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DENTAL CRITERIA
AND
TREATMENT NEEDS

"General Principles and Methods of Reporting Dental Criteria together with Review of Literature Relating to Prevalence of Dental Diseases, Abnormalities and Treatment Needs of Australian Adults."

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DIPLOMA IN PUBLIC HEALTH DENTISTRY

Department of Preventive Dentistry
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PREFACE

Whilst many epidemiological and prevalence surveys have been conducted in overseas countries for the purpose of finding causes, compiling clinical pictures and assessing the distribution of dental diseases and related treatment requirements throughout populations, comparative studies in Australia have to date been few in number.

Accounts of those that have been conducted have, in the main, been recorded in the various types of Australian dental literature, but, nevertheless, are difficult to locate due to their infrequent appearance and diversification throughout various types of dental publications.

The purpose of this thesis is to indicate the general principles and methods of reporting dental criteria and to compile an up to date review of the published and available unpublished literature of Australian adults and adolescents in relation to their dental treatment needs.
ACKNOWLEDGEMENTS.

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PART ONE.

DENTAL CRITERIA.
INTRODUCTION

An essential requirement for sound epidemiological investigation is a clear definition of the condition being studied together with standardised diagnostic criteria, methods of measurement, and terminology. In order to establish methods for detecting, recording, processing and reporting data on the clinical occurrence of dental caries so that the findings are reproducible, internationally comparable, and have a known level of accuracy, unification and standardisation of statistical techniques is necessary. To meet this need both the Federation Dentaire Internationale (18) and the World Health Organisation (52) have proposed general principles to ensure the accuracy and standardisation of examination techniques, definitions of dental diseases, procedures and analysis in respect of dental disorders; the former organisation detailing criteria and procedure in relation to dental caries statistics, and the latter, having adopted these forementioned principles, has also proposed standardisation of assessments concerning periodontal disease, dentofacial anomalies, dental prostheses, principles of survey planning, and report writing.
A. ASSESSMENT OF DENTAL CARIES.

In its proposal concerning standardisation of dental statistics the Federation Dentaire Internationale has detailed principles of classification, terminology and description of study. It has also stressed that the task of preparing accurate clinical caries statistics on a standardised basis demands intimate knowledge of conventional statistical theory together with familiarity of dental data, and that attainment of the aim is best achieved by close collaborative effort of the specifically trained dentist and the professional statistician.

1. CLASSIFICATION.

Clinical occurrence of human dental caries is measured by statistical techniques. The major purposes for which such statistical data are collected include epidemiological research, surveys for public dental health programmes, and testing of methods for the individual and mass prevention and control of dental caries.

Epidemiology is one of the scientific ways to study the processes which determine or influence the health of people. It is concerned with the study of factors that influence the occurrence and distribution of disease, defect, disability or death in aggregations of individuals. The aims of epidemiological research on individuals is therefore to determine the:

a. Prevalence of dental caries within different ethnic, national or geographic groups of people;
b. Causes for the differences manifested between and within these groups.

The aims of a dental caries survey for planning, conducting and evaluating a public dental health programme are to:-

a. Determine the type, extent and severity of dental caries relative to other dental and general health problems;
b. Assess the extent to which a community or nation can and will support an effective curative and preventive programme;
c. Obtain objective data which can be used in evaluating the effectiveness of existing dental health programmes;
d. Stimulate and maintain public awareness of the importance of dental health.
e. To determine for epidemiological research purposes the prevalence and incidence of dental diseases and conditions in different groups of people and to elucidate the factors responsible for or associated with the differences manifested between groups.

The aim of trial studies designed to ascertain the effect of new control or preventive measures is to test clinically the validity of hypotheses which are formulated from laboratory or epidemiological studies. Two types may be distinguished:-
a. Trials of the prevalence type of study using large population samples for cross sectional comparison (field trials);

b. Trials of the incidence type of study checking longitudinally by serial examinations on caries activity of representative samples of individuals.

Generally, the technique of collecting, recording and processing data varies in accordance with the type of study intended. The methods used for each study will need to be differently standardised at least for each of the three main study types. Terminology and description of study, however, being a common element of all of them may be uniformly standardised.

II. TERMINOLOGY.

In defining the following terms the F.D.I. has had to compromise in order to ensure that definitions retain their original meaning regardless of the language into which they are translated.

1. Description of Dental Caries.

Dental caries is defined as a localised, pathologic process of external origin, involving softening of the hard tooth structures and progressing to cavitation.

Being a disease process caries starts with a microscopic lesion and eventually progresses into macroscopic cavity; from a diagnostic point of view caries therefore may be classified into:-
a. Initial Lesion: which is defined as caries not having reached the stage of a visible surface breakdown (white, chalky, discoloured, rough spot); it is inscrutable to physical examination. Synonyms are - microscopic carious lesion, radiographic lesion, questionable caries. The term precarious lesion is to be avoided.

b. Clinical Caries: which is defined as caries having reached the stage of visible cavitation 'that can be diagnosed with certainty by clinical (physical) examination'. Synonyms are - microscopic carious lesion; untreated carious defect; cavity. The term 'carious lesion' usually stands for 'clinical caries' unless otherwise specified.

Clinical caries may be further divided into:

(i) primary caries - to designate a positively diagnosed cavity which is not associated with a restoration.

(ii) secondary caries - to designate a positively diagnosed carious lesion which occurs at the margin of an existing restoration.

(iii) new caries - to designate a positively diagnosed cavity which has appeared since the time of last examination. (This term is only used in an incidence study of the same individual).
Caries degree is used in connection with a calibration of the depth of penetration of caries with the help of standardised radiographs:

1st degree caries – carious involvement of enamel
2nd degree caries – carious involvement of dentine
3rd degree caries – inflammatory involvement of the pulp due to caries.

c. Past Caries: is defined as a carious lesion which has been eliminated by tooth extraction or treated and restored by means of a filling. In an incidence study (e.g. trial of a control or preventive measure) restorations may be defined as:-

(i) old filling – a restoration present at the time of the first examination.

(ii) new filling – a restoration which replaced a primary or secondary caries positively diagnosed at a previous examination.

(iii) immediate filling – a restoration of an area which was caries free at a previous examination.

d. Caries Status: is the term used to describe the caries involvement of the teeth present at the time of examination with untreated caries and fillings.

e. Caries Experience: is the term used to describe the total amount of caries destruction of a dentition. It includes the caries status of the teeth present
at the time of examination and the teeth lost due to caries (life caries experience). Relative caries may be graded in low, moderate, high, rampant.

f. Caries Prevalence: is the term used to describe the proportion of a population showing dental caries experience. It is usually expressed as the age-specific caries experience rate per person.

g. Caries Incidence (Increment): is the rate per unit of time (usually one year) at which new caries affects an individual or population or the amount of new carious lesions occurring in an individual or population within a stated period of time.

h. Caries Progression: is the term used to describe the rate at which an untreated carious lesion increases in volume in a stated period of time.

j. Caries Arrest: is the term used to describe a spontaneous or induced cessation (excepting by operative procedures) in the progression of a carious lesion, as observed by serial examination.

k. Caries Activity: designates the state of action of cariogenic factors. Clinically, it is expressed by the rate at which new caries develops (caries increment) and old caries progresses (caries progression). Caries activity may also be tested biochemically with the help of specific laboratory tests. (Caries activity tests
measure in general only one factor of caries susceptibility).

1. Caries Susceptibility: is the term used to describe the relative inherent or acquired predisposition of a person, an individual tooth or an individual tooth surface, to dental caries.

m. Caries Resistance: is the term used to describe the inherent or acquired capacity of the hard tooth structures to remain unaffected by dental caries.

n. Caries Control: (caries reduction) should be specified as a decreased (reduced) caries incidence rate and/or caries progression rate within a stated period of time or a smaller caries prevalence rate in one or two equivalent groups; the term caries control is also used to describe operative measures to limit the progression of caries.

c. Caries Prophylactics, Caries Preventives and Caries Inhibitors: are terms used to describe agents or measures which bring about a decrease in the incidence, progression or prevalence of dental caries - systematically, internally by creating and promoting resistance of the tooth structures and saliva composition against cariogenic factors, and/or topically, externally by inhibiting the cariogenic factor.
2. **Caries Indices.**

Indexing is the term used to express a certain condition in terms of a ratio or number derived from a series of observations and used as an indicator.

a. **Caries Index:** is a numerical expression of the occurrence of dental caries in terms of an absolute or relative frequency or ratio, and their distribution within classes of individuals respectively.

(i) caries frequency - appreciates occurrence in the proportion of individuals as a unit:

\[
\frac{\text{Number of caries affected or caries free persons}}{\text{Total number of persons examined}}
\]

The frequency may be expressed in terms of the absolute arithmetic mean or the relative percentage number by multiplying the numerator by 100.

(ii) caries ratio - relates smaller units - teeth, tooth surfaces or cavities in terms of an arithmetic mean, or quantity relative to 100 units respectively (which is not a true percentage).

(iii) caries distribution - is the scatter of caries frequency among various classes of individuals.

b. **DMF Index:** is a quantitative expression of the lifetime caries experience in the permanent teeth. It is perhaps the commonest measure in use today, and was developed by Klein (13) of the US Public Health Service. It reaches
its greatest usefulness in areas where the proportion of individuals with some evidence of caries is so high that changes in this proportion are meaningless and it becomes necessary to have a quantitative measure of caries within the average person's mouth. Large surveys measured in DMF teeth can be made by explorer examination without x-ray support, and constitute a standardised, though incomplete, picture of caries status. A defect in the method - and one reason for not taking x-rays in connection with it - is that, once a tooth has found its way into the DMF count, further caries on the tooth is not measured. A more sensitive measure of dental conditions per person is found in DMF surfaces, which includes the use of radiographs. Surface counts have an advantage over tooth counts in that changes in caries experience can still be seen easily in mouths having such high caries already that almost no completely unattacked teeth remain.

