to time, and to different degrees.

Given the above, duplicate examinations of approximately 10% of the survey sample were conducted to evaluate interexaminer variability. This would enable assessment of the magnitude of error that might have applied to the results. Such duplicate examinations were conducted at three stages during the survey - near the beginning, the middle and the end - to facilitate assessment of possible drift in criteria interpretation.

Due to the constraints of funds and time, a predetermined number of duplicate examinations were conducted in six schools selected for survey that were within easy access to the provincial dental clinic. The same subjects were reexamined by the second examiner a day after the initial examination by the first examiner. It was recognised that the examiners' knowledge of the schools where duplicate examinations would be conducted might have influenced their examination techniques.

The selected schools, and their intended number of duplicate examinations in the different survey stages were as follows:

Schools with initial examination by examiner 1 and duplicate examination by examiner 2

Survey Stage	School Code	School	Number of Duplicate Examination
Beginning	32	Togoba	100
Middle	29	Kindeng	100
End	50	Holy Trinity	100

Schools with initial examination by examiner 2 and duplicate examination by examiner 1

Survey Stage	School Code	School	Number of Duplicate Examination
Beginning	36	Mt Hagen	100
Middle	38	Minimp	100
End	34	Rebiamul	100

4.5 CONDUCT OF THE SURVEY

4.5.1 ORGANISATION

Letters were first sent to the 50 selected schools. The schools' cooperation was requested, and they were informed of the arrival time of the survey team.

The mode of travel (by air, road or foot) to the schools was carefully selected. 3 and 4 schools required air travel and foot travel respectively, whilst the rest could be reached by road. When foot travel was included, it was necessary to employ guides.

Predeparture organisation included checking the availability of accommodation with rural health staff, school teachers or the community; checklisting survey equipment; and the issuing of food rations and petty cash for survey personnel.

4.5.2 EXAMINATION SITE

This was determined by the physical condition of the school and its surroundings. Examinations were normally conducted near a window in a classroom, or if this was not possible, under roof projections, or in shady areas under a tree or building.

Examinations were made under natural light with the subjects seated to receive maximum illumination, but with no direct sunlight on either the subject or examiner. Subjects were seated on the portable dental

chair with the height adjusted to allow for both subject and examiner comfort. Examiners were at most times seated when conducting examinations. A table was placed next to the examiner to hold instruments. The recorder was seated near the examiner to facilitate data recording and instruction, and for the examiner to check if observations were properly recorded. Only on four occasions were examinations delayed because of lack of illumination due to rain.

4.5.3 EXAMINATION PROCEDURE

Just prior to clinical examination of a subject, relevant information for Boxes 1-20 (with the exception of boxes 14-15) on the survey form was recorded. Clinical examination then proceeded with a systematic examination of the oral mucosa and the hard and soft tissues in and around the mouth. This was followed by assessment of periodontal tissues and the dentition. Survey forms were reviewed after each day for completeness and accuracy of recording.

4.5.4 SURVEY PERIOD

The survey covered a period of approximately 5 months, from mid April to mid September, 1983.

4.5.5 EMERGENCY DENTAL TREATMENT

Emergency dental treatment such as dental extractions and temporary fillings were provided by the survey teams for both survey subjects and others whenever necessary. Such services were only provided in the absence of other dental staff visiting the community at the same time.

4.6 STATISTICAL ANALYSIS AND COMPUTATIONAL PROCEDURE

The raw data was sent to the WHO for analysis. A standard set of tables was produced for the three age groups with regard to dental caries, periodontal disease and fluorosis. Summarised data included age group by total sample, by access, by altitude, by school and access by altitude. For other assessments, data summarised were age group by total sample.

Further analysis utilising the Chi Square Test was conducted by this author for testing statistical significance of various summarised data. An example of such a test is as follows:

A Chi Square Test was conducted to assess whether there was any significant difference in caries experience for the number of persons affected by the three levels of altitude. In this particular analysis, the number of persons with their permanent teeth affected was assessed in the 11-14 years age group.

Altitude	DMFT = 0		DMFT > 0		
Code 1 - < 1500 metres	431	a	b	588	1019
Code 2 - 1501 - 1900 metres	985	c	d	1330	2315
Code 3 - > 1900 metres	263	e	f	407	670
	1679			2325	4004

$$E = (fr \times fc)/ft$$

where E = expected frequency

fr = total frequency of the row

fc = total frequency of the column

ft = total frequency of all outcomes

Therefore, $E_a = 1019 \times 1679/4004 = 427.30$

$E_b = 1019 \times 2325/4004 = 591.70$

$E_c = 2315 \times 1679/4004 = 970.75$

$E_d = 2315 \times 2325/4004 = 1344.25$

$E_e = 670 \times 1679/4004 = 280.95$

$E_f = 670 \times 2325/4004 = 389.05$

Cell	Observed Frequency (O)	E	O-E	(O-E) ²	(O-E) ² /E
a	431	427.30	3.70	13.69	0.03
b	588	591.70	-3.70	13.69	0.02
c	985	970.75	14.25	203.06	0.21
d	1330	1344.25	-14.25	203.06	0.15
e	263	280.95	-17.95	322.20	1.15
f	407	389.05	17.95	322.20	0.83

Chi Square (χ^2) = $\sum (O-E)^2/E = 2.39$

Degrees of freedom (df) = $(Nr-1) (Nc-1)$
= $(2-1) (3-1)$
= 2

With $\chi^2 = 2.39$ and $df = 2$, probability = $.5 > p > .3$

The level of significance was determined at probability level of .05 or 5%.

Ho = Null hypothesis

Accept Ho = no significance or likely differences in caries experience between population groups

Reject Ho = significance or likely differences in caries experience between population groups

Therefore, the Null hypothesis (Ho) is accepted in the above example. It would appear that there was no statistical significance in caries experience at the 3 altitude levels.

Finally, the use of ICD-DA codes for the survey enabled the reporting of various conditions by their number of recurrences, and the rate of occurrence per 10,000.

5 . RESULTS

5.1 COST ANALYSIS

The expenditure incurred for the survey was as follows:

1. Actual costs (estimated)

Printing of survey forms	K483
Photocopying of survey forms	K500
Vehicle fuel	K500
Air transport	K462
Travelling allowances for survey personnel	K266
Food rations for survey personnel	K347
Photographic costs	K380
Incidentals	K 18
Subtotal	K2956

2. Indirect costs

Hiring of designated provincial dental vehicle from the department of
Plant and Transport for survey purposes K1000

3. Salary costs

It was estimated that the number of days spent on the survey by survey personnel was approximately 75 days each i.e. 15 days per month for a period of 5 months. Thus, based on 260 working days per year, and 1983 annual gross salaries, the salary costs for survey personnel were as follows:

Provincial dental officer (expatriate officer) - K17,785 per year	
	= K5130
Resident dental officer - K4910 per year	K1416
Dental technician Grade I - K3765 per year	K1086
Nursing aide (hired as casual labourer) - K2291 per year	K 661
Subtotal	K8293
Total survey expenditure = K2956 + K1000 + K8293	= K12249

From the above, it can be seen that the actual expenditure was slightly less than the K3200 allocated for such purposes. Also the survey costs in terms of salary would have been less if a national dentist had assumed the place of the expatriate dental officer.

5.2 SAMPLE

The following tables list total sample by the various variables mentioned in Section 4:

Table 15 - Total sample by district

Table 16 - Total sample by age, by access and by altitude

Table 17 - Total sample by school

Table 18 - Total sample - access by altitude

These tables illustrate the following:

1. The total sample of 5340 persons examined was slightly higher than the intended total sample of 5000. This was due to "over-compensation", when the number of examinations in some schools was deliberately increased when the intended sample sizes of others were not met.
2. With the exception of South Wahgi, Dei and Anglimp districts,

sample sizes attained for the other districts were higher than those intended. However, since the individual sample sizes of these 3 districts were large in terms of a baseline survey, the validity of subsequent statistical analysis of the data was deemed to be unaffected.

3. The total number of children examined in the age group 6-7 years was 52. Individual samples of this age group by district, by access, by altitude, by school, and by access by altitude were extremely small, with none where N was higher than 30 except in Altitude code 2 (1501-1900 metres). Similarly, small sample sizes were also recorded in several schools involving the 8-10 years age group. Such low numbers can be explained by the fact that children normally attend school at an older age than in Western countries. Thus, as a general rule (Miller 1981), sample sizes where $N < 30$, will be disregarded for statistical analysis and subsequent discussion.

4. Several intended sample sizes of individual schools were not attained. This was due to inconsistent school attendance. Also data collected for Togoba school (school code 32, 80 examinations) was not summarised by the WHO. No explanation was given, and the survey forms concerned were presumed to be lost in transit.

5. No schools were examined in the access by altitude categories of code 4-2 (No road access: 1501-1900m) and code 5-3 (No road and air access: $> 1900\text{m}$). No schools were located in areas which correspond to these combinations of variables.

6. The total sample size for caries assessment was 5320. This represented a difference of 20 from the total sample size of 5340 for all the other clinical assessments in the survey. Further investigation, e.g. when comparing individual school samples between caries status and periodontal status, revealed that this difference was the sum of small discrepancies in the number of examinations involving several schools. However, given the large number of examinations conducted, such a small difference was considered insignificant with regard to the validity of the results.

5.3 CONDUCT OF SURVEY

On the whole, the survey was conducted successfully. No major alteration to the original planning was necessary.

Emergency dental treatment was provided for both the school children and the general community during the survey. The total number of patients seen was 281. Treatment services included 416 tooth extractions and 40 temporary dressings.

