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# **THE ETIOLOGY AND PREVENTION OF DENTAL CARIES**

**Report of a WHO Scientific Group**

WORLD HEALTH ORGANIZATION

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WHO SCIENTIFIC GROUP ON THE ETIOLOGY AND PREVENTION OF  
DENTAL CARIES

Geneva, 30 November - 6 December 1971

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# THE ETIOLOGY AND PREVENTION OF DENTAL CARIES

## Report of a WHO Scientific Group

A WHO Scientific Group on the Etiology and Prevention of Dental Caries met in Geneva from 30 November to 6 December 1971. Dr P. Dorolle, Deputy Director-General, who opened the meeting on behalf of the Director-General, welcomed the members and the representative of the International Dental Federation.

In his introductory remarks, Dr Dorolle pointed out that this was the tenth meeting of international experts convened by WHO to discuss various aspects of dental health. Member States were taking an increasing interest in dental health and the rising prevalence of dental caries in many areas was a cause of concern. He stressed the importance of prevention in public health and expressed the hope that the Group would make practical recommendations. Dr Dorolle drew attention to the importance of international co-operation in health affairs and expressed the gratitude of WHO for the continued co-operation of the International Dental Federation (FDI).

### 1. INTRODUCTION

Dental caries has been defined as "a localized, post-eruptive, pathological process of external origin involving softening of the hard tooth tissue and proceeding to the formation of a cavity".<sup>1</sup>

The pattern of the lesion varies with the site attacked and it is customary to distinguish between caries originating in pits and fissures, on smooth surfaces, and on the cemental surface of exposed roots. There is evidence to suggest that the nature of the pathological process may differ in each instance.

Dental caries is one of the most widely occurring diseases and it is a matter of serious concern that its prevalence is increasing in many countries. Moreover, there is a world-wide shortage of dental manpower. Treatment of the consequences of dental caries is time-consuming and expensive, and the costs of medical and dental services are constantly rising.

These facts make it obvious that dental caries cannot be controlled by treatment alone. The problem can be reduced to manageable propor-

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<sup>1</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1962, No. 242, p. 9.

tions only by preventive measures aimed at decreasing the prevalence of the disease.

It is important not only to seek ways and means of making the maximum use of existing methods but also to find new methods of prevention applicable on a mass scale.

The convening of this scientific group was approved by the Twenty-third World Health Assembly, its terms of reference being "to consider the achievements of research in different countries on the etiological factors of dental caries and recommend a co-ordinated approach in applying this knowledge to the actual means of prevention or reduction of dental caries".<sup>1</sup>

Accordingly, the Group undertook the following specific tasks :

1. To review the etiology of dental caries ; establish a consensus of opinion on present knowledge ; and define future areas of research.
2. To review available methods of prevention, specify those that are effective, safe, and practicable ; and define areas of research that might lead to the development of new methods.
3. To consider the need and possibilities for international co-operation in research on dental caries and to make recommendations on the role of WHO in such research.

## 2. ETIOLOGY OF DENTAL CARIES

In broad terms, the etiology of dental caries may be considered as a conflict between factors conducive to tooth decay and factors promoting resistance to the disease, each of these opposing forces being susceptible to environmental influences.

When the variables affecting resistance, environment, and virulence are standardized as far as possible in experimental situations, certain essential features of the various processes can be recognized. The disease does not occur in the absence of bacteria, and it requires the presence of fermentable carbohydrate in the oral cavity. The causative role of *Streptococcus mutans* has been confirmed by the fulfilment of Koch's Postulates in cases where non-human primates have been infected with this organism. Colonization of the tooth surface by cariogenic organisms is an essential precursor to demineralization of the underlying enamel.

Resistance to caries may reside in the intrinsic structure and composition of the teeth, in the oral environment, and in systemic factors. The surface configuration of the teeth as well as internal physiological processes are known to affect the ability of teeth to resist the onset and progress of caries ;

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<sup>1</sup> *Off. Rec. Wld Hlth Org.*, 1969, No. 179, p. 38.

an increased fluoride content of the enamel has been shown to raise resistance to demineralizing influences ; other factors such as permeability and the trace element content of the enamel are considered to be of possible importance to the intrinsic resistance of the tooth, as are variations in the nature of the organic-inorganic bond within the tooth substance. Saliva may influence the oral environment through such factors as buffering capacity, rate of flow, and hydrogen ion concentration, as well as by the action of the salivary enzymes, of antibodies, and of substances with a high molecular weight that contribute to dental plaque formation. Finally, it is considered that resistance may be subject to modification by genetic, prenatal, and postnatal maternal influences ; nutrition ; and general metabolic functions.

