

Delivery of evidence-based caries treatment and prevention among highly caries-active adults: a retrospective observational study of public dental records

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Research Article

Keywords: Caries epidemiology, high caries-active adults, caries prevention, caries treatment, dental records, quality of care

Posted Date: February 11th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8521684/v1>

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Oral Health on July 8th, 2026. See the published version at <https://doi.org/10.1186/s12903-026-09170-0>.

Abstract

Background

Evidence-based caries management emphasises causal and preventive strategies, but implementation in routine adult dental care is uncertain. The aim of this study was to assess the extent to which caries-active adults received evidence-based caries treatment and preventive measures in public dental care, and whether documented care targeted underlying causes of caries disease.

Methods

This retrospective observational study reviewed routinely collected computerized dental records for 418 caries-active patients across 19 public dental clinics. High caries activity was defined as ≥ 4 manifest caries lesions at a complete oral examination. Clinical data on documented caries treatment and preventive measures were extracted for the interval between two complete oral examinations.

Results

No patients had documentation indicating delivery of a recommended theory-based health behaviour change approach to address caries risk factors. Of 418 patients, 21% had no documented preventive measures. The most frequently documented preventive actions were verbal advice on oral hygiene (43.5%) and fluoride use (41.0%). Dental care professionals more frequently documented dietary enquiry (34.4%) than dietary advice aimed at behaviour change (16.3%). The likelihood of having documented preventive measures increased with age ($p < 0.03$).

Conclusions

The findings indicate limited documented implementation of evidence-based caries treatment and prevention among caries-active adults aged 25–65 years within public dental services in Region Västra Götaland, Sweden. Documented prevention focused primarily on oral hygiene enquiry and fluoride advice, while guideline-recommended behavioural and biological strategies were rarely recorded.

Background

Untreated dental caries in permanent teeth is among the most prevalent conditions globally, according to the Global Burden of Disease Study [1]. In 2011–2012 in Sweden, about 26% of the population was treated for caries [2]. The Public Dental Service (PDS) in the Region Västra Götaland (RVG) determined that in 2015–2016 approximately 146 000 individuals (23%) were diagnosed with manifest caries. Of these, 20–30% developed new cavities that required operative treatment each year [3, 4].

Dental caries is a multifactorial, non-communicable disease, for which several risk factors such as genetics (e.g., the quality of the saliva) and environment and behavior (e.g., diet and oral hygiene) interact, leading to the development of the disease [5–10]. Caries can be prevented through individual self-care and professionally delivered preventive measures. The concept of caries prevention involves measures to prevent the occurrence of clinical symptoms (e.g., pain) and treatment of early signs of the disease to prevent its progression [11].

Health promotion frameworks emphasise the interaction between individual behaviour, professional support, and broader determinants of health. For the individual, this means developing good health habits early in life and maintaining them into old age. For the health practitioner, it means teaching individuals how to achieve a healthy lifestyle, helping them to practice healthy behaviors and change poor habits, and monitoring those individuals at risk [12]. Contemporary caries management emphasises biological and behavioural approaches alongside restorative care, with attention to underlying causes rather than symptoms alone. This points to the importance of balancing protective and pathological risk factors. Hence, caries prevention and management is about controlling risk factors to maintain a balance [9].

For patients with active caries or high risk, national guidance recommends causal caries management delivered by dental care professionals, including dentists and dental hygienists [11]. Causal treatment aims to identify the individual's risk factors that cause caries (e.g., low saliva secretion, or high sugar intake), establish a risk profile, and design an individual therapy plan [6]. According to The Swedish National Board of Health and Welfare [13], only 6,4% of all patients who received restorative caries care were offered treatment and/or measures to prevent future caries. Some studies show that dental care professionals have insufficient knowledge of treatment options and strategies for individuals with high caries activity [14–16], and they focus more on teaching patients, even those with caries, toothbrush techniques and plaque removal [17]. A study by Sarmadi et al. [18] has found that 50% of the dental records they examined lacked information on oral hygiene and 75% lacked information on dietary habits.