Table 15 TOTAL SAMPLE BY DISTRICT

District	6-7 yrs	8-10 yrs	11-14 yrs	Total	Original intended sample size
Hagen Central	20	331	608	959	878
South Wahgi	6	157	375	538	622
North Wahgi	7	189	417	613	604
Dei	0	45	275	320	574
Anglimp	4	85	193	282	392
Tambul	4	136	377	517	376
Nebilyer	1	74	359	434	349
Mul	2	64	292	358	338
Baiyer	0	42	293	335	251
Upper Jimi	6	54	295	355	190
Middle Jimi	0	43	158	201	158
Lower Jimi	1	27	199	227	140
Lumis	0	13	108	121	108
East Kambia	1	7	72	80	22
Total	52	1267	4021	5340	5000

Table 16 TOTAL SAMPLE BY AGE, BY ACCESS AND
BY ALTITUDE

Description	6-7 yrs	8-10 yrs	11-14 yrs	Total
By age	52	1267	4021	5340
By access				
highway access	24	346	548	918
mainroad access	9	450	1371	1830
access road access	11	380	1476	1867
no road access	3	41	305	347
no road and air access	5	50	321	376
Total	52	1267	4021	5340
By altitude				
< 1500 m	7	197	1022	1226
1501-1900 m	37	875	2325	3237
> 1900 m	8	195	674	877
Total	52	1267	4021	5340

Table 17 TOTAL SAMPLE BY SCHOOL

School code	School	6-7 yrs	8-10 yrs	11-14 yrs	Total
1	Koinambe	0	15	95	110
2	Mt Au	1	7	72	80
3	Tsikisa	0	9	43	52
4	Kwinkya	0	19	121	140
5	Tapiakama	0	5	60	65
6	Kingaringa	0	9	69	78
7	Lumis	0	13	108	121
8	Gobo	3	16	76	95
9	Ambulla	2	20	138	160
10	Tabibuga	0	31	110	141
11	Togban	1	12	104	117
12	Paraka	0	1	27	28
13	Alimp	0	8	56	64
14	Nebilyer	1	32	86	119
15	Kuga	0	7	117	124
16	Fatima	2	38	100	140
17	St Anselm	2	66	62	130
18	Nondugl St Marys	0	19	89	108
19	Ambang	2	37	81	120
20	Millep	1	29	85	115
21	St John Bosco	2	40	79	121
22	Kugark	0	48	72	120
23	Kurumul	0	31	97	128
24	Piltange	1	20	98	119
25	Dama	3	18	29	50
26	Muglamp	0	34	104	138
27	Nunga	0	10	109	119
28	Golge	0	1	62	63
29	Kindeng	1	6	14	21
30	Kuli	1	51	99	151

Table 17 is continued overleaf

Table 17 TOTAL SAMPLE BY SCHOOL continued

School code	School	6-7 yrs	8-10 yrs	11-14 yrs	Total
31	Kaip	2	28	80	110
33	Arawagai	1	25	178	204
34	Rebiamul	14	153	133	300
35	Kokglamp	1	24	122	147
36	Mt Hagen	0	24	64	88
37	Anga	0	36	63	99
38	Minimp	0	1	16	17
39	Malbuga	0	18	101	119
40	Kelengha	0	17	102	119
41	Bukapena	2	29	89	120
42	Tambul	2	58	120	180
43	Yano	0	5	93	98
44	Tomba	2	13	25	40
45	Alkena	0	12	87	99
46	Kiripia	0	48	52	100
47	Kosap	1	18	81	100
48	Tsingaropa	0	12	48	60
49	Ulga	0	26	73	99
50	Holy Trinity	4	68	32	102
TOTAL		52	1267	4021	5340

Table 18 TOTAL SAMPLE - ACCESS BY ALTITUDE

Access code 1 - highway access Altitude code 1 - < 1500 m
 2 - mainroad access 2 - 1501-1900 m
 3 - access road access 3 - > 1900 m
 4 - no road access
 5 - no road and air access

Code (access-altitude)	6-7 yrs	8-10 yrs	11-14 yrs	Total
1-1	0	33	86	119
1-2	0	299	437	736
1-3	0	14	25	39
2-1	17	67	333	417
2-2	10	296	829	1135
2-3	11	87	209	307
3-1	2	31	175	208
3-2	4	275	999	1278
3-3	0	74	302	376
4-1	1	21	167	189
4-2	0	0	0	0
4-3	2	20	138	160
5-1	5	45	261	311
5-2	0	5	60	65
5-3	0	0	0	0
TOTAL	52	1267	4021	5340

5.4 INTEREXAMINER VARIABILITY

The number of duplicate examinations conducted by the two examiners during the 3 survey stages were as follows:

Survey stage	Examiner 1	Examiner 2
Beginning	149	146
Middle	255	240
End	98	209
Total	503	597

From the above, it can be seen that although duplicate examinations between the 2 examiners should have been equal in number, discrepancies are evident in all 3 stages. This is most pronounced in the "End" stage. One obvious reason for the differences could be the incorrect completion of the survey form concerning boxes 12 and 20 (see Figure 3).

Much smaller discrepancies exist in the "Beginning" and "Middle" stages. Hence, for these stages, the Chi Square test was used to ascertain whether the variation in disease assessment by the 2 examiners would be acceptable with regard to the validity of the data. The assessments chosen for statistical testing were caries status and periodontal status.

5.4.1 CARIES STATUS

The number of persons with their permanent teeth affected by caries was tested. The resultant probability levels were as follows:

Survey stage	Number of persons where DMFT = 0	Number of persons where DMFT > 0	Probability level	Outcome
"Beginning" stage				
Examiner 1	67	82	.98 > p > .95	Accept Ho
Examiner 2	66	80		
"Middle" stage				
Examiner 1	105	150	.7 > p > .5	Accept Ho
Examiner 2	103	137		

5.4.2 PERIODONTAL STATUS

The number of persons affected by periodontal disease as assessed by the CPITN was tested. The resultant probability levels were as follows:

Survey stage	Number of persons with no periodontal disease	Number of persons with periodontal disease	Probability level	Outcome
"Beginning" stage				
Examiner 1	2	147	.99 > p > .98	Accept Ho
Examiner 2	1	145		
"Middle" stage				
Examiner 1	1	254	.98 > p > .95	Accept Ho
Examiner 2	0	240		

NB

1. Level of significance determined at probability level of .05 or 5%
2. Ho = Null Hypothesis

Accept Ho = no significance or likely differences in examiner
variation

Reject Ho = significance or likely differences in examiner
variation

With the above probability levels for both assessments of caries status and periodontal status, the Null Hypothesis is accepted in all cases. The probability levels strongly suggest that the variation in disease assessment by the 2 examiners in the "Beginning" and "Middle" stages was minimal. The "End" stage could not be tested due to large differences in examination numbers between the 2 examiners. However, given the above results, it is unlikely that major discrepancies in examiner variability would have occurred in the survey.

5.5. CRIES

5.5.1 CRIES STATUS

Data concerning caries status is conventionally presented as decayed, missing and filled teeth i.e. DMFT or dmft. This index is a measure of past and present disease status and is useful for comparing disease prevalence within and between populations. In addition, ratios involving the different components of the index can indicate the success or failure of dental treatment programmes.

5.5.1.1 DMFT AND dmft BY AGE, ACCESS, ALTITUDE AND SCHOOL

DMFT levels of the 3 age groups surveyed (Table 19) revealed that there was a history of caries involvement of 8.1% of teeth at 6-7 years, 4.2% at 8-10 years and 5.6% at 11-14 years. For the whole sample, 5.3% of teeth were affected, and there was an average of 1.3 affected teeth per person in the survey. Such recordings indicate a low caries experience. Predominant among the components of the index in all age groups was the D component. The F component was low throughout, and only 13.4% of affected teeth in the whole sample had been restored. The high D and low F components may suggest an ineffective treatment service. Also, the high caries prevalence of the 6-7 years age group, relative to the 2 other age groups, may be due to its small sample. It may also suggest an increasing caries prevalence in the province being reflected in younger age groups. This may be caused by changing dietary patterns resulting in increased consumption of cariogenic foods.

dmft levels by age as shown in Table 19 indicated a higher decay rate than in the permanent dentition. The percentage of teeth affected for

the whole sample was 22.5% with 18.2% at 6-7 years, and 22.8% at 8-10 years. An average of 1.6 affected teeth per subject was recorded for the latter two age groups. Once again, the d component predominated with no recording of the f component. Finally, Figures 4 and 5 show the proportion and mean numbers of DMFT and dmft; and the percentage of persons affected in both dentitions respectively.

It would appear that little variation in caries experience existed for the permanent dentition between the different categories of access, and altitude (Appendices 1, 2 and 3). However, figures for the primary dentition suggest that caries prevalence increased with greater access, and higher altitude.

Whilst disregarding those involving samples where $N < 30$, more pronounced variations were recorded among the different schools. For the permanent dentition in the 11-14 year age group, the percentage of persons affected ranged from 38-95% and the mean DMFT values were between 0.9-2.9 (Appendix 4). Corresponding figures for both the permanent and primary dentitions in the 8-10 years age group were 18-50% and 0.4-1.1, and 43-79% and 0.9-2.5 respectively (Appendices 5 and 6).

The differences in caries experience between the different schools are illustrated in Figure 6. The latter shows the frequency distribution of schools by mean DMFT values in the 11-14 years age group. It can be seen that the mode is the mean DMFT value of 1.4. Given that the overall mean DMFT value for this age group is 1.5, and the median value is 1.4, these measures of central tendency suggest that the

caries experience distribution is approaching normal, with slight positive skewing contributing to a higher mean score.

