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**A GUIDE TO ORAL HEALTH
EPIDEMIOLOGICAL INVESTIGATIONS**



**Oral Health unit
World Health Organization
Geneva
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CONTENTS

	<u>Page</u>
Chapter 1	
Introduction	2
1 1 Rational for epidemiology	2
1 2 Purpose of manual	2
1 3 Assistance from WHO	3
Chapter 2	
Methods	
2 1 Basic standard methods	3
2 2 Non-basic standard methods	4
2.3 Recording format	4
2.4 Indices	5
2.5 Detailed description of indices and criteria	6
2 5 1 Caries	6
2.5.2 Plaque and calculus	10
2.5.3 Gingivitis and periodontal diseases	12
2 5 4 Enamel defects	16
2 5 5 Denture and bridge requirements and possession	20
2.5.6 Assessment of occlusal traits	21
Standard recording formats	27
Chapter 3	
Post Survey Action, Analyses and Reporting	
3 1 Data collection	33
3 2 Analysis	33
3 3 Reporting findings	34
References	36
Annex I - The design of an oral health survey	i-vi

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CHAPTER 1

INTRODUCTION

1.1 Rationale for epidemiology

Epidemiology is the study of disease as it affects populations. It is one of the sciences concerned with study of the processes which determine or influence the health of people. As an observational science it involves studying the distribution of diseases in populations and identifying and comparing groups having differing ranges in disease levels or conditions. From knowledge of similarities and differences between such groups, hypotheses as to causal process can be formed. Data are collected concerning the state of health or disease and the nature of the environment and habits of the groups. Specific indices have been developed to quantify such data and describe their distribution. Statistical procedures are required to estimate objectively, the strength of any associations found. In order that the findings may be generalized to the whole population it is essential to standardize the methods of data collection and to make the observations on a sample which is representative of the whole population.

If appropriate data are collected with clearly defined objectives and analysed appropriately, they can be used to plan treatment or preventive programmes, to evaluate current programmes, and to provide new knowledge to serve as the basis for innovations in dental health programming. They also can identify outstanding research opportunities.

1.2 Purpose of manual

To assist public health authorities who require basic epidemiological data on oral diseases and treatment needs for the planning of regional or national dental health programmes, the WHO has published a manual entitled "Oral Health Surveys: Basic Methods"⁽¹⁾. Another publication the "International Classification of Diseases - Application to Dentistry and Stomatology (ICD-DA)"⁽²⁾ for use in conjunction with the ninth revision of the ICD⁽³⁾ was prepared to assist the dental profession in reaching a consistent and comprehensive classification of oral and related diseases. Eventually, the use of this classification may facilitate the widespread collection of epidemiological data on the rarer diseases significant in oral health.

This Guide provides a selection of indices for use in situations where more detailed information on a condition or disease is required, than can be collected using the basic manual's methodology.

This Guide is complementary to the OHS:BM manual. Many of the methods described in the manual are applicable in situations to which the guide is directed. However, the objective is to assist those interested in applying more rigorous methods to the collection of epidemiological data than would usually be possible in a basic oral health survey.

The Guide outlines assistance that may be requested from the World Health Organization in Chapter 1; Chapter 2 provides a choice of indices with detailed criteria, appropriate recording formats and codes, plus guidance on selection and use of the various indices for different research situations. Chapter 3 deals briefly with post-survey action and reporting of findings.

1.3 Assistance from WHO

The Oral Health unit of the World Health Organization can provide the following assistance to investigators:

1. Help in contacting scientists working in similar or related areas of dental research to identify possible collaborators and to ensure that similar investigations in different populations use comparable methodology. This contact will also help to ensure that unnecessary duplication of work is avoided.
2. Assistance with planning investigations, choosing type and size of survey sample and the most appropriate indices and recording forms. An annex describing and evaluating various types of sampling methods is available on request. It includes examples of the use of such methods as simple random, stratified, systematic and cluster sampling, and gives examples of calculation of means and variance for each type.
3. Assistance with data summarization and analysis can only be offered to investigators who have no access to computing facilities, and only for studies of special relevance to the WHO programme, for example field demonstrations of preventive agents or collection of information for the planning of services for populations. Furthermore, assistance in this area is dependent on WHO being involved, from the start of the study, in the planning and design of the sample and choice of methodology.

