

Socio-behavioural aspects in the prevention and control of dental caries and periodontal diseases at an individual and population level

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Abstract

Aim: Aim was to systematically review behavioural aspects in the prevention and control of dental caries and periodontal diseases at individual and population level.

Material & Methods: With regard to caries, MEDLINE/PubMed was searched on three subheadings focusing on early childhood, proximal and root caries. For periodontal diseases, a meta-review on systematic reviews was performed; thus, the search strategy included specific interventions to change behaviour in order to perform a meta-review on systematic reviews. After extraction of data and conclusions, the potential risk of bias was estimated and the emerging evidence was graded.

Results: Regarding early childhood, proximal and root caries, 28, 6 and 0 papers, respectively, could be included, which predominantly reported on cohort studies. Regarding periodontal diseases, five systematic reviews were included. High evidence of mostly high magnitude was retrieved for behavioural interventions in early childhood caries (ECC), weak evidence for a small effect in proximal caries and an unclear effect of specific informational/motivational programmes on prevention of periodontal diseases and no evidence of root caries.

Conclusion: Early childhood caries can be successfully prevented by population-based preventive programmes via aiming at the change in behaviour. The effect of individual specific motivational/informational interventions has not yet been clearly demonstrated neither for the prevention of caries nor for periodontal diseases.

Key words: dental caries; motivation; periodontal disease; prevention; social behaviour

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Conflict of interest and source of funding statement

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Prevalence of caries and periodontal diseases show a clear association with the socio-economic status (SES; Schwendicke et al. 2015). More precisely, SES seems to influence caries or periodontal disease activity by influencing relevant behavioural parameters (Kim Seow 2012). In particular, oral hygiene habits, diet, smoking as well as coping with psycho-social stress and the patterns of seeking professional prevention or treatment vary with the SES and subsequently also with the prevalence of caries and periodontitis (Thomson et al. 2012).

Besides oral home care, there are significant differences when concerning the prevention of caries and periodontal diseases, in particular regarding the availability of preventive instruments and the ages of predominant incidence. While population-based and group-oriented strategies are frequently employed in caries control, periodontal disease prevention targets primarily on the individual modification of behaviour. These differences are mirrored in the published literature as caries prevention often addresses cohorts with several social levels (Watanabe et al. 2016), and in contrast, periodontal preventive programmes primarily focus on changing individual behaviour and do not address a cohort as such. Thus, in the literature about caries prevention and its control, especially cohort studies play an important role (Mejare et al. 2004), whereas in periodontal disease prevention, excellent and manifold systematic reviews on different measures exist (Gao et al. 2014). Due to this different body of evidence, this article will use different methods and search strategies regarding caries and periodontal disease prevention and control in order to retrieve the best available evidence without replicating already published papers.

With respect to lifetime, caries incidence has been shown to be the highest in children and adolescents. After major efforts in caries prevention in many countries, a marked caries decline could be observed in children and adolescents resulting in a highly polarized distribution of the remaining caries and leaving caries as almost exclusively a “social” disease (Do 2012), with mainly

remaining early childhood caries (ECC), proximal caries and root caries. Whereas periodontal diseases are more prevalent in adults and seniors, periodontitis in children is very rare and related to syndromes in general, which makes it independent from socio-behavioural aspects and was regarded to be out of the scope of this article.

Despite the caries decline, ECC is a global problem with prevalence rates from 10% to 50%. ECC is caused by frequent carbohydrate intake without sufficient oral hygiene (Pine et al. 2004). It seems that children with higher SES benefit from the widespread caries-preventive measures (Do 2012). In lower SES groups, however, these preventive measures do not seem to be successful.

