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COMPARING ORAL HEALTH CARE SYSTEMS

A SECOND INTERNATIONAL COLLABORATIVE STUDY

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Second International Collaborative Study of Oral Health Outcomes (ICS II)
In San Antonio TX. (CDC, WHO, AHCPR)

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Conducted from 1989-1992, this study involved a complex probability sample of San Antonio residents aged 12-13, 35-44 and 65-74.

Since the adult sampling occurred nine years after the most recent U.S. Census, a household census was conducted first by telephone or home visit, and then by interview at homes in systematically selected census tracts, to identify a quota of age specific persons in selected blocks. Several months later these homes were again visited to interview the identified adults in English or Spanish, using a detailed English/Spanish 220 question computerized questionnaire. The San Antonio investigators designed and tested this electronic, direct entry version of the questionnaire. Clinical examinations were conducted at another time at local dental van sites, by appointment. Thus four separate interactions were made with study subjects, over time.

The target number of subjects was 500 in each age group. 454 younger and 483 older adult participants were enrolled. The study completion response rate at households previously identified was 43 and 41% respectively.

Since the probability of selection of adults varied by census tract, the sample was of complex design, and unequal weights were applied to achieve representation of all adults in San Antonio.

The adolescent sample frame was school based, and representative of San Antonio schools. Schools, and children in their 6th and 7th grade classes, had an equal chance of selection , and so the sample was self weighting.
484 students participated(57% completion response rate), out of an estimated 27,000 12-13 year olds in 1992 in the city.

SUDAAN software was used to impute missing values.

To date (2009) this study provides the only known probability based study of oral health representative of the whole San Antonio population.

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General Introduction

Barmes, D. and Cohen, L.

The initiative to perform international collaborative studies on oral health that would combine clinical and sociological data originated in the study by Kohn and White (1976) on medical care utilization conducted from 1967 to 1974. Despite its pioneering status, that study fell short of the ultimate objective of matching a clinical survey with interview and questionnaire data from the same sample of consumers. From the 1970s to the present, two large series of investigations making up the first and second International Collaborative Studies (ICS I and ICS II) have been performed, under the auspices of the World Health Organization (WHO), in a wide range of communities. While this type of research is forever at the mercy of societal and system changes, sometimes with drastic effects on study protocol rules, as will become clear in this monograph, it is fitting to note that rarely has a set of international studies in the health sector had such impact on the existing health systems of nations.

The purpose of the ICS studies was and remains to compare oral health care systems and elements of those systems, using the epidemiological process, in order to discover the approaches that are effective in improving the oral health of communities, so as to guide all communities in confidence towards a system that best suits their health and social status. The results are of vital importance, not only to see what has been achieved but also to assess how systems that have been appropriate in the past need to change in order to cope with the rapid and massive changes in oral health status occurring in many countries. Therefore, in selecting the participants in ICS I – conducted from 1973 to 1981 – there was unequivocal emphasis on systems that had been in existence for at least 20 years and were well enough funded and organized to provide a solid reporting basis against which the value of the achievements of each system could be measured (Cohen, 1987). Though on the surface this emphasis could be construed as focusing on the needs of the highly developed/industrialized countries, the aim was exactly the opposite. The study was intended to show what had been "tried and succeeded", or "tried and failed", for what reasons and at what cost, in the hope that the most effective approaches would be chosen for all those developing countries just approaching the realization that oral health was no longer a heritage maintained without effort, but needed a carefully planned preventive and complementary curative national oral health programme.

The outcome of ICS I was spectacular in its impact on the remodelling of existing systems, even though the findings suffered from the fact that data was collected at only one point in time. That result suggests that the criticism labelling ICS I as a study only for the "haves" had some basis. However, less obvious but nevertheless substantial benefits came through the WHO oral health programme, because the lessons learned from ICS I were applied in many developing countries where WHO collaborated with health ministries in the development of appropriate national oral health plans.

Because of the impact of ICS I and the desirability of having a further set of data by which to gain some insight into the effects of national systems over time, WHO, in collaboration with the Center for Health Administration Studies (CHAS) at the University of Chicago, decided to conduct a second international collaborative study of oral health care systems (ICS II) (Leclercq, 1990). The study was undertaken from 1988 to 1992 at seven sites in five countries: Erfurt, Germany; Yamanashi, Japan; New Zealand; Lodz, Poland; and three sites in the United States of America, Baltimore and two Indian Health Service sites for the Navajo and Lakota peoples. It was also hoped to add some sites from developing countries which had reached the stage where oral health was being given a middle-level priority. However, funding and administrative difficulties proved to be insurmountable problems at the time. Eventually, the countries participating in ICS II included several which had taken part in ICS I and several others which were performing this type of study for the first time. Three additional sites: Rhone-Alpes, France; Latvia; and San Antonio, United States also participated; unfortunately, with the exception of the clinical examination data reported in Chapter 7, the findings from these sites were not available in time to be included in the main analysis.

ICS I aimed at identifying the relationships between the basic structural components of oral health care delivery systems, oral health status and the economic costs of care, and focused on human resources in oral health care systems (Arnljot et al., 1985). While ICS II followed logically from ICS I, its goals were significantly broader in scope. The aim was to investigate how factors in the oral health care system, the socioenvironmental characteristics and the individual characteristics of the populations served affected three sets of oral health outcomes: oral health behaviour, oral health status, and oral quality of life. Though the underlying intention was to keep the same research instrument in order to maximize the comparison between the two ICS studies, a number of both clinical and questionnaire/interview items had to be changed to be sure that the best possible data were collected, including more emphasis on behavioural rather than system information (availability, accessibility, acceptability). During the lapse of time between the two studies many changes occurred which had important effects on the response to a study of this type. The whole concept of linked clinical and questionnaire/interview data collection raised problems even at the time of ICS I. Resistance to each of these means of data collection has hardened in recent years, intensified by a perception of excessive surveying on a wide range of subjects. Furthermore, the social and political changes of various types across the different populations sampled, as well as spiralling research costs combined to cause many sampling problems for ICS II despite intense efforts to overcome these difficulties.

Nevertheless, ICS II has achieved the main goal of providing for all nations, both participant and non-participant, both highly developed and developing, a further comprehensive set of data which, when used together with those from ICS I, should enable administrators to plan national and subnational oral health programmes most relevant to their present and evolving oral health status (Barmes, 1994). It is hoped that

detailed study of these findings will not only help in solving existing problems, but will lead to use of the ICS approach at any community level in reaching solutions on the care system needed, whether by modifying an existing system or by making radical changes.

In presenting the results of ICS II, this book focuses on the factors that influence people's personal oral health practices and use of oral health services, and emphasizes how these behaviours are linked to health status and quality of life. Chapter 1 describes the research issues involved and the methods employed in the study. Chapter 2 gives details of the socioenvironmental characteristics and the oral health care system at each study site. This information provides the context for subsequent chapters, which examine and compare the relationships between these variables and oral health outcomes for individuals at each study site and consider the factors involved. Chapters 3, 4 and 5 focus on the analysis of the first set of oral health outcome variables, oral health behaviour. Chapters 6, 7, 8 and 9 cover the second set, oral health status, and chapters 10, 11 and 12 the final set, oral quality of life. The concluding chapter highlights some of the main findings of ICS II and considers their implications. Further details of the procedures, questionnaires and forms used in the study are provided in a series of Annexes.

1 Research Issues and Methodology

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Cross-national research has a long and well established tradition as an analytical strategy in the social sciences, and social scientists such as Comte, Marx, Durkheim and Weber have made great theoretical contributions through their comparative studies of various societies (Berting, 1982). The cross-national approach is particularly valuable for establishing the generality of findings and the validity of interpretations derived from single-nation studies (Kohn, 1989). In fact, as pointed out by Przeworski & Teune (1982), social science theories can only be confirmed if they are evaluated in settings with different systems.

As international interdependence, global trade and worldwide networks of information technology expand, more cross-national studies are being initiated. Policy-makers and politicians are calling for such comparative studies to increase their understanding of national issues in order to better inform their decision-making (Oyen, 1990). The numerous books and articles that have now been published on the subject of cross-national research demonstrate just how popular it has become (e.g. Kohn & White, 1976; Szalai et al., 1977; Armer & Marsh, 1982; Niessen & Peschar, 1982; Ragin, 1987; Kohn, 1989; Boswell & Dixon, 1990; Oyen, 1990; Wong, 1990).

