Original Article

Caries preventive interventions in community-dwelling elders: a systematic review

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Abstract

Objective: To conduct a systematic review of identifying the clinical efficacy of caries preventive interventions in community-dwelling elders.

Background: As the human lifespan increases, the elders are known to retain their teeth for longer. Therefore, the need to uncover effective ways of preventing caries among this age group is relevant.

Methods: A search was conducted using four databases: Cochrane, MEDLINE, EMBASE and Web of Science using the keywords (caries OR demineralization) AND prevention AND (adult OR aged). The titles and abstracts were initially screened for the use of caries prevention interventions. Studies were excluded based on the predetermined criteria. The full texts of the remaining studies were then evaluated.

Results: Of 6952 articles identified from the search, fifty full texts were evaluated. Finally, ten studies were analyzed. One study found rinsing with 0.05% of NaF twice daily resulted in lower coronal caries increment. Another study reported the use of 1,100 ppm of NaF dentifrice twice daily showed lower percentage of coronal and root caries. A reduction of root caries was observed from using 5,000 ppm fluoridated toothpaste twice daily, annual professional 38% SDF solution application, six-monthly professional cleaning and APF gel application. The use of 0.12% CHX rinse and xylitol chewing gum did not show reduction of caries incidence.

Conclusion: Toothbrushing with 5,000 ppm of NaF dentifrice, rinsing with 0.05% NaF, professional application of 38% SDF solution and APF gel may be effective at preventing caries among the elders.

Keywords: dental caries, root caries, prevention, ageing

Abbreviations: APF (acidulated phosphate fluoride); CHX (chlorhexidine); NaF (sodium fluoride); OHI (oral hygiene instruction); OHE (oral health education); OHP (oral health promotion); ppm (parts per million); RP (root planning); Sc (scaling); SDF (silver diamine fluoride); SnF (stannous fluoride)

Introduction

Ageing produces unfavorable effects on the teeth. Multiple risk factors are believed to be associated with caries development among the older population including loss of periodontal attachment, past caries experience, high cariogenic bacterial load, low socioeconomic status, lack of awareness, diet or nutrition, low salivary flow, existing medical condition and

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medication (1, 2). Loss of periodontal attachment, as a result of periodontal disease or physiological process, leaves the root surfaces of the teeth unprotected against the hostile oral environment (3).

In most developed countries, individuals above the age of 65 are considered as the older people (4). Nevertheless, this age cutoff has not been accepted worldwide. The United Nations (UN) came to an agreement that those above the age of 60 be referred to as the older population (4). Hence, for this review, adults aged 60 years and above were described as the elders.

Description of the condition

To date, dental caries among the elders is becoming increasingly common and the rate of new caries development is said to be at least as great as that experienced by adolescents (5). Possible explanations for this include the increased life expectancy (1) and emerging trend that old people are retaining their teeth for longer (6). Though it may sound auspicious that people are less likely to become edentulous as they get older, the prevention and treatment of dental caries among this population are now becoming more challenging and demand attention (7).

Exposed root surfaces are at risk of root caries development (8). The root surface is composed of dentine covered by a cementum layer. This layer is often removed, either by erosion, abrasion or iatrogenic causes (8), which leaves the collagenous dentine exposed and susceptible to demineralisation. Furthermore, the pH required to cause dentin demineralisation is higher than that of enamel, resulting in much faster caries progression on the exposed dentinal surface (9).

Among the bacteria species known to be responsible for caries development are *Streptococcus mutans*, *lactobacilli*, and

Actinomyces (2). However, in root surface caries, other species of bacteria exist including *Atopobium*, *Olsenella*, Pseudoramibacter, Proprionibacterium and *Selenomonas (10)*.

A study of caries incidence at nursing homes in Adelaide saw 64% of coronal caries and 48% of root caries increment after one year (11). Another study in Iowa found the annualised attack rates of coronal and root caries to be 2.13 and 0.80 surfaces respectively in older Iowans (12). In their study, approximately 93% individuals developed new coronal caries and 43% new root caries at a two-year follow-up. A study that looked at older North Carolinians found the annualised rate of coronal caries to be 1.4 surfaces per 100 susceptible coronal surfaces and the annualised rate of root caries to be 2.6 surfaces per 100 susceptible root surfaces (13). These figures show that both coronal and root caries incidence is high among the older population, regardless of their level of dependency, demanding caries preventive strategies. The rate of new caries development is much higher than those seen in children (12) and yet the focus on caries prevention for older people is relatively limited (14).