Like caries, periodontal diseases in adults are associated with socio-behavioural aspects (Thomson et al. 2012) resulting in a higher risk for periodontal diseases in low-income groups (Do et al. 2003, Heitz-Mayfield 2005). Caries in patients of an age, at which chronic periodontitis is generally prevalent, is predominantly located at proximal sites. The preventive approaches at this age shift from collective to individual measures and, therefore, from socio-behavioural to behavioural aspects. The slow progression of both diseases allows the use of preventive, non- and minimally invasive approaches (Mejare et al. 2004). These comprise mainly biofilm control for both diseases and additionally on the caries side fluoride use and on the periodontitis side smoking cessation. As biofilm control and smoking cessation have been covered by other publications either within this workshop (Figuro et al. 2017) or from the last workshop (Ramseier & Suvan 2015), these parts will not be covered by this article.

The high rate of edentulism in seniors with low SES (Kim et al. 2012) leads to a selection bias with root caries being associated with more retained teeth in higher SES groups (Splieth et al. 2003, 2004). With the caries decline shifting to adults with more teeth retained, seniors will be of high interest due to the combination of increased plaque retention areas, marked attachment loss and exposed root surfaces,

relevant medical diseases and medications in addition to difficulties following preventive or therapeutic strategies (Norderyd et al. 2015). The same is true for periodontal diseases as in seniors the highest prevalence of periodontitis exists due to the same reasons as mentioned above (Jordan & Micheelis 2016).

Consequently, a major aspect in the prevention and control of caries and periodontitis should be to change health behaviour. Up to now, there are no controlled interventions to approach socio-behavioural risks. Aspects of socio-behaviour are covered by the paper from Campus et al. in this issue. Oral health education is commonly performed by dental professionals, but it is exclusively directed to changing health-related behaviour. However, oral health education has been shown to have mainly a short-term effect (Watt 2005). Several psychological interventions such as the health belief model, the theory of planned behaviour, the self-regulatory model and social learning theory aim to improve the effectiveness of oral health education (Newton & Asimakopoulou 2015, Werner et al. 2016). Relying on limited data with low risk of bias, this review led to the conclusion that goal setting and self-monitoring seem to be effective for changing patients' behaviour. To date, it is not clear which is the most effective way to change patients' behaviour.

Aim of the review, therefore, is to systematically evaluate the current state of knowledge with regard to interventions on behavioural aspects in the prevention and control of dental caries and periodontal diseases at the individual and the population level.

Material and Methods

Due to the completely different strategies in addressing behavioural interventions in the prevention and control of the two major topics caries and periodontal diseases, the methods differ substantially answering the following PICO questions (Participants, Interventions, Comparisons and Outcomes):

What is the effect of behavioural interventions on the prevention and control of caries in

children, adolescents, young adults and seniors compared to standard measures in terms of caries development?

What is the effect of specific motivational/informational interventions to change health behaviour compared to standard information with respect to the prevention and control of periodontal diseases in terms of pocket probing depths as well as of parameters of plaque and gingivitis?

The authors developed a review protocol a priori. No further registration was performed as the topic was given to the authors by the chairs of the workshop.

Search strategy

For the comprehensive search strategy, the Internet source National Library of Medicine, Washington, DC (MEDLINE/PubMed), was used to search for appropriate papers that satisfied the study purpose up to and including July 2016. For details regarding the search terms used, see Box 1. All of the reference lists of the selected studies were hand-searched for additional published work that could possibly meet the eligibility criteria of the study. Further unpublished work was not sought. Publications on humans in English and German languages, in periodontology also in French or Dutch language were included.

Regarding ECC, the following inclusion and exclusion criteria were considered:

The inclusion criteria were as follows:

- Patients: children aged 0–6 years
- Intervention: prevention of ECC dealing with behavioural aspects

- Outcome: behavioural factors or final health outcomes such as caries or its association with missing teeth
- Randomized controlled clinical trials (RCTs), cohort studies

The exclusion criteria were as follows:

- Case presentations, case series, cross-sectional surveys and reviews

The search words for proximal caries in adolescents and young adults and for root caries are also listed in Box 1 and the following inclusion and exclusion criteria followed:

For proximal caries, the inclusion criteria were as follows:

- Intervention: prevention of proximal caries dealing with behavioural aspects
- Randomized controlled clinical trials, cohort studies, reviews

The exclusion criteria were as follows:

