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**Prevention and control of dental caries and periodontal diseases at individual and population level:**

**Consensus report of group 3 of joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases**

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**Key words:** mechanical plaque control; oral hygiene; chemical plaque control; clinical recommendations; consensus conference; dental caries; evidence based medicine; fluoride; gingivitis; interdental cleaning; periodontitis; prevention; systematic review

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### **Clinical Relevance**

#### *Scientific Rationale*

Prevention and control of the highly prevalent dental caries and periodontal diseases continue to pose an enormous challenge for the dental profession and public health bodies.

#### *Principal Findings*

Persistence of a high global burden of disease necessitates renewed and enhanced professional efforts towards prevention at individual and population level. Despite socio-behavioural inequalities within/between populations, control of dental biofilm activity is the key factor to prevent progression of dental caries and periodontal diseases.

#### *Practical Implications*

The consensus has developed a series of recommendations for practitioners, researchers and public health bodies to improve prevention and control of dental caries and periodontal diseases.

## **Abstract**

**Background:** The non-communicable diseases dental caries and periodontal diseases pose an enormous burden on mankind. The dental biofilm is a major biological determinant common to the development of both diseases and they share common risk factors and social determinants, important for their prevention and control. The remit of this working group was to review the current state of knowledge on epidemiology, socio-behavioural aspects as well as plaque control with regard to dental caries and periodontal diseases.

**Methods:** Discussions were informed by three systematic reviews on (1) the global burden of dental caries and periodontitis; (2) socio-behavioural aspects in the prevention and control of dental caries and periodontal diseases at an individual and population level; and (3) mechanical and chemical plaque control in the simultaneous management of gingivitis and dental caries. This consensus report is based on the outcomes of these systematic reviews and on expert opinion of the participants.

**Results:** Key findings included: (i) Prevalence and experience of dental caries has decreased in many regions in all age groups over the last 3 decades, however not all societal groups have benefitted equally from this decline; (ii) although some studies have indicated a possible decline in periodontitis prevalence, there is insufficient evidence to conclude that prevalence has changed over recent decades; (iii) because of global population growth and increased tooth retention the number of people affected by dental caries and periodontitis has grown substantially, increasing the total burden of these diseases globally (by 37% for untreated caries and by 67% for severe periodontitis) as estimated between 1990 and 2013, with high global economic impact; (iv) there is robust evidence for an association of low socioeconomic status with a higher risk of having dental caries/caries experience and also with higher prevalence of periodontitis; (v) the most important behavioural factor, affecting both dental caries and periodontal diseases, is routinely performed oral hygiene with fluoride; (vi) population-based interventions address behavioural factors to control dental caries and periodontitis through legislation (antismoking, reduced sugar content in foods and drinks), restrictions (taxes on sugar and tobacco) guidelines and campaigns, however their efficacy remains to be evaluated; (vii) psychological approaches aimed at changing behaviour may improve the effectiveness of oral health education; (viii) different preventive strategies have

proven to be effective during the course of life; (ix) management of both dental caries and gingivitis rely heavily on efficient self-performed oral hygiene, i.e. tooth brushing with a fluoride containing toothpaste and interdental cleaning; (x) professional tooth cleaning, oral hygiene instruction and motivation, dietary advice, and fluoride application are effective in managing dental caries and gingivitis.

**Conclusion:** The prevention and control of dental caries and periodontal diseases and the prevention of ultimate tooth loss is a lifelong commitment employing population- and individual-based interventions.

Dental caries is an ubiquitous process defined as the result of a localized chemical dissolution of the tooth surface caused by acid production by the dental biofilm (dental plaque) exposed frequently to sugars (Fejerskov et al. 2015).

Periodontal diseases (gingivitis and periodontitis) are inflammatory diseases of microbial origin. The most important risk factor is the accumulation of a dental plaque biofilm at and below the gingival margin, which is then associated with an inappropriate and destructive inflammatory immune response (Chapple et al. 2015).