Cross-national research also offers many practical applications in the health field. For instance, it provides those who formulate and implement national health plans with a means of learning about the successes and failures of one another (White, 1976).

During the last two or three decades, dental caries rates have been declining in industrialized countries while incidence in some industrializing countries has increased, in several cases dramatically. As a result, both groups of countries are responding with changes in the emphasis and direction of their oral health care systems. So far, however, few cross-national studies have been conducted in the area of oral health, owing to the prohibitive costs, time and other resources involved. Consequently, the literature is mainly limited to reports of single-country or single-site studies. This leaves oral health policy-makers, professionals and researchers with wide theoretical and practical gaps. Many explanations and interpretations of phenomena related to oral health (e.g. poor oral health status or the adoption of recommended oral health behaviour) derived from single-country or single-site studies cannot be generalized to other countries or situations. For example, it is not possible to know for sure whether the finding that "a lower socioeconomic status leads to poor oral health status" in a single country is generally true or is unique to that particular country. In the practical sense, countries have been deprived of opportunities to evaluate their current status and improve their own oral health outcomes (e.g. oral health service utilization and oral health status) by comparing themselves with others. Such comparisons allow them to understand and learn about the strengths and weaknesses of their own and other oral health care systems.

1.1 Research objectives

To address the practical and theoretical issues described above, ICS II established three major research goals. The first was to describe each of the seven study sites according to (1) oral health outcomes, including oral health behaviour, oral health status and oral quality of life;[1] (2) social group differences in oral health outcomes, and (3) differences between individuals in each of the oral health outcomes. For all three of these dimensions, the sites were compared to gain a better understanding of the status of each site. The second goal was to investigate how the socioenvironmental and oral health care system characteristics of the various sites were related to: (1) differences in the status of their oral health outcomes; (2) differences in the magnitude of gaps between social groups in these outcomes; and (3) differences in the explanatory factors for these outcomes. The final goal was to test whether certain explanations for the three sets of oral health outcomes derived from previous single-country studies could be generalized to all the sites in the study.

1.2 Theoretical model

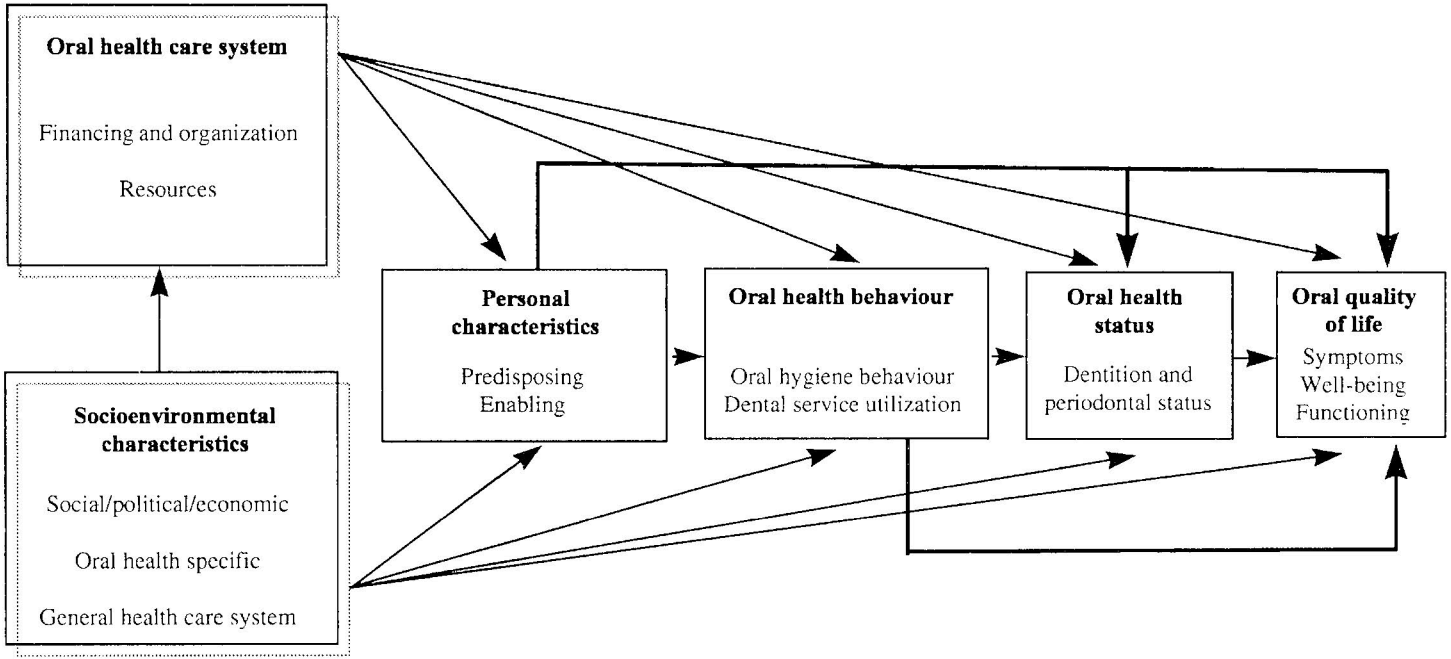
A theoretical model was developed to guide the ICS II research design and analysis (Figure 1.1). Although several theoretical models have been developed to explain determinants of oral health behaviour (Petersen & Holst, 1995) and oral health status (Slater & Shuval, 1976; Markkanen, Rajala & Paunio, 1983; Hamp et al., 1984; Arnljot et al., 1985; Maizels, Maizels & Sheiham, 1991), they do not incorporate all three oral health outcomes. The ICS II theoretical model is derived from an integration of existing oral health behaviour and oral health status models and the general health models of Andersen (1976) and Blum (1973). As indicated in Figure 1.1,[2] the factors affecting the oral health outcomes of an individual can be categorized at two levels, the individual and the system.

The ICS II model postulates that an individual's oral health behaviour (including oral hygiene practices and oral health service utilization), as the intermediate outcome variable, is affected by his or her predisposing and enabling characteristics. In other words, characteristics such as sex, education, occupation and health beliefs "predispose" an individual to engage or not engage in certain oral health behaviour, while enabling variables, such as income, having or not having a usual source of oral health care, residence and family size, represent conditions that might facilitate or impede the individual's practice of such behaviours. Furthermore, these personal characteristics are influenced by the system-level variables – socioenvironmental characteristics and the oral health care system. These variables are considered further in section 1.6.

[1] Oral quality of life is the term used to refer to the impact of oral health problems on an individual's quality of life. This concept is discussed further in section 1.6 and in Chapters 10-12.

[2] The model shown in Figure 1.1 is a refined version of the model used in the ICS II research protocol (copies of which are available on request from the Oral Health Programme, Division of Noncommunicable Diseases, World Health Organization, 1211 Geneva 27, Geneva, Switzerland). There are two major differences: (1) the revised model clearly distinguishes the individual- and system-level factors; and (2) oral health status and oral quality of life are now categorized separately because their causal relations differ.

Figure 1.1 ICS II theoretical model



The model also postulates that an individual's personal characteristics and oral health behaviour affect his or her oral health status, as measured mainly by dentition and periodontal status. As the model indicates, both personal characteristics and oral health behaviour operate under the influence of system-level factors. Finally, the model postulates that an individual's oral quality of life is determined, directly and indirectly, by his or her personal characteristics, oral health behaviour and oral health status, all of which are influenced by the system-level factors.

These hypotheses are general in nature. Later chapters describe the testing of specific research hypotheses concerning the impact of the system- and individual-level factors on an individual's oral health behaviour, oral health status and oral quality of life

1.3 Study design

The WHO/CHAS central team developed a research protocol[3] describing the objectives, organization, resources and methods of ICS II. The protocol included instructions for sampling, data collection, data processing and data analysis. During the ICS II inaugural meeting held at WHO headquarters, Geneva, Switzerland in February, 1987, the WHO/CHAS team presented the overall research design and data collection materials to representatives of the participating countries and study sites for discussion. The materials were revised in the light of the many comments and suggestions made at the meeting.