5.5.1.2 DMFT AND dmft - ACCESS BY ALTITUDE

Cross tabulation recordings (Appendices 7 and 8) between the various categories of access and altitude showed the following trends. Little variation was detected in mean DMFT values and the percentage of persons affected in the 8-10 years age group. However, larger differences were evident in the permanent dentition for the 11-14 years age group, and for the primary dentition in the 8-10 years age group.

TABLE 19 CRIES STATUS BY AGE % OF PERSONS AFFECTED AND MEAN NUMBERS OF TEETH PRESENT, DMFT AND dmft

Age (yrs)	Sample size N	% persons affected	Mean Number of teeth present	D	M	F	DMFT
6-7	51	43	9.9	0.6	0.0	0.1	0.8
8-10	1263	37	16.8	0.6	0.0	0.1	0.7
11-14	4006	58	27.0	1.2	0.1	0.2	1.5

Age (yrs)	Sample size N	% persons affected	Mean Number of teeth present	d	m	f	dmft
6-7	51	67	13.7	2.4	0.1	0.0	2.5
8-10	1263	60	7.0	1.5	0.1	0.0	1.6

FIGURE 4 CARIES STATUS BY AGE - PROPORTION OF DMFT AND dmft

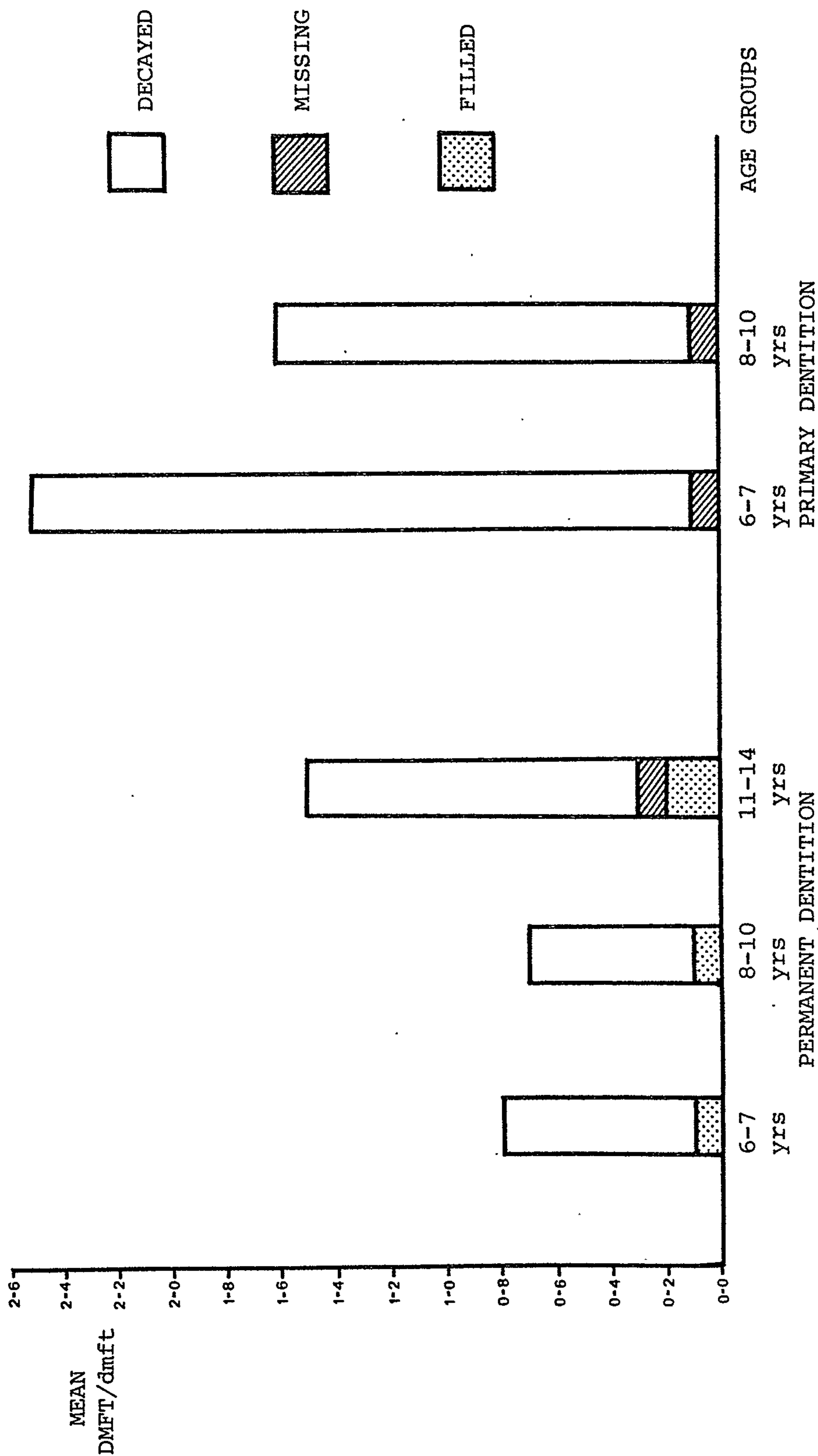


FIGURE 5 CARIES STATUS BY AGE - % OF PERSONS AFFECTED - PERMANENT AND PRIMARY DENTITIONS

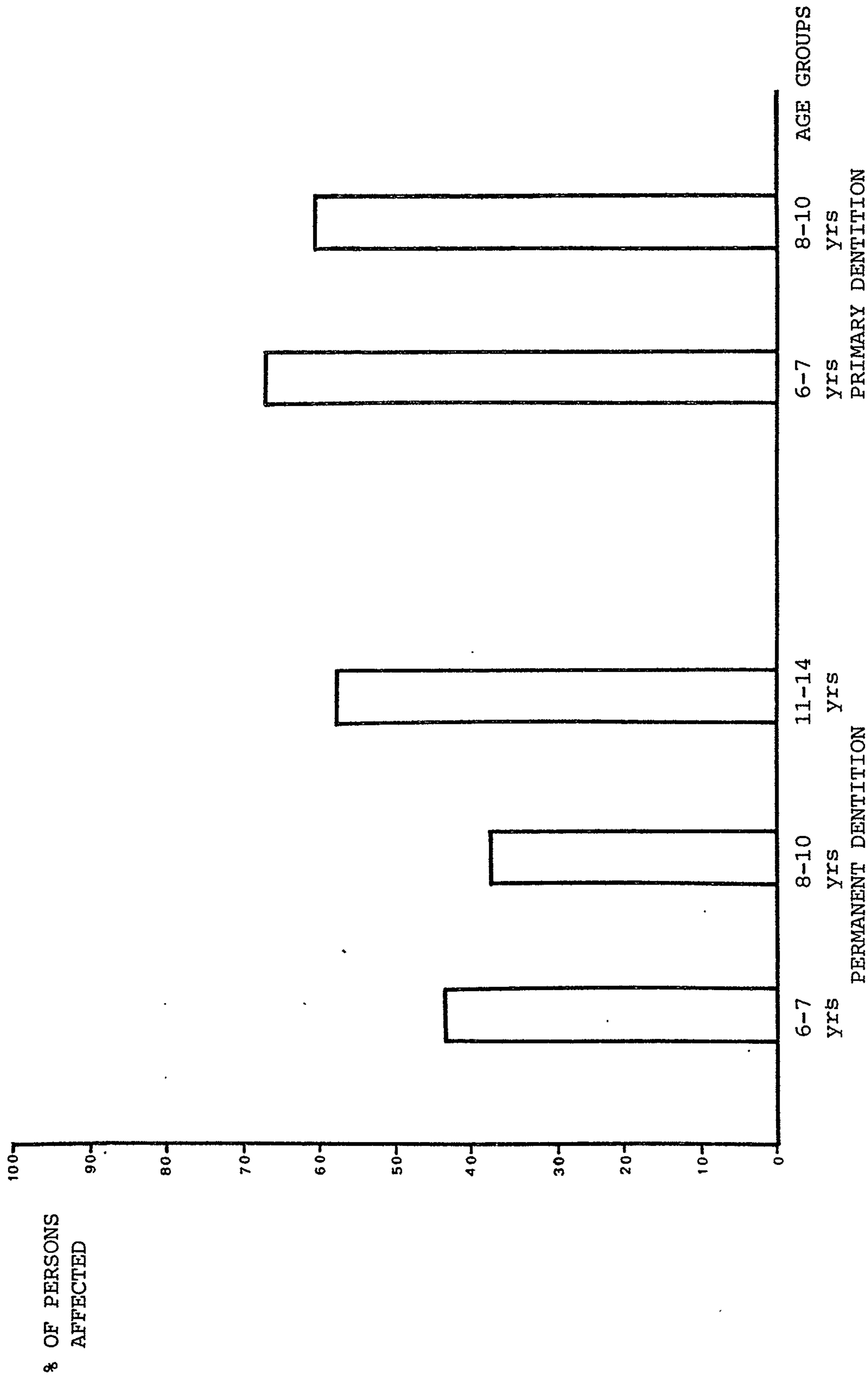
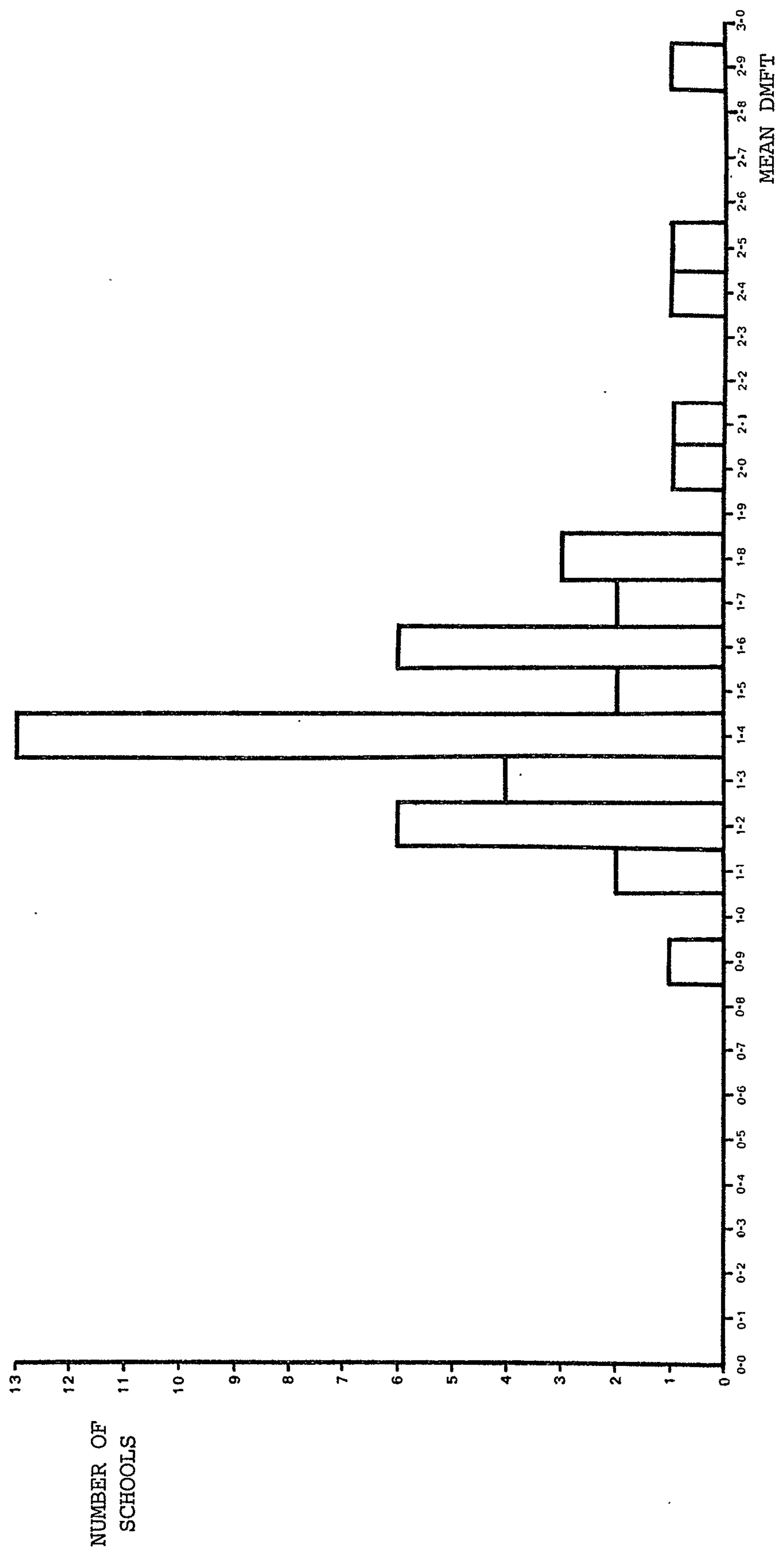