Thus, the dental biofilm is a major biological determinant common to the development of both diseases (Sanz et al. 2017).

Periodontal diseases (gingivitis and periodontitis) are a continuum of the same inflammatory disease (Kinane & Attström 2005). While not all patients with gingivitis will progress to periodontitis, management of gingivitis is both a primary prevention strategy for periodontitis and a secondary prevention strategy for recurrent periodontitis (Chapple et al. 2015, Sanz et al. 2015).

Likewise, there is a continuum from health to disease in the development of coronal caries presenting initially as non-cavitated enamel lesions to more advanced cavitated lesions involving enamel and dentin (Björndahl & Mjör 2001). Preventive strategies have been implemented at all stages to control the progression of the caries lesions (Kumar et al. 2016).

Root caries occurs on exposed root surfaces. It is associated with the aging population and will be dealt with separately (Heasman & Nyvad 2017, Tonetti et al. 2017).

The remit of this working group was to review the current state of knowledge with regard to prevention and control of dental caries and periodontal diseases at individual and population level.

This report represents the consensus views of Working Group 3 of the joint EFP/ORCA workshop on the boundaries between caries and periodontal disease. It is substantially, but not entirely based on 3 systematic reviews of the available and published evidence from clinical studies. Data on the global burden of dental caries and periodontal diseases were retrieved by a systematic search of the literature and the reference documentation is provided (Frencken et al. 2017). One systematic review deals with socio-behavioural aspects in the prevention and control of dental

caries and periodontal diseases at individual and population level (Sälzer et al. 2017) and another systematic review with mechanical and adjunctive chemical plaque control in the simultaneous management of gingivitis and caries (Figuro et al. 2017).

## **The Global Burden of Dental Caries and Periodontitis**

The prevalence of dental caries and periodontitis is high, with untreated dental caries being the most common disease affecting humans worldwide (GBD 2016). According to recent global estimates, 621 million children had untreated cavities in dentine in primary teeth and 2.4 billion people had untreated cavities in dentine in permanent teeth (Kassebaum et al. 2015). Severe periodontitis affected 743 million people worldwide (Kassebaum et al. 2014a). The term “burden of disease” includes several concepts, including the number of affected individuals, the impact of the diseases on quality of life as well as the burden of the diseases on society in terms of healthcare cost and wider economic and social impact.

### **What are the global trends in the prevalence and severity of dental caries and periodontitis?**

There is evidence that overall, the prevalence and experience of dental caries has decreased in many regions in all age groups over the last three decades (Frencken et al. 2017). However, there are poor or non-existing data for some regions. Furthermore, there is some evidence that not all societal groups have benefitted equally from this decline (Patel 2012).

Data on trends over time of periodontitis prevalence are sparse and riddled by methodological inconsistencies. Although some national and regional studies have indicated a possible decline in prevalence (Holtfreter et al. 2014, Jordan & Micheelis 2016), overall there is insufficient evidence to conclude that the prevalence of periodontitis has changed over recent decades (Frencken et al. 2017). There is robust evidence that the prevalence of tooth loss and edentulism has declined over the last three decades globally (Kassebaum et al. 2014b.).

Because of global population growth (from 5.5 billion in 1990 to 7.4 billion in 2015), ageing societies (globally, the proportion of people 65 years and older increased from 6.0% in 1990 to 8.2% in 2015) and increased tooth retention, the number of people affected by dental caries and periodontitis has grown substantially, increasing the

total burden of these diseases globally. It has been estimated that between 1990 and 2013, the number of people affected by untreated cavities in dentine in permanent teeth increased by 37% and the number of people affected by severe periodontitis increased by 67% (GBD 2015). The global economic impact of oral disease in 2010 has been estimated at US\$ 442 billion (Listl et al. 2015).