The factors conducive to tooth decay can be conveniently classified as (a) micro-organisms and (b) dietary substrates, both of which contribute to the formation of dental plaque and its maintenance on tooth surfaces.

(a) *Micro-organisms.* The etiological significance of all the components of the oral microflora has yet to be elucidated, but those that have received the most attention so far are streptococci and lactobacilli. The former comprise not only the *S. mutans* group, which has been convincingly implicated in the initiation of smooth-surface caries, but also *S. sanguis* and other streptococci that do not appear to be directly associated with caries activity. The role of lactobacilli is a source of controversy. The relative absence of these organisms from the dental plaque itself may seem difficult to reconcile with the many observations indicating that high lactobacillus counts in salivary samples are indicative not only of prevailing but also of impending caries activity. The metabolic activity of cariogenic organisms has been shown to influence the composition of dental plaque, especially by the production of glucans from particular forms of dietary carbohydrate.

(b) *Dietary substrates* implicated in cariogenesis include various forms of fermentable carbohydrate. Sucrose is considered to play a dominant part because it is not only fermentable to acid but also readily polymerized to insoluble glucan. However, although other sugars do not contribute in the same way to glucan production they can also, on the basis of available knowledge, be incriminated as promoters of caries. The deleterious effect of carbohydrates is determined especially by frequency of intake, their fermentability in the plaque, and the form and quantity in which they are consumed.

Finally, consideration must be given to the external or environmental factors that can modify both the resistance of teeth and the antagonistic forces. Geographical factors include the presence of fluoride and other trace elements in the soil, in water, and in food. The acidity and alkalinity

of soils may also be of significance. Of major importance is the influence of socioeconomic conditions which, in particular, may affect diet and health practices.

### 3. PREVENTIVE MEASURES

Although the eradication of dental caries is the goal of research in this field, only a progressive reduction in incidence and prevalence can be expected in the foreseeable future. The attainment of this objective calls for a combination of methods rather than any single form of preventive therapy.

Preventive measures may increase resistance, reduce the capacity of attacking agents to promote caries, or both. For example, the beneficial effects of fluoride may be exerted on the enamel or on the plaque; likewise, phosphates could exert a beneficial effect either by buffering acid produced in the plaque or by facilitating remineralization of a damaged tooth surface.

#### 3.1 Fluorides

##### 3.1.1 *Fluoridation of water supplies*

The use of fluoride in various forms remains pre-eminent among the measures available for increasing the resistance of teeth to carious attack. Continuing attention should be focused on the resolution of the Twenty-second World Health Assembly on fluoridation and dental health,<sup>1</sup> which

Recommends Member States to examine the possibility of introducing and, where practicable, to introduce fluoridation of those community water supplies where the fluoride intake from water and other sources for the given population is below optimal levels, as a proven public health measure; and where fluoridation of community water supplies is not practicable, to study other methods of using fluorides for the protection of dental health...

Despite this recommendation, many communities and health authorities are not exploiting the full potential of this and other methods of using fluorides for the prevention of dental caries.

Recognizing that there are many parts of the world where water fluoridation is not practicable for technical or other reasons, and that fluoridation should be introduced only when a strictly maintained optimum level can be guaranteed by proper facilities and supervision, the Group considered the following alternative methods of using fluorides:<sup>2</sup>

##### 3.1.2 *Fluoridated salt*

Salt is universally used and can be fluoridated at a low cost. Several studies in Europe and Latin America have given promising results and it is

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<sup>1</sup> *Off. Rec. Wld Hlth Org.*, 1969, No. 176, pp. 12-13.

<sup>2</sup> No order of priority is intended.

recommended that, if the investigations now in progress confirm the efficacy and safety of this procedure, high priority should be given to the early and widespread implementation of this potentially valuable public health measure, always provided that water fluoridation is not feasible. Further research should be directed towards establishing the optimum level of fluoride in salt necessary to ensure an intake equivalent to that provided by water fluoridation.