FIGURE 6 CARRIES STATUS BY SCHOOL - FREQUENCY DISTRIBUTION BY DMFT - 11-14 YEARS (SCHOOLS WHERE N < 30 EXCLUDED)



5.5.1.3 DT AND dt BY AGE, ACCESS AND ALTITUDE

Percentage values of DT/DMFT and dt/dmft strongly indicated that most carious teeth found in the survey were untreated (Appendices 9-13). This was irrespective of age, access and altitude. Figures for the latter two variables were perhaps a little surprising since it might be assumed that access to dental care might have influenced the amount of treatment provided. In general, DT/DMFT percentage values for age, access and altitude ranged from 73-100%, whilst the corresponding dt/dmft percentage values were between 94-100%. Finally, untreated decay appeared to be uniformly distributed among persons affected by caries.

5.5.1.4 FT AND ft BY AGE, ACCESS AND ALTITUDE

Findings indicated that the number of permanent teeth restored in the 11-14 years age group, was consistently higher than for the other age groups. Minimal differences were observed between access and altitude categories in their respective age groups. No recording was made of restored teeth having either primary and/or secondary decay (Appendix 14). Finally, the number of restored primary teeth was negligible.

5.5.1.5 MT AND mt BY AGE, ACCESS AND ALTITUDE

Similar trends to FT were observed for MT, i.e. a higher recording for the 11-14 years age group and little variation seen between the different access and altitude categories. Also Appendix 15 highlights 2 findings: few, if any, permanent teeth were deemed missing due to reasons other than caries; and the 2 younger age groups had the same recording of mean 0.1 teeth as primary teeth prematurely missing due to any reason.

5.5.2 TREATMENT NEEDS

Treatment requirements were assessed visually under natural light, and with the dental mirror and explorer. Since recordings were made without the aid of radiographs, pulp vitality tests or other explorative investigations, this would invariably have resulted in carious lesions and other "hidden" pathology being undetected. Thus such treatment needs may be regarded as minimal estimates.

Recordings consisted of the need for 4 types of restorations (1, 2 or 3 surface restoration; or 3 surface restoration or crown), and for 3 types of tooth extraction (due to caries, periodontal disease or other reasons such as orthodontic reasons, trauma etc).

5.5.2.1 RESTORATIVE CARE AND TEETH REQUIRING EXTRACTIONS BY AGE, ACCESS AND ALTITUDE

For the permanent dentition, the percentage of persons requiring care in all the different treatment categories was highest in the 11-14 years age group (Tables 20 and 21). Minor differences were evident between the two other age groups. The percentages of persons and teeth requiring treatment for the whole survey were 48% and 4.4% respectively. Of the teeth needing treatment, 59.5% needed 1-surface restorations, 16.7% 2-surface restorations, 7.2% 3-surface restorations and 16.7% extractions for caries. The average number of teeth needing treatment per person in the survey was 1.1 teeth. Of the latter, 0.9 of a tooth required a restoration and the remainder required extraction primarily for caries. Negligible recordings were made of persons needing 3-surface restorations or crown, and extractions because of periodontal disease or for other reasons.

Finally, Figure 7 illustrates the pattern and type of treatment needs by age.

The same tables show that despite the higher decay rate in the primary dentition, the percentage of persons requiring treatment for the survey (7.2%) was much lower than that for the permanent dentition. Although 22.5% of all teeth were affected by caries, only 1.4% were deemed as requiring treatment. The latter consisted primarily of teeth requiring extraction due to caries.

Little variation in treatment needs was found between the 5 categories of access, and between the 3 categories of altitude (Appendices 16-23). The 11-14 years age group was consistently recorded as requiring more treatment when compared to the others in all access and altitude categories.

TABLE 20 CARIES TREATMENT NEEDS BY AGE - RESTORATIVE CARE - PERMANENT AND PRIMARY DENTITIONS
NUMBER AND % OF PERSONS, AND MEAN NUMBER OF TEETH REQUIRING CARE

Age (yrs)	N	No treatment		1 surface restoration		2 surface restorations		3 surface restorations		> 3 surface restorations or crown						
		No.	%	Mean	No.	%	Mean	No.	%	No.	%	Mean				
Permanent dentition																
6-7	51	30	58.8	9.3	14	27.5	0.4	6	11.8	0.1	0	0.0	0	0	0.0	
8-10	1263	819	64.8	16.2	328	26.0	0.4	122	9.7	0.1	39	3.1	0.0	4	0.3	0.0
11-14	4006	1937	48.4	25.8	1673	41.8	0.7	518	12.9	0.2	187	4.7	0.1	24	0.6	0.0
Primary dentition																
6-7	51	47	92.2	13.6	0	0.0	0.0	0	0.0	0.0	0	0.0	0	0.0	0.0	0.0
8-10	1263	1173	92.9	6.9	1	0.1	0.0	1	0.1	0.0	0	0.0	0.0	0	0.0	0.0