The Swedish National Guidelines (SNG) for adult dental care [19] recommend different evidence-based treatment approaches as well as preventive measures, enabling dental care professionals to perform highly precise caries treatment and superior caries prevention. The SNG emphasise twice-daily toothbrushing with fluoride toothpaste and reduced sugar intake as cost-effective measures, and describe professionally applied fluoride varnish as effective in reducing caries progression [19]. Fluoride varnish applied at least twice a year is described as an effective treatment in reducing caries progression. Neither standardized counseling nor oral health information from dental care professionals are effective in changing unhealthy habits. Instead, The Board recommends advisory counselling, or a theory-based behavior change approach to improve patient oral health behaviors [19].

Evaluating quality of care is essential for identifying implementation gaps and informing service improvement. There is a lack of clinical follow-up studies that evaluate the effect of the quality of care or of evidence-based results on treatment effectiveness in general dental practice settings, especially in the

region Västra Götaland. To our knowledge, no previous peer-reviewed study has examined the documented delivery of evidence-based caries treatment and prevention among highly caries-active adults in routine public dental care using regional electronic dental records. Therefore, the aim of this study was to assess the extent to which caries-active adults received evidence-based caries treatment and preventive measures in public dental care, and whether documented care targeted underlying causes of caries disease.

Methods

Study Design

This study was a retrospective observational review of routinely collected electronic dental records. The study is reported in accordance with the STROBE statement and the RECORD guidelines for studies using routinely collected health data. No large language models or artificial intelligence tools were used in the design, analysis, or writing of this manuscript.

Study Setting

The study was conducted in the Public Dental Service of the Region Västra Götaland. The Region has the second largest population in Sweden, with 1.7 million inhabitants, and ~ 0.5 million live in the Gothenburg area. Almost 40% of the adult population are patients of the PDSs. Adults usually pay for their own dental care, and only one-third of all adult patients have insurance-paid dental care. There are PDSs in all the region's municipalities, with ~ 106 dental clinics providing general dental care [20]. Close to one-fifth of the region's clinics, 19, were selected to be representative of the RVG. The 19 clinics included different geographic locations (e.g., urban, and rural areas), as well as different socio-economic conditions. Nine of the clinics were located in Gothenburg, and the remaining ten were in smaller cities and communities.

In 2015, 625 621 patients were examined in the PDS in the RVG and manifest caries was registered in 146 340 individuals (23%), and 6% of the women and 9% of the men were assessed as having high caries risk. In 2016, a total of 632 914 individuals were examined, and of these 146 656 (23%) had manifest caries, with 4.4% of the women and 6.7% of the men assessed as having high caries risk. According to the records, the proportion of caries treated women (51%) and men (49%) has been constant since 2010, as well as the distribution between the sexes since the assessment of caries risk began in 2008 [21].

Study Population

A total of 418 patients aged 25–65, paying for their own dental care and on regular recall, were identified and included based on their caries prevalence, which was extracted from computerized dental records from 2015 and 2016 (Fig. 1). The patients, registered as regular attendees, were strategically selected

from different PDS clinics, including both urban and rural areas in the RVG. A regular dental attender was defined in this study as an individual that had more than two complete dental examinations at the same clinic. In accordance with regulations and the 2016 General Data Protection Regulation (GDPR) law [22], we were presented with 19 PDS clinics that were eligible to supply data. Each patient had at least four manifest caries lesions recorded at a complete dental examination in 2015 or 2016 and was followed until their next recall examination (Exam 2).

The inclusion criteria were patients 25–65 years of age, having ≥ 4 manifest caries lesions recorded at a complete dental examination (Exam 1) in 2015 or 2016 in the dental records. The observation interval was defined as the time between two complete dental examinations (Exam 1 and Exam 2).

Exclusion criteria were patients < 25 years of age (who received free, tax-paid dental examinations and care in the PDS of the RVG), patients 25–65 years of age, with a different payment model and tax-funded or insurance paid dental care, and Exam 2 missing.

Data about caries treatment and preventive measures were obtained through a retrospective review of these patients' computerized dental records between two complete oral examinations (Exam 1 and Exam 2) based on individual recall. The inclusion period was set for 1/1–31/12 for both 2015 and 2016.