- Case presentations, case series, cross-sectional surveys

For root caries, the inclusion criteria were as follows:

- Intervention: prevention of root caries dealing with behavioural interventions.
- Outcome: influence of behavioural factors on final health outcomes such as root
- Randomized controlled clinical trials, cohort studies, reviews, representative, population-based oral health surveys

The exclusion criteria were as follows:

- Case presentations, case series, single-centre, non-representative cross-sectional surveys

For periodontal diseases, the structured search strategy was designed to include any systematic review published on behavioural interventions with regard to prevention of periodontal diseases. The meta-review was performed according to the methodology used previously in dentistry (Sälzer et al. 2015, Slot & Van der Weijden 2015, Van der Weijden & Slot 2015, Van der Weijden et al. 2015).

The inclusion criteria were as follows:

- Systematic reviews with or without a meta-analysis
- Intervention: behavioural interventions to prevent or control periodontal diseases

The exclusion criteria were as follows:

- Behavioural changes in dental professionals
- No clinical outcomes reported

Screening and selection

Two reviewers (DES and SS) for periodontal diseases, (JS and MA) for ECC, (MA and CS) for proximal and (CS and JS) for root caries independently screened the titles and abstracts for eligible papers. If eligibility aspects were present in the title, the paper was selected for further reading. If none of the eligibility aspects were mentioned in the title, the abstract was read in detail to screen for suitability. After selection, the full-text papers were read in detail by the two reviewers. Any disagreement between the two reviewers was resolved after additional discussion.

Box 1

Search terms for early childhood, proximal and root caries as well as periodontitis with socio-behavioural aspects

ECC: "preschool child*" AND ("caries" OR "ECC") AND ("socio*" OR "behavio*") AND ("prevention" OR "control") AND "program*" AND (RCT OR cohort OR longitudinal OR prospective) in MEDLINE/PubMed

Proximal caries: "proximal caries" AND ("prevention" OR "treatment") AND "behavio*" (*search word "socio" did not result in any further publications*)

Root caries: "root caries" AND ("socio*" OR "behavio*") and additional searches with ("treatment" OR "prevention" OR "RCT")

Periodontal diseases: (((behavio*) OR "Behavior"[Mesh])) AND (((("Periodontal Diseases"[Mesh] OR periodontitis) OR "periodontal disease") OR ((dental) AND ("Smoking Cessation"[Mesh] OR "Tobacco Use Cessation"[Mesh]))))

The papers that fulfilled all of the selection criteria were processed for data extraction.

Assessment of heterogeneity

The heterogeneity across studies was detailed according to the following factors as retrieved by the included literature:

- Study and subject characteristics
- Methodological heterogeneity (variability in study design and risk of bias)
- Analysis performed (descriptive or meta-analysis)

Quality assessment

Two reviewers (DES and SS) estimated the risk of bias by scoring the reporting and methodological quality of the included systematic reviews on periodontal diseases according to a combination of items described by the PRISMA (2017) guideline for reporting systematic reviews and the (AMSTAR, 2014) checklist for assessing the methodological quality of systematic reviews.

The quality assessment for the caries studies regarding ECC and proximal caries was performed by the teams according to the Newcastle-Ottawa Scale (NOS) for assessing the quality of non-randomized studies (Wells et al. 2016).

Data extraction

Information extracted from the studies included publication details, focused question, search results, descriptive or (weighted) mean outcomes and conclusions. Disagreements between the reviewers were resolved by discussion.

Besides, the number of studies showing no difference or a significant effect of behavioural interventions on prevention and control of early childhood and proximal as well as clinical periodontal outcomes as well as the weighted mean difference of total studies showing an effect/no effect for each parameter are calculated.

Grading the “body of evidence”

The Grading of Recommendations Assessment, Development and

Evaluation (GRADE) system, as proposed by the GRADE working group, was used to grade the evidence emerging from this meta-review of systematic reviews (GRADE, 2017). Two reviewers for each field rated the quality of the evidence as well as the strength of the recommendations according to the following aspects: study design, risk of bias; consistency and precision among outcomes; directness of results, detection of publication bias and magnitude of the effect.