Description of the intervention

It is unquestionable that toothbrushing using fluoridated toothpaste is fundamental in the prevention of caries (15). It is said to be more significant than thorough plaque removal alone (15). Caries initiates when acids produced by the bacteria present in the biofilm start to demineralise the tooth structure. Fluoride is a compound that has been proven to have the ability to

remineralise enamel that has been subjected to caries attack by stimulating enamel crystal development and prevent demineralisation through reducing acid production by bacteria (16). Fluoride also, when acquired systemically, will fuse into the enamel crystal making the surface more resistant to acid (16). Fluoride can be added to a variety of media including drinking water, toothpaste, gels, varnishes and milk (17).

High concentration sodium fluoride (NaF) dentifrice containing 5,000 parts per million (ppm) of fluoride ion (F^-) has been shown to have a primary root caries arresting effect and is more effective when compared with those containing a low concentration of F^- (18, 19). Studies have also shown the effectiveness of NaF varnishes, rinses, topical application of silver diamine fluoride (SDF) and acidulated phosphate fluoride (APF) at preventing and arresting caries among the elders (20-22).

Chlorhexidine (CHX) acts by inhibiting *Streptococcus mutans*, which leads to inhibition of plaque formation and subsequently inhibition of acid production that causes mineral loss from the tooth structure (23).

Xylitol is a sugar alcohol that is known to prevent caries for its anti-caries effect and the inability of *Streptococcus mutans* to metabolise it (21). However, sugar alcohol has its own drawback of possibly causing osmotic diarrheoa (9).

Application of topical cream containing casein phosphopeptide - amorphous calcium phosphate (CPP-ACP) onto the tooth surface is shown to be effective at remineralising early caries (24). GC Tooth Mousse is a non-fluoridated, water-based, sugar-free CPP-ACP. It exists in the form of a topical cream that acts by restoring the mineral balance and neutralising acid challenges (25). On current evidence, CPP-ACP containing cream shows no superior beneficial effect when used with fluoridated toothpaste than a prolonged application of fluoridated toothpaste alone (26).

The use of ozone in dentistry is known to reduce biofilm and bacterial count. A non-cavitated root caries lesion may be reversible with the use of ozone, together with meticulous oral hygiene and diet modification (27). Even though ozone therapy sounds promising in caries management, it still lacks viable successful clinical trials (28).

Why it is important to do this review

Prolonged survival of teeth among the older population and the high propensity for these teeth to be heavily restored are of concern. Presence of extensive restorations along with the potential of having dry mouth associated with polypharmacy and reduced level of oral hygiene mean that these teeth are highly susceptible to caries (6, 14). This calls for an attention at caries preventive strategies targeted at this population. The focus of this review will exclude the elders living in nursing homes as their oral health promotion may differ to those living independently. It is still unclear which caries preventive intervention is potentially useful to reduce new caries formation among the elderly. Available reviews are focused on children and adolescents. This review aims to specify the clinical efficacy of available interventions in caries prevention among community-based elderly.

Methods

The reporting of this review followed the PRISMA statement for reporting systematic review and meta-analysis of studies (29).

Inclusion Criteria

Randomised controlled trials, controlled clinical trials, longitudinal studies, case-control studies and cross-sectional studies were eligible for inclusion in this review. For the purpose of this review, individuals aged 60 years and above was considered as older people and included in this review, in accordance with UN definition of older population.

This review looked at multiple caries preventive interventions such as fluoride, chlorhexidine, calcium phosphate, xylitol and ozone in various methods of application (toothpaste, mouth rinse, varnish, gel, foam and tablet) and concentrations. Fluoride in various chemical formulas was also looked at such as sodium fluoride (NaF), stannous fluoride (SnF), acidulated phosphate fluoride (APF) and silver diamine fluoride (SDF).

Since this review aimed at looking at caries preventive interventions, only preventive trials which measured coronal and/or root caries incidence and increment were considered.

Exclusion criteria

Studies that have the following criteria were excluded: reviews, case reports, studies conducted *in-vitro*, *in-situ* and non-English articles. Studies that were conducted on subjects who were medically compromised, subjects with advanced periodontal disease and subjects aged 59 years and younger or had no clear age distinction were also excluded. This review focused on community-based elders, hence, studies that were conducted on institutionalised elders were excluded. Studies on remineralising and arresting effect and studies with surrogate endpoints (plaque index, gingival index, salivary flow rate, or/and microbiological findings) were also excluded.

Search strategy

A systematic search of the literature was conducted on four databases: Cochrane Central Register of Clinical Trials (*The Cochrane Library* 2016, Issue 6), MEDLINE via Ovid (1946 to July Week 1 2016), EMBASE via Ovid (1980 to 2016 week 30) and Web of Science – Core Collection (1900 to July Week 1 2016) by two investigators (E.M.Y.) and (M.L.M), independently. The key words used were (caries OR demineralisation) AND prevention AND (adult OR aged).