Data Collection

In accordance with the 2016 GDPR law [22] and regulations created by the PDS in the RVG, an information technology consultant was responsible for extracting all data from the database without containing any information that could identify the patients or the service providers. To collect the data, patients' computerized dental records were obtained and extracted, and a retrospective record review was performed based on dental care professionals' documented registrations of the following patient-, tooth-, and treatment-specific characteristics:

- Patient-based variables: age (years), gender (male, female), whether or not a regular dental attender, and pay for their own dental care.
- Dental status, tooth-specific diagnoses: dental caries (defined as manifest caries lesion in the inner third of the dentine requiring operative treatment). According to clinical guidelines, manifest dental caries is defined as visible tooth substance loss without the characteristics of a developmental defect, or in pits and fissures when the point of the probe catches upon gentle pressure. Manifest radiographic caries is defined as a lesion extending beyond the enamel-dentine junction.
- Risk assessments for caries and treatment-specific variables: codes covering caries preventive measures or specific caries treatment.

These variables were prespecified as relevant to the study aim and were available within the routine record system. Registered clinical data on caries treatment and preventive measures performed and registered between the two examinations in 2015 and 2016 were collected and studied for their

association to caries disease relevant to this study and are presented in Table 1. All items of dental treatment (e.g., tooth specific or non-tooth specific) and preventive measures have specific three-digit codes. Retrieval of information about all dental appointments, cause of caries investigations, the number of registered caries treatment and preventive measures, and the content of the treatment and preventive measures performed were followed and extracted from daily notes and documentations between Exam 1 and Exam 2. The dental record review was carried out by one person, a licensed practitioner (author SB). To enhance data validity, all extracted treatment codes were cross-checked against the corresponding clinical notes.

Table 1

The description of the treatment and preventive measures codes registered in computerized dental records. All dental procedures are registered by specific codes. The Dental and Pharmaceutical Benefits Agency determines which treatment codes and fees are eligible to charge. The code is applied on completion of the treatment and/or preventive measure, and a fee is charged. *SEK (Swedish Krona) exchange rate 2015–2016: SEKEUR: 9.5 and SEKUSD: 8.4

(source: Swedish Riksbank)

Treatment code and meaning	The general service provider's fees	Description
101, 112, 111 Complete Examination	SEK 792, EUR 83, USD 94 SEK 772, EUR 81, USD 91 SEK 582, EUR 61, USD 69	Examination and investigation performed by a dentist or dental hygienist on one occasion.
161 Saliva secretion measurement	SEK 542 EUR 57 USD 64	The measure includes information about the sampling, collection of saliva, measurement of secretion values, documentation, and possible consultation responses.
162 Microbiological examinations	SEK 302 EUR 32 USD 36	The measure only includes laboratory costs for microbiological examinations.
Disease preventive measures		
201 Information or instruction on risk of oral health-related illnesses or problems	SEK 420 EUR 44 USD 50	The measure includes informing the patient about causation to prevent caries or giving detailed instruction regarding self-care.
204 Prophylaxis in individual trays, per tray	SEK 730 EUR 77 USD 87	The measure includes impression taking as well as the production, testing, and delivery of trays of fluoride gel or chlorhexidine gel home-care treatment.
205 Fluoride treatment, shorter treatment time	SEK 155 EUR 16 USD 18	The measure includes professional tooth cleaning for biofilm removal, approximal cleaning and required fluoride treatment, and requires approximately 10 minutes of treatment time.

Treatment code and meaning	The general service provider's fees	Description
206 Fluoride treatment	SEK 307 EUR 32 USD 36	The measure includes professional tooth cleaning for biofilm removal, approximal cleaning and required fluoride treatment, and requires approximately 20 minutes of treatment time.
Disease treatment measures		
311 Information or instruction for oral health-related illnesses or problems	SEK 430 EUR 45 USD 51	The measure includes information on causation in oral health-related diseases or problems, or detailed instructions regarding self-care.
312 Follow-up information or instruction in case of oral health-related diseases or problems	SEK 152 EUR 16 USD 18	The measure is eligible for a maximum of six times per patient.
313 Behavioral change treatment, 60 minutes or more	SEK 940 EUR 99 USD 112	The measure includes qualified behavioral change approach in managing oral health-related diseases and must contain an individualized treatment plan for theory-based behavioral effects.
314 Behavioral change treatment	SEK 455 EUR 48 USD 54	The measure includes qualified behavioral change methods in managing oral health-related diseases and must contain an individualized treatment plan for theory-based behavioral effects.
321 Non-operative treatment of caries disease	SEK 435 EUR 46 USD 52	The measure includes intensive fluoride treatment, antimicrobial treatment, or dietary advice. The measure includes, if applicable, professional tooth cleaning. The measure is eligible for compensation for in-depth dietary advice only if it has its background in a diet anamnesis.