It was recognized that many social science concepts, including those relating to health and oral health are largely determined by context and cannot be compared because they are unique to each location. However, it was held that the oral health outcomes at each study site could be measured and expressed as general variables that could be compared across all the sites. Efforts were therefore made to ensure that the procedures employed at each phase of planning and implementation, including the study design, sampling, the design of questionnaires and clinical examination forms, and data collection, processing and analysis, would promote comparability.

In accordance with the protocol, the oral health outcomes in three different age groups at seven study sites in five countries were compared. The data were collected primarily through population-based social surveys. Examinations provided the necessary clinical data on individual oral health status. Aggregate secondary data concerning the socioenvironmental characteristics and oral health care system at each site were also collected.

1.4 Sampling

In choosing the sites for ICS II, the aim was to obtain a broad representation of regions, with diverse types of oral health care systems in terms of organization and financing (e.g.

[3] WHO/ORH/EIS/ICSII 88.1

public versus private systems), the presence of an organized school oral health services programme, and exposure to fluoride. However, there were certain practical constraints: countries needed to be interested in participating and were required to have access to sufficient human, financial and material resources to conduct the study. Unfortunately, the latter criteria prevented the inclusion of any African or South or Central American countries.

Individuals in three age groups were studied: children aged 12–13 years, adults aged 35–44 years, and adults aged 65–74 years. Data were collected from all three age groups at each site; however, for the oldest group in Yamanashi, Japan, the sociological component of the study was completed too late to be included in most analyses reported here. Similarly, data collection at the three additional sites was not completed early enough to be included. However, some findings from the clinical examinations are included in Chapter 7 for the group aged 65–74 years in Yamanashi, and for all age groups in San Antonio, USA, Latvia and Rhone-Alpes, France. Data collected for children aged 6–7 years in Baltimore and adults aged 20–24 years in New Zealand are not included in this report, since comparable age group data were not collected at other sites. However, they are sometimes mentioned in the discussion.

Since it was recognized that few countries would have the resources required to conduct a survey of their entire country, recommended guidelines were established for the selection of study areas, target sample sizes and sampling methodology. First, the selected study sites, also called "defined administrative units" (DAUs), should be served by an oral health care delivery system that was at least 15 years old, and was typical of the country or a significant portion thereof. This was to ensure not only that the results of the study would be relevant to the whole of each participating country, but also that the observed outcomes could, for the most part, be attributed to the oral health care delivery systems in place. Secondly, in order to guarantee a large and diverse population from which to draw the samples, the DAU should contain a non-institutionalized population of at least 300 000, with more than one-third residing in urban areas. Thirdly, the selected DAU should have an oral health care provider–population ratio of at least 1:3000.[4] Fourthly, a target sample size of 1000 was established for each age group to ensure adequate sample sizes. This recommendation was based on a power analysis of the sample sizes required to detect the observed differences at the 0.05 confidence level in 70% and 80% of the samples. The differences used were the observed differences between the urban and rural populations in ICS I in the proportions of people brushing their teeth and visiting a dentist. Finally, the samples should be drawn as probability samples from sample frames known to include at least 90% of the population.

Since each country has its own unique characteristics, it was recognized that it would not be possible to follow these guidelines in all instances. For example, in Poland the DAU was not a single contiguous area, and the Indian Health Service sites in the United States were divided to reflect the diversity and geographical spread of the area.

[4] Questionnaires were administered to samples of oral health care providers at most sites to gain an understanding of the patterns and characteristics of the current oral health care practices and providers. The data obtained are not reported here.

1.5 Variables

As indicated in section 1.3, ICS II took into account individual- and system-level variables. The former included personal characteristics and oral health outcomes, and the latter included socioenvironmental characteristics and the nature of the oral health care system.

Personal characteristics were divided into predisposing and enabling variables. The former included sex, level of education and occupation, perceived general health status and health beliefs. According to the Health Belief Model,[5] health beliefs, which include the perceived seriousness of oral disease, importance of oral health, benefits of brushing, flossing, oral health service visits, and the number of perceived barriers (fear, being too busy, lack of services) to obtaining oral health care, influence the individual's likelihood of engaging in various health behaviours. Enabling variables facilitate or impede oral health behaviour, and included the level of income, residence (more or less urban), family size and having/not having a usual source of oral health care.

The oral health outcomes investigated were oral health behaviour, oral health status and oral quality of life. Oral health behaviour, as an intermediate outcome variable, in turn comprised the oral hygiene practices of toothbrushing and flossing, and oral health service utilization. The oral health status parameters used were dentition status, measured by the number of decayed, missing and filled teeth; periodontal status, measured by the Community Periodontal Index of Treatment Needs;[6] and dentofacial anomalies, measured by the Dental Aesthetic Index.[7] The variables used to measure oral quality of life were the number of oral health symptoms, perceptions of oral well-being, and social and physical functioning as affected by oral health problems.

Annex 1 provides a more detailed list of the individual-level variables and their construction.

Socioenvironmental characteristics were comprised of social, political and economic characteristics, socioenvironmental characteristics specific to oral health (i.e. diet, including sugar consumption, the availability of fluoridated toothpastes, and water fluoridation), and the resources and organization of the general health care system. Oral

[5] The Health Belief Model is a sociopsychological model developed in the 1950s to explain health behaviour. It postulates that an individual will not engage in certain health behaviour until he or she believes that (1) the disease will have serious consequences for himself or herself; (2) doing something about the disease is more important than doing other things; (3) the action will be of benefit for either preventing or alleviating the seriousness of the disease; and (4) the action will not cause anxiety or inconvenience, or entail high cost. For a detailed description of this model, see Rosenstock (1974).

[6] The Community Periodontal Index of Treatment Needs (CPITN) indicates levels of periodontal conditions in populations for which specific interventions might be considered. For a detailed description, see Cutress, Ainamo & Sardo-Infirri (1982).

[7] The Dental Aesthetic Index (DAI) is specifically designed to measure dental aesthetics. Using objective measures of occlusal conditions, it ranks a person's dental aesthetics on a scale of societal norms for socially acceptable dental appearance. It can also serve as an index of the need for orthodontic treatment by indicating, for any set of occlusal measurements, the amount of deviation from social norms for aesthetic dental appearance. The categories, based on DAI scores, include minor or no anomaly, definite malocclusion with treatment elective, severe malocclusion with treatment highly desirable, and handicapping malocclusion (Cons, Jenny & Kohout, 1986; Cons et al., 1990).

health care system characteristics included the development of modern oral health care and the organization and financial, human and material resources of the system. Chapter 2 provides a detailed description of all these system-level variables for each study site.

1.6 Data collection, processing and analysis

Data collection

At each site a local research team was formed, generally consisting of a project director, an oral epidemiologist and three or four oral examiners, a survey sociologist, interviewers, and consulting economists and biostatisticians. The project director was an experienced researcher and manager who had established relations with national (and regional) government, and the research and oral health care communities. The director had overall responsibility for the project at the site, including team recruitment and supervision, and for liaison with the ICS II central team. The other members of the team were also generally experienced researchers with recognized expertise and skills in the research disciplines needed to carry out the study. Core staff, who worked on study design, instrument testing, data collection, data analysis and reporting, were involved in the project until its completion. The names of the project director and key researchers of each study team are listed in the Acknowledgments.

Primary data were collected using surveys and clinical examinations. Secondary data were also collected to provide information on the socioenvironmental characteristics and oral health care system at each study site.

The ICS II research protocol served as a reference for the local teams to guide data collection and to ensure the optimum possible measure of comparability between sites. In addition to the protocol, the central team also developed and distributed guidelines on the following to ensure understanding of the study by local teams and to standardize field procedures:

- power analysis
- list of variables
- pretest protocol
- examples of cross-tabulations for data analysis
- protocol for interviewer training
- protocol for the management of field work
- example of training materials.

Members of the central team visited each study site and engaged in extensive communications throughout the study concerning overall research plans, survey plans, aggregate data collection, social survey instruments, clinical examination forms, and coding criteria and procedures. They coordinated the special interests of each country with the standardized procedures and questions to be used at all sites. They also worked with local

teams in the areas of interviewer training, data collection systems, quality control procedures, and methods for transmitting data to the central team.