The titles and abstracts were initially screened for the use of various interventions at preventing caries. Irrelevant studies were excluded. Studies were also excluded based on the criteria determined at the beginning of this review. The full texts of the remaining studies were then obtained and evaluated. Finally, studies that met the inclusion criteria were considered in this review and analyzed.

After screening, the two investigators discussed the selected potential studies to be included. Any uncertainties between the two investigators were discussed with a third investigator (A.W.) to achieve consensus before they were evaluated for this review.

Data collection

Data from the included studies were categorized into two groups; those for

coronal and root caries, respectively. The outcome measurement should include caries increment from baseline to follow-up period. If the study was retrospective in nature, caries increment from the start of the intervention up to baseline should be included.

The following data were extracted from the included studies:

Authors' name, year of publication, type of study, age of subjects at baseline, grouping of subjects, follow-up period, and study outcome.

Risk of bias of included studies

The risk of bias of the included studies was assessed using the method suggested by the Cochrane Handbook for Systematic Review of Interventions (30).

Results

The initial search conducted on the four databases identified 6952 articles from the year 1900 to 2016. Out of the total, 543 articles were found from Cochrane Library, 2688 from MEDLINE, 2168 from EMBASE and 1553 from Web of Science Core Collection (Fig. 1). Duplicated articles were then removed, which reduced the total down to 5128 articles. After this was done, the titles were screened and any irrelevant studies excluded. Total articles after exclusion by title were 2641, which were then analysed by reading the abstracts and some removed according to the exclusion criteria.

The full texts of fifty articles were then obtained and evaluated. Fourty articles were removed because of the following reasons; studies which focused on institutionalised elders, studies which had no clear indication of the age of the subjects, subjects that were solely children, adolescents or adults aged 59 years and below, studies which analysed the outcome of all age groups not separating the elderly group, studies that did not analysed caries incidence and an in-vitro study (Table 4). Finally, a total of ten studies were included in the review (15, 31-39).

Characteristics of the included studies

Of the ten included studies, five were randomised controlled trials, two were controlled clinical trials, two were retrospective cohort studies and one was a prospective cohort study. One study assessed subjects aged 54 years and above, however, this study was included, for its potential to yield a beneficial intervention for the older population (35). The outcome measurement of the ten studies was found to be either root surface caries only or both coronal and root caries. Three studies investigated the effect of caries preventive intervention on root surface caries alone, two studies did not specify the surface and five studies looked at both coronal and root caries. It was, therefore, valuable for the studies' outcome to be categorised into two separate groups, coronal caries and root caries, in order to clearly visualise the efficiency of the interventions on two separate tooth surfaces.

Outcome of caries preventive interventions on coronal caries

One study reported the use of 0.05% of NaF rinse twice daily was associated with lower mean coronal caries increment compared to NaF tablet, slurry toothpaste and control (subjects brushed teeth in the usual manner) groups (34) (Table 1). All the groups were given 1,500 ppm NaF fluoridated toothpaste throughout the