### **What are the reasons for tooth loss?**

It is recognised that tooth loss is not only the direct outcome of dental caries, periodontitis and other factors such as trauma or orthodontic indications, but also determined by a complex set of factors not directly related to dental diseases, such as attitudes to health care and preferences, access to dental care, ability and willingness to pay. A number of studies have looked at reasons for tooth extraction as reported by dentists in various countries. In children and adolescents, dental caries is the single most important disease causing tooth loss, due to the extremely low prevalence of periodontitis. In adults, both dental caries and periodontitis are major reasons for tooth loss; however, there is marked variation in terms of the relative contribution of each disease across studies.

### **Is there evidence for an association of socioeconomic status and the prevalence and experience of periodontitis and dental caries?**

There is robust systematic review evidence for an association between low socioeconomic status/position, including components such as education, parental education, income and social position and a higher risk of having dental caries and caries experience (Schwendicke et al. 2015). The association is particularly strong in developed countries. Similarly, there is good evidence from systematic reviews for an association between low socioeconomic status and higher prevalence of periodontitis (Boillot et al. 2011, Klinge et al. 2005).

### **Is there a correlation between occurrence of both dental caries and periodontitis?**

There is a surprising paucity of robust studies analysing the co-occurrence of dental caries and periodontitis, with no evidence from systematic reviews. A recent report from a national survey in Finland found a significant positive association between both diseases in adults (Mattila et al., 2010), and data from a recent national survey



in Germany indicated that in adults there were significantly higher attachment loss and probing depths at sites with caries experience compared to sites without caries experience (Jordan & Micheelis 2016). However, no attempts were made to explore to what extent this association was explained by common risk factors.

### **Is there evidence that there are gender differences in prevalence of dental caries and of periodontitis?**

There is robust evidence from systematic reviews that the prevalence of periodontitis is lower in females compared to males (Shiau & Reynolds 2010). There is little evidence for a difference in the prevalence of dental caries between males and females.

### **Is there a difference in the peaks of the incidence of dental caries vs. periodontitis with regard to age?**

There is a wealth of data on the incidence of untreated cavitated dentine carious lesions across age suggesting that there is a major peak in incidence in young children, followed by a second, lower peak in adolescents and young adults. There is a nadir at around 40 years of age, followed by a gradual increase in incidence in older age (Kassebaum et al. 2015). Nevertheless, the disease is incident at all ages. In contrast, there is a dearth of data on the incidence of periodontitis; however, the methods employed in the Global Burden of Disease study (Kassebaum et al. 2015) allowed estimation of incidence data from prevalence data using a number of strong assumptions. While these estimated incidence data have to be cautiously interpreted, the data suggest that there is a major peak of severe periodontitis between 30 and 50 years of age. However, it has to be recognised that the onset of periodontitis likely precedes the point at which diagnostic criteria for severe periodontitis are met by years. Likewise, the onset of dental caries precedes the clinical detection of a cavitated lesion.

The prevention of the two most common dental diseases and the prevention of ultimate tooth loss is therefore a lifelong commitment.

## **Socio-behavioural Aspects in the Prevention and Control of Dental Caries and Periodontal Diseases at an Individual and Population Level**

Socio-behavioural factors may be regarded as behaviours finding their origin in the individual's social background. They will be determined by the individuals' peer groups, which will be related to ethnicity, religion, family traditions, socio-economic status, education, labour and others (Bouchard et al. 2016). The social determinants of health are the conditions in which people are born, grow, live, work and age (WHO 2016a). Health determinants are also strongly associated with environmental factors including all the physical, chemical, and biological factors external to a person and all the related factors impacting behaviour (WHO 2016b).

Recent insights into socio-economic inequalities in health show that the most important aspect is the effect of social gradient on health (Marmot 2003). Worldwide, non-communicable diseases including dental caries and periodontal diseases, remain a major public health problem. Health promoting behaviours become more difficult to sustain further down the social ladder (Heilmann et al. 2016).