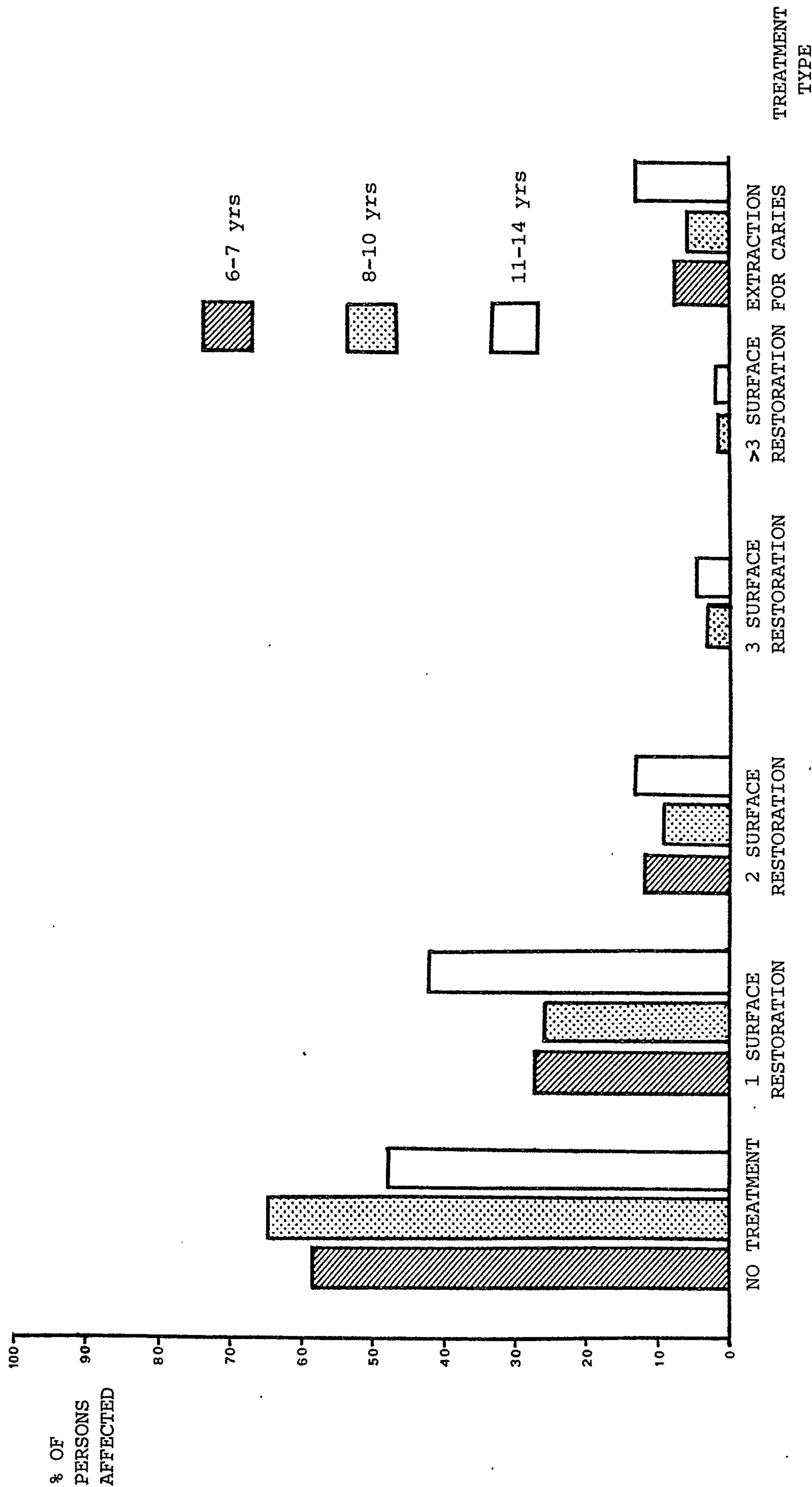
TABLE 21 CRIES TREATMENT NEEDS BY AGE - TEETH REQUIRING EXTRACTIONS - PERMANENT AND PRIMARY DENTITIONS
NUMBER AND % OF PERSONS, AND MEAN NUMBER OF TEETH REQUIRING EXTRACTIONS

Age (yrs)	N	Caries			Periodontal disease			Other reasons		
		No.	%	Mean	No.	%	Mean	No.	%	Mean
Permanent dentition										
6-7	51	4	7.8	0.1	0	0.0	0.0	0	0.0	0.0
8-10	1263	73	5.8	0.1	0	0.0	0.0	5	0.4	0.0
11-14	4006	546	13.6	0.2	3	0.1	0.0	12	0.3	0.0

Primary dentition

6-7	51	4	7.8	0.1
8-10	1263	88	7.0	0.1

FIGURE 7 CARIES TREATMENT NEEDS BY AGE - RESTORATIVE CARE AND TEETH REQUIRING EXTRACTION
FOR CARIES - % OF PERSONS AFFECTED - PERMANENT DENTITION



5.5.3 REPORTING OF STATISTICAL ANALYSIS

Statistical analysis of caries data was undertaken mainly by utilising the Chi Square test on the number of persons affected by caries as indicated by the DMFT/dmft indices. The method employed was outlined in section 4. Also standard deviations (standard errors of the mean) were calculated for age group DMFT/dmft values in order to determine schools lying outside the 95.44% limit. Results of statistical analysis were used as indicators for significance or likely differences in caries status between population groups as defined by the various variables i.e. age, access, altitude, school and access by altitude. Significance for the Chi Square test was determined by the probability level of 0.5 or 5%. Samples where $N < 30$ were excluded from statistical analysis. Tables 22 and 23 list the results of analysis by the above statistical methods from which the following conclusions are drawn:

1. Caries status by age

Significance was found in the permanent dentition between the 3 age groups. This is not surprising since there are more permanent teeth present in, say a person of 14 years, when compared to one of 6 years. This result compares favourably with the generally accepted supposition that caries prevalence increases with age.

2. Caries status by access

Significance was found in the primary dentition between the 5 categories of access. None was apparent in the permanent dentition. Further comparison of primary dentition data between the categories of "greatest access" and "least access" indicated that the level of

accessibility to services etc was likely to influence caries prevalence i.e. the greater the accessibility, the greater the caries experience.

Path analysis was conducted on cross tabulation data for further evaluation of the effects of access on caries status. Since higher altitudes are likely to increase caries experience (see below), data comprising the population group with the "greatest" access with the lowest altitude, and those with the "least" access and lowest altitude were compared. No significance was found. This may be due to smaller samples being tested, and hence having the effect of "minimising" the influence of access of caries prevalence.

3. Caries status by altitude

As with access, caries status in the primary dentition would appear to be influenced by altitude. The higher the altitude, the greater the caries prevalence. Again, no significance was detected in the permanent dentition.

Path analysis was also conducted on altitude's influence on caries status. Small sample sizes ($N < 30$) prevented the comparison of data comprising the least access and lowest altitude group with that of the least access and the highest altitude group. However, the results of 3 other tests utilising near equivalent data indicated a strong relationship between altitude level and caries for the primary dentition.

4. Caries status by school

Utilising the 95.44% limit, no significance was found between the schools in the 8-10- years age group. However, 3 schools in the 11-14 years age group were found to be outside this limit for the permanent dentition. This explains the slight positive skew in Figure 6. Further analysis of these 3 schools by the Chi Square test confirmed that significance existed between them and other schools. Although the reasons are unclear, the fact that 2 of the schools were located within the highest altitude category, whilst the other was within the second most "accessible" category, may partly explain the above significance.

95.44% of all values in a normal distribution fall between the limits of ± 2 standard deviations (Miller 1981). With significance being found in only 3 out of a total of 44 schools (Table 23), 41 schools or 93.2% of all values lie within the 95.44% limit. Hence, caries prevalence distribution in the permanent dentition, for the 11-14 years age group, can be regarded to be approximating that of a normal distribution.

5. Caries status - access by altitude

Significance was found between population groups in the primary dentition. Because of constraints caused by inadequate sample size, but utilising near equivalent data, path analysis strongly suggested that a combination of greater accessibility and high altitude was more likely to result in greater caries prevalence, than that of a lesser accessibility and low altitude.

With the probability level of the 11-14 years age group approaching significance, path analysis was conducted to test the effects of a combination of greater accessibility and high altitude on the permanent dentition. With sample sizes once again restricting usage of optimum data, the nearest equivalent were tested. However, no significance was found.

Path analysis was also conducted in the 2 access by altitude categories representing the lowest and highest caries prevalence in terms of DMFT levels and percentage of persons affected (Appendix 7) i.e. Code 3-3 and Code 4-3. Although significance was indicated, the reason for such is unclear.

DISCUSSION

It can be seen above that caries prevalence differences between various population groups were mainly confined to the primary dentition. No significance was found for the permanent dentition when the same population groups were tested. It may be that the primary dentition is more susceptible to decay than the permanent dentition. Studies in French Polynesia (Baume 1969; 1973) reported that this could be due to a high incidence of enamel hypoplasia in the primary dentition caused by nutritional disturbances; and a lower fluoride uptake in the primary dentition than the permanent dentition. According to Barmes (1979), there is evidence to suggest that there is often no correlation between the caries experience of primary and permanent dentitions of the same population group. However, these factors do not explain the results of the analysis. Hence the reasons for the findings are unclear.

It would seem that the access and altitude variables, both individually and as a combination, affected the caries status of the primary dentition of the population groups surveyed. Greater accessibility and high altitude appeared to result in higher caries prevalence when compared with lesser accessibility and low altitude. The effects of access may be explained by several factors. There may be differences in diet and food habits; the availability of tradestores selling Western products and foods containing fermentable carbohydrates; the degree of exposure to Western ways and habits; and the general accessibility to services. While the above factors apply equally to the effects that altitude may have in caries status, other considerations must be taken into account. Several racial groups, each with their own distinct cultural identity, reside at different altitudes. These groups differ in their customs, beliefs, practices and habits. Differences may exist in trace element content, micronutrients and macronutrients of soils, food and water at different altitudes. It may be recalled that people living at high altitude are dependent on sweet potato as their main staple. The latter is extremely high in starch content, but extremely low in protein. Barmes (see section 3) contended that this may be the reason for the caries prevalence picture at high altitudes.

Finally, according to his unpublished findings, McIntyre (1987) observed that people living at high altitudes normally do not possess any water storage mechanism, and often travel long distances to fetch it. He noticed that these people did not perspire or excrete much, and of those he examined, several had hypertrophy of the salivary glands and "dry mouths". He suggests that this scenario, together with the sweet potato diet, may have a significant bearing on caries prevalence at high altitudes.

