Group A
Initiator Paper
Plaque control: Home remedies practiced in developing countries

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Introduction

The importance of plaque control measures to contribute to the oral health status of an individual has been emphasized in all workshops on periodontology (Claydon, 2008). Oral cleanliness is important for the preservation of oral health as it removes microbial plaque, thereby preventing its accumulation on teeth and gingivae (Choo *et al.,* 2001). Self-care includes all self-supporting activities that an individual performs to prevent and treat personal ill health. Self-care or home-use activities include toothbrushing combined with interdental cleaning. People brush their teeth for a number of reasons: to feel fresh and confident, to have a nice smile, and to avoid bad breath and disease (Choo *et al.,* 2001). But despite the widespread use of both toothbrushes and fluoride toothpastes, the majority of the population do not clean their teeth thoroughly enough to prevent plaque accumulation (Claydon, 2008).

There is, however, substantial evidence showing that toothbrushing and other mechanical cleansing procedures can reliably control plaque. The development of a variety of powered (electric) toothbrushes has been undertaken with the aim of enabling the user to achieve higher standards. Although power toothbrushes are sold worldwide and have been shown to be more effective than manual toothbrushes (Deacon *et al.,* 2010), their significance in developing countries is limited because of costs. The minimum level of income deemed adequate in developing countries (also called the poverty line) has been estimated at $1 a day. In 2008, the World Bank came out with a revised figure of $1.25 as purchasing-power parity (PPP). Thus the purchase costs and the need for electricity for recharging or the cost of batteries restricts the potential use of power toothbrushes in developing countries. Additionally, the use of interdental brushes on a daily basis would be far beyond what the average consumer in developing countries could afford. Subsequently for this paper, manual toothbrushing, flossing and the use of wood sticks were considered to be suitable methods for mechanical plaque control by oral self-care in developing countries.

With respect to toothbrushing, a PubMed search at the time of preparation of this manuscript revealed that over 6500 relevant papers are indexed in this database. Consequently it was decided to consider the totality of the evidence as presented in systematic reviews. Such a synthesis is a comprehensive summary of all the research evidence related to a focused clinical question that integrates the best available evidence from original single studies. The present synopses of syntheses (Dicensio *et al.,* 2009), summarizes the findings of a systematic review on various methods of mechanical plaque removal which are affordable in developing countries, with the aim to assess the effect on plaque scores and oral health.

Materials and methods

This synopsis of synthesis was conducted in accordance with the Cochrane handbook (Higgings and Green, 2011) for systematic reviews of interventions, which provides guidance for the preparations and the guidelines of Transparent Reporting of Systematic Reviews and Meta-analyses (PRISMA-statement; Moher *et al.,* 2009; Dicensio *et al.,* 2009).

Focused question

Based on evidence as presented in systematic reviews, what is the effect on plaque scores and oral health of self-care manual plaque control measures appropriate for developing countries?

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Search strategy

Three internet sources were used to search for appropriate papers that satisfied the study purpose. These sources included the National Library of Medicine, Washington, D. C. (MEDLINE-PubMed) and the Cochrane Central Register of Controlled Trials. For this comprehensive search, both databases were searched for eligible studies up to 1 January 2015. The structured search strategy was designed to include any systematic review published that evaluated the effect of self-care regarding plaque control. For details regarding the search terms used, see Box 1.

Screening and selection

Two reviewers (DES and GAW) 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 two reviewers (DES and GAW). Any disagreement between the two reviewers was resolved after additional discussion. The papers that fulfilled all of the selection criteria were processed for data extraction. All of the reference lists of the selected studies were hand-searched by two reviewers (DES and GAW) for additional published work that could possibly meet the eligibility criteria of the study. Unpublished work was not sought.

- The eligibility criteria were as follows:
- Systematic reviews
- Papers written in the English or Dutch language
- Evaluating studies conducted in humans
  - ≥ 18 years old
  - In good general health
- Intervention: self care products for controlling the dental biofilm.
- Evaluation with one or more of the following clinical evaluation parameters: plaque scores (PS); gingival index (GI); and bleeding scores (BS).

Exclusion criteria: rechargeable or battery powered devices.

Assessment of heterogeneity

The heterogeneity of the outcome parameters across studies was detailed according to the following factors:

- Databases searched
- Study and subject characteristics
- Manner of analysis of the obtained data

Quality assessment

Two reviewers (DES and GAW) scored the methodological qualities of the systematic reviews. Assessment of methodological study quality was performed by combining the proposed criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement Checklist, together with items of the systematic review reviewers checklist (Ades *et al.,* 2013), Quality Assessment Scale for Systematic Reviews (Barton *et al.,* 2008, modified by Haladay *et al.,* 2013) and reporting items suggested by Zorzela *et al.* (2014). Criteria were designated for evaluating the methods. This comprehensive combination of quality criteria is presented in *Table 2*.