Although it is essential to know about the socio-behavioural background in order to identify risk groups, there is no evidence how to address these issues in order to promote prevention and control of dental caries and periodontal diseases. To date, therefore, studies on interventions target primarily behaviour. However, they have proved to have had limited success in reducing health inequalities. They fail to address social determinants for changing people's behaviours, including attendance to oral health care. The alternative requires changing their environment (Sheiham et al. 2011). Strategies targeting social change need political action.

### **What are the most important socio-behavioural factors that have an impact on both dental caries and periodontal diseases?**

In general, social background is strongly associated with risk for dental caries and periodontitis. Furthermore, social background heavily influences the behaviour of individuals. The most important behavioural factor, affecting both dental caries and periodontal diseases, is routinely performed oral hygiene with fluoride toothpaste either by the individuals themselves or by caregivers.

There is clear evidence of diet having a strong influence on caries and there is some evidence that it affects periodontal diseases (Hujuel & Lingström 2017). However, to date, the size of this effect on periodontal diseases has not been clarified. There is clear evidence that smoking influences periodontal diseases (Sälzer et al. 2017) and

some evidence that exposure to smoke is associated with caries (Chapple et al. 2017).

An individual's perception of control (locus of control) is regarded as an important socio-behavioural factor in general. There is some evidence that having a strong internal perception of control contributes to the prevention and control of dental caries and periodontal diseases (Acharya et al. 2015).

### **Which population-based interventions address behavioural factors to control dental caries and periodontitis?**

Existing population-based interventions in some countries mainly address prominent risk factors for both dental caries and periodontitis. They include legislation (antismoking legislation, legislation to reduce the sugar content in processed foods and drinks; free dental care for children up to the age of 18), restrictions (taxes on sugar and tobacco), guidelines (e.g. rinsing with water after every meal in senior homes by caregivers) and public campaigns (anti-smoking and anti-obesity campaigns, promotion of fluoride use). These interventions are designed using underlying evidence. However, the efficacy of these interventions on oral health remains to be confirmed.

Promoting periodic comprehensive oral health assessments to allow early detection and preventive management of dental caries and periodontal diseases is important. Individualized risk-based recalls should then be initiated (Tonetti et al. 2015).

There is evidence from cohort efficiency studies that group prophylaxis (e.g. supervised brushing with fluoride toothpaste) is beneficial in reducing the incidence of dental caries (Sälzer et al. 2017) and one RCT has shown benefits of group prophylaxis on plaque and gingivitis (Hugoson et al. 2007), whereas an effect on periodontitis has not been demonstrated yet (Sälzer et al., 2017). There is evidence that a combined population- and individual-based prevention program is effective in early childhood caries (Sälzer et al., 2017).

### **Which individual-based interventions address behavioural factors to control dental caries and periodontitis?**

There is evidence from systematic reviews indicating that psychological approaches aimed at changing behaviour may improve the effectiveness of oral health education

(Newton & Asimakopoulou 2015, Werner et al. 2016). These approaches include the health belief model, the theory of planned behaviour, the self-regulatory model, and social learning theory. Evidence from one systematic review supports the benefit of computer aided learning interventions (Ab Malik et al. 2016).

Specific professional support based on i.e. caries risk assessments, supportive periodontal therapy and patient counseling are shown to be effective in the prevention and control of dental caries and periodontal diseases and they may promote beneficial behaviour (Axelsson et al. 2004).

The use of interactive devices to aid oral hygiene such as electronic support systems for power tooth brushes and timers is currently promoted, but evidence of long term successful change of behaviour is not yet available. .

### **How should the preventive strategies change during the course of life?**

#### *Early childhood:*

In early childhood strategies addressing behavioural factors to control dental caries and periodontal diseases are mostly population-based campaigns targeting parents starting already during pregnancy (Sälzer et al. 2017). These should be complemented by regular preventive medical and dental check-ups for early identification of children at risk and parental counselling on drinking habits, diet, brushing the child's teeth, and use of fluoridated toothpaste. These actions should be integrated into the healthcare program of the Mother and Child clinic.