Social surveys

Core questionnaires for children and adults were developed, in English, by the central team (Annex 2). The questions were designed to elicit information on the variables described in section 1.6. The questionnaires were then translated into the languages used at each site. In order to ensure accuracy and comparability, the translated questionnaires were translated back into English by a different translator.

The prepared questionnaires were discussed extensively by the central and local teams during the central team's visit, to review and solve differences in translation and the associated meanings of each question. The primary purpose was to achieve conceptual equivalence between questions. A measurement is only conceptually equivalent if it satisfies two conditions: (1) it is valid for each country/study site; and (2) it is reliable or comparable between sites (Przeworski & Teune, 1982). Therefore, every effort was made to meet these two conditions. The questionnaires used were adjusted to allow for cultural differences while maintaining constancy of meaning, so that each site was assessed for conceptually equivalent information.

The questionnaires were also pretested at each study site prior to the start of data collection using the pretest protocol, with the aim of resolving difficulties arising from language and sociocultural differences and any specific problems related to general data flow management and administration of the instruments.

For the study itself, selected children and adults were asked to complete questionnaires. The questionnaire for children was self-administered, and filled out at school. It contained about 60 questions and took an average of 30 minutes to complete. The adult questionnaires were administered by an interviewer, usually in the respondent's home. They contained about 200 questions, and the interviews took an average of 40 minutes.

Clinical examinations

The oral examiners at each site were trained and assessed by an experienced epidemiologist, who also served in this capacity for ICS I. He spent 7–10 days at each site prior to the start of the examinations for this purpose. An inter-rater reliability correlation coefficient of 0.75 or better was required before an examiner was allowed to examine study subjects. Procedures for checking data reliability (inter- and intra-examiner reliability) and determining the correlation coefficient are described in a WHO document,[8] which was discussed with and distributed to the local teams.

[8] Calibration of examiners for the International Collaborative Study of Oral Health Outcomes, Geneva, World Health Organization, 1993 (document ORH/EIS/EPID.93.1); available on request from the Oral Health programme, Division of Noncommunicable Diseases, World Health Organization, 1211 Geneva 27, Switzerland.

The epidemiologist returned to each study site in the middle of the examination period for one week to reassess examiners. Checks for examiner bias and variance were carried out periodically. A random sample of 5% of the subjects was examined independently by two examiners, to permit an estimate of inter-examiner reliability during the data collection period.

Examiners undertook an oral examination and completed a clinical examination form for each subject (Annex 2).

Secondary data collection

Sources of information included books and articles, published reports from government health agencies, the oral health profession, institutions that could provide data on the oral health care system, and administrators of the system. The central team developed a DAU and country aggregate data collection form for use in obtaining this information. The local and central teams completed this form jointly for each study site. The secondary data collection was important for a comprehensive description to provide a better understanding of the socioenvironmental and oral health service factors that influence oral health and behaviour outcomes.

Data processing

In order to ensure as high a level of consistency, quality and comparability as possible, all data were processed through a multistage sequence of checks, cleaning and imputation. Interview and clinical data were treated similarly, and both were reviewed in the field for completeness and correctness.

Field supervisors reviewed all initial interview data and conducted spot checks throughout the interview period. In each country, editors/coders reviewed the data for each completed interview, specifically checking for out-of-range values and improperly executed skip patterns. At each stage, problems were referred back to the interviewer and, occasionally, to the respondent.

At this point, the data were usually sent to WHO for data entry, although in some instances this was undertaken at the study site. The keyed data were screened for out-of-range values and improperly executed skip patterns at the site of data entry and at CHAS, where the data were sent for analysis. Additional processing at CHAS consisted of further screening for inconsistent values, missing value imputation (see Annex 3), variable construction (see Annex 1), and weighting (see Annex 4). The final data sets were returned to the originating country and copies were stored at WHO and CHAS.

Data analysis

Data analysis, guided by the ICS II theoretical model, focused on the three sets of oral health outcomes: oral health behaviour, oral health status and oral quality of life. Three main levels of analysis were conducted: to describe each of the outcomes; to address the social

group differences in outcomes; and to attempt to explain the differences through multivariate analysis using a range of predisposing and enabling predictors. Both quantitative and qualitative comparative methods were applied at all levels of analysis, and all data were weighted statistically to adjust for the probability of selection and non-response rates. Annex 4 provides a description of the weighting procedures applied to each data set at each site. Furthermore, for all levels of analysis, standard errors and significance tests were adjusted for the clustering and stratification introduced by the complex sample designs used. Annex 5 describes the procedures for calculating measures of standard error for each site.

Descriptive analysis

Univariate analyses were conducted for oral health behaviours, oral health status and oral quality of life at each site and the results were compared to the findings of ICS I and previous studies. Finally, the status of oral health outcomes was compared across all sites, with the aim of acquiring a better understanding of (1) oral health outcomes at each site (i.e. how well the site was doing in terms of these outcomes), and (2) the relations between status of oral health outcomes and socioenvironmental characteristics and the resources and organization of the oral health care systems. Student t-tests[9] were used to determine the significance of differences between countries. Only statistically significant differences are reported. The comparative analysis relating system-level variables to oral health outcomes was primarily qualitative because there were only seven sites, and was based on a careful study of the relevant literature (reviewed in later chapters) and of the characteristics of the social, political, economic and oral health care systems of the sites (described in detail in Chapter 2).

Analysis of social group differences

Bivariate analyses were conducted in order to examine the social group differences (sex, education, income, and having/not having a usual source of care) in oral health outcomes for each site. Chi-square tests (for percentages) and t-tests (for means) were conducted to examine the statistical significance of social group differences. Finally, social group differences were compared across sites with the aim of determining patterns of social group disparities and relating these patterns to system-level factors.

Analysis of explanatory factors

Multivariate analyses were conducted on selected key oral health outcome variables for each site. Multiple regression analyses were conducted on the oral health outcome variables that were treated as continuous (e.g. the number of missing teeth and perceived health status measured with a Likert scale[10]). Logistic regression analyses were conducted on the

[9] The t-tests were conducted to determine the significance of differences in each of the outcome variables (expressed as percentages or means) between every pair of study sites, taking into account standard errors.

[10] The Likert scale is an ordinal measurement of a respondent's level of certain status or agreement with an attitudinal or other statement. In ICS II, respondents' perception of their oral health status was measured by asking them to rate their status as excellent, very good, fair, poor, or very poor.

dichotomous outcome variables (e.g. brushing/not brushing more than once a day, having/not having periodontal pockets, and avoiding/not avoiding laughing or smiling because of the appearance of teeth).

The regression analysis models were developed systematically on the basis of the ICS II theoretical model (Figure 1.1). The independent variables chosen were selected because: (1) they had theoretical and policy relevance; (2) the literature suggested their potential importance; and (3) comparable measures were available at most sites. These regression models were used to examine how a single specific predictor affects oral health status after adjustment to correct for the effects of all the other predictors included. The effects of each predictor are shown in the tables in later chapters as: "standardized regression coefficients" in the multiple regression model; and "adjusted odds ratios" in the logistic regression model. The standardized regression coefficients show how the dependent variable changes in relation to each unit increase in the independent variable. The odds ratios indicate approximately how much more likely (or less likely) it is for the outcome to be present among people with one value of a predictor than among those with another.

The results of the multivariate analyses for each study site were compared with those of other sites, to test the generality of the findings. Furthermore, differences in the patterns across sites were analysed according to system-level factors.

Weighting

Weights were developed for all of the ICS II data sets, and most of the tables in this book present weighted data. These weights served to adjust for different probabilities of sample selection and were constructed from selection probabilities, non-response rates, and post-stratification. The selection probability weight component corrected for the fact that, at most of the sites, individuals did not all have the same chance of being selected; the non-response adjustment corrected for differences in the rate of participation in surveys by different groups of individuals within a site; and the post-stratification weight component corrected for residual deviations in the samples from known population distributions, such as sex or type of residence. Final weights were constructed by multiplying the three components. A more detailed description of the construction of weights is given in Annex 4. Weights for the Baltimore study were developed by the Baltimore local team, while weights for all other data sets were developed at CHAS.