As data collected in epidemiological investigations may be subjected to a great many and varied statistical analyses, the usual assistance is limited to the provision of summary tables and crosstabulations for the various subdivisions of the sample, and to simple correlation coefficients between certain variables. Where the research requires extra analyses, WHO can assist with contacting institutions able to provide these services. It should be noted that the variability and sharply focussed specificity of clinical trials normally preclude the possibility of WHO assistance in that area.

CHAPTER 2

METHODS

2.1 Basic standard methods

The OHS manual outlines in detail methods and indices suitable for conducting a basic oral health survey to obtain data for planning, evaluating and monitoring oral health services. The recording forms provide indices for the assessment of caries (DMFT); individual tooth treatment requirements, periodontal status and treatment need, oral mucosal conditions and diseases, bone diseases and teeth defects, gross dentofacial anomalies, space for the (simple) recording of any other conditions or diseases which may be of particular importance in a population and a simple questionnaire on utilization of services.

The Guide to Diagnosis and Epidemiology of Oral Mucosal Diseases and Conditions (GEOM)⁽⁴⁾ outlines specific methodology for surveying populations in which oral cancer and related conditions are particularly prevalent. A standard interview and recording form for habits and diseases and a topographical recording system is provided. Investigators wishing to make use of these standard methods can request assistance from the Oral Health unit, WHO.* ^a

* Requests for assistance should be addressed to: Oral Health Unit
World Health Organization
Avenue Appia
1211 Geneva 27
Switzerland

2.2 Non-basic standard methods

For investigators wishing to collect information on oral conditions and diseases for which no provision has been included in the OHS or GEOM. or for which more detailed information is needed than is possible to collect using the basic methods, this chapter outlines a selection of indices that may be used to measure certain conditions and diseases.

For each of the 'standard' indices included, there is a description of methodology and criteria. Indications and contra-indications for use in various situations and a choice of a recording format suitable for different investigations is also discussed.

2.3 Recording format

For some of the commonly used epidemiological indices, the generally accepted methods and criteria allow for recording only one score for the whole dentition, e.g. enamel opacities; one score for each segment of the mouth, e.g. the Oral Hygiene Index; or a score for specified teeth or surfaces only, e.g. OHI(S). On the other hand, for some methods, each tooth or tooth surface is the recording unit. Where information for each tooth, tooth surface or segment is recorded, it is usual to compute a mean score for the whole dentition.

Although the use of an 'established' index or method is desirable in order to make comparisons with previous research, there will be many studies in which an investigator will require more detailed information of the condition of various tooth types, individual teeth or tooth surfaces. For example, when making an evaluative assessment of a caries preventive treatment in a field or clinical trial, or for research involving investigation of associations between diseases and environment, detailed, specific information for each tooth surface may be essential.

For these reasons a set of 4 basic recording formats for use with the various indices is provided. Depending on data needed, and the index to be employed, conditions may be scored according to:

- (i) entire dentition (Format 1 - 1 box)
- (ii) by six designated, representative surfaces or by segment (Format 2 - 6 boxes)
- (iii) by individual tooth (Format 3 - 32 boxes)
- (iv) by individual tooth surface (Format 4 - space provided for as many as 7 measurements per tooth).

For measurements that do not fit any of the 4 basic formats, special formats are provided, e.g. measurement of occlusal traits. Examples of these recording formats are given at the end of Chapter 2. Each measurement and format is identified by a code which will link the data to a standard programme specifically designed for that measurement. The programme will provide for the summarization of the data which can be made more or less detailed according to the particular needs of an investigator.