Results

Early childhood caries

Search and selection results

Nineteen articles were retrieved by the search, of which eight were selected for the review. Via hand-search, another 20 articles were added, leading to a total of 28 eligible papers Table S1 and Fig. S1). These were 13 RCTs, 14 cohort studies and one serial cross-sectional study.

Study outcome results and assessment of heterogeneity

The studies showed that population-based prevention programmes often reduced ECC prevalence and mean caries levels as well as the severity of ECC (tables 1 and S1, for example Kowash et al. 2000, Blair et al. 2004, Slade et al. 2011, Wagner et al. 2014, Si et al. 2016). Besides the distribution of free toothpaste for fluoride use (Davies et al. 2002), early maternal counselling including home visits (Feldens et al. 2007, Plonka et al. 2013) and regular recall intervals (Gomez & Weber 2001, Plutzer & Keirse 2011) showed to be beneficial in reducing caries levels in pre-school children (Wagner et al. 2014, Naidu et al. 2015, Wagner & Heinrich-Weltzien 2017). More so in an individualized setting, motivational interviewing also successfully reduced ECC (Weinstein et al. 2004, Naidu et al. 2015). The heterogeneity was comparatively low, as most interventions showed a clear effect. Nonetheless few studies reported limited or diluted effects of the prevention programme (Davies et al. 2007,

Tubert-Jeannin et al. 2012, Chaffee et al. 2013, Jiang et al. 2014, Van den Branden et al. 2014), showing that reaching the high-risk children maintains the main challenge.

Due to the diverse types of studies included in the review on caries neither the PRISMA (PRISMA, 2017) nor the MOOSE (Stroup et al. 2000), guidelines could be applied for quality assessment. Therefore, NOS was used (Table S4).

Grading the “body of evidence”

The evidence, which emerges from this systematic review, indicates that there is high evidence to support the efficacy of ECC prevention programmes (Table 2).

Proximal caries

Search and selection results

The review on proximal caries in adolescents and young adults resulted in a total of 26 papers. Excluded were irrelevant abstracts (11), non-English (3) and publication on pre-school children or ECC (5). Seven articles (Table S2 and Fig. S1) dealing with proximal caries and related preventive or therapeutic behavioural determinants were included for further reading and analysing.

Assessment of heterogeneity

Considerable heterogeneity was observed within the original six papers included in the systematic review of Hujoel et al. (2006) with respect to the study design and duration, subject characteristics such as age and sample size. Similar heterogeneity was also observed between the other five included papers.

Quality assessment

The systematic review included (Hujoel et al. 2006) shows moderate estimated potential risk of bias. A possible potential publication bias for the other included papers (one RCT and four cohorts) could not be excluded but for (Murtomaa et al. 1984). Quality assessment by NOS was carried out (Table S4).

Study outcome results

Reviewed studies showed a slow progression of proximal caries and that adherence to flossing is a problem as only 18% of the participants

reported regular flossing (Martignon et al. 2010).

Studies revealed that ECC experience, oral hygiene habits and parent-related factors recorded early at 3–6 years of age had a great predictive value concerning proximal caries in adolescence, in spite of the high level of dental prevention offered in Sweden (Alm et al. 2007, 2008). As early as 1984, Murtomaa et al. (1984) reported that instructions on flossing had no effect on the reported frequency of use, even in university students. Furthermore, no correlation could be found between dental caries experience and the reported use of dental floss. Only professional flossing performed in schools was associated with a clear caries risk reduction (relative risk 0.60), while self-performed flossing in young adolescents did not reduce caries risk (relative risk 1.01, Hujoel et al. 2006). Toothbrushing with 5000 ppm fluoride seems to be effective in preventing and arresting proximal caries in adolescents with a high caries risk (Nordström & Birkhed 2010). In a school-based programme, the salivary lactobacillus counts were used as a behaviour motivating tool for control of sugar consumption, resulting in a slight reduction in the increment of proximal enamel caries in the study group (Nylander et al. 2001).