DMF index is the average number of decayed (D), missing (M) and/or filled (F) permanent teeth (T) or tooth surfaces (S) per person. Survey findings of population groups are given in age-specific, sex-specific, race-specific averages. This index is a measure of dental caries experience under the condition that M includes only those teeth which were lost due to caries.
c. Palmer (29) and Knutson (37) also contributed to this index by development of an examination chart together with a coding system relevant to specific tooth surfaces. Knutson's coding system is shown at Figure 1.

d. **dmf Index**: is a quantitative expression of the caries experience of caries prevalence in the primary teeth in which only those teeth that should be present at the time of examination are considered. It is the number of decayed (d) missing (m) and filled (f) primary teeth (t) or tooth surfaces (s). It may be expressed in the same way as the DMF index.

e. **DF Index**: is the sum of the number of decayed and filled permanent teeth or tooth surfaces relative to the sample examined. (Quantitative expression of caries status of the permanent teeth).

f. **df Index**: is the sum of the number of decayed and filled primary teeth or tooth surfaces relative to the sample examined. (Quantitative expression of caries status of the primary teeth).

g. **def Index**: is a quantitative expression of the observable caries experience or caries prevalence in the primary dentition. It is the sum of the number of primary teeth which are decayed (d), decayed beyond repair; i.e., need to be extracted (e), and filled (f). This index
**FIGURE 1**

**DMF CODING SURFACES**

<table>
<thead>
<tr>
<th>LEFT HAND COLUMN</th>
<th>RIGHT HAND COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>S  Permanent Tooth Present</td>
<td>Caries by Surfaces</td>
</tr>
<tr>
<td>D  Deciduous Tooth Present</td>
<td>x  Occlusal</td>
</tr>
<tr>
<td>0  Unerupted Permanent Tooth</td>
<td>0  Lingual</td>
</tr>
<tr>
<td>1  Permanent Tooth Extracted</td>
<td>1  Buccal or Labial</td>
</tr>
<tr>
<td>2  Deciduous Tooth Unerupted</td>
<td>2  Mesial</td>
</tr>
<tr>
<td>3  Tooth Free of Pathos</td>
<td>3  Distal</td>
</tr>
<tr>
<td>4  Tooth Carious</td>
<td>v  Roots only</td>
</tr>
<tr>
<td>5  Tooth Filled</td>
<td>Fillings by Surfaces</td>
</tr>
<tr>
<td>6  Tooth Hypoplastic</td>
<td>4  Crown</td>
</tr>
<tr>
<td>7  Development Pits or Fissures</td>
<td>5  Occlusal</td>
</tr>
<tr>
<td>8  Arrested Caries</td>
<td>6  Lingual</td>
</tr>
<tr>
<td>9  Caries Involving Pulp</td>
<td>7  Buccal or Labial</td>
</tr>
<tr>
<td></td>
<td>8  Mesial</td>
</tr>
<tr>
<td></td>
<td>9  Distal</td>
</tr>
</tbody>
</table>

Source: Knutson(37)
differs from the dmf index in that primary teeth
which are missing at the time of examination are ignored.

h. Cavity Index: is the ratio between the number of new
caries developed within a stated period (caries increment)
and the total number of persons, teeth or surfaces in
terms of the arithmetic mean or the rate per 100.

j. Caries intensity denotes a ratio of units that has a
bearing on the severity of caries experiences such as:—

(i) Number of carious teeth
__________________________
Number of persons with
caries

(ii) Number of carious surfaces
__________________________
Number of persons with
caries

(iii) Number of cavities
__________________________
Number of persons with
caries

(iv) Number of carious surfaces
__________________________
Number of carious teeth

(v) Number of cavities
__________________________
Number of persons with
caries

(vi) Number of cavities
__________________________
Number of carious surfaces

(vii) age specific DMT prevalence and incidence ratios.

k. Bodecker Index: is a quantitative expression of the
number of decayed, missing and/or filled permanent tooth
surfaces. It is only used in conjunction with the
Bodecker geometric dental chart upon which allowance is
made for the different caries susceptibility of various
types of teeth. In this system a complete permanent
dentition of 32 teeth is recognised as having 180 tooth
surfaces.
1. Scandinavian Moulage System: is a method to measure the extent of carious lesions. Pictures of different stages and locations of carious lesions are numbered whereby a clinical lesion is scored by comparison with the standard.

m. 100 Surfaces Index: is a quantitative expression of the number of decayed, missing and/or filled permanent tooth surfaces. Excepting third molars reference is given to 100 surfaces, omitting all lingual surfaces (molars and bicuspids 4, canines and incisors 3: $16 \times 4 + 12 \times 3 = 100$).

n. Tooth Morbidity Rate: is defined as the number of teeth showing untreated clinical caries present, that is, decayed deciduous and/or permanent teeth, and 'e teeth indicated for extraction related to the total number of persons examined.

o. Tooth Mortality Rate: is defined as the number of permanent teeth lost or indicated for extraction per 100 teeth examined.

p. Tooth Fatality Rate: is defined as the number of permanent teeth that have been extracted or are indicated for extraction per 100 permanent teeth showing attack by caries (M/DMF).

q. Teeth or Surfaces at Risk: comprise the sum of the unattacked tooth structures (teeth, surfaces) eventually available for caries.
r. Caries Attack Rate: is the percentage of teeth or surfaces at risk which decayed within a stated period of time (usually one year).

3. Terms of Diagnostic Procedure
   a. Types of Dental Examination:

      Type 1. Complete Examination - using mouth mirror and explorer, adequate illumination, thorough radiographic survey and when indicated, percussion, pulp vitality tests, transillumination, study models and laboratory tests.

      Type 2. Limited Examination - using mouth mirror and explorer, adequate illumination, posterior bite-wing radiographs; when indicated, periapical radiographs. This type of limited examination is the standard diagnostic procedure in trial studies for accurate and consistent determination of the identity, state of health, pathology and past therapy of each tooth present and the establishment of the history of missing teeth by anamnestic and radiographic means. Each examination includes a record of the examiner's age, sex and additional information.

      Type 3. Inspection - using a mouth mirror and explorer, adequate illumination. Standard diagnostic procedure for an estimation of caries prevalence in a large strata of population with the help of minimum equipment considering
a reduced number of criteria such as the presence or absence of caries, or its treatment respectively and numbers of missing teeth.

Type 4: Screening - using tongue depressor, available illumination. Method for obtaining simple epidemiological data like the tooth mortality rate.

b. Serial Examination: Subsequent to a base-line examination, periodic re-examination of the same individual following determined intervals using the same standards.

c. Pilot Examination: Limited dental examination of a small sample in order to assess the scatter of the mean, and to determine the numerical minimum of a base-line examination.

d. Types of Recording (Connotation):

(i) total recording of dental caries - includes the examination and connotation of the caries experience of the entire dentition of an individual person.

(ii) partial recording of dental caries - considers for each subject only one tooth or a group of teeth or one half of the dentition to represent the whole dentition.

(iii) blind recording - standard procedure for incidence studies not having access to the records of previous examinations in order to avoid any bias.
e. Eruption: in a clerical examination it is necessary to determine the number and identity of teeth present in the mouth at the time of examination. For this reason it is essential to define the state of eruption of individual teeth:

(i) partially erupted tooth - is one of which at least part of the crown has broken through the gingiva.
(ii) fully erupted tooth - is one which has reached the line of occlusion so that it cannot be distinguished from other fully erupted teeth.

f. Enamel Defects, acquired:

(i) abrasion (attrition) - is a loss of tooth substance with consequent regressive changes of the dental tissue due to wear originating from functional and mechanical habits.
(ii) erosion - is a loss of tooth substance due to chemical interference from ingested food and agents (acid demineralization, increased solubility). Eroded surfaces are glossy and smooth in contrast to incipient carious demineralization which is rough.

g. Enamel Defects, Congenital: enamel hypoplasias of various degrees, originating from metabolic interferences during tooth development.
h. Dental Anomalies: these comprise congenital deviation in number, form and structure of teeth.

j. Method Error: experimental error pertains to inconsistencies of data collected by the same examiner in repeated controls at short intervals or discrepancies of data of different examiners of the same subject. They involve errors of examination and errors of recording; they may be systematic, that is, statistically significant for one examiner, or they may be at random. Examining errors arise from:

(i) inadequacies of technical aids, amendable to statistical evaluation;
(ii) human factors (fatigue, bias etc.) which are highly irrational;
(iii) differences of definitions and interpretation (border line cases).

k. Reversal: this represents a change in the reporting of a carious lesion diagnosed at the first examination into a non-caries area recorded at the second examination.

4. Terms Concerning Design of Study.

a. Field Survey: refers to a cross section study of a population to determine the prevalence of a disease at a specific time.

b. Field Review: refers to a long term inquiry into the incidence of a disease.
c. Prevalence Study: refers to a statistical appraisal of a representative group of individuals in which a single dental examination (inspection) is made in order to determine their life caries experience at a given time.

d. Incidence Study: refers to a statistical appraisal of a representative group of individuals in which two or more examinations are made in order to determine the increments of caries over a specific period of time.

e. Field Trial: refers to a prevalence study comparing the data of two populations under operational conditions of one variable (fluorides for instance) identified as pertinent through specific investigation.

f. Clinical Test: refers to an incidence study in which the increments of two groups, a control (base-line) group and an experimental group are compared usually to ascertain the effect of a preventive measure or an etiological factor.
   (i) intergroup comparison - refers to the plotting of two individual groups.
   (ii) intragroup comparison - is used when the scores of the same subjects collected during a pre-experimental period serve as control for the scores during the experimental period.

g. Sampling: involves study design regarding proper selection and computation of study and control groups in accordance with statistical science.
h. Significance Test: for a survey or study to be significant or meaningful in terms of data provided the results of the survey must conform to statistical principles.

TII. STANDARD DESCRIPTION OF THE STUDY

Every preliminary and final report should include under "material and method" all relevant information such as:

a. The Purpose of Study: Epidemiology - screening - prevalence trial; incidence trial.

b. Comprehensive Description of the Material Studied:

(i) composition of sample according to the national, regional, racial and family (consanguinity) background.

(ii) age distribution listed according to last birthday.

(iii) type of dentition present - deciduous, mixed, permanent.

(iv) distribution of the sexes.

(v) number and loss of subjects during study period.

(vi) interval and sequence of individual examination.

c. Meticulous Description of Method Used for Examining and Recording Caries:

(i) type of physical equipment and procedures of examination - probe, (measurements of working end), mirror, illumination, compressed air, previous cleaning and drying of teeth, number and type of radiographs and laboratory tests.

(ii) place of examination - in private office, clinic,
open air.

(iii) time spent on intraoral examination of each mouth.

(iv) grading of unerupted, partially erupted and erupted teeth.

(v) definition and interpretation of clinical caries, initial lesion on smooth and pitted surfaces and evaluation of tooth lost or erupting during the observation period.

(vi) criteria used for judging the presence of caries.

(vii) extent of examination - total recording, type of partial recording.

(viii) type and standardization of supplementary data, pulp treatment, enamel defect, and hygiene.

(ix) detailed description of the methods and forms employed for recording.

d. Qualifications of the Examiners:

(i) educational and professional background - student, general practitioner, school dentist, public health officer.

(ii) training directed towards the development of reproducibility of findings.

(iii) number of examiners - indicate if some or different observers made the serial examination, how inter-examiner differences were assessed statistically before, during and after study.
(iv) objectivity - was 'blind' recording method used in which examiner is unaware of experimental arrangement. State to what degree 'blindness' could be observed.

(v) were the observations recorded by the examiner or recording secretary?

(vi) were the various groups examined after each other or in a random sequence?

e. Selection and Computation of the Study Control Samples including one of the following possibilities:

(i) systematic examination of distinct strata of population.

(ii) at random assignment.

(iii) allocation established on the basis of examination, regarding equal distribution of the prevalence rates in both groups.

(iv) balanced sampling by matched pairs.

f. Conditions Influencing the Investigation:

Ecological, nutritional, hygiene and specific local factors influencing caries prevalence and activity. Special attention must be given to the amount of fluoride contained in foods ingested or in agents used, as well as to the type and amount of fermentable carbohydrate consumed.
g. Description of Statistical Analysis:

(i) significance test, specific method applied.

(ii) interpretation of statistical data.
B. **SURVEY OF DENTAL DISEASE AND INDICES**

The focus of any purposeful dental health survey necessarily involves the measurement of dental disease, or morbidity, as well as other dental conditions. For purposes of survey dental disease and other defects may be considered under the following headings.