Computation of standard errors

The basic formulae used for computing standard errors and significance levels were different from those found in most introductory statistical texts because of the complex sampling designs used. Depending upon the degree of clustering and stratification, use of basic elementary formulae would have provided either an overestimate or an underestimate of the actual appropriate standard error levels. Standard errors were therefore calculated

using a software package for estimates based on complex multistage sample designs[11] (Shah 1981), which uses the widely known first-order Taylor series approach. A more detailed description of the computation of standard errors is given in Annex 5.

[11] Software for Survey Data Analysis for Multistage Sample Designs (SUDAAN), version 5.30, Research Triangle Institute, Research Triangle Park, NC, 1991.

Real entitlement for adults was greatest in the former GDR, where curative and preventive oral health care was available free of charge. In Poland and at the IHS sites adults were similarly entitled to preventive and curative oral health care but these sites had limited resources. At the time of the ICS II survey, the national health insurance and other insurance plans in Japan covered only part of adult costs for curative services. The general adult population was not entitled to receive any free oral health services in New Zealand or Baltimore.

2.7 Additional sites

Three additional sites participated in ICS II although, as indicated in Chapter 1, most of the findings from these sites were not received in time for the main analysis. These sites are described briefly below.

San Antonio, USA

As in Baltimore, the health care system at this site, located in the state of Texas, is served predominantly by private practice.

The population of San Antonio was 940 000 at the time of the study and was not subdivided into urban and rural categories. The population comprised 56% Hispanic, 36% Caucasian, non-Hispanic and 8% other, mainly African American. Sampling of adults was based on clusters within which census tracts were randomly selected. From these census tracts, blocks were selected using a weighting system to approximate the community profile. Sampling of children was performed randomly from lists of school pupils in the sixth and seventh grades.

Latvia

As in New Zealand, the study in Latvia was based on a national sample. The system of health care had for some 40 years been predominantly in the style of that of the former Soviet Union, with all health centres and personnel paid from public funds and costs of health care borne by the Government, except for certain special items, mostly prosthetic in the case of oral health.

The population of Latvia at the time of the study was 2.7 million. The main city, Riga, had a population of 0.9 million and the proportions of urban and rural dwellers were 71% and 29% respectively. Sampling was based on three subdivisions– the main city, large towns and rural districts – to provide a multistage stratified sample that respected the study protocol demands.

Rhône-Alpes, France

The system of oral health care in France is based predominantly (95%) on private practice. In the virtual absence of a public health service focused on prevention, the Union

7 Oral Health Status

Barmes, D.E. and Leclercq, M.-H.

A major purpose of ICS II was to develop a methodology that could be employed at sites throughout the world to make a situation analysis and plan future oral health services on a continuing basis. Evidence that this purpose has been achieved is given by the number of additional sites which have adopted the ICS II protocol and conducted their own studies after those of the initial sites described in detail in this report. As these sites could not complete their data collection in time for the deadline applied to the initial seven sites, they could not be fully incorporated into the comparative framework and detailed analyses.

However, it was decided to include the findings on oral health status from three later sites and to compare them with results from the initial sites and ICS I data as an extension of the comparison described in Chapter 6. Consequently, this chapter differs from the others as it includes oral health status data collected in epidemiological surveys in San Antonio, Texas, USA; Latvia; and Rhone-Alpes, France. The characteristics of these sites are described in section 2.7. Also included here, but not in the rest of the volume, are data on older adults aged 65–74 years in Yamanashi, Japan, which were collected later than for younger adults and children.

As in ICS I, the data are not presented separately for males and females. The prime purpose of this chapter is to allow the reader to see a summary of the data as they were collected without statistical adjustment, except compilation of standard indices, means and percentages. These data are compared across sites and with ICS I data (Arnljot et al., 1985) where possible. They form a background in relation to similar data collected by age and standard measurements (in the case of DMF for more than 50 years) against which observed trends and disease levels as well as statistically analysed relationships can be assessed for practical action in the future. This action could take many forms including prevention, curative/restorative services, research or provision of personnel.

The tables in this chapter also differ from those presented in other chapters because they report unweighted data. Whereas weighted data are used elsewhere in the report for detailed comparisons and relationships between clinical and other data to take into account the complex sampling designs used at most sites, unweighted data are used here as they had already been reported by some of the initial sites and weighting was not used at the later sites. As a result, some estimates in this chapter will differ slightly from those presented elsewhere in the report for the initial sites. In no case were these differences substantial. Tabular data have been presented throughout this publication with two decimal places, but the text regularly refers to quantities rounded to one decimal place or to a whole number for easier perception and contemplation of differences.

7.1 ICS II findings

Children

Number of teeth

Although normal children aged 12–13 years are expected to have 28 permanent teeth, the population samples almost always showed a mean of less than this number. The mean number of teeth present in these samples varied from 25.7 to 27.1 (Table 7.1) and the M component of the DMFT index, which measures the number of missing teeth, varies only from 0.0 to 0.2 (Table 7.1). Apart from late eruption, the only important element in the

Table 7.1 Dentition status in children aged 12–13 years

Site	DMFT	D	M	F	No. of teeth
Erfurt, Germany	3.1	0.3	0.1	2.7	25.7
Yamanashi, Japan	5.3	1.2	0.01	4.1	27.0
New Zealand	2.4	<0.1	0.01	2.3	26.0
Lodz, Poland	5.1	2.9	0.2	2.2	26.5
Baltimore, USA	1.7	0.5	0.01	1.2	26.2
IHS Navajo, USA	2.2	0.8	0.04	1.4	27.1
IHS Lakota, USA	3.2	1.3	0.05	1.8	26.7
Latvia	5.8	3.5	0.2	2.1	26.1
San Antonio, USA	2.3	1.0	0.03	1.3	26.8

D, M, F, mean number of decayed, missing, filled teeth per person; DMFT, total of D+M+F; IHS, Indian Health Service

discrepancies of about 1 to 2 teeth from the expected 28 was extraction for orthodontic purposes. In ICS I the M component of DMFT was slightly higher at all the sites represented in both studies. Overall, there were no important contrasts or comparisons between ICS II and ICS I data for this variable.

Decayed, missing and filled teeth (DMFT)

The mean DMFT score in ICS II for children aged 12–13 years ranged from 1.7 in Baltimore to 5.8 in Latvia (Table 7.1). This compares to a range of 3.0 to 12.6 in ICS I for the age group 13–14 years. For the five data sets for countries which participated in ICS I, allowing for the age difference, all had much lower mean DMFT scores in ICS II, the most

spectacular being for New Zealand, 2.4 compared with 10.7 (Canterbury) and for Baltimore, 1.7 compared with 3.0.

The components of DMFT also exhibited positive changes compared with ICS I in terms of reductions in the D and M components and increases in the F component proportion. The only exception was Lodz where the D component was about the same and the F component, which had been over 50% in ICS I, was only about 43% in ICS II. In Yamanashi, although the change in treatment coverage represented by the F component, which rose from 44% to 77%, was most impressive, the absolute level of 1.2 D teeth per student was relatively high compared with Baltimore where the proportion of coverage was slightly lower but the absolute level of D teeth was only 0.5. New Zealand retained first place for coverage with 97% and a D component of less than 0.1.

For data sets not represented in ICS I, the mean DMFT score for Latvia was the highest of all sites though of the same order of magnitude as Yamanashi and Lodz. IHS Navajo, San Antonio and IHS Lakota, were low to middle of the range at 2.2, 2.3 and 3.2 respectively. However, whereas the D components for Lodz (54%) and Latvia (61%) were high, those for the three non-ICS I sites other than Latvia reached 36% for the Navajo sample and 42% for both the Lakota and San Antonio samples compared with 23% for Yamanashi from a mean DMFT score of 5.3 and a range of 3% to 27% for the other ICS I sites. This contrast begs for an explanation of why the overall low disease levels in the IHS samples and San Antonio were not matched by better treatment coverage.

Treatment needs for teeth

The data presented in Table 7.2 show, as expected, that the proportion of children needing any restorative care, including extraction, caries arresting care, fillings, crowns/bridges, pulp care, and other care generally followed the order of the mean number of D teeth. The order was not maintained, however, for the relatively rare needs at this age for crowns and bridges. The Lakota site, Yamanashi, San Antonio and New Zealand had the highest proportions needing crowns and bridges (3% to 0.9%) while proportions at the other sites ranged from 0.2% to zero. These four sites ranked third, fourth, fifth, and ninth respectively on the basis of mean D teeth. The proportions requiring pulp care also departed from the mean D teeth ranking, the results for Lodz and Latvia, at 10% and 15% respectively being another disturbing element in those samples.