Box 1. Search terms used for PubMed-MEDLINE and Cochrane-CENTRAL.
The search strategy was customized according to the database being searched.

The following strategy was used in the search:
{ <Intervention> AND <outcome> }
Filter used: systematic review OR meta-analysis

{ <Intervention: [MeSH terms] Toothbrushing OR (Home Care Dental Devices) OR [text words] toothbrush OR toothbrushing OR toothbrush* OR toothpick* OR wood stick* OR (wooden interdental cleaner) OR (wedge stimulator*) OR (wooden stimulator*) OR miswak OR miswaak OR arak OR siwak OR sewak, (Kayu Sugi) OR (chewing stick) OR Floss OR (Dental floss) OR Flossing OR Tape OR (Dental tape) OR Superfloss OR Ultrafloss OR (Interdental cleaning devices) OR (Interproximal cleaning devices) OR (Interspace cleaning devices)>

AND

<(Outcome: <[MeSH terms] (Dental Plaque) OR (Dental Plaque Index) OR (Dental Deposits) OR [text words] (dental deposit*) OR (dental deposits) OR (dental deposit) OR plaque OR (plaque removal) OR (plaque index) OR (dental plaque)>}

The asterisk (*) was used as a truncation symbol.

Figure 1. Search and selection results.

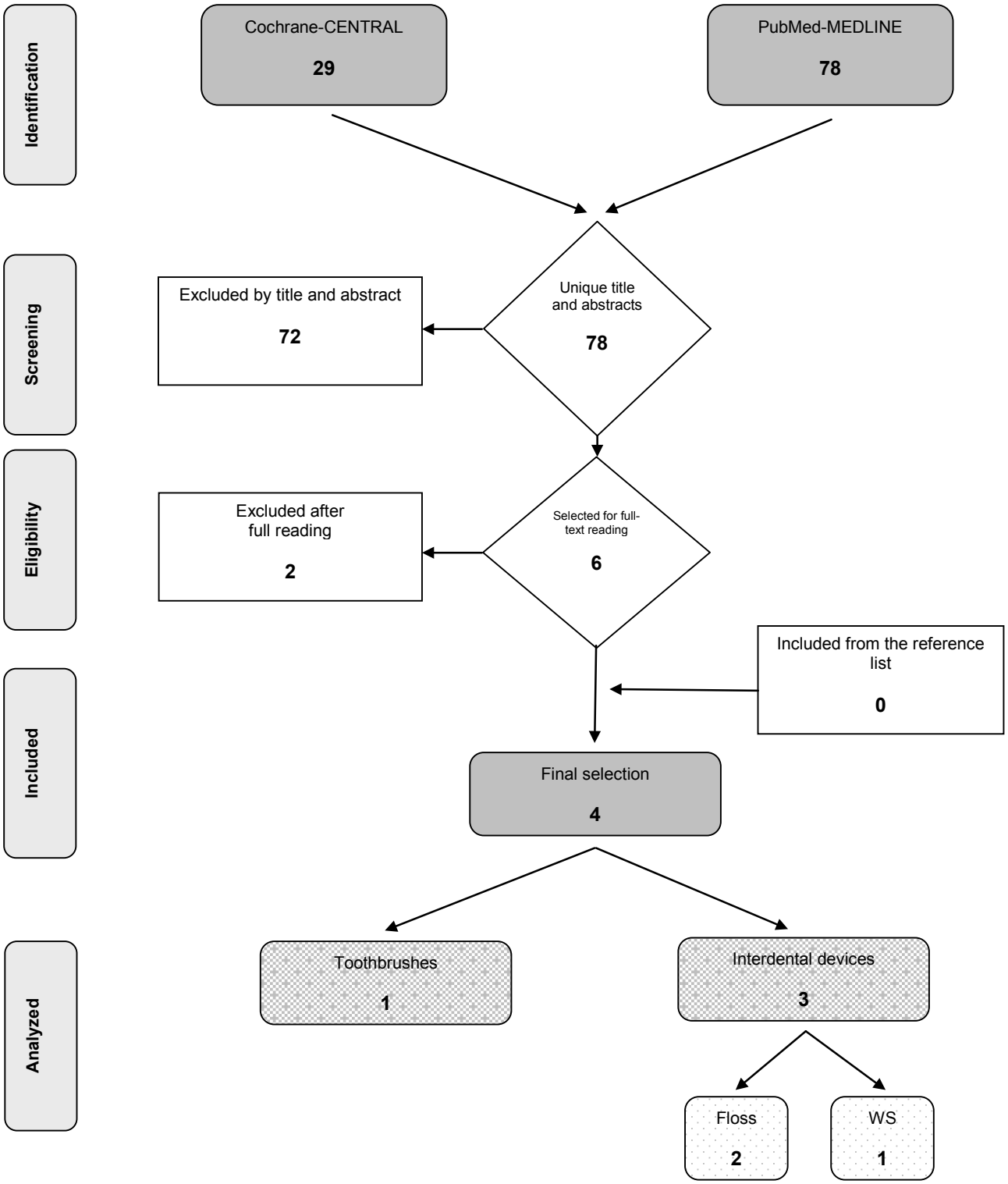

Table 1. Overview of the characteristics of the included systematic reviews processed for data extraction.

ID Author (year)	Databases searched Data	Number of included studies/trials # participants	Mode of analysis (methodology, meta-analysis, vote counting)	Original review authors' conclusions	COMMENTS of the synopsis authors
Brushing					
Slot *et al.*, 2012	PubMed-Medline Cochrane CENTRAL	212 experiments 10,806 participants	Meta-analysis Weighted mean and 95% confidence interval	The efficacy in plaque removal following a brushing exercise is a reduction from baseline plaque scores of 42% on average, with a variation of 30 – 53% dependent on the plaque index used. The available evidence indicates that bristle tuft arrangement (flat trim, multilevel, angled) and brushing duration are factors that contribute to the variation in observed efficacy.	Lacks a comparison intervention
Interdental cleaning					
Berchier *et al.*, 2008	PubMed-Medline Cochrane CENTRAL	11 studies 559◊ participants	Meta-analysis Weighted mean difference Vote counting	The dental professional should determine, on an individual patient basis, whether high-quality flossing is an achievable goal. In light of the results of this comprehensive literature search and critical analysis, it is concluded that a routine instruction to use floss is not supported by scientific evidence.	Two included studies reported the same experiment; however, they were of different durations.