Data analysis

All collected data from the computerized dental records were decoded and entered unidentified into a database for analysis, to prevent individual identification. No patients or computerized dental records were excluded from the study or the review. The population was studied with reference to selected treatment variables in each patient's computerized dental records. The outcomes were presented with both descriptive and analytical statistics. All collected data were compiled and presented descriptively in tables and figures. In addition to the main aim of discovering the associations between treatment, preventive measures, and caries disease, further analyses investigated possible associations between

the number of preventive measures and patients' gender and age. Comparisons were also made with respect to gender and age.

Statistical analysis

A statistical power analysis was performed to determine the minimum sample size, based on the total number of 2 988 patients examined in 2015 in the RVG who had at least four manifest caries lesions. With 80% power and a two-sided α of 0.05, the minimum required sample size was determined to be 341 patients. Based on this calculation 418 patients' computerized dental records were extracted.

Differences between men and women were compared using Fisher's exact test for dichotomous variables and Mann-Whitney U-test for continuous numerical variables (e.g., number of treatments and age). For each age-group, Fisher's exact test was used to investigate associations between gender and treatment measure. Associations with age, both for all patients and for men and women separately, were tested using Mann-Whitney U-test and rank statistics for dichotomous and ordered variables, respectively, and actual value of age (i.e., years) was used in these calculations.

Binary multiple logistic regression analysis was performed to investigate the effects of age and gender on the treatment measure and to study whether the impact of age on the outcome of any treatment differed between men and women by calculating the difference in -2 log likelihood from the model without and with the inclusion of a sex*age interaction.

To investigate effects of gender on specific treatment measures, confidence intervals of prevalence of the different treatments were calculated using the exact Clopper-Pearson method. Two-sided tests were used and p-values < 0.05 were regarded as statistically significant.

All statistical analysis was performed by two statisticians using the statistical management program SPSS version 26 Chicago, IL, USA, and SAS for Windows version 9.4.

Results

The results are based on a retrospective record review of 418 caries-active patients treated at 19 different public dental clinics (2015: n = 234; 2016: n = 184) and their computerized dental records obtained from the database in RVG. The distribution of gender was 56% males (n = 233) and 44% females (n = 185), and mean age was 39 years. Other patients' characteristics enrolled in the study are presented in Table 2. The mean interval between recall examinations was 2.2 years (or 804 days) for high caries risk patients. The shortest recall time (Exam 2) was 4.8 months (147 days) and the longest was 4.4 years (1607 days). No patients or computerized dental records were excluded from the study or the review.

Table 2
General patient characteristics enrolled in the study by gender and age (n = 418).

	Age 25 – 34 n = 183 (%)	Age 35 – 44 n = 118 (%)	Age 45 – 54 n = 71 (%)	Age 55 – 65 n = 46 (%)	Total n = 418 (%)	Age mean ± sd	Age median (IQR)
Female	88 (48.0)	52 (44.0)	30 (42.2)	15 (32.6)	185 (44.2)	38 ± 10	35 (30,44)
Male	95 (51.9)	66 (55.9)	41 (57.7)	31 (67.3)	233 (55.7)	40 ± 11	37 (31,46)
p-value						0.29 _A	0.11 _B

Most of the patients (n = 330, 79%) received at least one documented preventive or treatment measure considered relevant for limiting disease progression, while 21% (n = 88) received no preventive or treatment measures. No statistically significant differences were found between genders regarding received caries treatment or preventive measures ($p < 0.55$, $p < 0.93$), Table 3a.

Table 3

a. The presence or absence of caries treatment and preventive measures provided to highly caries-active adults (n = 418), retrieved from patients' computerized dental records between Exam 1 (the baseline) and Exam 2, divided among males and females and between four age groups.