The most notable features of the proportions needing extraction were the extremely low figure (0.1%) in New Zealand and the extremely high one (23%) in Lodz. However, the figure for Erfurt (6%) was somewhat higher than would be expected from its ranking on the mean D teeth scale.

There was a remarkable variation in recorded need for caries arresting care at all the sites, which ranged from 0.1% to 90%. The absence of any relationship of caries arresting care to the mean D teeth results and the wide range in the proportion of those who needed it

Table 7.2 Proportion of children aged 12–13 years needing tooth care, expressed as a percentage of the sample

Site	Extraction	Caries arresting care	Fillings, 1 or more surfaces	Crowns and/or bridges	Pulp care	Any restorative care	Other
Erfurt, Germany	6	0.1	24	0.2	0.3	24	0
Yamanashi, Japan	3	20	42	2	4	43	0
New Zealand	0.1	10	7	0.9	0.4	8	0.2
Lodz, Poland	23	18	73	0.1	10	74	1
Baltimore, USA	0.8	30	25	0	2	26	0
IHS Navajo, USA	7	90	45	0	4	46	0.2
IHS Lakota, USA	3	90	52	3	2	54	3
Latvia	14	8	84	0	15	85	0.3
San Antonio, USA	3	48	39	2	2	40	2

IHS, Indian Health Service

suggest that, because this procedure is relatively new and not available to all communities, there has been variation in recording this type of treatment need. Cross-site comparison is therefore difficult. Relevant to the availability of this procedure is the existence of special services, for example, at the IHS sites to provide this type of care routinely.

Treatment needs data by number of teeth in each category provide no further insight concerning these observations. The main contrast between ICS I and ICS II was seen in the data for Lodz and Yamanashi. In ICS I, the results were similar, although higher in Yamanashi. In ICS II, there was a large difference in the other direction, reflecting both a worsening situation in Lodz and a much improved status in Yamanashi.

Periodontal conditions

Of the four indicators measured in the Community Periodontal Index of Treatment Needs (CPITN) (Miyazaki, 1991a, 1991b; Pilot, 1992), only bleeding and calculus are relevant measures at this age. Table 7.3 indicates the mean number of sextants[1] with periodontal conditions per person for the nine sites. Prevalence of bleeding and calculus was extremely low in New Zealand, low in Lodz, Erfurt and San Antonio, and moderate at the Navajo, Latvia, Baltimore, Lakota and Yamanashi sites. No direct comparison is possible

[1] Sextants refer to the grouping of teeth, three groups in each jaw, the left and right sextants being composed of molars and premolars, the central sextants of incisors and canines.

with ICS I data which were based on another index, the Periodontal Index (PI, also called Russell's Index). The proportion in ICS I with no gingivitis, as measured by the Oral Health Index - Simplified (OHI-S), ranged from 0 to 15% compared with the apparently similar measurement of no bleeding for which in ICS II the proportions ranged from 5% (Navajo) to 72% (New Zealand). However, as the CPITN results depend on probing and the OHI-S does not, it would not be advisable to make comparisons supporting a claim that improved hygiene

Table 7.3 Mean number of sextants per person with periodontal conditions in children aged 12-13 years

Site	Healthy	Bleeding	Calculus	Blank	Missing
Erfurt, Germany	5.0	1.0	0.1	0	0
Yamanashi, Japan	3.8	2.2	1.3	0	0
New Zealand	5.6	0.4	0.3	0	0
Lodz, Poland	5.0	0.9	0.3	0.1	0
Baltimore, USA	3.3	2.7	0.7	0	0
IHS Navajo, USA	1.3	4.7	2.0	0	0
IHS Lakota, USA	3.7	2.4	0.3	0	0
Latvia	3.0	3.0	0.5	0	0
San Antonio, USA	4.8	1.2	0.6	0	0

IHS, Indian Health Service

has reduced the early signs of periodontal diseases. There are several other outstanding features in these data:

- the contrast between the two IHS samples
- the difference between Baltimore and San Antonio samples
- the low level in Lodz considering the caries data compared with moderate levels in Latvia with a similar caries experience
- the remarkably low level in New Zealand.

There are some changes in the order of prevalence for the data on calculus (score 2). The proportion in San Antonio was higher than expected and that for the Lakota sample was lower. The proportion at the Navajo site remained the highest.

Periodontal treatment needs

The two categories used under this heading are oral hygiene instruction and prophylaxis, as observed from the recording of the CPITN (see *Oral Health Surveys, Basic Methods*, 3rd

Table 7.4 Proportion of children aged 12–13 years needing periodontal treatment, expressed as a percentage of the sample

Site	Oral hygiene instruction	Prophylaxis
Erfurt, Germany	47	10
Yamanashi, Japan	76	65
New Zealand	28	22
Lodz, Poland	44	18
Baltimore, USA	80	44
IHS Navajo, USA	95	71
IHS Lakota, USA	77	19
Latvia	85	27
San Antonio, USA	52	30

IHS, Indian Health Service

ed., WHO 1987, pages 31–32). The need for oral hygiene instruction (Table 7.4) follows closely the Table 7.3 order for number of affected sextants with a CPITN score of 1 or 2, with New Zealand having markedly the least and the Navajo the greatest need. Given the difficulties of comparing ICS I and ICS II data for periodontal disease conditions, the ICS I data for major scaling gave no hint of the ICS II contrast; Baltimore, Canterbury and Leipzig had low levels of need, Yamanashi a little higher and Lodz highest by a wide margin.

Dentofacial anomalies

On the basis of a four-stage categorization of Dental Aesthetic Index (DAI) data (Cons, Jenny & Kahout, 1986), Table 7.5 presents the main cross-site comparison. The Navajo data record the highest prevalence of the severe categories of malocclusion ever measured in ICS studies. The score for severe malocclusion was marginally to moderately higher than the scores for other sites, but for handicapping malocclusion there was a difference of 2–5 times. The contrast of these findings with those for the Lakota site, which were the second highest, is striking, especially for handicapping anomalies.

In comparing results for minor or no anomaly, those for New Zealand (41%) were marginally better than those for the Lakota site (37%), followed by Yamanashi and San Antonio (both about 50% and very similar results overall). Erfurt, Baltimore, Lodz and Latvia had the highest levels of minor or no anomaly, but Baltimore differed in distribution, the proportion of those with handicapping malocclusion being 1.5–2 times the proportions at the other two sites.

Table 7.5 Dentofacial anomalies in children aged 12–13 years; proportion with anomalies expressedas a percentage of the sample

Site	Minor or no anomaly	Definite malocclusion: treatment elective	Severe malocclusion: treatment highly desirable	Handicapping malocclusion	Mean DAI score per subject
Erfurt, Germany	60	25	8	8	25.3
Yamanashi, Japan	50	29	11	10	26.5
New Zealand	41	28	15	16	28.3
Lodz, Poland	60	23	9	8	24.5
Baltimore, USA	60	18	9	13	26.2
IHS Navajo, USA	16	24	17	43	34.5
IHS Lakota. USA	37	30	15	19	29.2
Latvia	62	22	7	9	24.9
San Antonio, USA	52	28	10	10	26.6

DAI, Dental Aesthetic Index; IHS, Indian Health Service;

No direct comparison can be made with ICS I data because the criteria were altered and because the ICS II data exclude minor anomalies. There are no major reasons why the prevalence of anomalies would have changed markedly and that is the overall impression gained from a review of the two sets of data.

Orthodontic treatment needs

The DAI methodology used in ICS II has proved to be a vast improvement over previously used methodologies. By weighting contributions of different anomalies to a single scale it provides more soundly based estimates of the treatment need burden of malocclusion. As far as can be seen from the review of unlike data, there were no large variations from the estimated treatment needs in ICS I. On the basis of the index score per child, only the Navajo site (34.5) was any distance from the narrow range of 24.5 to 29.2 for the other sites, thus clearly indicating the increased community burden of the high scores for handicapping malocclusion in the Navajo sample. From tables of treatment completed or being given (not reproduced in this report), Erfurt, Baltimore and Lodz had the highest treatment levels in ICS II which were consistent with their low levels of minor or no anomaly. However, the two IHS samples had the lowest and third lowest treatment levels which, considering their extremely high need, may reflect policy decisions rather than unrestrained choice.