Sambunjak *et al.* 2011	Ovid-Medline OVID-EMBASE Cochrane CENTRAL Cochrane OHG trials LILAC-BIREME CINAHL-EBSCO ZETOC Web of science mRCT clinicaltrials.gov	12 trials 1083 participants	Meta analysis Standardized Mean Difference	There is some evidence from 12 studies that flossing in addition to toothbrushing reduces gingivitis compared to toothbrushing alone. There is weak, very unreliable evidence from 10 studies that flossing plus toothbrushing may be associated with a small reduction in plaque at 1 and 3 months. No studies reported the effectiveness of flossing plus toothbrushing for preventing dental caries.	Two studies included a control group using a 5% hydro alcohol. One study included an intervention group using a hummingbird power flosser which is not dental floss but a rubber stimulator.
Hoenderdos *et al.* 2008	PubMed-Medline Cochrane CENTRAL	8 experiments 438◊ participants	Vote counting	Evidence from controlled trials, most of which were also randomized, shows that wood sticks do not have an additional effect on visible interdental plaque or gingival index, but do, however, provide an improvement in interdental gingival inflammation by reducing the bleeding tendency.	No statistical analysis could be performed. Only triangular wood sticks were evaluated.

◊ = Calculated by the review authors

Table 2. Methodological quality scores and estimated risk of bias of the included systematic reviews.

Quality criteria: **Study:**	**Slot *et al.*, 2012**	**Berchier *et al.*, 2008**	**Sambunjak *et al.*, 2011**	**Hoenderdos *et al.*, 2008**
Oral hygiene device evaluated	Brush	Floss	Floss	Wood sticks
Defined outcome criteria of interest	+	+	+	+
Target population in developing countries	-	-	-	-
Describes the rationale	+	+	+	+
Describes the focused (PICO)[S] question/hypothesis	+	+	+	+
Describes if a protocol was developed 'a priori.'	-	-	+	-
Protocol registration/publication	NA	NA	+	NA
Presented eligibility criteria (inclusion/exclusion criteria)	+	+	+	+
Presents the full search strategy	+	+	+	+
Various databases searched	+	+	+	+
Performed (manual) search in additional sources (*e.g.* grey literature or trial registers)	-	-	+	-
Stated if selected studies were screened by more than one reviewer	+	+	+	+
Non-English language papers included	-	-	+	-
Provided details on the performed study selection process/flow chart	+	+	+	+
Reports study characteristics, such as patient demographics or length of follow-up	+	+	+	+
Provide data of the selected studies on the outcome measures of interest	+	+	+	+
Data were extracted by more than one reviewer	+	+	+	+
Report heterogeneity of the included studies	+	+	+	+
Estimated risk of bias in individual studies	+	+	+	+
Performed a meta-analysis	+	+	+	-
Performed a descriptive analysis	+	+	+	+
Performed an analysis based on vote counting	-	-	-	+
Describes additional/sub-analyses	+	-	+	-
Grading of the obtained evidence	-	-	+	-
Present limitations of the systematic review	+	-	-	-
Provide a conclusion that responds to the objective	+	+	+	+
Funding source	+	?	+	+
Authors estimated quality score	**71%**	**63%**	**88%**	**71%**
Authors estimated quality	**substantial**	**substantial**	**high**	**substantial**