I. **DENTAL CARIES**

There are five major measures of dental disease:

a. Percentage or prevalence measures, which is particularly useful where evidence of caries is low.

b. DMF: is a quantitative measurement expressing caries experience in individuals or population. Large surveys measured in DMF teeth can be made by explorer examination without x-ray support and constitute a standardised, although incomplete picture of caries status. When deciduous teeth form the dentition, a def tooth count is used.

c. DMF surfaces: is a more sensitive measure of dental conditions per person, achieving its greatest accuracy when x-rays are used. Detailed definition of DMF and DMF surfaces together with related indices of dental caries has been given at an earlier section.

d. Carious lesions: is a sensitive measure involving new points of caries entry. As there may be more than one
point of entry on a given surface this measure is more sensitive than surface counts. It is used in short-term studies which involve such methods of prevention as topical fluoride therapy, but since differentiation between a new lesion and extension of an adjacent old lesion is often difficult, it is considered an inferior measure to DMF surfaces.

e. Number times size of lesions: this method accurately determines the volume of the lesion under laboratory conditions. A total figure is obtained which is far more descriptive of the caries invasion in a given mouth than could be given by the number of lesions involved.

II. PERIODONTAL DISEASE

Measurement of periodontal disease is rendered difficult by the reversible and irreversible nature of gingival or alveolar bone disease respectively, and further complicated by alveolar damage which is almost always chronic, cumulative and hard to observe. This disease has its greatest incidence late in life and subjective measurement of its severity is usually necessary.

Various indices have been developed for the study of periodontal diseases.

1. Indices of Periodontal Disease

One reversible index particularly useful for measurement of
gingivitis is the PMA index as developed by Schour and Massler (42). This index is based on the concept that the extent of inflammation serves as an indicator of the severity of the affection. In severe gingivitis the inflammation is usually indicated by its location, mild forms being papillary (P), moderate gingivitis involving the marginal gingiva (M), and severe gingivitis affecting the attached gingiva (A). As this index requires positive scoring for any deviation from a stringently defined ideal condition of the tissues, interpretation of the gingival condition varies and comparability of results is sometimes difficult to achieve. It is however most useful for work among children, particularly when deviations of normal gingiva are observed by a single examiner (35).

Another reversible index as proposed by Jolliffe and used by Barnard (3) in his survey of N.S.W. school children, is the gingivae index which is ascribed to the upper anterior region as being representative of the rest of the mouth. Observations are recorded thus:

Normal: Gingiva firm and pink with natural, stippled appearance.

H.: Gingiva firm, with slight loss of pink colour and of stippling.

H.I.: Gingiva showing definite hyperaemia.

H.I.S.: Gingiva showing hyperaemia with oedema of the interdental papillae and margin.
H.II.S. : Gingiva extremely red and hyperaemic, with oedema of the interdental papillae and margin, and sometimes loss of attached gingival.

Categories of these gingival conditions were, for practical purposes, combined into three groups - (a) Normal: Normal and H; (b) Hyperaemic: H.I. and H.II; (c) Hyperaemic and Oedematous: H.I.I.S. and H.II.S.

An index which assesses chronic destructive periodontal disease as well as provides assessment for gingival conditions is the Periodontal Index (PI) as developed by Russell (40). Criteria for this index is tabulated in Figure 2.

The condition of the investing tissues is estimated individually for each tooth in the mouth, and is scored according to a progressive scale which gives relatively little weight to soft tissue inflammation and relatively great weight to destruction of bone. The score for an individual is the arithmetic average of the scores for the teeth in the mouth. The population score is the arithmetic average of individual scores for the persons examined. Each tooth is scored according to the clinical condition of its supporting tissues. In the absence of overt inflammation in the free gingival, or loss of function due to destruction of investing tissues, a tooth is considered to be negative and is assigned a score of zero. The scale provides for two stages of simple gingivitis, differing only in the extent of inflammation, and
**FIGURE 2**

**CRITERIA USING RUSSELL'S PERIODONTAL INDEX**

<table>
<thead>
<tr>
<th>SCORE</th>
<th>CRITERIA FOR FIELD STUDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NEGATIVE  No inflammation in periodontium or loss of function due to its destruction.</td>
</tr>
<tr>
<td>1</td>
<td>MILD GINGIVITIS An overt area of inflammation in the free gingivae but which does not circumscribe the tooth.</td>
</tr>
<tr>
<td>2</td>
<td>GINGIVITIS Inflammation completely surrounding the tooth but no apparent break in the epithelial attachment.</td>
</tr>
<tr>
<td>6</td>
<td>GINGIVITIS WITH POCKET FORMATION Broken epithelial attachment producing a pocket, but no loss of masticatory function.</td>
</tr>
<tr>
<td>8</td>
<td>ADVANCED DESTRUCTION WITH LOSS OF MASTICATORY FUNCTION The tooth may be loose; may have drifted; may sound dull to percussion with a metallic instrument; may be depressible in its socket.</td>
</tr>
</tbody>
</table>

**RULE:** When in doubt, assign the lower score.
scored 1 and 2. A score of 6 is assigned when a periodontal pocket is demonstrated, except when tissue destruction is so far advanced that masticatory function has been impaired, in this case the highest score, 8, is given.

In application, the most difficult decision required of the examiner would seem to be that of distinguishing between negative gingivae and gingivae with mild gingivitis. Comparability at this point is enhanced if a score for gingivitis is assigned only when the inflammation is clearly evident at first sight in good light. Throughout the scale the problem of questionable diagnosis is minimised by the rule which required the examiner to assign a lesser score whenever he is in doubt.

Field equipment required to perform this index is reduced to a minimum. Mouth mirror and explorer are supplemented occasionally by a straight scaler or chip blower for demonstration of a periodontal pocket. Adequate light is essential from a source corrected to approximate the colour of sunlight.

Another index (PDI) based on reversible and irreversible criteria has been developed by Ramfjord (39). This scoring system for periodontal disease fulfils the following aims:-

a. Describes the distribution of the disease:–
   (i) in population groups.
   (ii) within each dentition
(iii) around each individual tooth.

b. Records the progress and behaviour of the disease.
c. Serves as a basis for evaluation of various aetiological factors in the pathogenesis of periodontal disease.
d. Allows an estimate of total need for periodontal therapy in population groups.

The index is based on strict procedures and criteria. Six teeth, the maxillary right first molar, maxillary left central incisor, maxillary left first bicuspid, mandibular left first molar, mandibular right central incisor and mandibular right first bicuspid are examined in order to indicate the periodontal condition of the whole mouth. Observations are made around each of the specified teeth, and deviation from health in terms of colour, form, density and bleeding tendency are noted.

Inflammation is scored in three degrees:—

a. A score of 1 for mild to moderate inflammatory gingival changes, not extending all around the tooth.
b. A score of 2 for mild to moderately severe gingivitis extending all around the tooth; and
c. A score of 3 for severe gingivitis characterised by marked redness, tendency to bleed and ulcerate.

When the gingival crevice is found, on probing, to be apical to the cemento-enamel junction, the inflammatory condition is ignored and a score of 4 or 5 assigned depending on the depth of crevice.
This method still requires considerable examiner skill and whether the sample teeth specified are representative of the whole mouth, especially where there has been extensive tooth loss, is still to be determined.

The Gingival-Bone count (GBC) of Dunning and Leach (14) follows a similar rationale (Figure 3) except that all teeth are examined and bone loss is estimated from radiographs.

Somewhat similar examination procedure is suggested for the Periodontal Disease Rate (PDR) as developed by Sandler and Stahl (41) wherein a probe and x-rays as used to examine the tissues.

Positive scores are assigned to gingival necrosis or inflammation encircling the tooth, a gingival crevice of 3mm or more, tooth mobility greater than one mm in any direction, or x-ray evidence of alveolar bone extending more than 3mm apically from the cemento-enamel junction. Gingival and bone conditions are combined as one score.

Most recently the USAF School of Aerospace Medicine - Dental Science Division (20) has produced an index for periodontal screening of USAF personnel. This index was not designed to provide a complete summary of existing gingival and periodontal health as would be obtained by full mouth x-rays and gingival probing, but rather to accurately determine the presence and location of any gingival or periodontal problem requiring treatment, and give a general estimate of the health of the tooth supporting structures.
### FIGURE 3
GINGIVA-BONE COUNT: A PERIODONTAL SCORING SYSTEM

<table>
<thead>
<tr>
<th>SCORE</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NEGATIVE</td>
</tr>
<tr>
<td>1</td>
<td>MILD GINGIVITIS  Involving the free gingiva.</td>
</tr>
<tr>
<td>2</td>
<td>MODERATE GINGIVITIS Involving both free and attached gingivae.</td>
</tr>
<tr>
<td>3</td>
<td>SEVERE GINGIVITIS WITH HYPERTROPHY AND EASY HAEMORRHAGE.</td>
</tr>
</tbody>
</table>

**GINGIVITIS**
(One score is assigned for each tooth studied, and a mean is computed for the whole mouth).

**BONE LOSS**
(One score is assigned for each tooth studied visually or by x-ray, and a mean is computed for the whole mouth).

<table>
<thead>
<tr>
<th>SCORE</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NEGATIVE</td>
</tr>
<tr>
<td>1</td>
<td>INCIPENT (Not greater than 2mm) bone loss.</td>
</tr>
<tr>
<td>2</td>
<td>BONE LOSS Approx. $\frac{1}{4}$ root length or pocket formation one side not over $\frac{1}{2}$ root length.</td>
</tr>
<tr>
<td>3</td>
<td>BONE LOSS Approx. $\frac{1}{2}$ root length or pocket formation one side not over $\frac{3}{4}$ root length. Mobility slight.</td>
</tr>
<tr>
<td>4</td>
<td>BONE LOSS Approx. $\frac{2}{3}$ root length or pocket formation one side to apex. Mobility moderate.</td>
</tr>
<tr>
<td>5</td>
<td>BONE LOSS COMPLETE Mobility marked.</td>
</tr>
</tbody>
</table>

8 is maximum GB count per person
In this examination system the mouth is divided into six segments:

a. Segment 1: upper right third molar to first bicuspid;
b. Segment 2: upper anterior teeth, canine to canine;
c. Segment 3: upper left first bicuspid to third molar;
d. Segment 4: lower left third molar to first bicuspid;
e. Segment 5: lower anterior teeth, canine to canine;
f. Segment 6: lower right first bicuspid to third molar.

The segments are examined in sequence for gingival status (G Score), periodontal status (P Score), and presence and extent of local irritants (I Score); hence is derived the GPI Index. Scoring is accomplished per media of periodontal and irritant indices, the higher score (gingival or periodontal) being used to compute the periodontal index whilst the irritant index is calculated separately. The periodontal index (Figure 4) is achieved by dividing the sum total of the high scores by the number of dentulous segments in accordance with the following criteria:

a. Gingival Score: G Score, for each dentulous segment with range between 0 and 3.

b. Periodontal Score: P Score, for each dentulous segment with pockets extending 1mm past the cemento-enamel junction.

The Irritant Score is derived from:

a. Determination of the presence and extent of local
irritants, including materia alba, supra or subgingival calculus, overhanging restorations, and underfilled restoration. Scores ranging from 0 to 3 are determined for each dentulous segment.

b. Computation of the Irritant Index is accomplished by totalling the individual scores and dividing by the number of dentulous segments.

The Irritant Index is scored in accordance with the following criteria:

SCORE 0: No detectable material alba or supragingival calculus present anywhere in the segment.

SCORE 1: Slight amount of material alba or calculus not extending more than 2mm from gingival margin.

SCORE 2: Material alba or supragingival calculus covering up to \( \frac{1}{2} \) clinical crown on any tooth surface.