Tooth designation

The international system of tooth identification is used in the recording formats; the first digit specifies the quadrant of the mouth, the second the actual tooth.

primary dentition	55 54 53 52 51	61 62 63 64 65
permanent dentition	(18 17 16 15 14 13 12 11	21 22 23 24 25 26 27 28
	(48 47 46 45 44 43 42 41	31 32 33 34 35 36 37 38
primary dentition	85 84 83 82 81	71 72 73 74 75

2.4 Indices

1. Caries

Index Code

- 1.1 DMFS - format 4
- 1.2 Counts of lesions by site type (DFPS decayed and filled predilection sites) - format 4

2. Plaque and Calculus

Index Code

- 2.1 & 2.2 Oral Hygiene Index, OHI(S)⁽⁵⁾* - formats 2, 3 or 4
- 2.3 Plaque Index, PI⁽⁶⁾ - format 4
- 2.4 Visible Plaque Index⁽⁷⁾* - special format 5
- 2.5 Calculus Prevalence Index* - special format 5

3. Gingivitis and Periodontal Diseases

Index Code

- 3.1 Gingival Index⁽⁶⁾ - format 4
- 3.2 Periodontal Index, PI⁽⁸⁾ - format 3
- 3.3 Gingival Bleeding Index (GBI)* - special format 5
- 3.4 Pocket depth measurement* - special format 5
- 3.5 Periodontal Treatment Need System (PTNS)⁽⁹⁾ - special format 6

4. Enamel Defects

Index Code

- 4.1 Dean's Index of Dental Fluorosis⁽¹⁰⁾ - formats 3 or 4
- 4.2 Enamel opacities⁽¹¹⁾ - formats 3 or 4
- 4.3 Hypoplasia⁽¹²⁾ - format 3
- 4.4 Attrition⁽¹³⁾ - formats 2 or 3

5. Denture and bridge possession and requirements

Index Code

- 5.1 Denture and bridge possession and need⁽¹⁴⁾ - special format 7

6. Assessment of occlusal Traits

Index Code

- 6.1 Assessment of Occlusal Traits⁽¹⁵⁾ - special format 8

* Where a combination of indices form a methodology, e.g. the Debris Index and the Calculus Index of the Simplified Oral Hygiene Index, or the Gingival and Periodontal Site Prevalence Index, which combines the visible plaque, calculus prevalence and gingival bleeding indices and a pocket depth measurement, the methodology will be described as an integral system, but each individual index will retain the code given here.

2.5 Detailed description of indices and criteria

2.5.1 Caries

Index Code 1.1 Decayed Missing and Filled Surfaces (DMFS)

Indications for use

A large number of studies have been performed using this index. It is used when a more detailed picture of a population's or group's dentition is required than is available from the DMFT index. It provides some measure of severity of attack, at least in the count of decayed surfaces. For this reason the three components DS, FS and MS should always be reported.

Difficulties regarding the assignment of number of surfaces for each missing tooth may be resolved either by assuming (a) a missing tooth counts as 5 surfaces, (b) each missing posterior tooth counts as 3 and each anterior tooth as 2 surfaces, or (c) by calculating the mean ratio of decayed surfaces to decayed teeth (DS/DT) for each subgroup and age group in the survey and using this figure as multiplier for missing teeth. All these alternatives will give a more realistic estimate of number of surfaces which have ever been affected than the mere addition of number of missing teeth to the count of carious surfaces. It is important to specify which alternative is used.

The DMFS index is often used in clinical trials, and field testing of preventive agents or regimens. The main unit of interest is then the increase in affected surfaces during the period of the trial or project.