Each aspect of the score list was given a rating of '+' for an informative description of the item at issue and a study design meeting the quality standard, '-' for an informative description without a study design that met the quality standard, and '?' for insufficient information. NA, not applicable.

Disagreements in scoring for the final quality assessment scores were resolved by consensus. The consensus quality assessment scores and percent agreement were calculated. Each aspect of the item score list was given a rating of '+' for informative description of the item at issue and a study design meeting the quality standard, '-' for an informative description without a study design that met the quality standard and '?' for insufficient information. If all quality items were given a positive rating a 100% quality score was obtained. The percentage estimated quality was interpreted as follows: 0% to 40% - low quality, 40% to 60% - moderate quality, 60% to 80% - substantial quality, 80% to 100% - high quality.

Data analyses

Plaque scores were considered to be the primary parameter of interest and formed the basis for selection of publications for this review. The data from those papers that met the selection criteria were extracted and processed for further analysis by two reviewers (DES and GAW). As a measure of oral health also bleeding scores (BS) and the gingival index (GI) scores were considered from those studies in which these outcomes were presented in conjunction with plaque score data. Data and conclusions as presented in the selected papers were extracted. Statistical heterogeneity and potential publication bias were evaluated. Disagreements between the reviewers were resolved by discussion.

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 synopsis of synthesis (GRADE, Guyatt *et al.,* 2008). Two reviewers (DES and GAW) rated the quality of the evidence as well as the strength of the recommendations according to the following aspects: risk of bias, consistency and precision among outcomes, directness of results, and detection of publication bias.

Results

Search and selection results

The searches resulted in 78 unique papers (*Figure 1*). The screening of titles and abstracts initially resulted in six papers. Based on detailed reading of full texts two papers were excluded. Hand searching of the reference lists did not reveal any additional suitable systematic reviews. As a result, four studies were identified as eligible for inclusion in this synopsis according to intervention and outcome parameters.

Assessment of heterogeneity

Considerable heterogeneity was observed in the four 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, report of effect scores, presence of meta-analysis, and conclusions made. Information regarding the included papers is displayed in detail in *Table 1*. Various clinical indices and their modifications have been evaluated.

Quality assessment

Quality assessment values, including details, are presented in *Table 2*. Based on a summary of these criteria, the estimated quality is substantial in three studies (Slot *et al.* 2012; Berchier *et al.,* 2008; Hoenderdos *et al.,* 2008) based on quality scores of 71%, 63% and 71% respectively. A high estimated quality based on a score of 88% was given to the Cochrane paper of Sambunjak *et al.*, 2011.

Study outcomes results

Table 1 shows the results from the data extraction. The conclusion of the original review authors and the comments of the authors of this synopsis and a descriptive summary are presented per oral hygiene device.

Manual toothbrushes

The effect of a single brushing exercise using a manual toothbrush was assessed by Slot and coworkers (2012). In total, 212 individual brushing exercises as separate legs of experiments, including 10,806 participants, were used to calculate a weighted mean overall plaque score reduction in percentage. Based on the baseline and end scores, a plaque reduction percentage was calculated for each of the eligible brushing exercises taken from the selected studies. Using these data, a weighted mean difference (WMD) in plaque index scores reduction from baseline was calculated to be 42% including all methods of scoring plaque. Taking plaque index scores used into account, plaque scores dropped from 30% to 53% on average. Sub-analysis of the efficacy in relation to brush head configurations and brushing duration shows a numerical advantage of multilevel and angled designs relative to flat trim. In addition, the effect of a single brushing exercise with regard to toothbrushing time was evaluated. From this sub-analysis, based on Quigley and Hein plaque index scores, the estimated weighted mean efficacy was 27% after 1 minute and 41% after 2 minutes.

Floss

Berchier and coworkers (2008) evaluated the effect of flossing as adjunct to toothbrushing. Independent screening of titles and abstracts resulted in 11 publications that met the eligibility criteria. The majority of these studies showed that there was no benefit from flossing on plaque or clinical parameters of gingivitis.