SCORE 3: Material alba or supragingival calculus covering more than \( \frac{1}{2} \) the clinical crown, also subgingival deposits of calculus and over-hanging or defective restorations detectable by probing on tooth or root surfaces.
FIGURE 4
CRITERIA FOR CPI INDEX
GINGIVAL SCORE (20)

SCORE 1: Slight to moderate inflammatory change, involving one or more teeth in the segment; may include one or a combination of the following signs not completely surrounding any one tooth:
   a. any colour change from normal;
   b. loss of normal consistency of tissue as evidenced by retraction of the gingival margin (1 mm) when tissue is dried by a firm blast of air;
   c. blunting and slight enlargement of the marginal or papillary tissue when associated with (a) or (b).

SCORE 2: If above changes, singly or commonly, are found completely encircling one or more teeth in the segment.

SCORE 3: Marked inflammation present, including:
   a. Loss of surface continuity, necrotizing ulcerative gingivitis, chemical burns and mechanical trauma;
   b. spontaneous haemorrhage following thorough drying of tissue with a firm blast of air or from light probing;
   c. loss of continuity of any interdental papilla from facial to lingual aspect;
   d. marked deviation from normal gingival contour.

PERIODONTAL SCORE

SCORE 0: Probe does not extend 1 mm apically to C-E junction.

SCORE 4: Probe extends 3 mm apically to the C-E junction.

SCORE 5: Probe extends 3-6 mm apically to the C-E junction.

SCORE 6: Probe extends 6 mm apically to the C-E junction.
III. INDICES FOR RECORDING OTHER DENTAL CONDITIONS.

1. Oral Hygiene Indices

Oral Hygiene Index (OHI)

This index as devised by Green and Vermillion\(^{23}\) provides a systematic assessment of debris and calculus and has been particularly useful in studying the relationship between periodontal disease and oral cleanliness. This index is a simple quantitative expression of oral cleanliness and is based on clearly defined criteria which reduces examiners’ variations to a minimum.

This index has two components, the debris index and the calculus index. Each of these indices in turn, is based on twelve numerical determinations representative of the amount of debris or calculus found on the buccal and lingual surfaces of each of three segments of each dental arch:-

a. The segment distal to the right cuspid;

b. The segment distal to the left cuspid;

c. The segment mesial to right and left first bicuspid,

and the buccal or lingual surface with the most debris or calculus is scored for each segment.

Surface scoring is based on the fraction of tooth surface covered by debris or calculus, and only fully erupted teeth are included in the count. The buccal then lingual surfaces of teeth in the upper right posterior segment are examined and scored first, followed by the labial and lingual surfaces of the upper anterior
teeth. This procedure is continued in the upper left segment and subsequently repeated in the lower arch commencing with the left segment and concluding with the lower right. This routine is subsequently repeated in the examination for calculus.

The portion of surface area covered by debris is estimated by running an explorer along the buccal, labial and lingual surfaces, and noting the occlusal or incisal extent of the debris as it is removed from the tooth surface. Scores are allotted in accordance with Figure 5.

The method of scoring calculus is the same as that applied to debris, but additional provisions are made for recording subgingival deposits.

Scores for debris and calculus are tabulated separately and the index for each calculated independently, but in similar manner. The debris index for an individual is determined by totalling the debris scores recorded and then dividing by the number of segments scored. The maximum index is thus six, and the minimum is zero.

An identical procedure is used to determine the calculus index. The two indices are combined and expressed as the oral hygiene index (OHI), which has a possible range from zero to twelve. As the ratio of debris and calculus scores vary in respect of populations and age groups, both component indices should be shown in conjunction with the oral hygiene index.
<table>
<thead>
<tr>
<th>SCORE</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No debris or stain present.</td>
</tr>
<tr>
<td>1</td>
<td>Soft debris covering not more than one third of the tooth surface, or the presence of extrinsic stains without other debris regardless of surface area covered.</td>
</tr>
<tr>
<td>2</td>
<td>Soft debris covering more than one third, but not more than two thirds of the exposed tooth surface.</td>
</tr>
<tr>
<td>3</td>
<td>Soft debris covering more than two thirds of the exposed tooth surface.</td>
</tr>
</tbody>
</table>

**ORAL CALCULUS**

<table>
<thead>
<tr>
<th>SCORE</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No calculus present.</td>
</tr>
<tr>
<td>1</td>
<td>Supragingival calculus covering not more than one third of the exposed tooth surface.</td>
</tr>
<tr>
<td>2</td>
<td>Supragingival calculus covering more than one third but not more than two thirds of the exposed tooth surface, or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both.</td>
</tr>
<tr>
<td>3</td>
<td>Supragingival calculus covering more than two thirds of surface or subgingival calculus around the cervical portion of the tooth or both.</td>
</tr>
</tbody>
</table>
Simplified Oral Hygiene Index (OHI-S)

In order to reduce the number of examiner decisions and attendant inspection time as required by the OHI procedures, Greene and Vermillion developed the simplified oral hygiene index (OHI-S) (24).

This index differs from the original OHI in the number of tooth surfaces scored (six as apposed to twelve), the method of selecting the surfaces to be scored, and the scores which can be obtained. The criteria used for assigning scores to the tooth surfaces are the same as those used for the OHI. The OHI-S, like the OHI, has two components the debris index and the calculus index. Each of these indices is based on numerical determinations representing the amount of debris or calculus found on six preselected tooth surfaces.

The six surfaces to be examined are selected from four posterior teeth. Posteriorly, the first fully erupted tooth distal to the second bicuspid is examined, on each side of the arch. The buccal surfaces of the selected upper molars and the lingual surfaces of the selected lower molars are inspected. In the anterior portion of the mouth, the labial surfaces of the upper right and lower left central incisors are scored. In the absence of either of these anterior teeth, the central incisor on the opposite side of the midline is substituted.
2. Other Oral Health Indices

Prior to development of OHI, assessment of oral hygiene was indefinite and subject to individual examiner interpretation. A method used by Barnard (3) in a survey of N.S.W. school children was recorded:

GOOD: The mouth is clear - there is no debris in the mouth or around the teeth.

FAIR: The mouth is fairly clean, except that there is some debris in small areas.

POOR: There is a heavy accumulation of debris and no effort has apparently been made to remove it.

Another earlier index was designed by Hewat (26):

GOOD HYGIENE: No discernable debris on tooth.

FAIR HYGIENE: Discernable debris on tooth.

BAD HYGIENE: Pronounced debris on tooth.

3. Dental Fluorosis Index and Classification

Another index which has been crudely used, is the community fluorosis index originated by Dean (10). Individual teeth are classified as normal, questionable, very mild, mild, moderate, moderately severe, or severe fluorosis. Each person's status is determined by the two teeth showing the most advanced stages.

NORMAL: The enamel is translucent and of the semi-vitriform type of structure with smooth glassy surface, usually of a pale, creamy white colour.
QUESTIONABLE: Slight aberration in enamel translucency ranging from a few white flecks to occasional white spots. In some instances thin, irregular, white opaque streaks or veinings are noted on the incisal third of the superior incisors and occasionally the summit of bicuspids show unusual white opacities 2-3mm in extent, with the remainder of the tooth normal.

VERY MILD: Small, opaque, paper-white areas scattered irregularly or streaked over the tooth surface. These defects are usually observed on the labial or buccal surfaces, and involve up to 25 per cent of the tooth surface of the particular teeth affected. Small, pitted, white areas are frequently found on the summit of the cusps.

MILD: White opaque areas in tooth enamel which involve at least half of the tooth surface. Surfaces of molars, bicuspids and cuspids subject to attrition, show thin white layers worn off, and bluish shades of underlying normal enamel become apparent. Light brown stains are sometimes present, generally on the superior incisors.

MODERATE: Minute pitting is often present, generally on labial and buccal surfaces. Brown stain is frequently a
disfiguring complication but for the most part
the stain ranges from tan to chocolate in colour
and frequently involves as much as half of the
labial surface.

**MODERATELY SEVERE:** A greater depth of enamel appears to be involved and
a smoky white appearance is often noted. Pitting
is more frequent and generally observed on all
tooth surfaces; these pits are discrete and may be
1-2mm in diameter. Brown stain, if present, is
generally deeper in hue and involves more of the
tooth surface.

**SEVERE:** Hypoplasia is so marked that tooth form is effected;
older children often present a mild incisal-occlusal
pathologic abrasion. Pits are very deep and often
confluent. This confluent pitting results in the
loss of outer enamel surface and the tooth often
presents a corroded appearance. Stains are widespread
and range from chocolate brown to almost black.

4. **Idiopathic Mottling and Enamel Fluorosis Classification**

A further classification of mottling and fluorosis is based
on etiological factors:—

**NORMAL:** No mottling present. Enamel is smooth, glossy, trans-
lucent and pale creamy-white in colour.

**ACCEPTABLE IDIOPATHIC MOTTLING:** White opacities or pigmented
spots are present, without associated hypoplasia.
Patient's appearance is not seriously affected, therefore treatment is not required.

UNACCEPTABLE IDIOPATHIC MOTTLING: The white opacity, pigmentation or staining constitutes a handicap to the patient's physical appearance, or hypoplasia adversely affects the patient's appearance or predisposes to excessive wear.

ACCEPTABLE ENAMEL FLUOROSIS: An enamel opacity varying from a slight aberration in the normal translucency of the enamel is a white opaque area not exceeding 50 per cent of the enamel surface. Hypoplasia is absent.

UNACCEPTABLE ENAMEL FLUOROSIS: White opacities or pigmented areas affecting 50 per cent or more of the enamel surfaces or marked hypoplasia with discrete or confluent pitting of the enamel which constitutes a handicap to the patient's appearance and the teeth are subject to excessive wear.

Differentiation between idiopathic defects and fluorosis can be made on the basis of the patient's history. The differentiation of acceptable and unacceptable is based on the status of the tooth showing the severest defect. An unacceptable condition would require treatment to eliminate the handicap or defect.
C. OTHER INDICES AND INTERPRETATION OF DATA.

I. MALOCCLUSION

Failure to agree on objective criteria has hindered the development of universally acceptable indices of malocclusion. In the past subjective elements have rendered impossible, comparisons between survey results of different age groups in the various countries throughout the world.

1. Indices of Malocclusion

An acceptable index of malocclusion must express bony disharmonies as well as dental deviations and neuro-muscular abnormalities which cause malocclusion; and in accordance with requirements as expressed by Massler, must:

a. represent the situation with reasonable accuracy in a survey.

b. be simple, as it may have to be quickly applied to a large group.

c. be reproducible, comparable and reliable.

d. be non-complicated in order that general practitioners can use the index.

Many indices have been devised, the first being founded on Angle's classification. This method, however, was unsuccessful as it did not indicate the severity of the condition and therefore did not meet the requirements of comparability and objectivity.
Massler and Frankel (34) modified Angle's classification and produced an index based on individual teeth as being representative of units of occlusion rather than arch segments. Twenty eight teeth were regarded in relation to an ideal parabola and each offending tooth was credited with an appropriate score. Whilst this method was simple, objective and quantative, it did not indicate antero-posterior jaw relationships or the amount of overjet, overbite or crowding. Additionally, it did not indicate the need or length of the treatment period, nor did it illustrate osseous discrepancy or abnormal neuro-muscular patterns.

Another subjective index was devised by Moore (36) which registered the clinical orthodontic needs of patients in terms of restoration or aversion to ill health. Being subjective it was neither comparable or quantative but it was, however, useful as a method of preliminary screening to assess the needs of the community, pending sophistication of a more suitable method.