Criteria and Methodology

Molar and premolar teeth are divided into five surfaces: occlusal (O), mesial (M), distal (D), buccal (B), and lingual-palatal (L): each incisor or canine is divided into four surfaces - mesial, distal, buccal, and lingual, giving a total of 148 surfaces for the full dentition of 32 teeth. (Note: (i) pits or fissures located on the buccal, lingual or palatal surfaces of teeth are included in these surfaces, (ii) buccal, lingual and approximal surfaces are limited apically by the cemento-enamel junction). The examination should proceed in an orderly manner commencing with a maxillary posterior tooth, examining in order each tooth in that arch, then proceeding to the mandible. Similarly, a systematic procedure for the examining of the surface of each tooth should be established and maintained. A commonly used, convenient system is to examine the occlusal surface first, then proceed in a clockwise manner round the tooth from the mesial surface to the buccal, distal and lingual surfaces. An extra column has been provided on the form to allow the recording of additional information relevant to the study, for example conditions such as root caries, enamel mottling or the presence of plaque.

After the examination of the status of all surfaces of a tooth is complete, the examiner should record any additional information and then assess and record the treatment requirements for that tooth, before proceeding to the next tooth. It is advisable to prepare a code and criteria summary card as provided in the following text, so that the examiner can rapidly and easily check codes. The DMFS index is recorded on format 4.

Criteria and Codes for caries recording by surface (DMFS)

Before commencing the examination by surface, each primary tooth or tooth space is classified in one of the following categories, and is coded in the 'STATUS' column. No recording in the status box is necessary for permanent teeth present - the box should be left blank.

Status

<u>Code</u>	<u>Category</u>
A	Sound primary tooth
B	Decayed primary tooth (irrespective of fillings present)
C	Filled primary tooth (otherwise sound)
D	Permanent tooth unerupted (and primary tooth missing)
E	Permanent tooth extracted due caries
M	Permanent tooth lost due to other reasons

For primary teeth or tooth spaces no further recording is required,

It is not intended to provide here for the recording of primary teeth by surface. It is recognised, however, that investigators may wish to make these measurements for special, clinical trial objectives.

For each permanent tooth present each surface is then classified according to the following criteria and the appropriate code is recorded:

<u>Code</u>	<u>Category</u>	<u>Criteria</u>
0	Surface sound	a tooth is recorded as sound if it shows no evidence of treated or untreated clinical caries
1	Initial caries	no clinically detectable loss of substance. For pits and fissures there may be staining, discolouration or rough spots in the enamel that do or do not catch the explorer, but where loss of substance cannot be positively diagnosed. For smooth surfaces these may be white opaque areas with loss of lustre
2	Caries of enamel	there is demonstrable loss of tooth substance in pits, fissures, or on smooth surfaces, but no softened floor, or wall, or undermined enamel. The texture of material within the cavity may be chalky or crumbly, but there is no visible evidence that cavitation has penetrated into dentine
3	Caries of dentine	there is a detectably softened floor, undermined enamel, or a softened wall, or the tooth has a temporary filling. On approximal surfaces the explorer point must enter a lesion with certainty
4	Caries with pulpal involvement	deep cavity with <u>probable</u> pulp involvement. PULP SHOULD NOT BE PROBES
5	Filled with primary caries	a surface with one or more fillings and another discrete area of decay not contiguous with a filling
6	Filled with secondary decay	a surface with one or more fillings and recurrent decay around a filling

7	Filled	a surface should be considered filled whenever a filling of any permanent material is present and there is no discrete or recurrent caries. A defective filling, e.g. cracked or partly missing, but where there is no discrete or recurrent caries, is scored 7, and the appropriate treatment code indicating that a replacement restoration is required is given
8	Excluded	this category should be used for surfaces which have been banded for orthodontic purposes, and for all surfaces which cannot be properly examined because of gross hypoplasia or fracture

Criteria and Codes for root surface lesions

<u>Code</u>	<u>Category</u>	<u>Criteria</u>
0	Sound	No evidence of treated or untreated clinical caries
1	Caries of cementum	There is demonstrable loss of tooth substance but there is no visible evidence that cavitation has penetrated into the dentine
2	Caries of root dentine	There is a detectable softened floor with obvious penetration into the dentine or the root has a temporary filling
3	Caries with pulpal involvement	Caries of dentine with undermining of coronal enamel and probable pulpal involvement