From the collective data of the studies, it appeared possible to perform a meta-analysis of plaque and gingival index scores. In both instances, baseline scores were not statistically different. Comparing brushing and flossing against brushing only, the Quigley and Hein plaque index WMD was - 0.04 (95% CI: -0.12; 0.04, $p = 0.39$) and the Loë and Sillness gingival index WMD was -0.08 (95% CI: - 0.16; 0.00, $p = 0.06$). End scores also showed no significant differences between those groups that flossed in comparison to those that did not floss for the Quigley and Hein plaque (WMD: -0.24, 95% CI: -0.53; 0.04, $p = 0.09$) or Löe and Silness gingival index (WMD: -0.04, 95% CI: - 0.08; 0.00, $p = 0.06$).

In a Cochrane review, the effects of flossing in combination with toothbrushing were compared with toothbrushing alone in the management of periodontal diseases and dental caries in adults (Sambunjak *et al.*, 2011). Twelve trials were included in this review, with a total of 582 participants in flossing plus toothbrushing (intervention) groups and 501 participants in toothbrushing (control) groups. All included trials reported the outcomes of plaque and gingivitis. Seven of the included trials were assessed as at unclear risk of bias and five were at high risk of bias. Flossing plus toothbrushing showed a statistically significant benefit compared to toothbrushing in reducing gingivitis at the three time points studied, the standardized mean difference (SMD) being -0.36 (95% CI -0.66 to -0.05) at 1 month, SMD -0.41 (95% CI -0.68 to -0.14) at 3 months and SMD -0.72 (95% CI -1.09 to -0.35) at 6 months.

Wood sticks

Hoenderdos and coworkers (2008) presented a qualitative summary of the effect of wood sticks in combination with toothbrushing. Seven publications describing eight clinical experiments met the inclusion criteria. None of the studies that scored plaque demonstrated any significant advantage of the use of wood sticks. The improvement in gingival health observed in the studies represented a significant reduction of bleeding realized by the use of triangular wood sticks.

Evidence profile

Table 3 shows a summary of the various factors used to rate the quality of evidence and strength of recommendations according to GRADE (Guyatt *et al.,* 2008). Because the data are fairly consistent, indirect and moderately precise, the strength of the recommendation is considered to be 'moderate to strong' for the self-care mechanical plaque removal devices.

Discussion

The model to guide clinical decision begins with original single studies as the foundation, and builds up from these to syntheses (systematic reviews), followed by synopses of the syntheses. Such synopses intend to describe the current best evidence that matches the patients' specific circumstances. The advantages of a relevant synopsis of a synthesis are 2-fold: first, the synopsis provides a convenient summary of the corresponding synthesis (systematic reviews), and second, it is often accompanied by a commentary that addresses the methodological quality of the synthesis and the clinical applicability of its findings (Dicenso *et al.,* 2009). The current synopsis intended to evaluate oral hygiene measures suitable for developing countries. For these specific patients with limited financial resources no evidence could be retrieved. The papers selected summarized research performed in Western societies.

Based on the observations by Slot *et al.* (2012) the efficacy of plaque removal following a toothbrushing exercise is a reduction from baseline in plaque scores of 42% on average, with a range of 30–53% dependent on the plaque index used. It appears that there is room for improvement in the efficacy of manual toothbrushes in their capability for reducing plaque score during a brushing exercise. The duration of toothbrushing is likely to be an important determinant of plaque removal in the general population; therefore, it should be stressed during toothbrushing instruction sessions. As plaque removal is strongly correlated with brushing time for any given toothbrush, brushing for 2 minutes or longer should be encouraged, regardless of the brush used. Brushing time is also likely the most easily controlled parameter of effective everyday brushing (Slot *et al.,* 2012).

Table 3. GRADE evidence profile for the effect of various methods of mechanical plaque removal suitable for developing countries based on the selected systematic reviews.