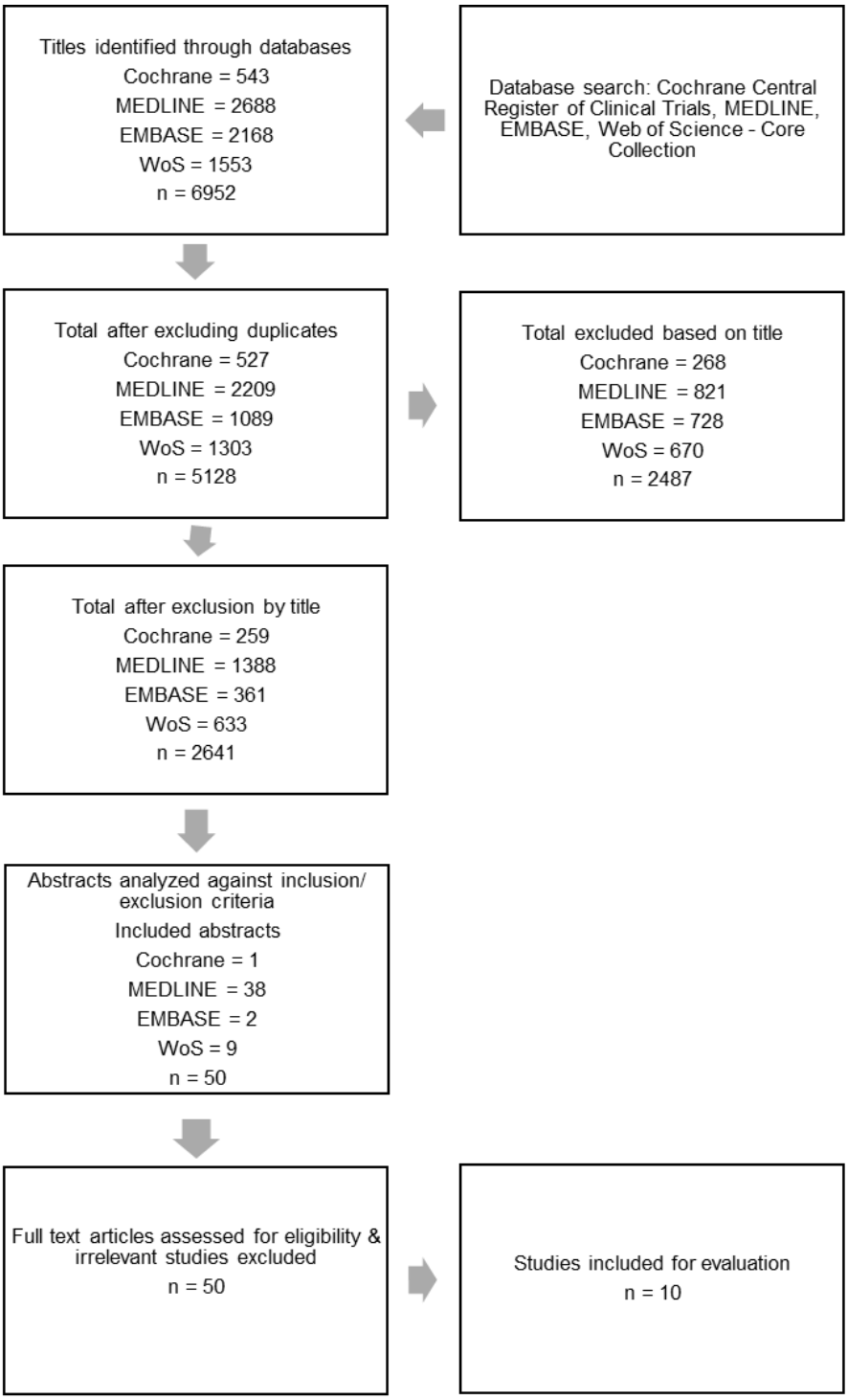

Figure 1. Flow chart of literature search

Author, year	Reason for exclusion
Baca et al., 2009	Institutionalized elderly
Bader et al., 2013	Not solely on subjects aged 60 years and above
Banoczy and Nemes, 1991	No clear distinction of subjects' age
Brailsford et al., 2002	Institutionalized elderly
Brown et al., 2014	Outcome is not on caries incidence
Brown et al., 2015	Outcome is not on caries incidence
Caplan et al., 1999	Study on children and adolecents
Cheng et al., 2015	Subjects aged younger than 60 years old
Donly et al., 1999	Subjects aged younger than 60 years old
Ekstrand et al., 2013	Institutionalized elderly
Ennever et al., 1980	Study on children
Feller et al., 1996	Not solely on subjects aged 60 years and above
Gibson et al., 2014	Not solely on subjects aged 60 years and above
Gokalp and Baseren, 2005	Subjects aged younger than 60 years old
Hunt et al., 1989	Not applicable for caries preventive intervention
Isokangas et al., 1989	Study on children
Lu et al., 1980	Not solely on subjects aged 60 years and above
Liu et al., 2013	In vitro study
Ma, 1996	Not solely on subjects aged 60 years and above
Makinen et al., 1995	No clear distinction of subjects' age
Mann et al., 2001	Not solely on subjects aged 60 years and above
Papas et al., 2012	Not solely on subjects aged 60 years and above
Ringelberg et al., 1979	Study on children
Ripa et al., 1987	Not solely on subjects aged 60 years and above
Ritter et al., 2013	Not solely on subjects aged 60 years and above
Ritter et al., 2016	Outcome is not on caries incidence
Rosen et al., 2004	Not solely on subjects aged 60 years and above
Schaeken et al., 1991	Not solely on subjects aged 60 years and above
Scheinin, 1976a	Not solely on subjects aged 60 years and above
Scheinin, 1976b	Not solely on subjects aged 60 years and above
Scheinin et al., 1976	Not solely on subjects aged 60 years and above
Skudutyte et al., 2000	Not applicable for caries preventive intervention
Symington et al., 2014	Not solely on subjects aged 60 years and above
Tan et al., 2010	Institutionalized elderly
Torell and Gerdin, 1977	Study om children
Tseveenjav et al., 2011	Not solely on subjects aged 60 years and above
Vered et al., 2009	Not solely on subjects aged 60 years and above
Wang et al., 2012	Not solely on subjects aged 60 years and above
Wyatt and MacEntee, 2004	Institutionalized elderly
Wyatt et al., 2014	No control group