Grading the “body of evidence”

The evidence, which emerges from this systematic review, indicates that there is weak evidence to support the efficacy of flossing to control proximal caries (Table 2).

Root caries

Search and selection results

Regarding root caries, 21 references were screened of which no paper presented behavioural interventions for an outcome of root caries.

Periodontal diseases

Search and selection results

The searches resulted in 235 systematic reviews (see Fig. S2) of which 11 were selected for full-text reading. As no systematic review on behavioural changes with regard to smoking cessation was published more recently than the meta-review

by Ramseier & Suvan (2015), the authors decided to consider this review as the actual evidence and not to evaluate this topic again. Consequently, the meta-review and corresponding systematic reviews focusing on smoking cessation were excluded after full-text reading. One further paper was excluded due to missing control group (Kay & Locker 1998).

Hand-searching of the reference lists did not reveal any additional suitable systematic reviews. As a result, five studies were selected to be included in this meta-review.

Assessment of heterogeneity

Considerable heterogeneity was observed in the five systematic reviews with respect to the databases searched, study and subject characteristics of the original individual papers, description of inclusion and exclusion criteria, quality assessment scale used, reporting of effect scores, presence of meta-analysis and conclusions made. Information regarding the included papers is displayed in detail in Table S3.

Quality assessment

Estimation of the risk of bias by scores related to the reporting and methodological quality of the included systematic reviews is presented in Table S5. Four reviews were considered to have a moderate estimated potential risk of bias (Gao et al. 2014, Newton & Asimakopoulou 2015, Ab Malik et al. 2016, Werner et al. 2016). The remaining review had a substantial estimated risk of bias (Cascaes et al. 2014). Critical items in quality assessment were found to be the development of a focused question and protocol “a priori” and its registration, searches in additional sources including non-English literature, contacting of authors of included papers for additional information, data extraction by more than one reviewer, grading obtained evidence and the assessment of publication bias.

Study outcome results

Table S3 shows the results from the data extraction. Two of the papers considered motivational interviewing, only (Cascaes et al. 2014, Gao et al. 2014). Another two papers

evaluated different psychological approaches to change the behaviour (Newton & Asimakopoulou 2015, Werner et al. 2016) such as health belief model, the theory of planned behaviour, the self-regulatory model and social learning theory aim to improve the effectiveness of oral health education. The remaining review investigated computer-aided learning interventions (Ab Malik et al. 2016). Independently on the intervention, data within and between the papers were highly heterogeneous and no clear effect could be demonstrated. For the computer-aided learning intervention, only one study investigated the clinical outcome, which found a positive effect on parameters of gingivitis.

Regarding the influence of behavioural interventions on clinical outcomes, the data of about half of the systematic reviews demonstrated a positive effect of behavioural interventions on parameters of plaque gingivitis (Table 1), whereas on pocket probing depth, only 21.43% showed a beneficial effect.

Grading the “body of evidence”

The evidence, which emerges from this systematic meta-review, indicates that there is weak evidence to support the efficacy of behavioural interventions to improve periodontal parameters (Table 2).

Discussion

In spite of socio-behavioural factors being a clear risk factor for insufficient oral hygiene, plaque accumulation, gingivitis, periodontitis and also the development of caries in all age groups, a systematic review on the socio-behavioural interventions in the prevention and control of caries or periodontal diseases yields very little direct results for caries and periodontitis. Caries, gingivitis and periodontitis can be seen as behavioural diseases influenced by cultural norms, expectations and opportunities that are socio-economically determined and structurally maintained (Baelum 2011). Consequently, a major task in primary prevention of caries and periodontal diseases is to influence the social behaviour not only on an individual but also on a population level.