Table 22 CRIES STATUS - RESULTS OF STATISTICAL ANALYSIS -
CHI SQUARE TEST

Variable	Age group (yrs)	Dentition	Probability level	Outcome
1. Age	3 age groups 6-7, 8-10	Permanent Primary	$p < .001$ $.5 > p > .3$	Reject Ho Accept Ho
2. Access	Comparing 5 codes of access			
	11-14	Permanent	$.9 > p > .8$	Accept Ho
	8-10	Permanent	$.8 > p > .7$	Accept Ho
	8-10	Primary	$p < .001$	Reject Ho
	Code 1 (highway access) by Code 5 (no road and air access)			
	8-10	Primary	$p < .001$	Reject Ho
	Path analysis - cross tabulation data (access by altitude)			
	Code 1-1 (highway access: < 1500m) by Code 5-1 (no road and air access: < 1500m)			
	8-10	Primary	$.3 > p > .2$	Accept Ho
3. Altitude	Comparing 3 codes of altitude			
	11-14	Permanent	$.5 > p > .3$	Accept Ho
	8-10	Permanent	$.5 > p > .3$	Accept Ho
	8-10	Primary	$p < .001$	Reject Ho
	Code 1 (< 1500m) by Code 3 (> 1900m)			
	8-10	Primary	$p < .001$	Reject Ho
	Path analysis - cross tabulation data (access by altitude)			
	Code 3-1 (access road access: < 1500m) by Code 3-3 (access road access: > 1900m)			
	8-10	Primary	$.3 > p > .2$	Accept Ho
	Code 2-1 (mainroad access: < 1500m) by Code 2-3 (mainroad access: > 1900m)			
	8-10	Primary	$p < .001$	Reject Ho
	Code 1-1 (highway access: < 1500m) by Code 2-3 (mainroad access: > 1900m)			
	8-10	Primary	$.05 > p > .02$	Reject Ho

Table 22 continued

Variable	Age group (yrs)	Dentition	Probability level	Outcome
4. Schools outside 95.44% limit by age group sample				
Malbuga (mainroad access: < 1500m)	11-14	Permanent	.01 > p > .001	Reject Ho
Yano (access road access: > 1900m)	11-14	Permanent	.01 > p > .001	Reject Ho
Alkena (access road access: > 1900m)	11-14	Permanent	p < .001	Reject Ho
5. Access by altitude				
Comparing 13 codes of access by altitude				
	11-14	Permanent	.1 > p > .05	Accept Ho
	8-10	Permanent	.5 > p > .3	Accept Ho
	8-10	Primary	p < .001	Reject Ho
Path analysis - cross tabulation data - Primary dentition:				
Code 1-2 (highway access: 1501-1900m) by Code 5-1 (no road and air access: < 1500m)				
	8-10	Primary	.01 > p > .001	Reject Ho
Code 2-3 (mainroad access: > 1900m) by Code 5-1 (no road and air access: < 1500m)				
	8-10	Primary	p < .001	Reject Ho
Path analysis - cross tabulation data - Permanent dentition:				
Code 1-2 (highway access: 1501 - 1900m) by Code 5-1 (no road and air access: < 1500m)				
	11-14	Permanent	.9 > p > .8	Accept Ho
Code 2-3 (mainroad access: > 1900m) by Code 5-1 (no road and air access: < 1500m)				
	11-14	Permanent	.95 > p > .8	Accept Ho
Code 3-3 (access road access: > 1900m) by Code 4-3 (no road access: > 1900m)				
	11-14	Permanent	p < .001	Reject Ho

NB

1. Samples where N < 30 were excluded from statistical analysis
2. Level of significance determined at probability level of .05 or 5%
3. Ho = Null hypothesis
Accept Ho = no significance or likely differences in caries status between population groups
Reject Ho = significance or likely differences in caries status between population groups

Table 23 CARRIES STATUS - RESULTS OF STATISTICAL ANALYSIS - SCHOOLS OUTSIDE 95.44% LIMIT

Age group (yrs)	Number of schools where N > 30*	Dentition	Mean DMFT/ dmft - age group	Mean DMFT dmft range - schools	Standard deviation	95.44% limit (2 standard deviations)	Schools outside 95.44% limit
11-14	44	Permanent	1.5	0.9 - 2.9	0.38	0.73 - 2.27	1. Malbuga (2.4) 2. Yano (2.5) 3. Alkena (2.9)
8-10	15	Permanent	0.7	0.4 - 1.1	0.21	0.28 - 1.12	None
8-10	15	Primary	1.6	0.9 - 2.5	0.46	0.68 - 2.52	None

NB

Standard deviation (standard error of the mean) is calculated from the formula $\sqrt{\frac{\sum(x - \bar{x})^2}{N - 1}}$

where x = mean DMFT/dmft for individual school

$\bar{x}$ = mean DMFT/dmft for age group

N = number of schools

* schools where sample (N) < 30 were excluded from statistical analysis

5.5.4 SUMMARY

Caries status and tooth treatment requirements resulting from the survey's findings may be summarised as follows:

Permanent dentition

1. There was a generally low caries experience amongst the subjects surveyed.
2. The percentage of persons affected by caries for the whole survey was 53%, with 43% at 6-7 years, 37% at 8-10 years and 58% at 11-14 years.
3. There was caries involvement with 5.3% of all teeth. This represented 1.3 teeth per person.
4. DMFT levels were mean 0.8 at 6-7 years, mean 0.7 at 8-10 years and mean 1.5 at 11-14 years.
5. The generally high DT and DT/DMFT%, and low FT recordings were an indication of large amounts of untreated decay amongst the survey's subjects.
6. An average of 0.08 for the total sample was recorded as missing teeth due to caries.
7. Only 13.4% of caries affected teeth had been restored. This represented 0.2 teeth per person for the total sample.
8. Untreated decay appeared to be uniformly distributed among persons with caries involvement irrespective of age, access and altitude.
9. The percentage of persons requiring treatment for the whole survey was 48%, with 41% at 6-7 years, 35% at 8-10 years, and 52% at 11-14 years.
10. 4.4% of all teeth required treatment.
11. There was 1.1 teeth per person for the whole survey which required treatment - 0.9 for restorations and 0.2 for extractions

primarily for caries. Of teeth requiring treatment, 59% needed 1-surface restorations, 17% 2-surface restorations, 7% 3-surface restorations, and 17% extractions for caries.

12. Of teeth requiring restorative treatment, 71.4% needed 1-surface restorations, 20% 2-surface restorations and 8.6% 3-surface restorations.

Primary dentition

1. The percentage of persons affected by caries was 67% at 6-7 years and 60% at 8-10 years.
2. 22.5% of all teeth were affected by caries - this represented 1.6 teeth per person.
3. dmft levels were mean 2.5 at 6-7 years and mean 1.6 at 8-10 years.
4. High dt and dt/dmft values were recorded. ft values were negligible. mt values were mean 0.1 for both age groups.
5. Of the 61% of persons of both age groups affected by caries, only 7% were recorded as requiring treatment.
6. 1.4% of all teeth were recorded as requiring treatment. The latter consisted mainly of extractions for caries, and represented an average of 0.1 teeth for the 6-7 and 8-10 years age groups.

Access and altitude considerations

1. Greater accessibility and high altitude, both individually and as a combination, would appear to increase caries prevalence of the primary dentition.
2. Reasons for this may be differences in diet, food habits, general accessibility to services, cultural differences, soil and water composition etc
3. Access and altitude considerations did not appear to affect the caries prevalence of the permanent dentition in the same manner as they did for the primary dentition. The reasons for this are not known.

5.6 PERIODONTAL DISEASE

5.6.1 PERIODONTAL STATUS AND TREATMENT NEEDS (CPITN)

Periodontal status and treatment needs data are presented in the manner recommended by the WHO, and consist of 3 tabulations:

- 1) percentage of persons affected by the worst severity score i.e. prevalence of periodontically healthy mouths, gingival bleeding as the worst condition, presence of calculus as the worst condition, shallow pockets 4 to 5 mm as the worst condition, and deep pockets.
- 2) mean number of sextants affected per person scored for each of the above conditions
- 3) the prevalence of the indicated periodontal treatment need in percentage of persons requiring type of treatment; and mean number of sextants when professional intervention was indicated. Treatment need categories were classified as follows:
 - a) oral hygiene instruction only when gingival bleeding was observed as the worst condition (TN 1)
 - b) prophylaxis by professional intervention when calculus and shallow pockets were recorded (TN 2)
 - c) complex care by professional intervention when deep pockets were evident (TN 3)

Treatment needs 1 (TN 1 - oral hygiene instruction) represents the total percentage of subjects requiring treatment of some type, and includes those needing personal measures to control plaque, those needing prophylaxis and those needing complex care.

5.6.1.1 BY AGE (Table 24)

The percentage of persons in the survey with no periodontal disease

was low, and ranged from 1-4% for the 3 age groups. Periodontal disease was mainly restricted to gingival bleeding and calculus, and disease severity levels increased with age. Gingival bleeding was highest in the 6-7 years age group with 44% of persons affected, and at 9% lowest in the 11-14 years age group. The 8-10 years age group recorded 18%. The reverse was seen with calculus. 90% of persons were affected in the 11-14 years age group, 80% at 8-10 years, and 52% at 6-7 years. Recordings for shallow and deep pockets were extremely low, and were restricted to persons between 11 and 14 years.

A mean of 3 or more sextants (50% and over) per person were recorded as affected by periodontal disease in each of the age groups.

Sextants affected with gingival bleeding were mean 1.6 at 6-7 years, mean 1.8 at 8-10 years and mean 1.4 at 11-14 years. Respective figures for calculus were 1.4, 2.1 and 2.7

The vast majority in each group required treatment i.e. over 90% of persons. Oral hygiene instruction and prophylaxis were considered necessary for 96% and 52% of persons at 6-7 years, 98% and 80% at 8-10 years, and 99% and 90% at 11-14 years. Very few (19) persons in the survey required complex care.