Variable	Females n = 185 (%)	Males n = 233 (%)	p-value	Age 25 – 34 n = 183 (%)	Age 35 – 44 n = 118 (%)	Age 45 – 54 n = 71 (%)	Age 55 – 65 n = 46 (%)	p-value
No preventive and/or treatment measures	36 (19.5)	52 (22.3)	0.93	48 (26.2)	24 (20.3)	13 (18.3)	3 (6.5)	0.35
Some preventive and/or treatment measures	149 (80.5)	181 (77.7)	0.55	135 (73.8)	94 (79.7)	58 (81.7)	43 (93.5)	0.03
The mean ± sd of different preventive and/or treatment measures	2.8 ± 2.2	2.8 ± 2.2	0.93	2.7 ± 2.4	2.6 ± 2.0	2.9 ± 2.2	3.2 ± 2.1	0.35

Table 3

b. (Continued) The presence or absence of caries treatment and preventive measures provided to highly caries-active adults ($n = 418$), retrieved from patients' computerized dental records between Exam 1 (the baseline) and Exam 2, divided among males and females and between four age groups.

Variable		Age 25 – 34 ($n = 183$)	Age 35 – 44 ($n = 118$)	Age 45 – 54 ($n = 71$)	Age 55 – 65 ($n = 46$)	p- values
Some preventive and/or treatment measures	Female $n = 149$	$n = 88$ (%) 67 (76.1%)	$n = 52$ (%) 45 (86.5%)	$n = 30$ (%) 23 (76.7%)	$n = 15$ (%) 14 (93.3%)	0.45
	Male $n = 181$	$n = 95$ (%) 68 (71.6)	$n = 66$ (%) 49 (74.2)	$n = 41$ (%) 35 (85.4)	$n = 31$ (%) 29 (93.5)	0.02
No preventive and/or treatment measures	Female $n = 36$	21 (24%)	7 (13%)	7 (23%)	1 (7.7%)	0.57
	Male $n = 52$	27 (28%)	17 (26%)	6 (15%)	2 (6.5%)	0.59
p-values _A		0.33	0.05	0.37	0.99	
The mean $\pm$ sd of different preventive and/or treatment measures	Female	2.9 ± 2.4	2.7 ± 2.0	2.7 ± 2.0	2.5 ± 1.4	0.40
	Male	2.6 ± 2.3	2.5 ± 2.0	3.1 ± 2.3	3.5 ± 2.3	0.06

Of the patients 77.7% of the men ($n = 181$) and 80.5% of the women ($n = 149$) received preventive measures (Table 3b). There were statistically significant differences ($p < 0.03$) between age groups regarding the received caries preventive measures (Table 3a). The likelihood of having documented preventive measures increased with age; patients aged 55–65 years (93.5%) were more likely to receive preventive measures than those aged ≤ 34 years (73.8%), Table 3a.

Binary multiple logistic regression analysis with sex and age in terms of caries preventive measures showed no significant difference for sex i.e., no significant difference of impact of age between males and females ($p = 0.38$), Table 4. While sex showed no correlation ($p = 0.35$) in receiving preventive measures, age (per increasing year), showed significant correlation ($p < 0.01$) as a greater proportion of patients aged 55–65 received more measures.

Table 4

Presentation of the multivariate logistic regression analysis of relevant preventive and/or treatment variables related to age and gender.

Dependent variable	Independent variable	Odds ratio 95% Confidence interval	p-value
Some preventive and/or treatment measure (Dichotomous with reference category No)	Gender	1.26	0.35
	(Dichotomous with reference category Female)	(0.77–2.03)	
	Age (per increasing year)	1.03	0.01
	(Numerical)	(1.01–1.06)	
p-values_B		0.38	

Descriptive statistics for caries-related variables obtained from daily notes related to factors such as diet, use of fluoride, and oral hygiene are summarized in Table 5. A total of 598 caries preventive measures, obtained from daily notes, were performed on 330 patients, between Exam 1 and Exam 2. The most common preventive measure registered was inquiry into and advice about oral hygiene (63.4%, n = 265 and 43.5%, n = 182) and use of fluoride (31.6%, n = 132; and 40.9%, n = 171). Dental care professionals were more likely to inquire patients about current dietary habits (34.4%, n = 144), but less likely to give advice (16.3%, n = 68) on how to change their dietary habits to prevent caries. Few patients received information or health education on the association between general health and oral health (3.6%, n = 15), inquiry (3.6%, n = 15) or advice regarding xerostomia (4.1%, n = 17), and recommendations regarding high-fluoride (5000 ppm F, Duraphat) toothpaste (5.5%, n = 23). Of the 418 patients, only 15.6% (n = 65) received caries preventive measures, such as fluoride varnish or rinse treatment at the clinic between the two examinations (Table 5). More than half of the caries-active patients, across all ages, were not recommended additional fluoride for home-care use (59%, n = 247). Only 19% (n = 80) received recommendations of risk treatment for the daily use of fluoride at home. The most common self-care-based fluoride recommendation was a 0.2% NaF rinse (12.7%), followed by a high-fluoride toothpaste (5.5%), a NaF gel-CHX gel (0.7%), and fluoride chewing gum (0.2%). No patients had documentation indicating delivery of evidence-based causal caries management, such as a theory-based behaviour change approach, or adjunctive investigations (e.g., salivary secretion measurement) (Table 5).