Table 1. Influence of behavioural interventions on prevention and control of early childhood and proximal as well as clinical periodontal outcomes (The remaining percentage of studies did not indicate any values and/or significance. Specific interventions are described in the Material and Methods section.)

| | SR author or other source Number and types of included studies | Number of studies showing no difference between intervention and control | Number of studies showing a positive effect of intervention |
|--|---|--|--|
| ECC, caries reduction via comprehensive programme | Own review, see tables S1–S3 9 Cohort studies 4 RCTs | 1 Cohort study, 1 RCTs | 8 Cohort studies, 3 RCTs |
| ECC, caries reduction via repetitive health education and xylitol lozenges, pamphlet and verbal instruction, home visit and telephone contacts | Own review, see tables S1–S3 3 Cohort studies | None | 3 Cohort studies |
| ECC, caries reduction via free toothpaste, toothbrushing training and F varnish | Own review, see tables S1–S3 2 Cohort studies | None | 2 Cohort studies |
| ECC, caries reduction via training of non-dental healthcare workers | Own review, see tables S1–S3 1 Cohort study | 1 Cohort study | None |
| | Total | 17.6% | 82.4% |
| Proximal caries Reduction via flossing | Hujoel et al. (2006) 6 RCTs 2 Cohort studies from figs. S1 and S2 | 4 RCTs within 1 SR 2 Cohort studies | 2 RCTs within 1 SR None |
| Proximal caries Reduction via comprehensive programme | Own review, see figs. S1 and S2 1 Cohort study 1 RCT | None | 1 Cohort study, 1 RCT |
| Proximal caries Reduction via behaviour motivation | Own review, see figs. S1 and S2 1 Cohort study 1 RCT | 1 Cohort study | 1 RCT |
| Plaque index | Total Cascaes et al. (2014) 6 RCT Gao et al. (2014) 4 RCT Newton et al. (2015) 11 RCT 1 cohort study Werner et al. (2016) 10 RCT | 57.14% 2 RCT 2 RCT 4 RCT 6 RCT | 42.85% 2 RCT 2 RCT 7 RCT, 1 cohort study 4 RCT |
| Parameters of gingivitis | Total Cascaes et al. (2014) 4 RCT Gao et al. (2014) 3 RCT Newton et al. (2015) 2 Cohort studies 8 RCT Ab Malik et al. (2016) 1 RCT Werner et al. (2016) 6 RCT/7 papers | 43.75% 2 RCT 2 RCT 3 RCT None 4 RCT | 50.00% 1 RCT 1 RCT 2 Cohort studies + 5 RCT 1 RCT 2 RCT |
| | Total | 45.83% | 45.83% |
| Pocket probing depth | Cascaes et al. (2014) 3 RCT Gao et al. (2014) 2 RCT Newton et al. (2015) 5 RCT Werner et al. (2016) 4 RCT | 2 RCT 2 RCT 2 RCT 2 RCT | 0 0 1 RCT 2 RCT |
| | Total | 57.14% | 21.43% |

ECC, early childhood caries; RCT, randomized controlled clinical study; SR, systematic review.
Total = Weighted mean differences in percentage of total studies showing an effect/no effect.

Table 2. Estimated evidence profile (GRADE 2017) for the effect of behavioural or comprehensive interventions on the prevention and control of early childhood caries (ECC), proximal caries and periodontal disease

| Grade | Effect of preventive programmes on ECC | Proximal caries, home flossing | Effect of specific informational/motivational programmes on prevention of periodontal disease |
|--|--|---|---|
| Study designs | 13 Cohort 5 RCTs | 1 Systematic review includes 6 RCTs, 1 RCT 4 Cohort studies | Systematic review <i>N</i> = 5 |
| Reporting and methodological estimated potential risk of bias | Moderate | Moderate | Moderate |
| Consistency | Mostly consistent | Consistent | Inconsistent |
| Directness | Direct | Direct | Direct |
| Precision | Precise | Imprecise | Imprecise |
| Publication bias | Possible | Possible | Possible |
| Magnitude of the effect | Mostly high | Small | Unclear |
| Strength of the recommendation based on the quality and the body of evidence | High | Weak | Weak |
| Direction of the recommendation | In favour | In favour | In favour |