Table 4. Excluded studies and reason for exclusion

Author, year	Type of study	Number of subjects (n)	Age of subjects (mean)	Grouping	Follow-up period	Results	
						Number of subjects (n)	Outcome
Rothen et al., 2014 (12)	Retrospective cohort	1763	9-65+	Preventive treatments in the past 24 months: Fluoride toothbrushing, water rinse after brushing, interproximal cleaning, other fluoride products	Past 24 months	1400	65+ population: Mean caries rate Fluoride toothbrushing frequency (No or <1x/day)>2x/day Use of other fluoride product than fluoride toothpaste once a day or more = higher caries rate
Al-Haboubi et al., 2012 (27)	Randomized controlled trial	186	60+ (70.2)	Gp1: xylitol chewing gum 2x/day for 15 minutes (n=95) Gp2: control (not given chewing gum) (n=91)	6 months	146	Mean decayed coronal surfaces Gp1=Gp2 (p=0.522)
Ferracane et al., 2011 (29)	Retrospective cohort	1877	3-92	Preventive treatments in the past 12 months: Prophylaxis, fluoride (varnish and APF, SnF, NaF), sealant	Past 12 months	1877	Prophylaxis – no significant association with new carious lesion Fluoride – significant greater odd at having new lesion
Wyatt et al., 2007 (34)	Randomized controlled trial	1,101	60-75 (67.5)	Daily rinsing for 1 month followed by weekly rinsing for 5 months: Gp1: 0.12% CHX rinse Gp2: placebo rinse	5 years	828	% of coronal surfaces remained sound Gp1=Gp2 (p=0.21)
Powell et al., 1999 (32)	Randomized controlled trial	297	60+	Gp1: control (n=55) Gp2: OHE (n=48) Gp3: OHE + weekly 0.12% CHX rinse (n=52) Gp4: OHE + twice a year 0.12% CHX rinse + fluoride varnish by hygienist (n=52) Gp5: OHE + twice a year 0.12% CHX rinse + fluoride varnish + six-monthly Sc & RP by hygienist (n=55)	3 years	201	Average rate of coronal caries, fillings and extractions (Gp1+Gp2)= (Gp3+Gp4+Gp5) p=0.09
Fure et al., 1998 (30)	Cohort	176	60+ (71.5)	All groups given 1,500ppm NaF toothpaste + the followings: Gp1: 0.05% NaF rinse – 2x/day (n=55) Gp2: 1.66mg NaF table – 2x/day (n=56) Gp3: brush with *slurry* toothpaste rinsing technique – 3x/day (n=33) Gp4: control (brush as usual) (n=32)	2 years	164	Mean total caries increment Gp1<Gp4 (p<0.002)
Jensen and Kohout, 1988 (31)	Controlled clinical field trial	810	Gp1: 54 -93 (68.5) Gp2: 58 -90 (68.6)	Gp1: placebo dentifrice - 2x/day (<1ppm F) (n=406) Gp2: 1,100ppm NaF dentifrice – 2x/day (n=404)	12 months	810	% increment of coronal caries (p=0.006) Gp1>Gp2

ppm parts per million, *OHI* oral hygiene instructions, OHE oral hygiene education, *Sc* scaling, *RP* root planing, NaF sodium fluoride, *SnF* stannous fluoride, *CHX* chlorhexidine, *APF* acidulated phosphate fluoride

Table 1. Summary of caries preventive studies with coronal caries outcome

study. Another study reported the use of 1,100 ppm of NaF dentifrice twice daily resulted in a lower percentage of coronal caries compared to placebo dentifrice use which contained less than 1 ppm of fluoride (35). Interestingly, two of the retrospective cohort studies that assessed patients attending the practices of dentist-members of Northwest PRECEDENT (Practice-based Research Collaborative in Evident-based Dentistry) reported that fluoride placement among the 65+ group was associated with greater number of new caries lesion (15, 33). One of the studies showed fluoride toothbrushing of twice or more daily among the 65+ group was not associated with lower caries rate (15).

Two randomised controlled trials found the use of daily or weekly 0.12% CHX rinsing produced a lower rate of coronal caries compared to their control groups, however, these differences were found to be not statistically significant (36, 38).

Only one clinical trial studied the effect of xylitol chewing gum among the elders. The study found no statistical significant of this intervention at reducing coronal caries (31).