### 3.1.3 *School water fluoridation*

Preliminary results from studies in the USA have established that this is a safe, effective, and inexpensive procedure. It is particularly to be recommended where children are provided with regular meals at school and only when the maintenance of equipment and of fluoride levels can be properly controlled under the surveillance of a responsible engineer, teacher, or health official. Further research into the optimum level is recommended.

### 3.1.4 *Fluoride tablets*

The regular administration of soluble fluoride tablets is an effective method of caries prevention in children. However, when it is used within the family, its success depends upon a high degree of parental responsibility and persistence. Experience in several countries has shown that such persistence cannot be expected from everyone. Nevertheless, this problem can be overcome if the education and health authorities are willing to provide tablets for supervised consumption daily at kindergartens and schools. When tablets are supplied to parents through child health centres and schools, clear instructions should be given. The dosage should be adjusted to the age, as well as to the intake of fluoride from water and food. Ideally, administration should commence soon after birth and continue for several years after the last permanent tooth has erupted.

### 3.1.5 *Fluoride mouth rinses and brushing of the teeth with fluoride solutions*

Provided that the school authorities co-operate, either mouth rinsing or brushing of the teeth with fluoride solutions can be recommended as a simple, inexpensive, and practical procedure. However, if it is to be effective, both the technique and the frequency should be carefully controlled and the results monitored by periodic epidemiological studies on selected samples. Any programme in which fluorides are applied for a limited period—e.g., in schools—should be followed by continued self-application to achieve continuing benefits. Further research into methods of self-application is desirable.

The application of fluoride gels or solutions in specially constructed vinyl or wax trays is a procedure to be recommended in cases of excessive

susceptibility to caries, for example in xerostomia or following irradiation of the teeth.

### 3.1.6 *Applications of fluoride by health personnel*

The incidence and prevalence of clinical caries can be reduced by the direct application of fluoride solutions to the clean surfaces of teeth. Several efficacious solutions are available. According to the International Dental Federation's Policy Statement on Alternatives to Water Fluoridation:<sup>1</sup>

individual methods are time-consuming, relatively expensive, and difficult to administer on a public health scale. The group methods, using the techniques of rinsing or brushing the teeth with fluoride solutions, are preferable and much more economical and practical, particularly if natural congregating centres such as nursery and other schools are in common use.

The Group endorsed this view but in addition recommended that dental practitioners should be encouraged to incorporate topical applications of fluoride solutions into their regular procedure of treatment for children and young adults. Furthermore, topical applications by trained auxiliaries should be incorporated into public dental programmes when adequate facilities are available.

Clinical and laboratory experiments are being made with other vehicles, such as varnishes, for applying fluoride to the tooth surface in a form and for a duration designed to increase the uptake of fluoride by the enamel.

### 3.1.7 *Fluoride dentifrices*

Fluoride-containing dentifrices are now marketed in many countries. Clinical trials have consistently shown that regular use of some preparations is an effective preventive measure although the extent of protection may depend on the technique as well as the regularity of brushing the teeth.

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In making the above-mentioned recommendations, the Group realized that local circumstances, such as the duration of school curricula, availability of auxiliary personnel, and level of education, must determine what method of fluoride administration is most appropriate. Accordingly, Member States and Regional Offices of WHO should be encouraged to appoint experts to assist in determining the policy for their particular areas.

When due attention has been paid to local, regional, and national circumstances, the introduction of one or several of these auxiliary means of using fluorides will be of significant benefit.

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<sup>1</sup> International Dental Federation (1967) In: *Chronicle of the 55th Annual Session and XIVth World Dental Congress, Paris, France, 7-13 July 1967*. Published in *Int. dent. J.*, 17, 782-783.