Fluorosis

Baltimore, San Antonio, IHS, Lakota and IHS, Navajo recorded 30%, 81%, 52% and 10% of children respectively for no fluorosis, the remainder scored 93%–100% (Table 7.6). Baltimore and San Antonio scores for moderate or severe cases were only 1%–2%, but the IHS sites had scores of 9% and 12%. Thus, all the sites in the United States and particularly the IHS sites recorded noticeably more fluorosis than sites in other countries.

Table 7.6 Proportion of children aged 12–13 years with fluorosis, expressed as a percentage of the sample

Site	Normal	Questionable	Very Mild	Mild	Moderate	Severe
Erfurt, Germany	99	0.2	0.4	0.3	0.1	0
Yamanashi, Japan	99	0.5	0.2	0	0	0
New Zealand	93	5	2	0	0	0
Lodz, Poland	97	0	0.2	0	0	0
Baltimore, USA	30	37	24	7	2	0
IHS Navajo, USA	10	14	40	24	10	2
IHS Lakota, USA	52	11	22	7	7	2
Latvia	100	0.1	0.1	0	0	0
San Antonio, USA	81	9	6	3	1	0.2

IHS, Indian Health Service

Adults

Dental caries

The range of mean DMFT scores in adults aged 35–44 years for countries participating in both ICS I and ICS II was 12.3–20.9 (Table 7.7) compared with 12.5–24.5 in ICS I. For the five data sets allowing intra-country comparison, the mean for Erfurt in ICS II was 2 DMFT higher than that for Leipzig in ICS I, the Lodz mean was about 2 DMFT lower and the Yamanashi mean was about 1 DMFT higher, but the New Zealand and Baltimore means were lower by 4 and 6 DMFT respectively. The same order remained except that Baltimore dropped from third highest to lowest.

Study of the components shows that the D component for these sites ranged from 0.5 to 1.3 compared with 0.8 to 2.8 in ICS I, a decline at all sites except for Lodz where it remained at the level of 3+ in both studies. The M component plunged in New Zealand and Baltimore from 14.3 and 8.9 to 7.8 and 2.4, respectively, but remained at about the same level in Lodz for the two studies. The proportion of the F component changed from 31% to 60% in New

Table 7.7 Dentition status in adults

Site	Adults, 35–44						Adults, 65–74					
	E	DMFT	D	M	F	No. of teeth	E	DMFT	D	M	F	No. of teeth
Erfurt, Germany	0.5	16.3	1.1	6.6	8.6	24.3	29.2	26.6	0.9	23.3	2.3	8.6
Yamanashi, Japan	0.2	13.7	1.3	2.5	9.9	26.8	20.4	23.9	1.1	18.4	4.4	12.3
New Zealand	13.7	20.9	0.6	7.8	12.5	22.0	59.6	28.8	0.3	25.0	3.6	6.9
Lodz, Poland	0.9	19.3	3.8	10.9	4.5	20.7	40.7	28.6	0.9	27.1	0.6	4.9
Baltimore, USA	1.0	12.3	0.5	2.4	9.4	25.9	24.0	23.6	0.6	17.5	5.5	13.7
IHS Navajo, USA	0.2	12.0	1.7	1.8	8.5	25.9	28.5	24.8	2.1	21.2	1.5	10.8
IHS Lakota, USA	4.7	15.7	2.5	5.7	7.5	21.8	56.5	29.2	1.1	27.3	0.8	4.8
Rhone-Alpes, France	0.0	14.6	1.2	3.0	10.5	25.5	NA	NA	NA	NA	NA	NA
Latvia	0.0	19.2	3.7	7.8	7.7	24.0	15.5	24.9	1.7	20.0	3.2	12.0
San Antonio, USA	1.8	14.1	2.3	5.5	6.3	26.0	14.4	21.6	1.2	15.3	5.2	16.6

E, proportion edentulous, expressed as a percentage of the sample; D, M, F, mean number of decayed, missing, filled teeth per person; DMFT, total D+M+F; IHS, Indian Health Service; NA, not applicable.

Zealand, 41% to 77% in Baltimore, 53% to 72% in Yamanashi, 51% to 53% in Germany and 21% to 23% in Lodz.

Apart from Lodz, it is clear that oral health status and effective coverage by the oral health services had improved or, in the case of Germany, had remained at a substantial level.

Amongst the non-ICS I sites, Latvia again had the worst caries problem, similar to Lodz but with a more even distribution between the M and F components. For the Navajo site, the mean DMFT score was at the lower end of the range (12.0); it was about average (15.7) for the Lakota and Rhone-Alpes (14.6) sites. The D and M components for the Navajo sample compare favourably with those for the Lakota sample and while the D component for the Navajo site was fairly high, the F component proportion was 71% and the M component was the lowest of all sites, suggesting that preventive and care services have been effective. The F component for the Rhône-Alpes data was similar in proportion to the Navajo results, but was only 45% of the DMFT mean in San Antonio.

The proportion of edentulous individuals at this and subsequent ages is a very important indicator of how successful oral health services have been; it ranged from 0 to 14%. Although the reduction from 36% in ICS I to 14% in ICS II is spectacular, New Zealand still recorded the highest results followed by the Lakota site with only 5%. The remaining samples ranged from zero in Rhone-Alpes and Latvia to 2% in San Antonio. Lodz retained

a low level (1%), as in ICS I, despite negative scores in other aspects of caries. Equally surprising was the result for Latvia, considering the high DMFT mean and its components at this site.

Comparison with ICS I reflects the vast improvement in New Zealand and Baltimore from 36% and 10.5% to 13.7% and 1% respectively. The other sites showed virtually no change.

For adults aged 65–74 years, no comparison with ICS I was possible. The mean DMFT scores ranged from 21.6 to 29.2 (Table 7.7). That whole range was more than accounted for by the M component which was overwhelming at all sites, ranging from 15.3 to 27.3. The D component was conspicuously high for the Navajo (2.1) and the Latvia sites (1.7), and lowest for New Zealand (0.3). The F component was highest in Baltimore (5.5), although the other sites had fairly high scores (2.3 to 5.2) in comparison with D components, except for Lodz (0.6), the Lakota site (0.8) and the Navajo site (1.5).

The edentulous levels ranged from 14% to 60% with San Antonio the lowest and New Zealand the highest (Table 7.7). Whereas the massively high percentage for New Zealand is eye-catching, it was predestined by the level measured for adults aged 35–44 in ICS I – 36% for a cohort that had still not reached 65 by 1988. There is evidence that the level of DMFT was not significantly different between 1976 and 1988 and edentulousness might not even have reached its peak considering the figure for adults aged 35–44 in ICS I, although the saturation point must have been close. It is, therefore, intriguing to contemplate the massive change that will come when the reduced levels now recorded in the younger age group begin to show in older age cohorts. Even more remarkable results may be in store for Baltimore, recalling that the proportion of edentulous individuals among younger adults dropped from about 10% to 1% between 1973 and 1991 and yet a level of only 24% was recorded for the older cohort in 1991, representing an age group which must surely have shown double-figure levels when they were part of the younger cohort.

The most alarming of all these data are the consistently disastrous results for Lodz (41% edentulous from only 1% at 35–44 years. The picture at all ages is one of neglected high disease rates and no evidence that the situation is improving. Equally disturbing is the contrast between the two IHS samples: 29% of the Navajo sample and 57% of the Lakota sample were edentulous, the latter being consistently worse in almost all measurements.

In Latvia, the mean DMFT score and M component were somewhat lower than might be expected and the proportion of edentulous individuals was much lower, although the latter is consistent with the remarkable zero score at 35–44.

Treatment needs for teeth

As with the children, the proportion of adults aged 35–44 needing restorative care (Table 7.8) closely paralleled the mean number of D teeth, except that the needs for Latvia (85%)

Table 7.8 Proportion of adults aged 35–44 needing tooth care, expressed as a percentage of the sample.