Outcome of caries preventive interventions on root caries

The result of a randomised controlled trial on frail elders found that monthly professional tooth cleaning coupled with Duraphat varnish application on active root caries (Group 1) yielded fewer new active root caries compared with the use of 1,450 ppm of fluoridated toothpaste twice daily with oral hygiene instructions (Group 3) (Table 2). This study also found the use of 5,000 ppm of fluoridated toothpaste twice daily with oral hygiene instructions resulted in fewer new root caries lesions compared with Group 3 (32). Another study found the use of 1,100 ppm NaF dentifrice twice daily to be associated with a lower percentage of root caries increment compared with a placebo dentifrice (35). The semi-annual professional application of topical APF gel in one study found the number of new root caries lesion to be less than the control group which used daily placebo mouthrinse. Meanwhile, the usage of daily 0.05% NaF rinse had no significant effect on the number of new root caries lesion compared to the control group (37). Annual professionally applied 38% SDF solution on the root surface showed a significant reduction in the mean number of new root surface caries, when compared with water as placebo (39).

Two studies found no significant effect of using 0.12% CHX rinse daily or weekly at preventing root caries when compared with their control groups (36, 38).

Similar to coronal caries outcome, only one study found no significant reduction of root caries with xylitol chewing gum (31).

The risk of bias of the included studies is shown in Table 3.

Discussion

From the results, toothbrushing with commercially available fluoridated toothpaste twice daily was sufficient in preventing coronal caries. However, in preventing root caries, higher concentration of fluoridated toothpaste was needed and occasional professionally-applied fluoride proved useful. No significant effect was observed by using 0.12% CHX or xylitol chewing gum.

This review was conducted on four databases and resulted in thousands of searches. Nevertheless, the amount of studies included was not many. Moreover, the interventions and outcome measurement varied between the included

Author, year	Type of study	Number of subjects (n)	Age of subjects (mean)	Grouping	Follow-up period	Results	
						Number of subjects (n)	Outcome
Rothen et al., 2014 (12)	Retrospective cohort	1763	9-65+	Preventive treatments in the past 24 months: Fluoride toothbrushing, water rinse after brushing, interproximal cleaning, other fluoride products.	Past 24 months	1400	65+ population: <u>Mean caries rate</u> Fluoride toothbrushing frequency (No or <1x/day)>2x/day Use of other fluoride product than fluoride toothpaste once a day or more = higher caries rate
Zhang et al., 2013 (35)	Randomized controlled trial	277	60-89 (72.5)	Gp1: annual OHI + placebo (water) (n=84) Gp2: annual OHI + 38% SDF solution (n=98) Gp3: annual OHI + 38% SDF solution + 6-monthly OHE (n=84) All professionally applied.	24 months	266	Mean number of new root caries surfaces Gp1>Gp2>Gp3 (p<0.05)
Al-Haboubi et al., 2012 (27)	Randomized controlled trial	186	60+ (70.2)	Gp1: xylitol chewing gum 2x/day for 15 minutes (n=95) Gp2: control (not given chewing gum) (n=91)	6 months	146	Mean decayed root surfaces Gp1=Gp2 (p=0.154)
Ferracane et al., 2011 (29)	Retrospective cohort	1877	3-92	Preventive treatments in the past 12 months: Prophylaxis, fluoride (varnish and APF, SnF, NaF), sealant.	Past 12 months	1877	Prophylaxis – no significant association with new carious lesion Fluoride – significant greater odd at having new lesion
Ekstrand et al., 2008 (28)	Randomized controlled trial	215	75+ (81.6)	Gp1: professional cleaning + Duraphat varnish monthly (n=76) Gp2: 5,000 ppm fluoridated toothpaste 2x/day + OHI (n=74) Gp3: 1,450 ppm fluoridated toothpaste 2x/day + OHI (n=65)	8 months	189	Number of new active root caries Gp1=Gp2<Gp3 (p<0.02)
Wyatt et al., 2007 (34)	Randomized controlled trial	1,101	60-75 (67.5)	Daily rinsing for 1 month followed by weekly rinsing for 5 months: Gp1: 0.12% CHX rinse Gp2: placebo rinse	5 years	828	% of root surfaces remained sound Gp1=Gp2 (p=0.42)
Powell et al., 1999 (32)	Randomized controlled trial	297	60+	Gp1: control (n=55) Gp2: OHE (n=48) Gp3: OHE + weekly 0.12% CHX rinse (n=52) Gp4: OHE + twice a year 0.12% CHX rinse + fluoride varnish by hygienist (n=52) Gp5: OHE + twice a year 0.12% CHX rinse + fluoride varnish + six-monthly Sc & RP by hygienist (n=55)	3 years	201	Average rate of root caries, fillings and extractions (Gp1+Gp2)= (Gp3+Gp4+Gp5) p=0.15