3.1.8 *Use of fluoride in different circumstances*

The following table is intended for the guidance of health personnel in deciding on the most appropriate uses of fluorides in public health pro-

Fluoridation of water supplies	Target population and availability of health personnel	Methods to be considered <sup>1</sup>
Not feasible	Mainly rural with developing urbanization; large percentage of school-age children not at school; grossly insufficient numbers of health or dental health personnel.	Salt fluoridation; <sup>2</sup> administration of fluoride tablets; <sup>3</sup> brushing and rinsing of the teeth with a fluoride solution. <sup>4</sup>
Not feasible	Mainly rural with developing urbanization but with full primary school attendance; grossly insufficient numbers of dental health personnel.	Salt fluoridation; <sup>2</sup> school water fluoridation; administration of fluoride tablets; <sup>3</sup> brushing and rinsing of the teeth with a fluoride solution. <sup>4</sup>
Feasible but not fully implemented	Mainly rural with developing urbanization but with full primary school attendance; grossly insufficient numbers of dental health personnel.	<i>For population served by piped water supplies:</i> Water fluoridation plus brushing and rinsing of the teeth with a fluoride solution. <sup>4</sup> <i>For population not served by fluoridated piped water supplies:</i> Salt fluoridation; <sup>2</sup> school water fluoridation; administration of fluoride tablets; <sup>3</sup> brushing and rinsing of the teeth with a fluoride solution. <sup>4</sup>
Not feasible	Moderately or highly urbanized and at least full primary school attendance; abundant health and dental health personnel with or without comprehensive dental services.	Salt fluoridation; <sup>2</sup> school water fluoridation; administration of fluoride tablets; <sup>3</sup> brushing and rinsing of the teeth with a fluoride solution; <sup>4</sup> topical application of fluorides. <sup>5</sup>
Feasible	Moderately or highly urbanized and at least full primary school attendance; abundant health and dental health personnel with or without comprehensive dental services.	<i>For population served by piped water supplies:</i> Water fluoridation plus brushing and rinsing of the teeth with a fluoride solution. <sup>4</sup> <i>For population not served by fluoridated piped water supplies:</i> Salt fluoridation; <sup>2</sup> school water fluoridation; administration of fluoride tablets; <sup>3</sup> brushing and rinsing of the teeth with a fluoride solution; <sup>4</sup> topical application of fluorides. <sup>5</sup>

<sup>1</sup> No order of priority is intended.

<sup>2</sup> For the whole population.

<sup>3</sup> In schools by teachers and in maternal and child health clinics by nurses.

<sup>4</sup> In schools, supervised by teachers.

<sup>5</sup> As personnel permits, by health or dental health personnel as part of a regular treatment programme.

grammes, depending on whether water supplies are fluoridated and on the target populations and the health personnel available.

### **3.2 Adhesive sealants**

Attempts to occlude caries-susceptible fissures by means of sealant materials are being made in both clinical and laboratory studies in several countries. Promising results have been reported, particularly on recently erupted permanent teeth. The cost of this procedure in public health programmes has not yet been determined, and an evaluation of efficacy must await the result of trials based on uniform methods of clinical assessment and laboratory testing.

### **3.3 Phosphates**

There is at present no convincing evidence to warrant the addition of phosphates to sugar or other foodstuffs as a means of reducing the incidence and prevalence of dental caries. The Group supported the principle of using additives of proved safety and efficacy to foodstuffs in order to reduce their caries-promoting capacity, but recognized danger in the commercial implementation of this principle before such substances have been comprehensively tested to the satisfaction of dental scientists. Food additives for caries prevention should not only be of proved safety but should have been shown beyond doubt to possess a substantial degree of efficacy before their use can be justified.

### **3.4 Antimicrobial agents**

The principle of using topically applied antiseptics or antibiotics to attack cariogenic organisms on the tooth surface is being studied. In experimental animals, caries can be almost completely inhibited by this means but as yet no antimicrobial agent can be recommended for clinical use. Agents of this type should preferably be selective in their effect and the development of resistant strains can be an obstacle to their application. Nevertheless, it should be recognized that the inhibition of microbial colonization of the tooth surface remains an important research objective.

### **3.5 Enzymes**

The use of enzymes for caries prevention is based on the hypothesis that the cariogenic activity of bacteria can be inhibited by interfering with their metabolic processes and preventing the formation of products detrimental to the teeth. Dextranase especially has been studied, in the belief that by blocking dextran formation the amount of plaque as well as

its adhesiveness to enamel could be reduced. Some experimental results have lent support to this hypothesis. Satisfactory methods of transporting the enzyme to the target area and maintaining it there have yet to be perfected. The activity of many enzymes remains to be explored, and the labile nature of these agents constitutes a very difficult problem. The application of enzymes to caries prevention awaits developments not only in dental research but also in the more basic area of enzyme chemistry.