#### *School children:*

For children and adolescents, a high profile of community, in office and individual preventive measures has been implemented in many developed countries for many decades (Splieth et al. 2016). In order to successfully reach the less privileged children, school based prevention programs have proven to be effective (Anopa et al. 2015). In this age group parents are responsible to ensure tooth brushing with a fluoridated toothpaste twice a day, yet parents should check and complete brushing their children's teeth. Regular dental check-ups for identification of children at risk and detection of early signs of disease as well as parental and child counselling to promote healthy dietary and oral hygiene habits are recommended.

#### *Adolescence/young adults:*

From the age of adolescence the focus of public health campaigns lies on anti-

smoking, promoting healthy life style through e.g. sports programmes and diet programmes and campaigns to improve health awareness in general. In the main oral hygiene and dietary habits in the individual have become established. Individuals at risk of developing caries or periodontal diseases should be targeted to improve their existing behaviour. This requires an individual approach. Improvements of behavioural habits may include interdental cleaning in addition to efficacy and frequency of tooth brushing with fluoride toothpaste. Individuals undergoing orthodontic treatment with fixed appliances are at higher risk for developing dental caries (Sundaraj et al. 2015) and gingivitis (Liu et al. 2011; van der Kaaij et al. 2015) and require extra attention for oral hygiene and diet and additional use of fluoride when carious lesions are present (van der Kaaij et al. 2015, Benson et al. 2013).

#### *Adults/young seniors*

In adults (young seniors) preventive strategies aimed at promoting healthy dietary and oral hygiene habits mainly target the individual needs. The use of interdental brushes is recommended. Caution should be exercised in recommending interdental brushes at healthy sites where attachment loss is not evident and trauma may result. The use of dental floss may only play a role in this situation (Chapple et al. 2015). High risk subgroups should be addressed through guidelines increasing awareness of oral health.

## **Mechanical and Chemical Plaque Control in the Simultaneous Management of Gingivitis and Dental Caries**

A systematic review analysed the effect of mechanical or chemical plaque control procedures in the management of gingivitis and dental caries. The main strength of this study relies on being the first systematic review addressing simultaneously both diseases.

Given the particularities in concepts and definitions used by the literature in the specific areas of cariology and periodontology, the following terms are defined:

- Self-performed oral hygiene – tooth brushing with fluoridated toothpaste and interdental cleaning.
- Professional tooth cleaning (PTC) - removal of supragingival plaque with or without calculus removal.

- Structured prophylaxis programme – PTC plus oral hygiene instruction, motivation, dietary advice, fluoride application etc.
- Motivational programme - information and motivation about oral health and disease, oral hygiene instruction and supervised oral hygiene procedures, all given on a regular basis.

Also, given the distinct use of fluoride compounds for caries management and for plaque control, the group felt it was important to stress that the fluoride ion per se does not reduce plaque accumulation. However, it is extremely effective in the management of dental caries when available in the oral fluids (i.e. saliva, plaque fluid), by shifting the demineralisation-remineralisation process towards remineralisation (Cury & Tenuta 2008).

### **What is the role of self-performed mechanical plaque control in the simultaneous management of gingivitis and dental caries?**

There was consensus in the group that self-performed oral hygiene is of uttermost importance. Whilst there is a wealth of evidence on management of gingivitis and dental caries in isolation (Chapple et al. 2015; Kumar et al. 2016), the information on simultaneous effects on both diseases is limited. There are indeed methodological differences (i.e. study design, follow-up intervals, sample sizes) that make development of evidence difficult. Nevertheless, management of both diseases relies heavily on efficient self-performed oral hygiene, i.e. tooth brushing and interdental cleaning.