Author, year	Type of study	Number of subjects (n)	Age of subjects (mean)	Grouping	Follow-up period	Results	
						Number of subjects (n)	Outcome
Fure et al., 1998 (30)	Cohort	176	60+ (71.5)	All groups given 1,500ppm NaF toothpaste + the followings: Gp1: 0.05% NaF rinse – 2x/day (n=55) Gp2: 1.66mg NaF table – 2x/day (n=56) Gp3: brush with *slurry* toothpaste rinsing technique – 3x/day (n=33) Gp4: control (brush as usual) (n=32)	2 years	164	Mean total caries increment Gp1<Gp4 (p<0.002)
Wallace et al., 1993 (33)	Controlled clinical trial	603	60+	Gp1: daily placebo mouthrinse (n=171) Gp2: semi-annual application of topical APF gel (n=147) Gp3: daily 0.05% NaF rinse (n=148)	48 months	466	Number of new root caries lesion Gp1>Gp2 (p<0.05) Gp1=Gp3 (p=0.19)
Jensen and Kohout, 1988 (31)	Controlled clinical trial (field)	810	Gp1: 54-93 (68.5) Gp2: 58-90 (68.63)	Gp1: placebo dentifrice - 2x/day (<1ppm F) (n=406) Gp2: 1,100ppm NaF dentifrice – 2x/day (n=404)	12 months	810	% increment of root caries (p=0.014) Gp1>Gp2

ppm parts per million, *OHI* oral hygiene instructions, OHE oral hygiene education, *Sc* scaling, *RP* root planing, NaF sodium fluoride, *SnF* stannous fluoride, *CHX* chlorhexidine, *APF* acidulated phosphate fluoride, *SDF* silver diamine fluoride

Table 2. Summary of caries preventive studies with root caries outcome

	RANDOM SEQUENCE GENERATION	ALLOCATION CONCEALMENT	BLINDING OF PARTICIPANTS AND RESEARCHERS	BLINDING OF OUTCOME ASSESSMENT	INCOMPLETE OUTCOME DATA	SELECTIVE REPORTING	OTHER BIAS
Al-Haboubi et al., 2012	⊕	⊕	⊕	∅	⊕	⊕	⊕
Ekstrand et al., 2008	⊗	∅	⊕	⊗	⊕	∅	∅
Ferracane et al., 2011	⊗	⊕	∅	∅	⊗	⊗	∅
Fure et al., 1998	⊗	∅	⊗	⊕	⊕	⊕	∅
Jensen And Kohout, 1988	⊗	⊕	⊕	∅	⊕	⊕	⊕
Powell et al., 1999	⊗	∅	⊗	∅	⊕	∅	∅
Rothen et al., 2014	⊕	∅	∅	⊕	∅	∅	∅
Wallace et al., 1993	⊕	∅	∅	⊗	⊕	∅	∅
Wyatt et al., 2007	⊕	⊕	⊕	⊕	⊕	∅	⊕
Zhang et al., 2013	⊕	⊕	⊕	⊕	⊕	∅	⊕

Legend:
⊕ Low risk
∅ Unclear risk
⊗ High risk

Table 3. Risk of bias of included studies

studies, making comparison difficult. Consequently, a meta-analysis was not performed.

Some studies recorded different outcome measurement for caries, fillings and extractions. The justification given was that a tooth extraction may be caused by caries, periodontal disease or dental-related trauma. Similarly, a restoration may be a result of caries, trauma, management of sensitivity or simply for aesthetic reasons. A study that was conducted on frail elders was included in this review as it fitted the criteria of home-based elders living independently. In regard to the nature of the included retrospective cohort studies, it was difficult to factor out the subjects' medical condition due to a large sample size. Therefore, the outcome from these studies might be influenced by the subjects' general health. Nonetheless, the extracted data may be of value as it describes the older population living independently.

Studies that were conducted on institutionalised elders were excluded from this review as the oral hygiene of this group of old people is often very poor with the likelihood of having rampant dental caries (40). Furthermore, the results from these studies may influence the effect of oral health promotion (OHP) on community-based elders. Studies that included older people in a wider population sample but did not measure separately the outcome of older participants to the younger ones were also excluded as the efficacy of the interventions used could not be specifically determined for older participants.

This review assessed the risk of bias of each study with six legends as described by Cochrane Handbook of Systematic Review of Intervention. It also had two independent investigators (EMY and MLM) performing the search in effort to minimise selection bias. The limitations of this review include the absence of reference to "grey literature" and the exclusion of non-English articles.