### **3.6 Vaccination**

The use of vaccines, mainly antistreptococcal, as a means of caries prevention has been attempted in animal experiments. The problems associated with such procedures are particularly complex because the secluded site of the initial lesion on the tooth surface denies the more usual path of access to circulating or cell-mediated antibody. It is difficult, therefore, to explain the precise mechanism by which cariostatic effects have been achieved in non-human primates. The vaccines used so far in experimental studies are not applicable to human beings. However, the possibility of warding off dental caries by immunological means is attractive in principle.

### **3.7 Oral hygiene**

Oral hygiene is essential to oral health. However, in the prevention of dental caries, brushing of the teeth and other aids to oral hygiene are only likely to be effective to the extent—as yet undefined—that they are able to control the accumulation and retention of plaque. For this reason, their efficacy as a public health measure to prevent caries should not be over-emphasized. Brushing of the teeth, supplemented by appropriate methods of interdental cleansing, can be effective in individuals who are motivated and able to follow a strict, careful, and efficient regime. It should also be emphasized that brushing the teeth is part of a total preventive programme and that it can be used as a method of applying fluoride, but that it should not be regarded in isolation as a preventive measure against caries.

### **3.8 Advice on diet**

Controlled studies in man have established that the incidence and prevalence of caries can be markedly diminished by reducing the frequency of sugar consumption. There is convincing epidemiological evidence that, in many large population groups, the prevalence of dental caries rises and falls with changes in the total consumption of sugar. This is a matter of serious concern especially in those countries where traditional dietary habits are being abandoned in favour of an increased consumption of

fermentable carbohydrates. Therefore it is recommended that, where dietary counselling is practicable, emphasis should be laid specifically on the undesirability of taking fermentable carbohydrate frequently between meals.

#### 4. RECOMMENDATIONS FOR RESEARCH INTO THE ETIOLOGY AND PREVENTION OF DENTAL CARIES

##### 4.1 Etiology

Further research is required to elucidate the role of specific oral micro-organisms in the pathogenesis of human caries; the caries-conductive properties of various foodstuffs; and the influence of the environment. Regarding the induction of caries in animals, the virulence of the many serotypic forms of streptococci, actinomycetes, and other organisms that can be isolated from the mouth needs to be established. Among the investigations that appear to be necessary are the following:

(1) Studies on caries-free populations, especially in areas where increasing prevalence is expected; in populations with markedly contrasting prevalences; and where unique environmental influences are known to exist. Similarly, longitudinal studies should be carried out on the incidence in people who move from an area with a low prevalence of caries to one of high prevalence.

(2) A longitudinal investigation of the influence of salivary factors on the incidence of caries.

(3) A search for improved methods of detecting dental caries in its incipient stages.

(4) Investigations of clinical methods for defining and assessing caries-promoting dental plaque and for distinguishing it from other deposits on the surfaces of teeth.

(5) Studies of the effects of genetic, nutritional, and other systemic factors on the etiology of dental caries, supplemented by an investigation of the possible systemic effects of caries.

(6) Studies into the composition of the enamel and its physico-chemical properties, including an investigation into the phenomenon of enamel maturation in different local and environmental circumstances.

(7) Research into habits of sugar consumption, with special regard to the factors that stimulate an excessively frequent intake; and, further, into whether additives or sugar substitutes can be used to reduce caries incidence and prevalence.

The need for continued research into the fundamental aspects of the etiology of caries is fully recognized. Consideration of practical applications in disease prevention should be an integral part of this research. Moreover, in assessing the results of such applications, there is an urgent need for the development and adoption of uniform procedures for clinical trials.

## 4.2 Prevention

### 4.2.1 *Fluorides*

In its resolution on fluoridation and dental health<sup>1</sup> (see also section 3.1, paragraph 3.1.1), the Twenty-second World Health Assembly requested that "research into the etiology of dental caries, the fluoride content of diets, the mechanism of action of fluoride at optimum concentrations in drinking-water, and the effects of greatly excessive intake of fluoride from natural sources" should continue to be encouraged.