Study site	Extraction	Caries arresting care	Fillings, 1 or more surfaces	Crowns and/or bridges	Pulp care	Any restorative care	Other
Erfurt, Germany	7	0	44	23	2	56	0.2
Yamanashi, Japan	10	5	44	19	7	54	0
New Zealand	8	0.7	33	23	2	48	0.5
Lodz, Poland	42	3	70	36	8	83	0.3
Baltimore, USA	9	4	25	14	4	36	0
IHS Navajo, USA	35	0.7	60	1	9	63	0
IHS Lakota, USA	44	2	61	14	7	68	0.5
Latvia	19	0.6	81	10	22	85	0
San Antonio, USA	18	1	57	12	0.5	61	8
Rhône-Alpes, France	15	0	49	52	4	74	0.3

IHS, Indian Health Service

and Rhone-Alpes (74%) were higher than might have been expected. The need for crowns and/or bridges was remarkably high for the Rhone-Alpes sample and surprisingly low at the Navajo site. These results may have been related to the demand for services which were available. The need for pulp care was very high in the Latvia sample and somewhat higher than expected in Yamanashi.

The need for extraction was also related to D teeth means except for the very high level at the IHS sites. While this was not too surprising in relation to the D component, comparison with the M component and the recorded need for crowns and/or bridges suggested that there was a predilection for extraction rather than more complex restoration, especially at the Navajo site. In Latvia (19%) the result was lower, and in Rhone-Alpes (15%) higher than expected.

Caries arresting care for adult cohorts was not common at any of the ICS II sites.

For the older age group, the predominance of the M component had the expected effect of eliminating much of the variation in recorded need for fillings, compared to the younger age group (Table 7.9). As with that group, those in the older group at the IHS sites had a relatively high need for extraction and low need for crowns and/or bridges. Need for crowns and/or bridges was also low in Latvia (5%). Notable also was the high level of need for crowns and/or bridges combined with the lowest need for extraction and pulp care in New Zealand, and the high level of need for extraction in Lodz.

Table 7.9 Proportion of adults aged 65–74 years needing tooth care, expressed as a percentage of the sample

Site	Extraction	Caries arresting care	Fillings, 1 or more surfaces	Crowns and/or bridges	Pulp care	Any restorative care	Other
Erfurt, Germany	26	0.2	40	14	2	48	0.5
Yamanashi, Japan	25	0	36	16	7	46	0
New Zealand	9	4	26	17	0.5	38	0.5
Lodz, Poland	44	0.9	34	11	2	40	0.7
Baltimore, USA	16	3	28	10	3	36	0
IHS Navajo, USA	67	0	42	0.6	2	42	0
IHS Lakota, USA	62	2	28	7	2	30	2
Latvia	30	0	54	5	13	59	0
San Antonio, USA	25	0.7	42	14	2	51	6

IHS, Indian Health Service

Periodontal diseases

Rhône-Alpes (3.7), New Zealand (2.9), San Antonio (2.9) and Baltimore (2.6) stand out as the least affected among adults aged 35–44 (Table 7.10) on the basis of the mean number of sextants with score 0 on the CPITN, compared with a range of 0.5 to 2.0 for the other samples. Levels of shallow and deep pocketing in Latvia and Erfurt were lower, while in San Antonio they were higher than would be expected from the mean for zero scores. The level of shallow pocketing in New Zealand was higher than expected. The Yamanashi and IHS sites were consistent in having high mean sextant scores for all the disease indicators, although the missing sextant means were low to moderate. At first sight, Lodz appears to have lower scores for the disease indicators. However, the mean of 1.5 sextants missing' is higher than at all the other sites by a factor which ranges from 2 to 15.

Notwithstanding the difficulties of comparison with ICS I data, there are signs of an improvement in periodontal health in Baltimore. The same can be said for New Zealand in relation to a survey performed in 1982, whereas the periodontal disease data in ICS I were difficult to assess, owing to the effects of the very high levels of edentulousness.

For adults aged 65–74 (Table 7.11), the means for excluded sextants ranged from 1.4 to 3.9. On this basis the San Antonio sample was the healthiest, followed by that in Baltimore (1.6), the Navajo site (1.8) and New Zealand (1.8). The higher means for Erfurt, the Lakota site and Lodz ranged from 2.6 to 3.9. Since the distribution of scores 0, 1, 2, 3 and 4 was

difficult to compare because of the variation in excluded sextant means, the only findings of note were that older adults in New Zealand (2.0), San Antonio (1.9) and Baltimore (1.9) had by far the highest means for zero scores but that the pocketing score (3 + 4) for San Antonio was unexpectedly high (1.4).

Periodontal treatment needs

Table 7.12 shows a uniformly large need for oral hygiene instruction and prophylaxis for both adult age groups despite recorded differences in levels of periodontal disease indicators. For complex care, the needs for both age groups at the IHS sites were massively higher than at all the other sites except for Yamanashi, San Antonio and Latvia in the older group, where relatively high scores were recorded. The scores for Baltimore were surprisingly high considering the disease indicator levels. The scores for Rhones-Alpes were strikingly low, but consistent with the disease indicator levels.

Table 7.10 Periodontal status in adults aged 35–44 years

Site	Mean no. of sextants with CPI scores of:						
	0	1, 2, 3 or 4	2, 3 or 4	3 or 4	4	X	9
Erfurt, Germany	2.0	3.6	2.7	0.6	0	0.4	0
Yamanashi, Japan	1.7	4.2	3.4	1.4	0.2	0.1	0
New Zealand	2.9	2.7	2.4	1.0	0.1	0.4	0
Lodz, Poland	2.0	2.4	1.5	0.5	0.1	1.5	0
Baltimore, USA	2.6	3.2	2.7	0.5	0.1	0.3	0
IHS Navajo, USA	1.3	4.5	3.4	1.3	0.3	0.2	0.1
IHS Lakota, USA	1.0	4.2	3.8	2.2	0.5	0.8	0
Latvia	0.5	4.8	4.3	1.4	0.1	0.5	0.3
San Antonio, USA	2.9	2.9	2.5	1.2	0.2	0.2	0
Rhône-Alpes, France	3.7	2.2	1.7	0.5	0	0.2	0

CPI, Community Periodontal Index; X, excluded; IHS, Indian Health Service

Table 7.11 Periodontal status in adults aged 65–74 years

Site	Mean no. of sextants with CPI scores of:						
	0	1,2,3 or 4	2,3 or 4	3 or 4	4	X	9
Erfurt, Germany	0.8	2.6	2.2	0.6	0.1	2.6	0
Yamanashi, Japan	0.3	3.6	3.0	1.6	0.2	2.1	0.4
New Zealand	2.0	2.2	2.0	0.8	0.1	1.8	0
Lodz, Poland	0.7	1.5	1.0	0.3	0.1	3.9	0
Baltimore, USA	1.9	2.5	2.2	0.7	0.1	1.6	0.1
IHS Navajo, USA	0.4	3.6	3.0	1.4	0.4	1.8	0.2
IHS Lakota, USA	0.4	2.5	2.3	1.3	0.3	3.2	0
Latvia	0.1	3.3	3.0	1.4	0.2	2.2	0.4
San Antonio, USA	1.9	2.8	2.5	1.4	0.3	1.4	0

CPI, Community Periodontal Index; X, excluded; IHS, Indian Health Service

Table 7.12 Proportion of adults needing periodontal treatment, expressed as a percentage of the sample

Site	Adults, 35–44			Adults, 65–74		
	Oral hygiene instruction	Prophylaxis	Complex care	Oral hygiene instruction	Prophylaxis	Complex care
Erfurt, Germany	95	90	3	96	93	6
Yamanashi, Japan	97	93	9	99	96	19
New Zealand	89	86	4	90	87	7
Lodz, Poland	91	83	6	90	74	4
Baltimore, USA	89	84	5	86	82	11
IHS Navajo, USA	93	85	14	97	90	23
IHS Lakota, USA	98	93	28	95	92	21
Latvia	99	97	7	100	98	13
San Antonio, USA	83	47	9	87	80	18
Rhone-Alpes, France	88	83	2	NA	NA	NA

IHS, Indian Health Service; NA, not applicable.

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