GRADE	Toothbrush	Floss	Wood stick
Estimated quality	Substantial	Substantial to high	Substantial
Consistency	Fairly consistent	Fairly consistent	Inconsistent
Directness	Indirect	Indirect	Indirect
Precision	Moderate	Moderate	Moderate
Publication bias	Possible	Possible	Possible
Body of evidence	***Moderate***	***Strong***	***Moderate***

Based on the individual papers in the review by Berchier *et al.* (2008), a trend was observed that indicated a beneficial adjunctive effect of floss on plaque levels. However, this could only be substantiated as a non-significant trend in the meta-analyses. Routine recommendation to use floss is thus not supported by scientific evidence. The dental professional should therefore determine, on an individual patient basis, whether high-quality flossing is an achievable goal. One may critically ask why the review by Berchier *et al.* (2008) does not substantially show dental floss as a co-operative adjunct to toothbrushing? The advocacy of floss as an interdental cleaning device hinges, in large part, on common sense. However, common sense arguments are the lowest level of scientific evidence (Sackett *et al.,* 2000). A possible explanation is that the previous narrative reviews have not been conducted systematically. The fact that dental floss has no additional effect on toothbrushing is apparent from more than one review. Sambunjak *et al.* (2011) in their Cochrane review concluded that overall there is weak, very unreliable evidence that suggests that flossing plus toothbrushing may be associated with a small reduction in plaque. Hujoel *et al.* (2006) found that flossing was only effective in reducing the risk of interproximal caries when applied professionally. High-quality professional flossing performed in first-grade children on school days reduced the risk of caries by 40%. In contrast, self-performed flossing failed to show a beneficial effect. The lack of an effect on caries is most likely the consequence of plaque not being removed efficiently, as established by Berchier *et al.* (2008). Flossing also does not effectively clean wide interdental spaces, root surfaces or concavities. Such periodontally involved dentitions are more common in advancing age, when reduced dexterity and visual acuity further impede flossing.

Wood sticks can be used effectively where sufficient interdental space is available. Wood sticks fabricated from soft wood are designed to allow the mechanical removal of plaque from these interdental surfaces. When used on healthy dentition, wood sticks depress the gingivae by up to 2 mm and therefore clean part of the subgingival area. Thus, wood sticks may specifically remove subgingivally located interdental plaque that is not visible and therefore not evaluated by the plaque index. This physical action of wood sticks in the interdental area may produce a clear beneficial effect on interdental gingival inflammation (Finkelstein *et al.,* 1990). Evidence from controlled trials (Hoenderdos *et al.,* 2008), shows that hand-held triangular wood sticks do provide an improvement in interdental gingival inflammation by reducing the bleeding tendency. However, no concomitant effect on visible interdental plaque could be established. As explanation for this inconsistency one may consider a series of histological investigations in patients with periodontitis (Walsh and Heckman, 1985) which has shown that the papillary area with the greatest inflammation corresponds to the middle of the interdental tissue. It is difficult to clinically assess the mid-interdental area for plaque, as it is usually not available for direct visualization.

Toothbrushes

In normal use it must be concluded that the benefits of toothbrushing far outweigh the potential harm (Addy and Hunter, 2003). Although toothbrushing is known to cause gingival abrasions, data regarding the effect of toothbrushing on the initiation and progression of non-inflammatory gingival recession are inconclusive (Rajapakse *et al.,* 2007).

The exact moment at which a toothbrush should be replaced is difficult to determine. The American Dental Association advocates toothbrush replacement every 3 to 4 months or sooner if the bristles become frayed (American Dental Association, Statement on Toothbrush Care: Cleaning, Storage and Replacement, available at http://www.ada.org/1887.aspx). Common sense dictates that toothbrushes should be replaced because the filaments and tufts do not retain their shape forever. Completely worn brushes lose the capacity to remove plaque effectively. This most likely occurs because of a loss of shear force, as the tips of the filaments can no longer disrupt the plaque adequately. Rosema *et al.* (2013) evaluated 3-month-old used and new manual toothbrushes and did not observe a clinically relevant difference in plaque score reductions following a 2-minute brushing exercise. However, the wear rate of the brushes seems to be the determining factor in loss of efficacy, rather than the age of the toothbrush.

When old brushes showed more wear new brushes had greater benefits over old brushes. Therefore, it seems appropriate to replace a brush when it shows wear up to a point where 'the outer tufts are splayed and have lost tuft definition,' the 'inner tufts are splayed and become less distinct' and 'the definition between inner and outer tufts is lost.' Individuals show great variation in the progression of toothbrush wear so the age of a toothbrush should not be the guiding factor for replacement (Rosema *et al.,* 2013). The finding that heavily worn 14-month-old toothbrushes with severe bristle matting in the hands of 7- and 8-year-olds are not less effective than new toothbrushes with regard to plaque-removal capacity has important consequences for school brushing programs. If the old toothbrush can be maintained far beyond the generally recommended three-month period, school-based toothbrushing programs in underserved communities have a better chance to be sustained (Van Palenstein Helderman *et al.,* 2006).