Treatment requirements

<u>Code</u>	<u>Category</u>	<u>Criteria</u>
0	No treatment required	This code is recorded if a tooth is sound, or if it is decided that a tooth cannot or should not receive restorative treatment (filling or crown). Moreover, this code is used only if the tooth is not indicated for extraction on account of periodontal disease, prosthetic or orthodontic considerations, traumatic injury, or for any other reason
1,2 3 or 4	Restorations and crowns	Depending on how many surfaces will be involved for restoration, one of these codes should be used to designate the treatment required to remove primary or secondary caries, to repair damage due to trauma, or to replace unsatisfactory fillings. Discoloration of a tooth resulting from trauma, a pulpal condition or a development defect may also be reasons for a restoration. Replacement of a filling or crown should be recorded in the absence of caries when there are one or more signs of the following <ul style="list-style-type: none"> (a) a deficient margin to an existing restoration that is likely to permit leakage into dentine. The decision as to whether or not a margin is deficient should be based on the examiner's clinical judgement, on evidence gained by the insertion of an explorer at the margin, or on the presence of severe staining of the tooth structure (b) an overhanging margin of an existing restoration of a dimension that causes obvious local irritation to the gingivae and cannot be removed by recontouring the restoration (c) fracture of an existing restoration that either causes it to be loose or permits leakage into dentine
5	Extraction for caries	A tooth is recorded as "indicated for extraction because of caries" <u>depending on the treatment possibilities available when:</u> <ul style="list-style-type: none"> (a) caries has so destroyed the crown that it cannot be restored,

- (b) caries has progressed to an extent that there is an obvious and open exposure of the pulp, or
- (c) only the roots remain

A single tooth may be indicated for extraction for more than one reason - for caries and periodontal disease, for example. In such cases the examiner should attempt to decide the major reason for extraction and record that reason only

6	Extraction for periodontal disease	a tooth is recorded as indicated for extraction because of periodontal disease when the disease has progressed so far that the tooth is loose or functionless and, in the clinical judgement of the examiner, cannot be restored to a firm and functional state by periodontal therapy
7	Extraction for prosthetic reasons	a tooth should be recorded as "indicated for extraction for prosthetic reasons" when extraction is not specifically required because of caries or periodontal disease, but, rather, because a full denture is planned. Individually, these teeth could be restored or conserved but, because there are too few for proper function, extraction to make way for a prosthesis is the only possible treatment
8	Extraction for other reasons	a tooth is recorded as "indicated for extraction for other reasons" when extraction is required for orthodontic or cosmetic reasons, on account of a developmental defect or because of impaction
9	Other	this category is used to indicate any other treatment not specifically covered by codes 1-8. For example, removal of gross overhangs, replacement of pontics of bridges, splints for loose teeth, and removal of occlusal interferences on restorations might be included in this category

Note: no specific code for the treatment of pulpally involved teeth is needed as this information is available from the disease status recording.

Index Code 1.2 Count of lesions by site type DFPS (decayed and filled predilection sites)

For studies of caries etiology or the differential effectiveness of a preventive agent, an index which classifies positions or sites of teeth having a similar environment is useful. This measure (DFPS decayed and filled predilection sites) divides each tooth into the various sites where caries is likely to occur - fissures, pits, approximal smooth, other smooth surfaces and root surfaces.

The sites are defined as follows:

Fissures - fissure sites are intended to provide for lesions which actually occur in the grooves of the occlusal surfaces of molars and premolars, in certain cases extending to the palatal, buccal, or lingual aspects. Lesions occurring on the smooth surface slopes above or below the grooves would not be classified in this category even if they extended to the grooves.

Pits - as with fissure sites, pits which occur usually on the buccal surfaces of molars and the palatal surfaces of incisors, provide for lesions occurring only in those pits and not originating on adjacent smooth surfaces.

Approximal smooth - mesial or distal smooth surfaces delimited by their cavo-surface angles with buccal, lingual or palatal and occlusal surfaces and by the cemento-enamel junction.