Research is needed into the precise mechanism of action of fluoride compounds under the various conditions of application. For example, the effect of fluoride on microbial metabolism within the plaque requires elucidation, and the possible existence of an optimum level of fluoride in the enamel must be established. The conditions under which various reaction products are formed with enamel in respect of fluoride and of hydrogen ion concentration also require further study. Clinical trials of specific topical fluoride agents will probably provide little new useful information until such questions are resolved, although the possible efficacy of delivering fluorides in different vehicles, such as adhesive varnishes, may warrant further investigation.

Fluoridation of domestic salt has so far shown promising results. This research should be continued and expanded. Research on the fluoridation of school water supplies should be encouraged, especially in order to establish the optimum fluoride level in terms of both efficacy and safety. There is no longer any need for research to demonstrate the efficacy or safety of water fluoridation, but attempts should be made to explain why the benefits of fluoridation, although substantial, are limited to a degree of protection rather than total protection. In addition, it would be useful to acquire information on the long-term benefits of fluoridation in the elderly, on the effects to be observed in communities where fluoridation has been discontinued, and on the relationship between cost and benefit. Finally, as long as the beneficial effect of fluoridation is denied to large populations because of unscientific objections, it would be useful to promote behavioural studies relating to this problem.

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<sup>1</sup> *Off. Rec. Wld Hlth Org.*, 1969, No. 176, pp. 12-13.

#### 4.2.2 *Phosphates*

The mechanism of action of phosphates as possibly useful preventive agents against caries is not yet understood. Laboratory research should be pursued to examine this problem, and it is possible that evidence from epidemiological studies could contribute to knowledge in this field.

Carefully controlled clinical trials with phosphates are needed to clarify whether phosphates should be investigated further as aids in caries prevention. The systemic effects of prolonged ingestion of these compounds should be carefully evaluated in such studies.

#### 4.2.3 *Adhesive pit and fissure sealants*

Research now in progress should provide information on the average duration of retention of sealant materials. It is particularly important, in these and future studies, that detailed data be collected on the cost of, and time required for, widespread sealant application, as a guide to the practicability of this method as a public health measure.

Meanwhile, research should be encouraged in an attempt to find better sealant materials, especially such as will form stronger bonds with tooth enamel and, preferably, will not require pre-conditioning of the tooth by etching the enamel surface.

#### 4.2.4 *Antimicrobial agents*

Research is urgently needed in this potentially important field. Long-term clinical trials should be carried out with topical antibiotics and antiseptics screened to establish their range of activity against oral microflora, their ability to adsorb to enamel, and their capacity for preventing caries in animals. Additional requirements will have to be met before such agents can be adopted for clinical use. Because it is necessary to be cautious about administering most antimicrobial agents to human beings, it may be desirable to conduct initial caries trials in non-human primates. Among the questions to be answered regarding the use of antimicrobial agents against caries are :

- (a) To what extent can various agents prevent caries ?
- (b) At what frequency must these agents be used to control the microflora of the plaque ?
- (c) Do resistant strains of micro-organisms develop after the long-term use of such agents ?
- (d) Do any other adverse reactions result ?

Additional research should also be directed towards attacking the microbial component of the carious process by developing methods of oral

hygiene more effective and more widely applicable than those at present advocated.

#### 4.2.5 *Enzymes*

The current use of enzymes in caries prevention suggests the need for research at the laboratory rather than at the clinical level. There are problems not only in identifying the enzymes that interfere with the accumulation of plaque (e.g., glucanases) or with glycolysis, but also in devising methods of maintaining the enzyme at the tooth-plaque interface in an active state for prolonged periods.

#### 4.2.6 *Immunization*

There is at present no possibility that a streptococcal vaccine against caries will prove to be acceptable for administration to human beings. However, the prospect of preventing caries by vaccination is so attractive as a community measure that strenuous efforts should be made to isolate an alternative antigen. Since dental caries produced in monkeys is so similar in every respect to the disease in man, the results of experiments on non-human primates encourage the belief that immunization against caries in human beings is practicable and that research in this field should be energetically pursued.