The first acceptable objective index of malocclusion which could be applied to the community at large, was produced by Draker (11). This index measured the Handicapping Labio-lingual Deviation (HLD) of teeth in relation to the need for treatment, and included cleft palates as well as maloccluded teeth.

Weighted scores are given to the following:
<table>
<thead>
<tr>
<th>CONDITIONS</th>
<th>HLD SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cleft Palate</td>
<td>Score 15</td>
</tr>
<tr>
<td>b. Severe traumatic deviations</td>
<td>Score 15</td>
</tr>
<tr>
<td>c. Overjet in mm</td>
<td></td>
</tr>
<tr>
<td>d. Overbite in mm</td>
<td></td>
</tr>
<tr>
<td>e. Mandibular protrusion in mm</td>
<td>X5</td>
</tr>
<tr>
<td>f. Open bite in mm</td>
<td>X4</td>
</tr>
<tr>
<td>g. Ectopic eruption (anterior only) each tooth</td>
<td>X3</td>
</tr>
<tr>
<td>h. Anterior crowding maxilla-mandible</td>
<td>Score 5 each</td>
</tr>
<tr>
<td>j. Labio-lingual spread in mm</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL

A score of 13 and over constitutes a physical handicap.

This method conforms to Massler's requirements and is currently used in New York for purposes of screening handicapping conditions for treatment by public dental health facilities.

Van Kirk and Pennell (47) also developed a Malignment Index (MI) which is based on displacement of individual teeth in the anterior right and left posterior segments of the upper and lower arches. This method is objective in design, simple and quick to use, and attains a high degree of reproducibility. It does, however, lack specificity of the actual relationships of the
jaws.

Another method of malocclusion measurement is the Occlusion Feature Index (OFI) as originated by the US National Institute of Dental Research and reported by Poulton and Aaronson (38). This index is based on assessment of four primary features of occlusion:

a. Crowding in the lower anterior segment:
   - SCORE 0: no crowding.
   - SCORE 1: crowding of lower anterior teeth equivalent to one-half the width of the lower right central incisor.
   - SCORE 2: crowding equivalent to the width of one central incisor.
   - SCORE 3: crowding exceeding width of one central incisor.

b. Cuspal interdigititation of right pre-molar and molar area observed from the buccal aspect:
   - SCORE 0: cusp to groove relationship.
   - SCORE 1: between cusp and groove.
   - SCORE 2: cusp to cusp.

c. Vertical overbite, measured by that portion of lower incisors in occlusion:
   - SCORE 0: incisal third of lower incisors covered.
   - SCORE 1: middle third of lower incisors covered.
   - SCORE 2: gingival third of lower incisors covered.
d. Horizontal overjet, measured from labial surface of upper incisors to labial surface of lower incisors:

SCORE 0: Zero to 1.5mm.
SCORE 1: 1.5mm to 3mm.
SCORE 2: 3mm and over.

This method measures deviations from desirable positions of teeth within the dentition and satisfied most of Massler's requirements. It does not however indicate:

a. The need for treatment of severity of malocclusion.

b. Posterior spacing or crowding.

c. Upper anterior crowding or ectopic eruption; or
d. Mandibular prognathism.

Godfrey (21) has recently modified the OFI and expanded it to include additional features:

a. Crowding in the lower posterior segment - left and right sides are scored separately.

SCORE 0: no crowding.
SCORE ½: crowding of lower posterior teeth equivalent to one half the width of the lower bicuspids.
SCORE 1: crowding equivalent to width of one-half to one bicuspids.
SCORE 2: crowding equivalent to width greater than one bicuspids.

b. Cuspal interdigitation scored separately on left and right side.
c. Vertical overbite is divided into open and closed bite; and

SCORE 3: more than gingival third of lower incisors covered; is added.

d. Horizontal overjet is extended to cover mandibular protrusion as well as maxillary protrusion; and

SCORE 3: where labial surface of lower incisor lies beyond the gingival margin of the upper incisor; is added.

e. Buccal-lingual relationship (cross-bite) of molars and/or premolars are scored separately on left and right sides.

f. Functional mandibular shift is recorded.

Another index of malocclusion based on dentofacial morphological measurement in relation to specific anthropological facial landmarks by means of a facial orthometer, has been described by Elsasser (16) (17). This index, termed the Dentofacial Index (DFI), compares the orthometric findings with mean values of predetermined measurements obtained from children who appear to possess an ideal occlusion. Scoring is as follows:

SCORE 0: for measurements within one standard deviation of the predetermined results.

SCORE 1: for measurements within two standard deviations.

SCORE 2: for measurements within three standard deviations.
SCORE 3: for measurements outside the limits of three standard deviations.

A weight of three (3) is scored separately when cross-bites or crowded arches are present. Scores range from 0 - an ideal dentofacial pattern, to 21 - the most extreme dentofacial malrelation.
II. CLASSIFICATION OF BROKEN INCISORS

This classification as developed by Ellis (15) is basically a descriptive classification designed for clinical rather than epidemiological studies. A quantitative element can be included in this classification and consequently assessments of prevalence rates and assessment of relative severity of traumatised teeth in comparison with other groups, can be derived. Classification of fractures is as follows:

CLASS 1: Simple fracture of crown - involving little or no dentine.

CLASS 2: Extensive fracture of crown - involving considerable dentine, but not the dental pulp.

CLASS 3: Extensive fracture of crown - involving considerable dentine and exposure of dental pulp.

CLASS 4: Traumatised tooth which has become non-vital - with or without loss of crown structure.

CLASS 5: Tooth lost as a result of trauma.

CLASS 6: Fracture of root - with or without loss of crown structure.

CLASS 7: Displacement of tooth - without fracture of crown or root.

CLASS 8: Fracture of crown en masse, and its replacement.

CLASS 9: Traumatic injuries to deciduous teeth.
III. PROSTHETIC CODING

Although it is a coding and not a quantitative order Logan (33) has illustrated a method as developed by Beck, whereby scores are awarded to subjects either wearing or requiring denture prosthesis in accordance with the following criteria:

<table>
<thead>
<tr>
<th>SCORE</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UPPER</td>
</tr>
<tr>
<td>0</td>
<td>0 Edentulous, new full denture required</td>
</tr>
<tr>
<td>1</td>
<td>1 Full clearance required, new full denture</td>
</tr>
<tr>
<td>2</td>
<td>2 Wearing full denture, satisfactory</td>
</tr>
<tr>
<td>3</td>
<td>3 Wearing full denture, replacement required</td>
</tr>
<tr>
<td>4</td>
<td>4 Wearing full denture, adjustment required</td>
</tr>
<tr>
<td>5</td>
<td>5 Partially edentulous, new partial required</td>
</tr>
<tr>
<td>6</td>
<td>6 Extractions required, new partial required</td>
</tr>
<tr>
<td>7</td>
<td>7 Wearing partial denture, satisfactory</td>
</tr>
<tr>
<td>8</td>
<td>8 Wearing partial denture, replacement required</td>
</tr>
<tr>
<td>9</td>
<td>9 Wearing partial denture, adjustment required</td>
</tr>
</tbody>
</table>
IV. INTERPRETATION OF STATISTICAL DATA

'However great may be our aversion to figures, we cannot escape the conclusion that the solution of most of the problems of clinical or preventive medicine must ultimately depend on them' (22). Yule has defined statistics as 'methods specially adapted to the elucidation of quantitative data affected by a multiplicity of causes' (13); and although not new to dentistry dental health statistics has proceeded parallel to other fields of health statistics. With the upsurge of interest in dental public health, it has become highly desirable to establish international standards upon which surveys can be based for the planning and evaluation of dental services and for epidemiological studies (52).

Data once recorded must be summarised and understood. Some one measurement must be taken as characteristic of all observations in the sample, in order that comparison may be made with a similar characteristic measurement in another sample or samples. The central point of the frequency distribution is usually of most interest for it is around this point the greatest number of observations are likely to be found.

The three measurements of central tendency are the mean, or average, the median, and the mode. Of these three central values the mean is the value of choice for further mathematical analysis, particularly when testing differences between samples or populations to determine whether such differences could have occurred by chance.
In describing a series of measurements the variability of the measurements about the average must be taken into account, for individual measurements may cluster closely about the average or may deviate widely.

Before the significance of a difference between two mean values can be tested, the reliability of each mean must be determined. The two chief criteria associated are, the width of dispersal or scatter of individual scores about the mean and the number of items in the sample. The most acceptable measure of scatter is termed the standard deviation and has been defined as a description of the distribution of individual findings around the average (53), or, a measure of variability of data about a mean. It is determined by the formula:

\[ SD (\sigma) = \sqrt{\frac{\text{Sum of the squares of all deviations from the mean}}{\text{Number of observations comprising the mean}}} \]

and measures a fundamental characteristic of the sample irrespective of its size. A standard deviation which is large compared to the size of the arithmetic mean, indicates that the measurements are spread out, whilst a small standard deviation as compared to the size of the mean indicates the measurements are more closely clustered around the mean.

The larger the sample is, the closer it approximates the full size of the universe and the more nearly the sample mean approximates the mean of the universe. The reliability of a mean
therefore depends not only on the scatter of observations on either side of it, but also on sample size upon which it is based. A figure which measures the reliability of a mean and describes the expected deviation of means whilst recognising the variability of the individual measurements and sample sizes, is termed the standard error of the mean. The standard error indicates limits within which means of other similar samples will fall and can thus be used for predicting what proportion of a series of sample means (of similar size) will fall a given distance from the mean of the universe. Standard error of the mean is derived from the formula:

\[ SE = \frac{\text{Standard deviation}}{\sqrt{\text{Number of measurements of sample}}} \quad \text{or} \quad \frac{\sigma}{\sqrt{N}} \]

1 Standard Error: Approximately 68% of other means would be found within the range of one standard error either side of the mean.

2 Standard Errors: Approximately 95% of other means would be found within the range of two standard errors either side of the mean.

3 Standard Errors: Approximately 99.73% of other means would be found within the range of three standard errors either side of the mean.

Where only one sample is taken, a relative number (rate or percentage) could describe the variation of the rates or percentages
of other similar samples. However, where more than one sample is taken the rate or percentage will vary and tend to cluster about some central value which would represent the true rate of percent of the universe being studied. An indication of how much variation there would be in the true rate or percentage or other rates and percentages of samples drawn from the same universe may be derived from calculating the standard error of a rate or percentage, which is formulised:

\[
\text{SE of a rate or percentage} = \sqrt{\frac{pq}{N}}
\]

when \( p \) = probability of the event occurring, \( q \) = probability of event failing to occur, and \( N \) = the sample size.

One of the main reasons for estimating the standard error of a mean is to ascertain as to whether the difference between the mean derived and another mean could have arisen by chance. If the difference observed between the two means (or two rates or percentages) could be due to chance the difference is not statistically significant, alternatively, if there is only a small probability of the difference being due to chance, then the difference is significant statistically.