Finally, Figures 8, 9 and 10 show the trends of periodontal status and treatment needs by age.

TABLE 24 PERIODONTAL STATUS (CPITN) BY AGE

1. % of persons affected by worst severity score

Age (Yrs)	N	% of persons with				
		no periodontal disease 0	bleeding only 1	calculus 2	shallow pockets 3	deep pockets 4
6-7	52	4	44	52	0	0
8-10	1267	2	18	80	0	0
11-14	4021	1	9	90	0.3	0.1

2. Mean number of sextants affected

Age (yrs)	N	mean number of sextants with				
		no periodontal disease *	bleeding only 1	calculus 2	shallow pockets 3	deep pockets 4
6-7	52	3.0	1.6	1.4	0.0	0.0
8-10	1267	2.1	1.8	2.1	0.0	0.0
11-14	4021	1.9	1.4	2.7	(0.004)	(0.002)

* May include excluded sextants due to failure to meet measuring criteria. Excluded sextants assumed minimal due to age groups surveyed.

3. Treatment needs - % of persons and mean number of sextants

Age (yrs)	N	oral hygiene instruction		prophylaxis		complex care	
		TN1 %		TN2 %	MNS	TN3 %	MNS
6-7	52	96		52	1.4	0	0.0
8-10	1267	98		80	2.1	0	0.0
11-14	4021	99		90	2.7	(0.005)	(0.006)

TN = Treatment needs

MNS = mean number of sextants

FIGURE 8 PERIODONTAL STATUS (CPTN) BY AGE - % OF PERSONS AFFECTED BY WORST SEVERITY SCORE

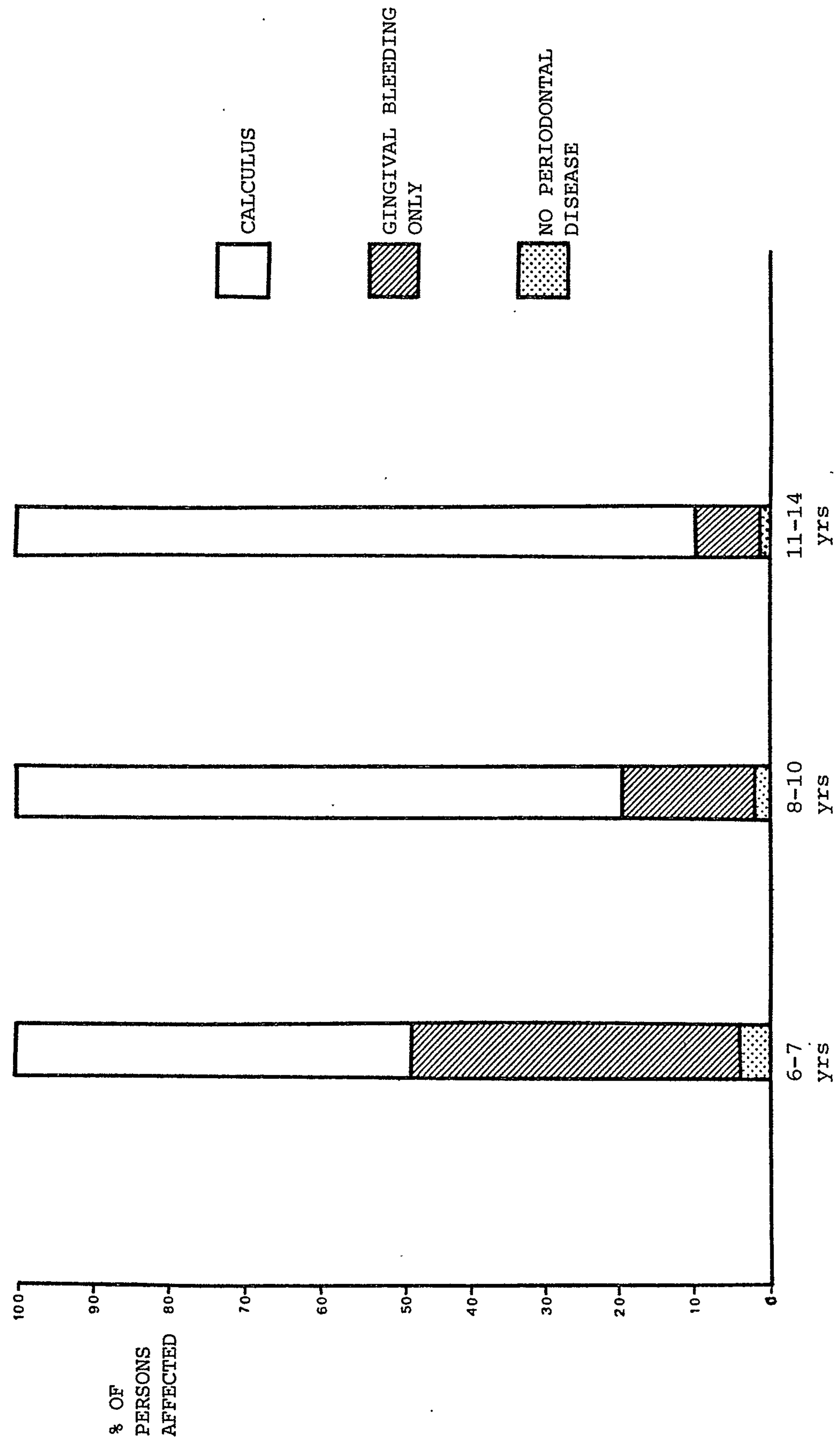


FIGURE 9 PERIODONTAL STATUS (CPITN) BY AGE - MEAN NUMBER OF SEXTANTS AFFECTED

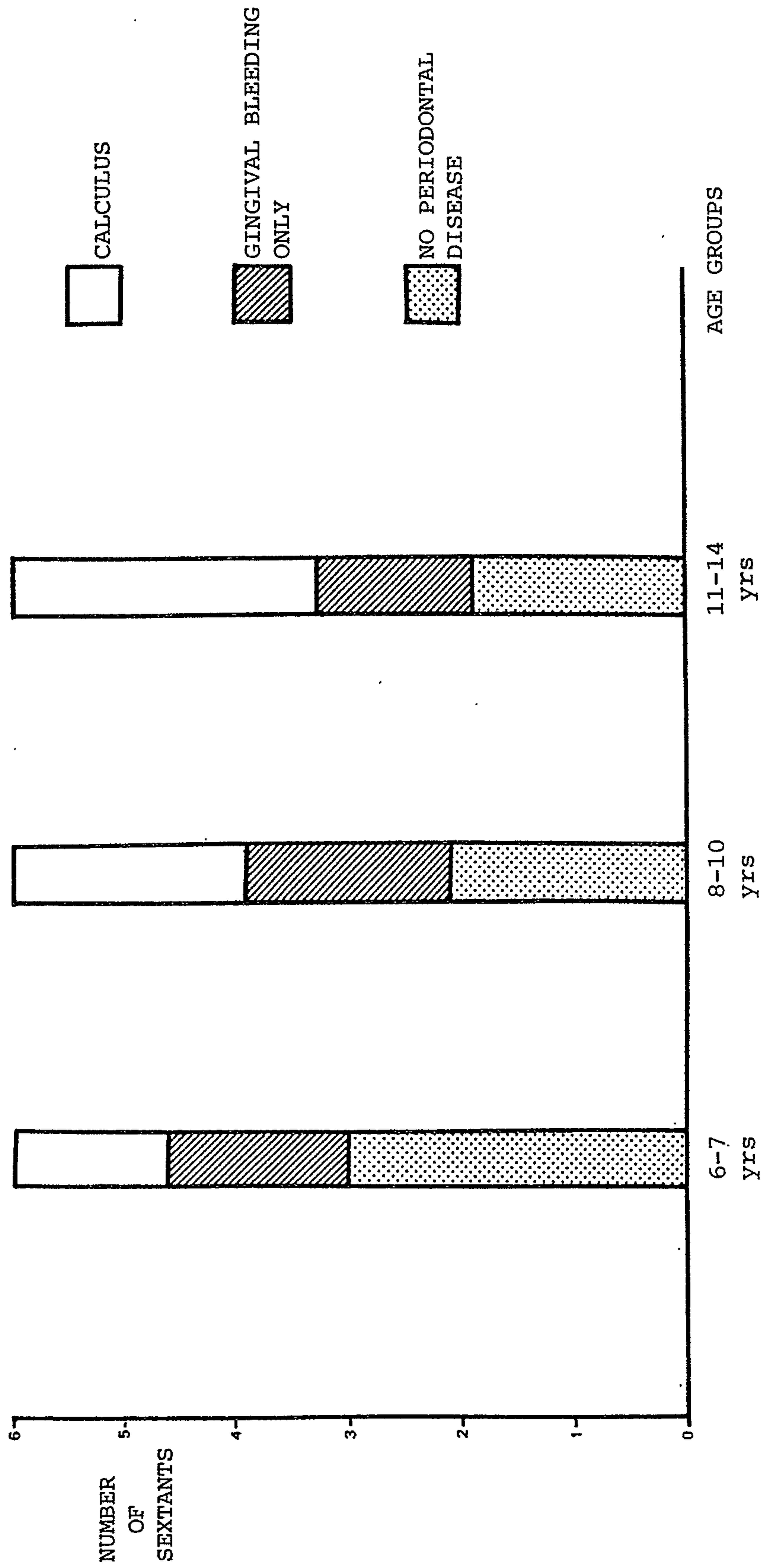
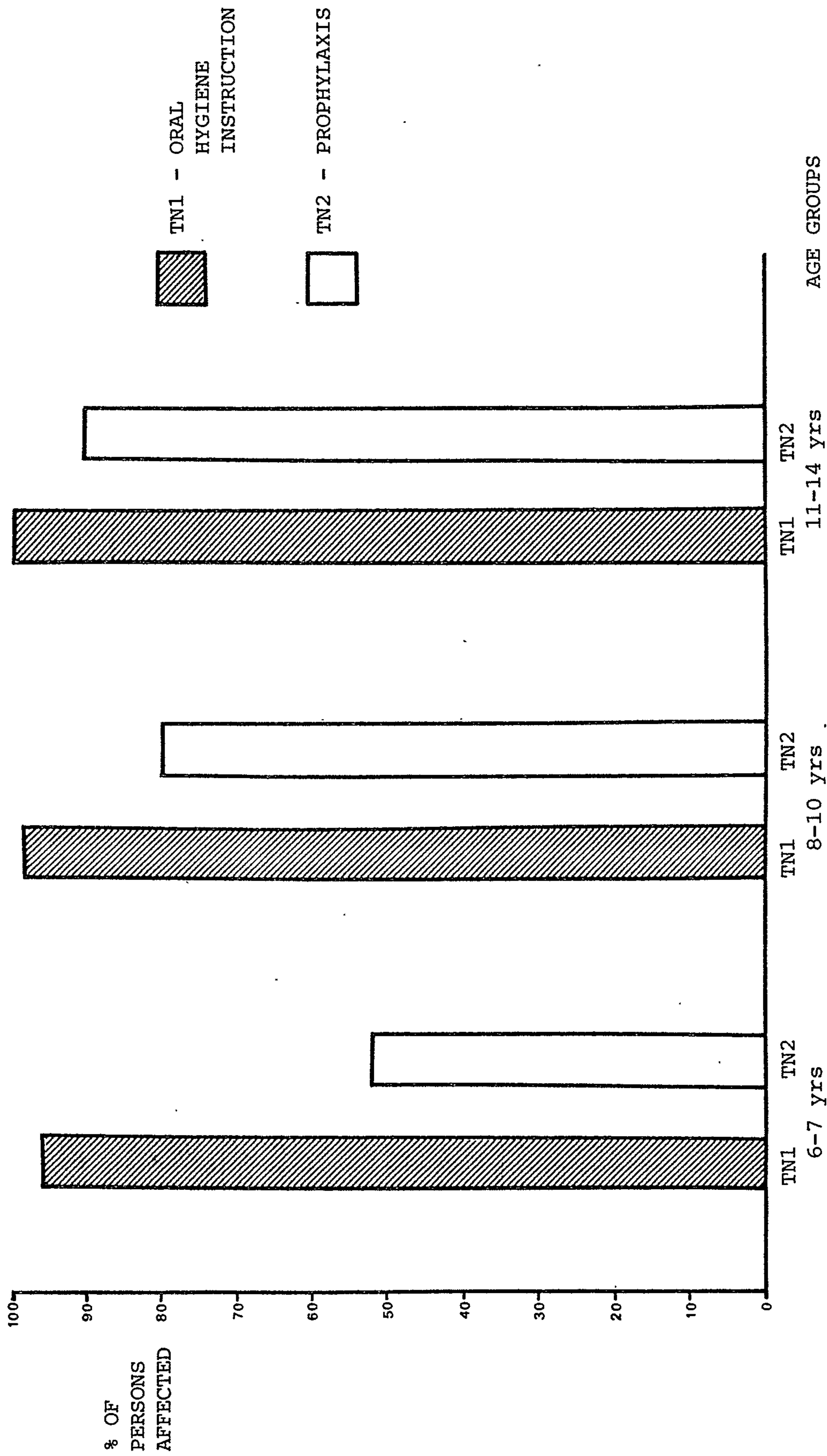