In schoolchildren, daily supervised flossing in addition to tooth brushing reduced gingivitis, compared to no self-performed oral hygiene at school. Although, caries increment was lower in the former, it did not reach significance by the end of a 3 year trial (Suomi et al. 1980).

In adults, systematic reviews of interdental brushing/flossing for the management of periodontal diseases and dental\_caries have shown some evidence that interdental flossing/brushing in addition to tooth brushing reduces gingivitis compared to tooth brushing alone. None of the studies included in these reviews reported interproximal caries as an outcome and therefore it was not possible to demonstrate the effectiveness of interdental flossing/brushing plus tooth brushing for dental caries management (Sambunjak et al. 2011, Poklepovic et al. 2013).

### **What is the evidence of professional tooth cleaning in the simultaneous management of gingivitis and dental caries?**

Professional tooth cleaning (PTC) as part of a structured prophylaxis programme including oral hygiene instruction and motivation, dietary advice, and fluoride application is effective in managing dental caries and gingivitis. As there is limited evidence to determine the most appropriate intervals between recall appointments (Figuro et al. 2017), an individualized risk-based programme is recommended.

### **What is the evidence of motivational programs in the simultaneous management of dental caries and gingivitis?**

The evidence suggests that motivational programs alone without PTC tested in studies assessing simultaneously gingivitis and dental caries showed no significant benefits for dental caries and gingivitis (Figuro et al. 2017). Oral hygiene instruction and motivation may lead to a small but significant reduction in plaque and gingivitis after 6 months (Chapple et al. 2015).

### **What is the role of fluoride in the simultaneous management of gingivitis and dental caries?**

In studies assessing the simultaneous management of both diseases, it has been found that fluoride (sodium fluoride or sodium monofluoro phosphate in toothpastes or rinses) is only effective in the management of dental caries. No significant effect of fluoride on plaque and gingivitis was noted. Other fluoride compounds, such as stannous fluoride or the combination of amine and stannous fluoride, have demonstrated a relevant impact on plaque and/or gingivitis (Serrano et al. 2015). Although this systematic review did not assess dental caries, fluoride has a widely recognized effect on dental caries management (Marinho et al. 2003, 2013, 2015, 2016). Therefore, products containing such fluoride compounds are likely to be effective in the simultaneous control of both diseases.

### **What is the role of adjunctive chemical plaque control in the simultaneous management of gingivitis and dental caries?**

There are only limited data on the role of chlorhexidine in the simultaneous management of gingivitis and caries (Figuro et al. 2017), that showed that

chlorhexidine rinses are only effective in managing gingivitis whilst no effect on caries increment was observed (Lang et al. 1982). It is possible that 6 month trials to assess the effect of chlorhexidine on both gingivitis and dental caries are insufficient to determine the effect on dental caries increment. Nevertheless, the studies assessing the effect of chlorhexidine on gingivitis and dental caries separately, have demonstrated a significant effect on dental plaque and gingivitis control (Chapple et al. 2015, Serrano et al. 2015), but no effect of chlorhexidine rinses on dental caries control (Twetman 2004). In another systematic review inconclusive evidence for the effect of chlorhexidine varnishes and gels on dental caries was reported (Walsh et al. 2015). Other adjunctive chemical plaque control agents, e.g. triclosan/copolymer, have demonstrated a consistent effect in dental plaque and gingivitis control (Riley & Lamont 2013, Serrano et al. 2015), but their effect on dental caries increments is either very small or yet to be determined (Twetman 2004, Riley & Lamont 2013). Thus, to ensure the simultaneous management of dental caries and gingivitis, the use of non-fluoride adjunctive plaque control agents proven effective in controlling gingivitis should be supplemented with fluoride, for caries protection, either in the same formulation (e.g. toothpastes with fluoride and plaque control agents) or separately (e.g. fluoride toothpaste plus chlorhexidine mouth rinses or gels).