Whether an observed difference is statistically significant depends on its size when compared to the standard error of the difference. The standard error of the difference is dependent upon the standard error of the two means (rates or percentages) and is the square root of the sum of the squares of the standard
errors of the two means (rates or percentages); and is formulated:

\[
\text{Standard Error of Difference} = \sqrt{(SE_A)^2 + (SE_B)^2}
\]

The final step in a significance test upon differences between means is achieved by computation of the significance ratio. This ratio determines how large the difference is when compared to the size of the standard error, and is formulated:

\[
\text{Significance Ratio} = \frac{\text{Difference}}{\text{Standard Error of Difference}}
\]

The larger the significance ratio, the greater the difference compared to the size of its standard error, the less likelihood that the difference is due to chance, the more significant statistically the difference, the less the risk of being wrong in stating that the difference is a real one, not due to chance. Generally, the following interpretation applies:

<table>
<thead>
<tr>
<th>If the Significance Ratio is</th>
<th>the observed difference is</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 or more</td>
<td>clearly significant</td>
</tr>
<tr>
<td>2 to 3</td>
<td>probably significant</td>
</tr>
<tr>
<td>1 to 2</td>
<td>probably not significant</td>
</tr>
<tr>
<td>less than 1</td>
<td>not significant</td>
</tr>
</tbody>
</table>

Another test of importance in small sample work, particularly sample groups whose numbers total less than thirty, is the 't' test. The quantity 't' is a value to be interpreted in terms of probability much as is the significance ratio, but also degrees of freedom have been added. When the difference between two
means is twice as great as the standard error of the difference, the probability is about nineteen to one that the difference is due to something beyond chance. This statistic is called the t test and the ratio between the difference and its standard error is called the t value.

A test used to determine whether the deviation between observed and the theoretical measures or frequencies is greater than that which could be due to chance was developed by Pearson in 1900, and called the $X^2$ test; pronounced chi squared. The $X^2$ test may be applied to test:

a. the statistical significance of an observed association of variables of two attributes;

b. an observed frequency distribution to determine the 'goodness of fit' to the pattern of the normal distribution.

In using this test a null hypothesis is assumed – that is, the assumption is made that nothing but the laws of chance have operated in producing the observed frequencies, that the deviation between what has been observed and the theoretical is merely chance deviation.

Interpretation of the $X^2$ test requires the use of the $X^2$ table; in formula:

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where large numbers of observations are to be compared, each related to the other on an internal scale, calculation of a correlation co-efficient is made which not only determines the
probability of accidental occurrence of the observed relation, but also provides a numerical measure of the relation in terms of a co-efficient \((13)\). As the objective of determinative epidemiological research is to discover relations between the way of life or the environment of a population and the prevalence or severity of disease, considerable use is made of correlation analysis. In the simplest form these involve determination of the relation between one population factor and some one other factor. When this relation is a straight line it can be expressed as the co-efficient of correlation \((r)\) which may vary in value between zero and \(+1.0\) or zero and \(-1.0\). When the relation is curvilinear rather than a straight line, the relation may be expressed as the correlation ratio \((n)\), with a single positive range of values between zero and 1.0.

Co-efficient of correlation \((r)\)  
0.2  No correlation  
0.2 to 0.4 Low correlation  
0.4 to 0.7 Moderate correlation  
0.7 to 0.9 High correlation  
0.9 Very high correlation

Where \(x\) and \(y\) are deviations of measurement from the means of their respective series, the co-efficient of correlation is determined,

\[
r = \frac{\langle xy \rangle - \langle x \rangle \langle y \rangle}{\sqrt{\langle x^2 \rangle - \langle x \rangle^2} \sqrt{\langle y^2 \rangle - \langle y \rangle^2}}
\]

or expressed for calculating machine:

\[
r = \frac{N \langle xy \rangle - \langle x \rangle \langle y \rangle}{\sqrt{N \langle x^2 \rangle - \langle x \rangle^2} \sqrt{N \langle y^2 \rangle - \langle y \rangle^2}}
\]
Correlation analysis, potentially the most valuable in epidemiology are particularly apt to be misleading. The correlation model requires strictly random samples and 'normal' universes, and the higher the number of independent variables in a multiple correlation, the greater the chance of falsely high estimates (53). It should always be remembered that no correlation estimate can prove that one factor is the cause of another, no matter how suggestive the words, or how logical the inference.
PART TWO.

TREATMENT NEEDS OF AUSTRALIAN ADULTS.
INTRODUCTION.

Before dental resources can be efficiently and effectively utilised in an organised programme of dental care the major pre-requisites of needs and demands must be known of the community (13) (5). Various estimates of community health needs have been made of the many groups of the Australian population over the past twenty years. It is now intended to examine these studies and, where appropriate, review the findings in terms of acceptable dental criteria as previously described.
I. PREVALENCE OF DENTAL CARIES

Prior to the development of the DMF index, dental caries prevalence studies were confined to assessment of people possessing one or more carious teeth. The DMF index as developed by Klein and Palmer (28) made accurate scoring of caries experience possible, such that reliable and reproducible studies in dental caries could be achieved in the community at large. One of the early studies of caries prevalence in Australia was conducted by Andrews (1) on male and female RAAF personnel during World War II, 1939–1945. Using standardised examination techniques a random sample of 2000 male recruits aged between 18 to 40 years were examined on arrival at recruit depots and found to have a DMFT of 19.73 which comprised 3.57 teeth requiring extraction, 9.73 teeth requiring replacement and 4.76 teeth satisfactorily restored.

Analysis of male recruits by age groups showed that:

a. The number of teeth affected by dental disease increased progressively with age.

b. The number of teeth lost through dental disease increased progressively with age.

c. The increased incidence of tooth loss is more marked in older age groups, among whom many teeth are lost per patient.

d. The proportion of teeth conserved, out of those affected, decreases with age.
A comparative sample study of female recruits illustrated at Table 1, that whilst the forementioned principles similarly applied, females in like age groups had a higher DMF index and more teeth missing than males. It was thus shown that the prevalence of dental disease is higher in females than males, that it increases with age, and appears to be influenced by environmental conditions such as:

a. Geographical and climatic conditions; and

b. Through dietary deficiencies and imbalance,
   and that dental disease was not affected by intrinsic qualities such as:
   (i) intellectual standard;
   (ii) standard of general health.

Other conclusions drawn from this study were that conservation of teeth affected by dental disease is:

a. Closely correlated with the intellectual standard.

b. Directly related to the standard of general health.

c. Governed principally by the availability of dental service.

d. Influenced in middle and lower socio-economic groups by the dental service provided for children by government instrumentalities, and by rural-urban distribution of the population.

Andrews also illustrated the close correlation between dental status and intellectual standard by comparison of DMFT and MT
indices between aircrew and ground staff personnel (Table 2), and higher and lower trade musters (Table 3), by age groups. Analysis showed that the dental health of male and female personnel in the higher (technical) trades was superior to that of the lower (unskilled) musterings. More recently Hutchinson (27) conducted a study on 140 Australian-borne school children and the trend for the more intelligent children to possess better standards of dental health was noted, particularly from the aspects of oral hygiene, gingival disease and dental caries.

Further demonstration as to the geographical distribution of dental caries was illustrated by Woolcott (50) following examination of all Naval recruits over the period 1954-57. The analysis also indicated a general increase in the DMFT index from 14.5 to 15.7, for all states as the years progressed, (Table 4).

Using the DMFT index supported by radiographs Woolcott (49) also noted a variation in the incidence of dental caries in cadet naval personnel over a four year period, which increased from a DMFT of 7.4 for 14 year olds on entry to a DMFT of 13.5 for 18 year olds on graduation.

Following a survey of nine hundred and fifty five Army personnel in 1960, Duncan (12) showed the mean DMFT of age groups
### TABLE 1
**DMFT AND MT VALUES OF RAAF MALE & FEMALE RECRUITS** (1)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 - 19 years</td>
<td>16.30</td>
<td>17.33</td>
<td>7.27</td>
<td>7.49</td>
</tr>
<tr>
<td>20 - 24 years</td>
<td>18.01</td>
<td>20.70</td>
<td>8.30</td>
<td>10.44</td>
</tr>
<tr>
<td>25 - 29 years</td>
<td>19.81</td>
<td>22.47</td>
<td>11.76</td>
<td>14.00</td>
</tr>
<tr>
<td>30 - 34 years</td>
<td>21.34</td>
<td>27.09</td>
<td>14.57</td>
<td>21.39</td>
</tr>
</tbody>
</table>

### TABLE 2
**DMFT AND MT VALUES OF RAAF GROUNDESTAFF AND AIRCREW PERSONNEL** (1)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Gnd Staff</th>
<th>Aircrew</th>
<th>Gnd Staff</th>
<th>Aircrew</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 - 19 years</td>
<td>16.16</td>
<td>16.70</td>
<td>7.90</td>
<td>5.49</td>
</tr>
<tr>
<td>20 - 24 years</td>
<td>17.68</td>
<td>18.52</td>
<td>8.95</td>
<td>7.33</td>
</tr>
<tr>
<td>25 - 29 years</td>
<td>19.48</td>
<td>20.56</td>
<td>12.98</td>
<td>8.93</td>
</tr>
<tr>
<td>30 - 34 years</td>
<td>21.59</td>
<td>20.07</td>
<td>15.03</td>
<td>10.37</td>
</tr>
<tr>
<td>35 - 39 years</td>
<td>23.85</td>
<td>17.58</td>
<td>17.59</td>
<td></td>
</tr>
<tr>
<td>40 + years</td>
<td>26.42</td>
<td>21.59</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 3
**DMFT AND MT VALUES OF HIGHER & LOWER TRADE MUSTERINGS** (1)

| | MALES | | |
| | DMFT | MT |
| Higher Musterings | 17.77 ± 0.836 | 9.04 ± 0.509 |
| Lower Musterings | 17.70 ± 0.473 | 10.63 ± 0.589 |

| | FEMALES | |
| Higher Musterings | 17.26 ± 0.414 | 6.77 ± 0.454 |
| Lower Musterings | 17.83 ± 0.481 | 10.87 ± 0.594 |
between eighteen and forty years to be 18.6, and ranged between 17.3 and 22.8, (Table 5). He also showed that for the whole groups the total number of decayed teeth per individual was 5.1 of which 0.81 represented teeth requiring extraction and 4.3 teeth requiring restoration.