For children and adolescents, a high profile of community, in office and individual preventive measures, has been implemented in many countries for many decades (Splieth et al. 2016). Thus, the current pattern of caries as a “social and behavioural” disease reflects the effect of socio-behavioural aspects in caries prevention. These data are mainly based on epidemiologic studies on a community or country level and to a lesser extent on RCTs. This is very common in fields, where preventive measures have been implemented since the early 1960s, when the methodology of RCTs was not common and at least not that sophisticated. The preventive interventions, therefore, were based more on healthcare epidemiology than on focused RCTs. This is also true for periodontology regarding the supportive periodontal therapy. To date, these findings are seen under the light of the evidence pyramid and cohort studies are regarded as less convincing due to a high risk of bias and a suboptimal control of study conditions. However, recently the evidence pyramid has been discussed controversial (Berlin & Golub 2014, Murad et al. 2016). It was developed to characterize the degree of the conditions of a clinical experiment similar to a laboratory experiment. Consistently, the highest level of evidence is achieved with RCTs. However, a higher control of study conditions also means that the results may not be valid for other conditions and make it more

difficult for the practitioner to transfer the results to the individual patient (Berlin & Golub 2014). Talking about the evidence in the field of prevention and control of caries and periodontal diseases, the use of well-performed cohort studies is, therefore, not necessarily a weakness. It may also be a strength as they may reflect reality better than well-focused RCTs. This may be the case in the form of ECC, where the prevention is based on daily oral hygiene with fluoride toothpaste performed by the parents and avoiding nursing bottles with sweet contents, especially at night (Wagner & Heinrich-Weltzien 2017). Another example is the supportive periodontal therapy, where numerous cohort studies show its necessity for long-term success, but RCTs are lacking. However, it has to be carefully weighed out in dependency of the topic and the research options whether the generalizability with less precision and higher risk of bias or the higher precision with less generalizability are the goals to aim at.

One of the issues of this review is the fact that different types of caries and periodontal diseases are related to different age groups with completely different frames regarding the options in influencing behavioural aspects.

Early childhood caries prevalence and the number of untreated decay (>50%) show a strong polarization in a risk group of about 20% of the children (Grund et al. 2015). In

general, children are accessible by the means of prevention in kindergarten. However, these risk children are difficult to address in preventive programmes and the information scarcely reaches the families most in need (Twetman 2008, Tubert-Jeannin et al. 2012, Garcia et al. 2015).

Despite the existence of many ECC prevention guidelines for dental practitioners, their effectiveness in the reduction in ECC incidence is not evident (Petti 2010). Thus, preventive programmes in children have combined the individualized, informative and educational approach with a focus on reaching out for social risks groups in their own setting, often with a common risk factor concept via midwives with home visits or in nurseries, kindergarten or school (Kowash et al. 2000, Splieth et al. 2016, Wagner & Heinrich-Weltzien 2017).

Regarding adolescents and young adults, proximal caries is still a relevant problem even in low-risk populations as in the Scandinavian countries (Murtomaa et al. 1984, Alm et al. 2007, 2008, Martignon et al. 2010) and it develops out of socio-behavioural-related prevention patterns such as oral hygiene habits in early childhood (Alm et al. 2007, 2008).

The slow progression of initial carious lesion allows non-invasive treatment with behaviour modifications, for example daily toothbrushing with higher concentrated fluorides, but also the home use of

interdental cleaning devices. In contrast to evident success of fluoride use (Nordström & Birkhed 2010), self-performed or unsupervised flossing does not seem to reduce proximal caries in adolescents, while supervised and professional flossing as well as minimally invasive sealing or infiltration clearly prevents or controls proximal caries (Hujuel et al. 2006, Alkilzy et al. 2011).

With regard to the elderly and the prevention of root caries, only very limited data exist considering behavioural interventions. In case of increased preventive efforts, there might be still attachment loss, exposed root surfaces and subsequent caries development. As well as ECC and proximal caries tooth loss and root caries are related to socio-behavioural aspects. In order to compensate for these socio-behavioural factors, it seems to be advisable to aim for out-reaching measures, like trying to reach and apply preventive measures for all of the individuals in certain risk groups of a community. These risk-specific population-based preventive approaches have been implemented in children and adolescents to tackle the socio-economic gap in caries prevalence after the caries decline (Splieth et al. 2016).