Toothpaste

The use of fluoride toothpaste is the primary intervention for the prevention of caries. A Cochrane systematic review (Walsh *et al.,* 2010) confirmed the benefits of using fluoride toothpaste in preventing caries in children and adolescents when compared to placebo, but was significant only for fluoride concentrations of 1000 ppm and above. The relative caries preventive effects of fluoride toothpastes of different concentrations increase with higher fluoride concentration. The decision of what fluoride levels to use for children under 6 years should be balanced with the risk of fluorosis (Walsh *et al.,* 2010). There is no evidence to support the use of low fluoride toothpastes by preschoolers regarding caries and fluorosis prevention. A more recent systematic review (Santos *et al.,* 2013) showed that low fluoride toothpastes significantly increased the risk of caries in primary teeth [RR = 1.13 (1.07 - 1.20); 4,634 participants in three studies] and did not significantly decrease the risk of aesthetically objectionable fluorosis in the upper anterior permanent teeth [RR = 0.32 (0.03 - 2.97); 1,968 participants in two studies].

The intra-oral retention or substantivity of active ingredients in toothpastes is important for their effectiveness, and this is influenced by user-related factors, among others. User-related factors include biological aspects such as salivary flow and salivary clearance, and behavioral aspects, such as frequency and duration of brushing, amount of toothpaste used and post-brushing rinsing behavior (Parnell and Mullane, 2013). An earlier study by Sjögren and Birkhed (1994) also showed that eating or drinking immediately after brushing reduced the salivary fluoride level by 12 to15 times.

There is a lack of high-quality evidence to support definitive guidance in this area. However, the currently available international guidelines provide consistent recommendations despite the limited evidence (Pitts *et al.,* 2012). A modified toothpaste technique has been suggested as a way to increase intra-oral fluoride and to prolong fluoride retention in order to maximize the anti-caries effect of toothpaste (Sjögren *et al.,* 1995). The technique involves four steps as follows: 1) apply 1 g (1 cm) of toothpaste to a wet toothbrush, spread evenly on the teeth and brush for approximately 2 minutes using the Bass technique, 2) spit out no more than necessary during brushing, 3) take a sip of water (approximately 10 ml) and with the remaining toothpaste foam in the mouth, use the toothpaste slurry as a mouthrinse and filter it between the teeth by active cheek movements for 1 minute before carefully spitting out, and 4) no further rinsing afterwards, and no eating or drinking for 2 hours after brushing.

Miswak

Methods for oral hygiene vary from country to country and from culture to culture (Khan *et al.,* 2009). Today, chewing sticks are being widely used in Asia, Africa, South America, and throughout the Islamic countries. They are known by different names in different cultures, such as miswak, siwak or arak. They were initially used by Babylonians around 7000 years ago, followed by the Greek and Roman empires. There are several shrubs and local trees being used as chewing sticks in different parts of the world, which are selected due to good taste and a texture like long bristles. The stick is chewed or tapered at one end until it becomes frayed into a brush. When the brushy edge is shredded after being frequently used, the stick becomes ineffective and it is then cut and further chewed to form a fresh edge. In this way, it can be used for a few more weeks (Sukkarwalla *et al.,* 2013). Miswak has been documented as a potent antibacterial aid and its use is encouraged in different countries because of its good taste, texture, availability, cost and beneficial effect on teeth and supporting tissues.

No systematic review could be retrieved with respect to miswak but a single, blind, randomized crossover study compared it against regular toothbrushing, Image analysis of the plaque distribution showed a significant difference in reduction of plaque between the miswak and toothbrush periods ($p < 0.05$) and it was concluded that the miswak is more effective than toothbrushing for reducing plaque and gingivitis. Miswak also appeared to be more effective than toothbrushing for removing plaque from the embrasures, thus enhancing interproximal health (Al Otaibi *et al.,* 2003). The World Health Organization has, based on consensus, also recommended and encouraged the use of these chewing sticks as an affordable and effective alternative tool for oral hygiene (Sukkarwalla *et al.,* 2013).

Interdental cleaning

Alternatives for commercially available products are scarce. During the International Symposium on Dental Hygiene in 2013, a presentation was given regarding the evaluation of substitutes for dental floss for lower socioeconomic groups. The fibers of fruit or vegetable bags were considered as a potential alternative to dental floss. Based on the results of a randomized controlled clinical trial there appears to be no difference on the plaque index scores when the teeth are cleaned with conventional floss or with the fibers of fruit or vegetable bags (Swart, *International Journal of Dental Hygiene* abstracts, p 167).