#### 4.2.7 *Trace elements*

The proved efficacy of fluoride in the prevention of dental caries and the findings of studies of geographical variations in prevalence have heightened awareness of the possible significance of other trace elements and environmental factors. The available epidemiological data suggest that differences in the prevalence of the disease may be related to variations in the trace element content of soil, water, food, and the teeth. Further research of this sort should therefore be encouraged, especially comparative studies of isolated communities that exhibit marked contrasts in prevalence.

#### 4.2.8 *Economic and social factors*

No matter how desirable a preventive measure may be, it is of little practical value unless it can be widely applied. When measures are suitable for application on a mass scale, or by the existing dental health personnel, it is essential to determine how the cost of the procedure is related to the results achieved. The attention of the FDI and of WHO is drawn to this important factor and to the need to support and promote the development of methods for determining the cost-effectiveness and cost-benefits of measures used in the prevention and treatment of dental caries.

Other preventive measures are applied by individuals. The problem here is not only one of cost but also of motivating people to act on the advice that is given to them.

The factors that determine personal and community attitudes to health are complex and incompletely understood. For this reason, dental personnel and behavioural scientists should collaborate in studying factors affecting attitudes to the maintenance of oral health as well as to the application of current or future preventive measures, whether taken individually or at a community level.

It is also of importance to consider systems for delivering preventive measures, and research should be undertaken to determine the most effective training and utilization of auxiliary personnel for this purpose.

#### **5. INTERNATIONAL CO-OPERATION IN RESEARCH INTO THE ETIOLOGY AND PREVENTION OF DENTAL CARIES**

In recent years substantial progress has been made by WHO in the classification of oral diseases and in the standardization of epidemiological methods and techniques. A manual on basic methods for oral health surveys has been published<sup>1</sup> and several national surveys have been conducted, particularly in the WHO Western Pacific Region.

The time has now come for these surveys to be co-ordinated, especially with a view to mapping the world-wide prevalence of dental caries. To facilitate this it is recommended :

1. that WHO Regional Offices be requested, in consultation with WHO Headquarters, to encourage Member States to undertake national oral health surveys as a basis for public health planning and for defining geographical variations in the prevalence of dental caries ;
2. that the results of these surveys be collated and co-ordinated by WHO ;
3. that, when areas in which the prevalence of dental caries is unusually high or unusually low are identified, WHO should stimulate and support studies to elucidate the reasons for such differences ; and
4. that consideration be given to the establishment of reference centres for dental epidemiology.

Developing countries may have difficulty in implementing some of the proposals in this report. Accordingly it is recommended that WHO should continue the practice of providing financial support for experts in preventive

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<sup>1</sup> World Health Organization (1971) *Oral health surveys : basic methods*, Geneva.

dentistry to act as consultants to Member States upon request from the states concerned. The WHO Regional Offices could play an important role in this respect.

Many of the existing methods of prevention can be implemented only by health personnel. Since there is a world-wide shortage of dental manpower, experimentation in the training of auxiliaries in preventive techniques should be encouraged. Furthermore, considerable savings in cost and facilities could be made through international co-operation in the establishment of training centres in all Regions of WHO.

The Group emphasized the importance of international co-operation and co-ordination in research aimed specifically at the development of techniques for assessing the cost-effectiveness and cost-benefits of measures utilized in the prevention and treatment of dental caries. This is a complex and important task that has been neglected in the past, and requires experts from several disciplines, including dentistry.

Although much has been done at both the national and international levels to promote uniformity in the conduct of clinical trials, there is a need for further international co-operation in this field.

The vast increase in the output of scientific knowledge has created a greater need for periodic reviews of current dental research and future prospects. Several such reviews have already been undertaken by WHO expert committees and scientific groups. The reports of these meetings have had a powerful influence on research, education, and practice in dental health and it is therefore recommended that other international bodies concerned with dental health should give consideration to the convening of similar meetings.

Despite the widespread occurrence of dental caries, its detrimental effect on health, and its high cost in terms not only of treatment but also of absenteeism from school and industry, the allocation of funds for research in this field is inadequate. This is particularly noticeable in the developed countries where large sums of money are spent on the treatment of disease. High priority must be given to the treatment of existing disease. However, prevalence—and thus the need for treatment—will be reduced only when research provides additional preventive measures applicable on a mass scale.

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