Interventions to prevent and control periodontal diseases are mainly based on individual levels and, therefore, address behaviour rather than social conditions. Adults, however, are more difficult to reach as compared to children, if they do not seek the dentist on their own. Consequently, group prophylaxis as in children is not as easy realizable. The only successfully performed prevention of periodontitis on a population level way seems to be antismoking campaigns, although evidence for its efficacy is completely lacking. A major goal for the prevention of periodontal diseases should be, therefore, to change the behaviour in the direction of a more health-conducive lifestyle on an individual level. Most of these interventions are based on behavioural theories (Newton 2010). In this meta-review, no clear superiority of a specific model could be demonstrated. It could even not be shown, whether or not specific behavioural interventions have a superior effect as compared to standard procedures with regard to parameters of plaque

gingivitis, periodontitis and proximal caries. Besides, the included papers have a moderate to substantial bias and considerable heterogeneity between the papers. Several individual variables seem to influence the likelihood of changing behaviour (Michie et al. 2011). As described in the COM-B model, the likelihood is influenced by the patients' physical and psychological capability, the local and socio-environmental opportunity and the motivation to change behaviour.

Consequently, to reach all socio-economic groups, further research is needed in order to prevent periodontitis on a population level, which might, for example, consider the effect of forced informational programmes on periodontitis and group education in the scope of medical education, for example for patients with diabetes. With regard to prevention of caries and periodontitis on individual level, more clinical trials are needed to monitor socio-behavioural aspects most effectively. However, in the mind of the authors, it became evident out of the published evidence, that further research in this field has not to be limited to clinical research but also complemented by healthcare research as the success of socio-behavioural changes on the prevention and control of long-lasting diseases such as periodontitis and different forms of caries will be seen rather under real-life conditions than under the well-controlled conditions of a clinical study.

Further research

To prevent periodontitis and caries in all socio-economic groups, further research is needed on population-based education and prophylaxis programmes. With regard to prevention of caries and periodontitis on individual level, more clinical trials are needed to develop a procedure, which changes socio-behavioural aspects most effectively. These studies should not be limited to well-controlled clinical trials but also should cover the level of healthcare research in order to prove efficiency rather than efficacy.

Conclusion

The beneficial effect of population-based preventive programmes

intending to change social behaviour has been demonstrated by cohort and population-based studies with regard to caries but not for periodontitis. On an individual level, the influence of specific motivational/informational interventions has not yet been clearly demonstrated.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1. Search and selection results on prevention of caries and socio-behaviour.

Figure S2. Search and selection results on prevention of periodontal disease and socio-behaviour.

Table S1. Eligible studies on the evaluation of the prevention of ECC with respect to socio-behavioural factors in children up to the age of 6 years.

Table S2. Included papers of systematic review on the preventive or therapeutic approaches for proximal

caries in adolescents and young adults with special respect to behavioural factors.

Table S3. Overview of the characteristics of the included systematic reviews on the prevention and control of periodontal disease processed for data extraction.

Table S4. Quality assessment of studies included for behaviour and caries according to the Newcastle-Ottawa Scale (NOS; Wells et al. 2016).

Table S5. Estimated risk of bias by scoring a list of items related to the reporting and methodological quality of the included systematic reviews on the prevention of periodontal disease.

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Clinical Relevance

Scientific rationale for the study: Interventions addressing behavioural factors are of key interest in the prevention and control of caries and periodontal diseases.
Principal findings: Available evidence on the topic differs substantially for

both diseases. Population-based preventive programmes intending to improve behaviour are successful with regard to caries as shown by cohort and population-based studies, but such evidence does not exist for periodontal diseases. The effect of specific individual interventions to change

behaviour has not yet been clearly demonstrated for both diseases.
Practical implications: Efforts should be made to prevent and control caries and periodontal diseases in all socio-economic levels and in all age groups on a population level with scientific monitoring.