Fluoride is known to be beneficial in reducing caries development and enhancing the remineralisation process (6). Evidence suggests that exposure to fluoride during childhood may reduce the incidence of root caries. A systematic review by Griffin et al. (2007) found that exposure to any form of fluoride reduced coronal caries by 25% among adults, which is almost similar to findings in children. Fluoride efficacy may be influenced by the fluoride compound used, the frequency of use, the duration of exposure, the concentration and the method of delivery (41). Fluoride dentifrices have been shown to exhibit caries-inhibiting effect on the permanent dentition. From this review, it can be said that 5,000 ppm of fluoridated dentifrice use twice daily may be valuable at reducing root caries incidence among the elders. Gotjamanos (1997), as cited by Zhang et al. (2013), stated that the use of high concentration of fluoride (40% silver fluoride) is acceptable in the older population and will not cause dental fluorosis. Alternatively, brushing with fluoridated toothpaste together with rinsing using 0.05% NaF solution twice daily or annual professional application of 38% SDF solution may be beneficial where high fluoride concentration toothpaste is not available (34, 37, 39). Apart from that, professional cleaning or application of APF gel six-monthly proved useful in reducing root caries compared to toothbrushing using a low concentration of fluoridated toothpaste alone (37).

The ability of dentifrices to retain fluoride ions for longer inside the oral cavity depends on the usage method. The frequency of toothbrushing with fluoride

dentifrices twice daily or more, longer duration of brushing and no rinsing after toothbrushing lead to fluoride lingering for longer (41).

Two of the retrospective studies in this review found any kind of fluoride placement to be related to increased caries incidence in elders. This is probably due to additional confounding factors for dental caries, such as the presence of any medical condition that offers greater vulnerability of the tooth surface to caries.

There is conflicting evidence about the value of CHX in caries prevention among adults. Featherstone et al. (2012) used 0.012% CHX rinse as part of a comprehensive caries reduction algorithm and showed it to be beneficial when used alongside other preventative strategies. Papas et al. (2012) evaluated a 10% weight/volume CHX varnish for caries prevention. They showed little efficacy in low-risk populations but when high-risk populations were analysed separately, the result showed a substantial caries reduction (42). These studies, however, did not focus on the elderly group per se and this review found limited evidence to support CHX rinse use among this age group at reducing new caries lesion. Likewise, a randomised controlled trial on institutionalised elders found daily rinsing with a 0.2% NaF solution produced a better result than rinsing with a 0.12% CHX solution (40). Emilson (1994), as cited by Powell et al. (1999) found that CHX rinse was less effective than other vehicles such as gels and varnishes because the concentration was not high enough to be effective at caries prevention.

Application of sodium fluoride, silver diamine fluoride and CHX varnishes are said to be effective at root caries prevention for those who are at high risk of caries. (42, 43). Systematic reviews by Slot et al. (2011), however, claimed that the evidence towards the benefits of CHX varnish is weak, especially for coronal caries prevention. Further studies are needed to look into these interventions at caries prevention.

In regard to this review, the use of xylitol chewing gum twice daily among the elders also did not show any significant reduction in coronal or root caries incidence (31). The study, nevertheless, was not conducted sufficiently long enough to show any caries preventive effects. A study design of xylitol for adult caries trial (X-ACT) also showed no statistically significant result of daily xylitol use in reducing caries incidence in caries-active adults (44). Lynch and Milgrom (2003) suggested using sugar alcohol, giving Xylitol as an example, as a sugar substitute as it is useful for its anti-cariogenic effect and for the reason that it is not readily metabolised by bacteria (45). To this point, no evidence has been found on the effectiveness of calcium phosphate or ozone use in caries prevention among the older population.

From the findings of this review, it appears that more studies are needed to prove the efficacy of caries preventive interventions such as the use of CHX varnish or gel, xylitol, calcium phosphate and ozone among the older population.

Conclusion

The results of this review demonstrated limited studies on caries preventive interventions in community-dwelling elders. Toothbrushing using 5,000 ppm fluoridated toothpaste may be useful at reducing root caries incidence. However, the water fluoride level of the population should be considered before recommending such toothpastes containing high concentration of fluoride. Semi-annual professional

cleaning and application of APF gel may also be beneficial in preventing root caries. Toothbrushing twice daily with widely available fluoridated toothpaste and having professionally applied 38% SDF solution as an adjunct are also practical at preventing both coronal and root caries. The use of 0.12% CHX rinse and xylitol chewing gum failed to show any preventive effect. More studies on caries preventive interventions in community-based older adults are needed due to a constricted number of well-designed studies observed from this review.

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