Table 5

Summary of descriptive statistics for caries-related variables obtained from daily notes between two examinations related to factors such as fluoride application, diet, use of fluoride, and oral hygiene (n = 418).

Preventive and/or treatment measures obtained from daily notes.	Group n = 418 % (95% CI)	Females p-value n = 185 (%)	Males n = 233 (%)	Age 25–34 Age 45–54 p-value n = 183 (%) n = 71 (%)	Age 35–44 Age 55–65 n = 118 (%) n = 46 (%)
Fluoride treatment at the clinic	65 15.6 (12.2,19.4)	33 (17.8) (13.7)	32 0.28	32 (17.5) (14.1)	17 (14.4) 6 (13.0) 0.30
Oral hygiene recall	265 63.4 (58.6,68.0)	121 (65.4) (61.8)	144 0.48	107 (58.5) (64.8)	78 (66.1) 34 (73.9) 0.15
Oral hygiene, verbal advice	182 43.5 (38.7,48.4)	81 (43.8) (43.3)	101 0.99	82 (44.8) (49.3)	48 (40.7) 17 (37.0) 0.51
Dietary recall	144 34.4 (29.9,39.2)	63 (34.1) (34.8)	81 0.92	63 (34.4) (39.6)	39 (33.1) 16 (34.8) 0.87
Dietary, verbal advice	68 16.3 (12.9,20.2)	24 (13.0) (18.9)	44 0.11	31 (16.9) (16.9)	19 (16.1) 6 (13.0) 0.57
Fluoride recall	132 31.6 (27.1,36.3)	60 (32.4) (30.9)	72 0.75	53 (29.0) (31.0)	33 (28.0) 24 (52.2) 0.07
Fluoride, verbal advice	171 40.9 (36.2,45.8)	73 (39.5) (42.1)	98 0.62	75 (41.0) (43.7)	42 (35.6) 23 (50.0) 0.48
Supplementary self-care recommendation regarding additional Fluoride (F)	80 19.1 (15.0,22.7)	37 (20.0) (18.5)	43 0.71	37 (20.2) (15.5)	18 (15.3) 13 (28.3) 0.74
• High F-toothpaste	23 5.5 (3.3,9.2)	9 (4.9) (3.3)	14 (6.0) 0.83	11 (0.6) 3 (6.5)	5 (4.2) 4 (5.6) 0.93
• NaF rinse (0,2%)	53 12.7 (9.6,16.3)	25 (13.5) (12.0)	28 0.66	24 (13.1) (9.9)	12 (10.2) 10 (21.7) 0.72
• NaF-CHX gel	3 0.7 (0.1,2.1)	2 (1.1) 0.59	1 (0.4)	1 (0.5) (0.0)	1 (0.8) 1 (1.4) 0.39
• F chewing gum	1 0.2 (0.0,1.3)	1 (0.5) 0.44	0 (0.0)	1 (0.5) (0.0)	0 (0.0) 0 (0.0) 0.85
Xerostomia recall	15 3.6 (2.0,5.8)	4 (2.2) (2.2)	11 (4.7) 0.19	4 (2.2) (4.3)	4 (4.4) 5 (7.0) 0.16
Xerostomia verbal advice	17 4.1 (2.4,6.4)	7 (3.8) (3.8)	10 (4.3) 0.99	7 (3.8) (6.5)	3 (2.5) 4 (5.6) 0.85
Information on the association between general and oral health	15 3.6 (2.0,5.8)	7 (3.8) (3.8)	8 (3.4) 0.99	7 (3.8) (3.3)	4 (3.4) 3 (4.2) 0.81
Behavioral medicine prevention and treatment (behavior change method)	0 0.0 (0.0, 0.9)	0 (0.0) (0.0)	0 (0.0)	0 (0.0) (0.0)	0 (0.0) 0 (0.0) 1.00