In a study of 6787 N.S.W. school children in 1954-55, Barnard (3) illustrated a DMFT of 11.9 and 13.74 respectively for fourteen year old boys and girls (urban and rural), which increased to a DMFT of 13.63 and 14.19 respectively for the fifteen year age group. From the same study he also showed a DMFS per child as being 25.7 and 19.1 for the fourteen and fifteen year age groups respectively.
### TABLE 4

**GEOGRAPHICAL DISTRIBUTION OF DENTAL CARIES PREVALENCE (50)**

AND DMFT IN RAN PERSONNEL - 1958

<table>
<thead>
<tr>
<th>STATES</th>
<th>Pre-War DMFT</th>
<th>1954 DMFT</th>
<th>1955 DMFT</th>
<th>1956 DMFT</th>
<th>1957 DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Aust.</td>
<td>11.4</td>
<td>12.0</td>
<td>11.5</td>
<td>14.2</td>
<td>13.3</td>
</tr>
<tr>
<td>West Aust.</td>
<td>11.7</td>
<td>13.7</td>
<td>13.2</td>
<td>14.8</td>
<td>15.8</td>
</tr>
<tr>
<td>N.S.W.</td>
<td>13.2</td>
<td>14.0</td>
<td>14.8</td>
<td>14.5</td>
<td>15.8</td>
</tr>
<tr>
<td>Queensland</td>
<td>13.3</td>
<td>15.0</td>
<td>15.5</td>
<td>16.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Victoria</td>
<td>14.5</td>
<td>15.6</td>
<td>14.9</td>
<td>16.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Tasmania</td>
<td>15.1</td>
<td>16.0</td>
<td>15.6</td>
<td>17.0</td>
<td>16.6</td>
</tr>
<tr>
<td>Average DMFT</td>
<td>13.6</td>
<td>14.5</td>
<td>14.5</td>
<td>15.0</td>
<td>15.7</td>
</tr>
</tbody>
</table>

### TABLE 5

**MEAN NUMBER OF DMFT AND TEETH REQUIRING TREATMENT (12)**

AND TEETH REQUIRING TREATMENT - ARA-CMF PERSONNEL - 1960

<table>
<thead>
<tr>
<th>Age</th>
<th>Number</th>
<th>DMFT</th>
<th>SD</th>
<th>SE</th>
<th>DT</th>
<th>XT</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>63</td>
<td>18.5</td>
<td>4.10</td>
<td>±0.366</td>
<td>4.66</td>
<td>1.44</td>
</tr>
<tr>
<td>19</td>
<td>153</td>
<td>17.9</td>
<td>5.67</td>
<td>±0.323</td>
<td>4.72</td>
<td>0.98</td>
</tr>
<tr>
<td>20</td>
<td>271</td>
<td>17.3</td>
<td>5.35</td>
<td>±0.230</td>
<td>4.75</td>
<td>0.95</td>
</tr>
<tr>
<td>21</td>
<td>193</td>
<td>18.8</td>
<td>5.37</td>
<td>±0.284</td>
<td>4.88</td>
<td>0.82</td>
</tr>
<tr>
<td>22</td>
<td>92</td>
<td>18.0</td>
<td>5.73</td>
<td>±0.423</td>
<td>3.50</td>
<td>0.60</td>
</tr>
<tr>
<td>23-25</td>
<td>93</td>
<td>19.7</td>
<td>5.58</td>
<td>±0.409</td>
<td>3.50</td>
<td>0.53</td>
</tr>
<tr>
<td>26-40</td>
<td>90</td>
<td>22.8</td>
<td>5.68</td>
<td>±0.423</td>
<td>2.52</td>
<td>0.38</td>
</tr>
<tr>
<td>18-40</td>
<td>955</td>
<td>18.6</td>
<td>5.74</td>
<td>±0.132</td>
<td>4.29</td>
<td>0.81</td>
</tr>
</tbody>
</table>
Comparison of Duncan's findings with those of Barnard indicates that adults of the eighteen to forty years age group require almost half as many restorations again (4.3 vrs 3.3), and six times as many extractions (0.81 vrs 0.14) as children in the six to fifteen years age group.

DMFT findings of Australian males aged between six and twenty four years by Barnard (3), Dale (9) and Duncan (12) are illustrated at Figure 6. A general increase in dental caries experience of males is evident as age progresses, and rises from a DMFT of 0.77 for the six years of age group to a DMFT of 21.69 for the twenty four years age group. On comparison of five year age groups for regular service male personnel between nineteen and thirty four years, Dale indicates a higher DMFT finding than Andrews (Figure 7). This difference may possibly be explained by a general and progressive increase in the main DMFT index of age groups over the years, as suggested by Woolcott (50) Table 4; or more probably is due to the difference in diagnostic procedure wherein Dale used visual as well as radiographic diagnostic aid, as opposed to the study by Andrews which provided for visual examination only. Mean value of diseased teeth (DT) requiring restoration is graphed at Figure 8 from the findings of Dale, Duncan, and the 1964 Tamworth Fluoridation Dental Survey (45). The relatively lower DT values as revealed by Dale in the seventeen to twenty four years age group is probably
FIGURE 6

DMFT OF AUSTRALIAN MALES

BY AGE 6 – 24 YEARS

Findings by: Barnard (3)
Dale (9)
Duncan (12)
FIGURE 7

DMFT OF PERMANENT SERVICE

PERSONNEL BY AGE GROUPS

Findings by: Andrews (I) —
Dale (9) —
FIGURE 8

MEAN DT VALUES OF AUSTRALIANS BY AGE 6–24 YEARS

Findings by: Dale (9), Duncan (12), Tamworth (45)

AGE IN YEARS

TEETH
due to the regular dental care as provided for permanent service personnel, and the slightly higher values as determined by Duncan reflect findings from a mixture of part-time as well as full-time service personnel. The tendency for the DT curve to deteriorate at approximately 6.7 in the twelve to eighteen year age group is therefore slightly misleading for Dale (9) and Storey (44) have shown DT values of 7.2 for NST and CMF personnel in the twenty and twenty one year age group respectively.

In a detailed study, which included full mouth and bitewing radiographs of eighty eight final year dental students with an average age of twenty two years ten months, Barnard and Bradley (6) showed the average student to possess a DMFT of 18.6 a DMFS of 46.8 ± 1.97, a DS of 7.0 and a DT of 5.7.

Findings resultant to entry examination of 177 RAAF apprentice personnel in the sixteen year age group, which included the use of radiographic diagnostic aid, showed a mean DT value of 5.04. During the same period 1963-64, adult recruit personnel in the eighteen to twenty two year age group revealed a mean DT value of 6.59.

In contrast to the foregoing Shannon et al (43) conducted dental examinations supported by radiographs, on 5298 recently enlisted males in the seventeen to twenty-two year group in the US Air Force. The sample comprised personnel from all parts of
the United States and excluded recruits who presented with fewer than twenty teeth, as well as third molars.

The analysis compared with Dale's findings on Australian Army personnel of the same age group in the following manner:

<table>
<thead>
<tr>
<th>Aust. Army</th>
<th>U.S. Air Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMFS 58.22</td>
<td>27.9</td>
</tr>
<tr>
<td>DS 5.68</td>
<td>11.2</td>
</tr>
<tr>
<td>DT 4.38</td>
<td>6.8</td>
</tr>
<tr>
<td>FS 9.32</td>
<td>12.8</td>
</tr>
<tr>
<td>FT 5.56</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Figure 9 illustrates the number of carious teeth requiring extraction (XT) in the seven to twenty-two year age group. It should be noted however that Barnard's findings, are representative of both boys and girls in the seven to fifteen year age group, whilst Duncan's XT findings refer to CMF males in the eighteen to twenty-two year age group.

As may be determined from Table 5, Duncan also determined the mean XT value of these personnel in the eighteen to forty year age group to be 0.81. This value appears higher than the mean XT value as determined by analysis of treatment records of RAAF adult recruit personnel of the same age group who entered the service during the period 1962-66, but is notably lower than the mean XT RAAF values of 1.03 observed during the period 1952-56, and 1.07 during the period 1939-45.
Mean XT values for the sixteen year old RAAF apprentice entrants in 1964 revealed an XT of 0.92.

Investigation as to missing teeth (M+X) and expressed as the mean number of teeth missing or due for extraction was undertaken by Duncan (12) and Dale (9) in respect of a military population. From a total of nine hundred and fifty five CMF and regular service personnel Duncan found the mean MT value to vary between 5.3 and 12.5 in the eighteen to forty year age groups respectively, whilst Dale determined the mean MT value to vary between 6.91 and 14.74 for regular Army personnel between the age groups of seventeen to twenty-two years respectively. Dale also investigated one hundred and seventeen NST's in the twenty year old age group and found the mean MT value to be 6.61.

In a survey conducted on final year dental students Barnard and Bradley (6) found the mean MT value for the twenty two year age group to be 1.80. This value was relatively low in comparison with the foregoing findings, and indicated a high amount of previous dental care.
MEAN XT VALUES OF AUSTRALIANS BY AGE 7-22 YEARS

Findings by: Bernard (3)
Duncan

AGE IN YEARS

0 1.5 3 4.5 6

X-DEPTH

0 2.0 4.0 6

22 20 18 16 14 12 10 8

FIGURE 9
II. PREVALENCE OF PERIODONTAL DISEASE.

It has been suggested by Cunningham (8) that the main reason as to the lack of statistical information about the prevalence of periodontal disease in the Australian population is that the incidence of dental caries is so high that the caries problem has overshadowed all other problems in the planning of treatment services, prevention, education and research. Whatever the reason the dearth of periodontal information in respect of the Australian population is most apparent and those publications which are available are mostly of limited value as they record subjective observations or opinions based solely on visual examination of the gingivae, and, are usually performed incidental to an examination for carious cavities.

In many communities approximately half the child population and almost the entire adult population is affected. Harris (25) states that it is reasonably certain that few health departments are aware of the magnitude of the disease in their communities, nor do they have an appreciation of the situation which is supported by research and clinical evidence. He also states that the damage caused to the supporting structures of the teeth by periodontal disease in early adult life is irreparable, and that many people have lost all their teeth long before old age because of such damage.
Recognising the tremendous magnitude of periodontal disease, the World Health Organization (51) set up an expert committee with Dr. A.L. Russell as Chairman. Inclusive in its findings this committee reported a positive correlation between mouth cleanliness and the health of periodontal structures. When further related to investigations as conducted by Hutchinson (27) this finding is of additional interest for a positive correlation has also been illustrated between intelligence based on IQ scores and oral hygiene and gingival disease. This latter correlation was also confirmed by Barnard and Bradley (6) in their detailed examination of final year dental students at Sydney University in the years 1962 and 1963.

In recent research in respect of periodontal conditions of the Australian population, Lilienthal and Amerena (31) illustrated that the distribution of gingivitis among eight hundred and fifty four subjects was shown to be satisfactorily described by a catalytic type of equation similar to that used by Knutson to access the dental caries prevalence (DMF) among children. The proportion of an age group with one or more Russell scores for gingivitis denoted by 2, was related to the Russell Periodontal Index. This relationship enables a simplified procedure to be employed in surveys. A linear regression was found which described the relation between periodontal index and the
proportion of a group with one or more periodontal pockets, and it was claimed that these simplified methods could be useful in rapidly making surveys of large population groups for gingivitis and periodontitis.

A further analysis was subsequently made by Lilienthal et al. (32), as to the relationships between the proportions of subjects in various age groups with respect to normal gingiva, gingivitis, pocket formation, and Russell's Periodontal Index (PI). The relationships found enable a survey to be carried out in which the subjects are examined for normal gingiva, gingivitis and presence of one or more pockets, by age. It was shown that an adequate estimate of the regressions for healthy gingiva, gingivitis and periodontal pockets in respective age groups, can be made from data obtained by the examination of fifty subjects in each classification using the detailed Russell method. Thus it is possible for a large survey to be carried out quickly at low cost and provide detailed information on the periodontal state of the population by combining a small detailed pilot study of one hundred and fifty subjects and a large survey of a group of one thousand or more subjects, using a simple examination procedure.
Despite the high and almost universal prevalence of periodontal disease, comparatively few periodontal investigations have been conducted on the Australian population. Of the studies available Duncan (12) illustrated in the eighteen to forty year age group, and within a range of 47.6 and 27.8 per cent, that 41 per cent of CMF and regular Army personnel required some form of periodontal treatment. In a recently published study on final year dental students Barnard and Bradley (6) revealed that all students in the twenty two year age group showed some evidence of gingival inflammation and that 13 per cent had pocket formation.

In his investigations of regular Army personnel Dale (9) found that 18.4 per cent of the group showed periodontal bone loss and that this loss increased with age. Studies by Lilienthal and Amerena (31) support these findings and the rise of the mean Periodontal Index with age as well as the percentage with one or more pockets is clearly illustrated at Table 6.