## **Clinical Recommendations**

- Both dental caries and periodontal diseases are preventable. Dental practitioners are encouraged to educate and motivate patients to reduce intake of free sugars and to practice proper dental plaque control.
- Individualized effective oral hygiene practices should be encouraged, taught and supported.
  - Oral hygiene instructions should be enriched by motivational approaches.
  - Smoking cessation advice should be part of the management of gingivitis and periodontitis.
  - Professionals should recommend toothpastes containing fluoride agents for the control of dental caries.
  - Professional fluoride application should be used in individuals with a high caries risk.
  - In the management of gingivitis for the primary prevention of periodontitis, fluoride can be supplemented by adjunctive chemical plaque control agents.
  - Oral care providers should be informed on nutrition and being able to provide dietary modification advice and counselling.
  - Professional tooth cleaning needs to be incorporated in a thorough structured prophylaxis programme including oral hygiene instruction, motivation, dietary advice and fluoride application in order to be effective in managing gingivitis and dental caries.
  - A regular individualized risk-based prevention programme should be designed for each patient.

## **Research Recommendations**

- Methodological development and consensus on suitable and robust epidemiologic measures are needed for:
  - several aspects of disease burden
  - disease surveillance over time within and across national and geographical boundaries
  - etiologic research

- Existing epidemiological data sets should be analysed to determine, if dental caries and periodontitis co-occur due to the effect of common risk factors.
- There is a need to have more trend studies in periodontitis to understand if there is a decline in periodontitis or not, and if so what drives the potential decrease of periodontitis in different populations.
- There is a gap of knowledge on gingivitis in children that should be addressed.
- Robust studies on the incidence of chronic periodontitis and increment of dental caries are highly desirable to better understand risk factors of periodontitis and dental caries in adults better.
- Efforts should be undertaken to link existing registries (education, socio economic conditions, general health) with dental registries (caries and periodontitis) to evaluate the effect of risk factors on dental caries and periodontitis or vice versa the effect of dental caries and periodontitis on general health to circumvent the problem of decreasing response rate in epidemiological studies.
- The dental scientific community should harmonize epidemiological data sets across cohorts to allow common analysis for an improved understanding of the prevalence as well incidence of periodontitis and dental caries or the influence of risk factors on these diseases.
  - Tailored multi-facetted and comprehensive preventive programmes for dental caries and periodontal diseases should be implemented and evaluated on the efficiency level. Such approaches have already been proven to be efficacious and efficient in early childhood caries.
  - There is a need for the evaluation of the effect of legislation, restrictions, guidelines and public campaigns on the change of behaviour and improved parameters of oral health on the efficiency level.
  - Comparative superiority studies with different types of psychological approaches in different groups both on the efficacy and the efficiency level are recommended.
  - Evidence is needed on the use of interactive devices to aid oral hygiene such as electronic support systems for power tooth brushes and timers which are currently promoted. At present evidence for a long-term successful change of behaviour is not available.
  - RCTs on the inactivation and monitoring of active caries lesions are needed.

- There is a need for authoritative evidence whether interdental cleaning aids help to prevent periodontitis and tooth loss.
- There is a need for properly designed RCTs addressing the simultaneous management of gingivitis and dental caries on the efficacy of:
  - Self-performed oral hygiene including tooth brushing considering fluoridated toothpaste and interdental cleaning
  - Different intervals between recall appointments in structured prevention programs
  - The adjunctive use of chemical plaque control agents including tooth brushing with fluoridated toothpaste as the control

## **Public health recommendations**

The following strategies are recommended:

- Tackling inequalities in oral health to prevent and control dental caries and periodontal diseases requires strategies tailored to the determinants and needs of each group according to socio-economic status.
- To encourage future oral health research, practice, and policy toward a 'social determinants' model, a closer collaboration and integration of dental and general health research is needed using a common risk factor approach
- For health policy makers, prevalence data have to be translated into disease burden data to plan and allocate resources for the dental work force.

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