Other smooth - all other surfaces coronal to the cemento-enamel junction not defined as fissures, pit or approximal sites.

Root - all tooth surfaces apical to the cemento-enamel junction.

The mean figure for each predilection position is reported. Because a certain amount of error is inevitable due to restorations covering more tooth area than the original caries lesion the measure is of most use in people who have received little or no dental treatment, or are still young, e.g. ≤ 14 years, or have low to moderate disease level. The categories and criteria listed for the DMFS recording may be used with format 4.

2.5.2 Plaque and Calculus

Indices 2.1 and 2.2 Oral Hygiene Index

When information on the amount of calculus and debris present is needed, the simplified oral hygiene index (OHI-S) developed by Greene & Vermillion⁽⁵⁾ is recommended since it has been used extensively for the assessment of oral hygiene status of large populations.

Recent work by Sheiham et al⁽¹⁶⁾ indicates that this index and the Periodontal Index can provide reliable data for estimating the immediate need for periodontal treatment and for predicting the approximate age at which tooth loss due to Periodontal Disease will begin to occur.

Criteria

The examination is limited to 6 permanent tooth surfaces - the labial surface of the upper right central incisor (tooth 21), the labial surface of the lower left central incisor (tooth 41), the buccal surfaces of the upper first permanent molars (teeth 16 and 26), and the lingual surfaces of the lower first permanent molars (teeth 36 and 46). When any of these teeth are missing a suitable adjacent tooth, i.e. a molar or central or lateral incisor, may be substituted.

A mean score for an individual is not assigned unless 2 of the 6 possible surfaces, or their substitutes, have been examined. Only fully erupted teeth are scored. Oral debris and stain are scored together and calculus is scored separately.

Index code 2.1: Oral debris

<u>Code</u>	<u>Criteria</u>
0	No debris or extrinsic stain
1	Soft debris covering not more than one-third of the tooth surface, or extrinsic stain without debris, regardless of the surface area covered
2	Soft debris covering more than one-third but not more than two-thirds of the exposed tooth surface
3	Soft debris covering more than two-thirds of the exposed tooth surface

Index Code 2.2: Oral Calculus

<u>Code</u>	<u>Criteria</u>
0	No calculus present
1	Supragingival calculus covering not more than one-third of the exposed tooth surface
2	Supragingival calculus covering more than one-third but not more than two-thirds of the exposed tooth surface, or individual flecks of subgingival calculus around the cervical portion of the tooth
3	Supragingival calculus covering more than two-thirds of the exposed tooth surface, or a continuous heavy band of subgingival calculus around the cervical portion of the tooth

Note:

- (a) a tooth is considered to be fully erupted and therefore available for scoring when the occlusal or incisal surface has reached the occlusal plane
- (b) a surface is defined as encompassing half the circumference of the tooth. It includes the buccal or lingual half of the tooth and the entire area between the incisal or occlusal edge and the crest of the gingivae
- (c) oral debris is detected by running the side of a sickle explorer along the surface to be examined
- (d) calculus is not considered to be subgingival unless it lies within the gingival sulcus at the time of examination

The mean oral debris and mean calculus scores for each patient are determined by adding the individual scores and dividing by the number of surfaces examined. The patient's OHI-S is obtained by adding the mean oral debris and mean calculus scores, and the group OHI-S by dividing the sum of individual OHI-S scores by the number of persons examined.

Recording format 2 (six boxes) is used for recording these indices. For an investigation requiring information on debris and calculus for all teeth or surfaces, the same criteria are suitable and recording format 3 or 4 may be used.

Index Code 2.3: Plaque Index PII

This index is used mainly for clinical trials of plaque reducing agents or plaque control programmes. The purpose of introducing this measure was to create a plaque index which would be comparable with the use of the Gingival Index (Index 3.1).

The Plaque Index attempts to distinguish clearly between the severity and the location of aggregates of soft debris. It measures only the thickness of the soft deposit at the gingival area of the tooth surfaces; no attention is paid to the coronal extension of the plaque.