Behavior

Good oral health is dependent on the establishment of the key behaviors of toothbrushing with fluoride toothpaste. Primary schools provide a potential setting in which these behavioral interventions can support children to develop independent and habitual healthy behaviors. Currently, there is insufficient evidence for the efficacy of primary school-based behavioral interventions for reducing caries (Cooper *et al.,* 2013). For example, 8- to 11-year-old school children who participated in a school-based toothbrushing program over 2 years did not reveal a statistically significant effect of this with respect to gingivitis and plaque scores (Rosema *et al.,* 2012). There is a need for further high quality research to utilize theory in the design and evaluation of interventions for changing oral health-related behaviors in children and their parents (Cooper *et al.,* 2013). Van der Weijden and Hioe (2005) systematically evaluated the quality of self-performed mechanical plaque removal in adults with gingivitis. Based on studies ≥ 6 months of duration, it appears that a single oral hygiene instruction, describing the use of a mechanical toothbrush, in addition to a single professional oral prophylaxis had a significant, albeit small, positive effect on the reduction of gingivitis.

In developing countries most patients receive in their lifetime only a single scaling, or if repeated scaling occurs they have large time intervals, at best accompanied with a single oral hygiene instruction. Because of a lack of dental manpower and resources, Lembariti *et al.* (1998) questioned whether an occasional scaling practice accompanied with limited professional attention for plaque control is effective in improving the periodontal condition. Scaling resulted in an approximately 20% reduction of the gingival bleeding score that remained during the 22-month follow-up period. Oral hygiene instruction had no significant effect on the calculus and bleeding scores. Formation of calculus still continued. The authors concluded that the effect of scaling alone on the gingival condition was small and the effect of a single oral hygiene instruction was negligible. Therefore, the practice of occasional scaling without repeated oral hygiene instruction, which is commonly employed in developing countries, should be considered as clinically irrelevant and of little use in improving the standard of periodontal health (Lembariti *et al.,* 1998).

Integrated approach

The high prevalence of poverty-associated diseases such as diarrhea, respiratory tract infection, parasitic infections and dental caries among children in the developing world calls for a return to primary health care principles with a focus on prevention. The 'Fit for School' program in the Philippines is based on international recommendations and offers a feasible, low-cost and realistic strategy using the principles of health promotion outlined in the Ottawa Charter. The cornerstone of the program is the use of school structures for the implementation of preventive health strategies. 'Fit for School' consists of simple, evidence-based interventions such as hand washing with soap, toothbrushing with fluoride toothpaste and other high-impact interventions such as bi-annual de-worming as a routine school activity for all children visiting public elementary schools. The program has been successfully rolled-out in the Philippines, covering 630,000 children in 22 provinces, and it is planned to reach six million children in the next three years (Monse *et al.,* 2010). Child health in many low- and middle-income countries lags behind international goals and affects children's education, well-being, and general development. Large-scale school health programs can be effective in reducing preventable diseases through cost-effective interventions. The paper outlining the baseline and 1-year results of a longitudinal health study assessing the impact of the 'Fit for School' program found a reduction in the prevalence of moderate to heavy soil-transmitted helminth infections, a rise in mean body mass index, and a trend towards reduction in dental caries and infections. The study design proved functional in actual field conditions (Monse *et al.,* 2013)

Limitations of this study

The available evidence as collected in the systematic review by Hoenerdos *et al.* (2008) with regard to wood sticks only refers to triangular shaped wood sticks. No data were gathered with respect to round or square toothpicks. None of the included systematic reviews included original studies that were carried out in developing countries. In particular, financial limitations should be considered in the evaluation of potential oral hygiene products.

Conclusion

No systematic reviews could be retrieved regarding the efficacy of mechanical plaque control as a measure of self-care in developing countries. Based on data of mechanical plaque control established in Western societies an affordable method should be to brush twice daily by means of a manual toothbrush and to use a fluoride-containing toothpaste. For interdental cleaning, wood sticks seem the most appropriate regarding costs effectiveness.

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As this is a synopsis of earlier work, parts of this paper have been published before and therefore some duplication are inevitable. This paper contains summaries of:

Van Der Weijden F and Slot DE. Oral hygiene in the prevention of periodontal diseases: The Evidence. *Periodontology 2000* 2011; **55**:104-123.

Interdental Oral Hygiene: The Evidence. GA Van der Weijden, DE Slot, Chapter 3 in: Proceedings of the 9th Asian Pacific Society of Periodontology; Hong Kong, 2011 - *Multi-Disciplinary Management of Periodontal Disease*, PM Bartold, and L Jin, eds. published by The Asian Pacific Society of Periodontology.

Mechanical Supragingival Plaque Control, F Van der Weijden, DE Slot, JJ Echeverría, and J Lindhe, Chapter 35, in *Clinical Periodontology and Implant Dentistry 6th edition*, J Lindhe, NP Lang and T Karring, eds. John Wiley and Sons Ltd, to be published in 2015.

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