Barnard (3) observed that approximately 75 per cent of school children showed gingival inflammation which was sufficiently advanced to warrant treatment in 15 per cent of the number examined. Studies by Lilienthal et al (32) and Dale (9) show an increase in prevalence and severity of periodontal disease in relation to age. Lilienthal found the mean RPI to be 1.07 and 1.21 for the age groups of twenty to twenty four years and
<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>Number in Group</th>
<th>Mean PI</th>
<th>Percentage with one or more Pockets</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19</td>
<td>169</td>
<td>0.93</td>
<td>7.4</td>
</tr>
<tr>
<td>20 - 24</td>
<td>148</td>
<td>1.07</td>
<td>19.0</td>
</tr>
<tr>
<td>25 - 29</td>
<td>103</td>
<td>1.21</td>
<td>29.4</td>
</tr>
<tr>
<td>30 - 34</td>
<td>103</td>
<td>1.70</td>
<td>39.8</td>
</tr>
<tr>
<td>35 - 39</td>
<td>61</td>
<td>1.73</td>
<td>51.6</td>
</tr>
<tr>
<td>40 +</td>
<td>92</td>
<td>2.59</td>
<td>88.1</td>
</tr>
</tbody>
</table>
twenty five to twenty nine years respectively, whilst Dale's investigation of similar age groups revealed the mean RPI to be 0.94 and 1.16. These latter findings closely compared with the RPI of senior dental students as observed by Barnard and Bradley (6). Both studies by Lilienthal and Dale revealed a rapid increase in the percentage of individuals possessing one or more periodontal pockets in the twenty to twenty four year age group, which progressively increased in prevalence wherein the forty plus age group Lilienthal observed that 88.1 per cent of those examined showed one or more periodontal pockets.
twenty five to twenty nine years respectively, whilst Dale's investigation of similar age groups revealed the mean RPI to be 0.94 and 1.16. These latter findings closely compared with the RPI of senior dental students as observed by Barnard and Bradley (6). Both studies by Lilienthal and Dale revealed a rapid increase in the percentage of individuals possessing one or more periodontal pockets in the twenty to twenty four year age group, which progressively increased in prevalence wherein the forty plus age group Lilienthal observed that 88.1 per cent of those examined showed one or more periodontal pockets.
III. **PROSTHETIC REQUIREMENTS.**

As with the prevalence of periodontal disease, studies in terms of denture requirements for the Australian population are few in number. In 1958 Woolcott (50) indicated the high percentage of recruits wearing dentures on entry to the Navy, following analysis of initial examination records over previous years (Table 7). Dale's analysis of six hundred and thirteen regular soldiers (9) at Table 8, indicates an appreciable and continuous increase in the percentage of personnel wearing dentures as age progresses to the twenty nine year age group. Andrews (1) also investigated a service population and showed that the proportion of males with full upper and lower dentures increased rapidly after twenty five years of age.

In the survey conducted by Barnard and Bradley (6), 48 per cent of final year dental students required some form of partial denture or bridge. Duncan (12) on the other hand found only 20 per cent of CMF and regular troops of the same age group, required partial dentures. This lesser finding was probably due to previous prosthetic issue following entry to the service.
TABLE 7

DENTURE WEARERS - RAN RECRUITS ON ENTRY

<table>
<thead>
<tr>
<th>State</th>
<th>Percentage Wearing Dentures on Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasmania</td>
<td>40</td>
</tr>
<tr>
<td>Victoria</td>
<td>25</td>
</tr>
<tr>
<td>N.S.W.</td>
<td>20</td>
</tr>
<tr>
<td>Sth. Aust.</td>
<td>18</td>
</tr>
<tr>
<td>West. Aust.</td>
<td>15</td>
</tr>
</tbody>
</table>

TABLE 8

PROSTHETIC APPLIANCES IN ARA GROUPS

<table>
<thead>
<tr>
<th>Age</th>
<th>Number</th>
<th>F/U and/or F/L</th>
<th>P/U and/or P/L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% Wearing</td>
<td>% Unsat.</td>
</tr>
<tr>
<td>17</td>
<td>100</td>
<td>11.0</td>
<td>3.0</td>
</tr>
<tr>
<td>18</td>
<td>106</td>
<td>11.5</td>
<td>3.1</td>
</tr>
<tr>
<td>19</td>
<td>106</td>
<td>18.9</td>
<td>2.8</td>
</tr>
<tr>
<td>20-24</td>
<td>266</td>
<td>24.0</td>
<td>3.1</td>
</tr>
<tr>
<td>25-29</td>
<td>35</td>
<td>28.5</td>
<td>8.5</td>
</tr>
</tbody>
</table>
IV. OTHER ABNORMALITIES AND TREATMENT REQUIREMENTS.

1. Hypoplasia and Hypocalcification

Few studies have been conducted in respect of hypoplasia or hypocalcification of the Australian population. In his observations of N.S.W. school children Barnard (3) revealed that 30 per cent of children examined showed either hypoplasia or hypocalcification in one or more permanent teeth. Severe or moderate hypoplasia of one or more teeth was found to be present in approximately 5 per cent whilst mild hypoplasia was present in 4.5 per cent of children. Mottling, white or brown spots, was found in the teeth of 23 per cent of children.

In a later study Barnard and Bradley (6) found hypoplasia of a mild form in almost 20 per cent of senior dental students, and in most cases this was also associated with opacity of the same tooth or elsewhere in the dentition. Using slightly different criteria in Tamworth and N.S.W. country and city areas, Barnard (4) found that there were no apparent sex differences in the prevalence of the types of hypoplasia or opacity. Prevalence increased with age to twelve or thirteen years and at twelve years of age 2429 children showed 40–64 per cent opacities and 6–8 per cent hypoplasia.
2. **Oral Surgery Requirements.**

   In a radiographical examination of one hundred and sixty three dental and medical students, Lilienthal (30) revealed the presence of embodied roots, apical rarefactions and resorption, impacted teeth, supernumerary teeth, cystic and congenital absence of teeth. He also found that 31 per cent of the group had impacted third molar teeth and that mandibular impaction outnumbered maxillary impactions in a ratio of two to one. In this latter regard the mesio-oblique position of impactions being the most common. An investigation by Barnard and Bradley (6) on senior dental students revealed that 23 per cent of the twenty two year age group possessed impacted teeth, and 23 per cent of these students revealed congenitally missing third molars.

3. **Oral Cancer.**

   In a recently concluded investigation as to the morbidity of oral cancer in Australia by site, sex and state, Tan (46) showed the incidence for males and females to be a rate of 9 per 100,000 with lip cancer of males predominant. In the same study in respect of the number of new cases diagnosed over a six year period between 1959-1964 he observed that total diagnoses of oral cancer approximated 6000 cases, or about 1000 per year. Lip cancer was predominately present in males and combined with the female cases accounted for 62 per cent of all oral cancers.
4. **Temporomandibular Joint Disturbances**.

With the exception of investigations by Christensen (7) and Wing (48) and despite the increase in the incidence of temporomandibular joint disturbances as referred to by Atkinson and Shepherd (2), review of available literature failed to reveal research in relation to the prevalence of temporomandibular dysfunction in the Australian population.
V. CONCLUSIONS.

With the exception of investigations into the prevalence of dental caries comparatively little research has been undertaken to date as to the prevalence of other dental diseases and abnormalities, or treatment requirements of Australian adults.

The foregoing review has described the available findings of the various investigators to date and has indicated treatment requirements of the various age groups of the Australian population. Further investigation as to the extent of outstanding treatment requirements is necessary in order that the problem of appropriate treatment provision can be evaluated.

In determining treatment needs for Australian adults consideration should be given to the following areas:

a. Prevalence of dental and other oral diseases, and includes dental caries, periodontal disease and oral cancer.

b. Abnormalities, which include malocclusion, maxillofacial deformities, oral clefts, congenital absence of third molars, unacceptable fluorosis, and hypoplasia and opacity of teeth.

c. Treatment requirements, including:

(1) Extractions - number because of decay, impactions, periodontal disease, prosthetic reasons solely, orthodontic and other reasons including trauma.
(2) Operative restorations - number of teeth requiring one, two and three surface restorations.

(3) Prosthetic restorations - number of individuals requiring full upper, full lower, partial upper and partial lower dentures.

(4) Fractured teeth.

(5) Impacted teeth.

(6) Bridges.

(7) Crowns.

(8) Root canal therapies.

(9) Prophylaxis.
SUMMARY.

This thesis indicates the general principles and methods of reporting standardised dental criteria and presents an up to date review of published and available unpublished literature of Australian adults and adolescents in relation to their dental treatment requirements.

Part One details the pre-requisites of sound epidemiological investigation in terms of clear and accurate definitions of conditions being studied as well as illustrates standardised diagnostic criteria, methods of measurement, and terminology. Part Two reviews dental literature in terms of this forementioned criteria and in relation to treatment needs of the Australian population.

In addition to detailing the methods for detecting, recording, processing and reporting data as to the clinical occurrence of dental caries, periodontal disease and other dental conditions such that the findings are reproducible, internationally comparable and have a known level of accuracy, standardised statistical techniques have been described together with interpretation of statistical data.

Part Two describes various investigations as to treatment needs of the adult and adolescent population and is summarised under the following headings and sub-headings:
a. Prevalence of Dental Caries: Analysis of the Australian population by age groups shows that:

(1) The number of teeth affected by dental disease increased progressively with age;

(2) The number of teeth lost through dental disease increased progressively with age;

(3) The increased incidence of tooth loss is more marked in older age groups;

(4) The proportion of teeth concerned, out of those affected, decreased with age;

(5) Prevalence of dental disease is higher in females than males of the same age group, and that it increases with age;

(6) Conservation of teeth affected by dental disease is closely correlated with intellectual standard, the availability of dental services, and the socio-economic group of parents;

(7) Comparison of DMFS values between Australian Army personnel and the US Air Force showed the Australian DMFS value to be double that of the US Air Force for the same age group.

b. Prevalence of Periodontal Disease:

(1) Although investigations in this field have to date been overshadowed by research into the prevalence
of dental caries, the universal magnitude of the prevalence of periodontal disease in world populations is such as to warrant intensive investigation in the future.

(2) Prevalence of periodontal disease progressively increased with age.

(3) Increased incidence in tooth loss through periodontal disease is marked in the older age groups.

(4) Positive correlation has been demonstrated between mouth cleanliness and the health of periodontal structures.

(5) Positive correlation has also been illustrated between intelligence based on IQ scores and oral hygiene and gingival disease.

(6) A simplified procedure in periodontal examination has been developed which will facilitate rapid survey of large population groups for gingivitis and periodontitis.

c. Prosthetic Requirements.

(1) Investigations of military populations showed a continuous increase in the percentage of personnel wearing dentures as age progresses, particularly after twenty five years of age;
d. Hypoplasia and Hypocalcification.

(1) Prevalence of hypoplasia and opacities increased with tooth number with age;

(2) No apparent sex differences were observed in regard to the prevalence of the types of hypoplasias or opacities.

e. Oral Surgery Requirements.

(1) Approximately 31 per cent of a sample of young adults revealed impacted third molar teeth;

(2) The same survey also showed mandibular impactions to outnumber maxillary impactions in a ratio of two to one, with the mesio-oblique position of impactions being the most common.

f. Oral Cancer.

(1) Investigation has revealed incidence of oral cancer for males and females to be at a rate of 9 per 100,000 with lip cancer of males the most predominant;

(2) Total incidence of oral cancer in the Australian population approximates 1000 cases per year;

(3) Lip cancer was predominately present in males, and combined with females accounted for 62 per cent of all oral cancers.
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