FIGURE 10 PERIODONTAL STATUS (CPITN) BY AGE - % OF PERSONS REQUIRING TREATMENT



5.6.1.2 BY ACCESS (Appendices 24, 25 and 26)

11-14 years age group

Minor differences, ranging from 0-2%, were recorded in the percentage of persons with no periodontal disease between the different access categories. However, larger variations were seen for gingival bleeding (4-12%), and for calculus (86-94%). Access code 5 (no road and air access) recorded 0% for persons with no periodontal disease, and registered the highest score for calculus. It also had recordings, of 1% each, for persons affected with shallow and deep pockets. Access code 2 (mainroad access) had the lowest calculus and the highest gingival bleeding scores.

The mean number of sextants affected by periodontal disease was highest in access code 5 (gingival bleeding 0.8, calculus 3.7) and lowest in access code 4 (no road access; gingival bleeding 1.1, calculus 2.5). The total percentage of persons requiring treatment (TN 1) between all access categories ranged from 98-100%. The treatment need for prophylaxis was highest in access code 5 (96%) and lowest in access code 2 (86%).

8-10 years age group

The percentage of persons recorded with no periodontal disease between the different access categories was generally between 1-3%. However, 10% was recorded for access code 4. Variations for gingival bleeding were mainly between 18-22% of persons affected, with access code 5 registering 2%. Larger discrepancies were evident for calculus. Access code 5 had the highest percentage of persons affected (96%) and access code 4 the lowest (68%).

The highest scores for mean number of sextants affected were access code 5 (gingival bleeding 0.8, calculus 3.3) and access code 2 (2.1, 2.1). Access code 4 had the lowest recordings (1.1, 1.6).

Recordings for the total percentage of persons requiring treatment (TN 1) were similar to the older age group. Scores for treatment by prophylaxis were generally lower with the exception of access code 5 at 96%.

The above data suggests that access code 5, representing the least accessible areas for the survey, had generally the highest periodontal disease prevalence, and the worst disease severity levels for both age groups. Variations between recordings of the other access categories were less apparent. Hence it would appear that periodontal disease and severity increases in geographical areas with little access, and decreases in those with greater access.

5.6.1.3 BY ALTITUDE (Appendices 27, 28 and 29)

Small differences were recorded between the 3 altitude categories. These applied to both the 8-10 years and 11-14 years age groups. Generally, altitude code 3 (> 1900m) had the highest periodontal disease levels, and altitude code 1 (< 1500m) the lowest.

5.6.1.4 BY SCHOOL (Appendices 30-36)

11-14 years age group

Of the 44 schools where $N > 30$, recordings for the percentage of persons affected were between 0-9% for no periodontal disease; 0-34% for gingival bleeding; and 64-100% for calculus. Figures for total percentage of persons requiring treatment (TN 1) were 91-100%.

Schools recorded as having the lowest periodontal disease prevalence were St John Bosco, Tabibuga, Kaip, Kindeng, Kokglamp and Malbuga. They generally had the highest recordings for percentage of persons with no periodontal disease (7-9%); the lowest for percentage of persons with calculus (64-73%); the lowest for percentage of persons requiring treatment - TN 1 (91-95%); and also the lowest for mean number of sextants affected by calculus (> 2.1). All these schools were located within access codes of 1 and 2, the two categories with most access.

Conversely, Kingaringa, Gobo, Alimp, Millep, Tambul, Alkena, Kosap, Tsingaropa and Tapiakama were schools recorded as having the highest periodontal disease prevalence. They had the highest recordings for percentage of persons with calculus (95-100%); the highest for mean number of sextants affected by calculus (> 3.3); and share the highest percentage of persons requiring prophylaxis (100%). All these schools were located in access codes 3 (access road access), 4 and 5. Gobo and Kosap (both access code 5) had the highest mean number of sextants affected by calculus - 4.4 and 4.5. Tsikasa (access code 3) and Alimp (access code 5) recorded the highest mean number of sextants affected by all levels of periodontal disease - 5.2 and 5.3. In addition, Tapiakama (access code 5) was the only school with a mean sextant recording for shallow pockets (0.1).

The differences in periodontal status between the different schools are shown in Figure 11. The latter illustrates the frequency distribution of schools by mean number of sextants affected by periodontal disease in the 11-14 years age group. It can be seen that

the distribution is bimodal i.e. 4.0 and 4.2 mean number of sextants. Given that the overall mean value for this age group is 4.1, and the median value is 4.2, these measures of central tendency indicate that the above distribution approximates that of a normal distribution.

Finally, no trends in school recording were evident with regard to altitude considerations.

8-10 year age group

Only 15 schools in this age group had samples where $N > 30$. The rest had extremely small samples. Generally, the highest recordings for the percentage of persons with no periodontal disease were found in schools within access codes of 1 and 2. No trends were apparent with other recordings.

5.6.1.5 ACCESS BY ALTITUDE (Appendix 37)

11-14 years

Minor differences were seen between the different access-altitude categories for percentage of persons with no periodontal disease i.e. 0-4%. Code 2-1 (mainroad access: $< 1500\text{m}$) had the highest recording at 4% with several codes registering 0%. The percentage of persons with calculus was lowest for code 2-1 (78%), and highest for code 5-2 (no road and air access: 1501-1900m) and for code 3-1 (access road access: $< 1500\text{m}$) at 95%. Generally, codes with "lesser" access had higher calculus scores than those with "greater" access.

8-10 years

Of those codes with sample where $N > 30$, similar findings to the above

were recorded. Code 2-1 had the higher percentage of persons with no periodontal disease, and the lowest with calculus. Code 5-1 (no road and air access: < 1500m) had the highest percentage of persons with calculus.

Generally, the access-altitude categories of 5-1, 5-2 and 3-1 registered the highest periodontal disease levels of both age groups. Code 2-1 recorded the lowest.