Preventive and/or treatment measures obtained from daily notes.	Group n = 418 % (95% CI)	Females p-value n = 185 (%)	Males n = 233 (%)	Age 25–34 Age 45–54 p-value n = 183 (%) n = 71 (%)	Age 35–44 Age 55–65 n = 118 (%) n = 46 (%)
Salivary secretion measurement	0 0.0 (0.0, 0.9)	0 (0.0)	0 (0.0)	0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 1.00	
Microbiological test	0 0.0 (0.0, 0.9)	0 (0.0)	0 (0.0)	0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 1.00	

Discussion

This retrospective review of routine clinical records found limited documented implementation of evidence-based caries treatment and prevention among highly caries-active adults receiving public dental care. Documentation indicated that preventive practice was dominated by oral hygiene enquiry and fluoride advice, while guideline-recommended causal and behaviour-oriented strategies were rarely recorded, suggesting a persistent gap between Swedish National Guideline recommendations and documented preventive practice in adult public dental care [19]. The overall pattern observed is consistent with the broader understanding of dental caries as a multifactorial, behaviourally mediated, non-communicable disease in which effective management requires attention to modifiable drivers of disease rather than restorative care alone [5–10]. Contemporary frameworks emphasise balancing pathological and protective factors and positioning prevention as a core component of long-term disease control [6, 9]. In the Swedish context, national guidance highlights that conventional oral health information alone is generally insufficient to change unhealthy habits and recommends advisory counselling or theory-based behaviour change approaches as part of causal caries management [19]. In this study, no records contained documentation indicating delivery of such behaviour-change approaches, and documentation of targeted preventive strategies beyond basic advice was uncommon, indicating limited alignment with the national recommendations. This gap was evident in that 21% of patients had no documented preventive measures between examinations, while documentation of diet-focused counselling (16.3%) and in-clinic fluoride varnish/rinse regimens (15.6%) was uncommon. No records indicated delivery of theory-based behaviour change support or adjunctive causal investigations (e.g., salivary secretion measurement). These findings are relevant beyond the regional context, as public dental services in many high-income countries face similar challenges in implementing prevention-oriented care for adults.

An important pattern emerging from the results is the discrepancy between enquiry and active intervention. While dietary habits were documented as enquired about in more than one third of patients, advice aimed at changing dietary behaviour was documented in only a small minority. This suggests that risk identification does not routinely translate into structured preventive action. A similar pattern was observed for fluoride based prevention, where general advice was common but escalation to higher intensity measures, such as high fluoride toothpaste or in clinic fluoride regimens, was infrequent. Taken

together, this indicates that preventive care was often limited to identifying risk factors rather than systematically addressing them.

These findings should be interpreted as reflecting documented care. Record-based studies are dependent on the completeness and consistency of clinical documentation, and under-documentation of non-operative preventive interventions (particularly counselling content and behavioural support) cannot be excluded. This concern is supported by prior record-review evidence showing frequent absence of key preventive information (e.g., oral hygiene and dietary habits) in dental records [18]. However, documentation is not merely a methodological constraint: it is an essential component of quality of care, enabling continuity, accountability, and monitoring of adherence to evidence-based practice. In this sense, limited documentation of guideline-recommended preventive strategies remains relevant regardless of whether it reflects incomplete recording, incomplete delivery, or both [19]. Thus, the findings indicate either (i) under-documentation of preventive counselling and causal management, (ii) under-delivery, or (iii) both; regardless, incomplete documentation itself constitutes a quality-of-care problem because it impairs continuity and auditability. Although the data are from 2015–2016, the analysis remains informative as a baseline assessment of guideline implementation in routine adult dental care and supports evaluation of subsequent implementation efforts.

These findings should also be interpreted in light of the growing recognition of oral diseases as part of the broader non communicable disease burden. Dental caries shares key risk factors with other chronic conditions, particularly dietary patterns characterised by frequent sugar intake. When preventive dental care focuses primarily on oral hygiene advice without structured support to address shared behavioural drivers, its potential contribution to population level prevention is limited. Strengthening causal caries prevention in adult dental services may therefore support wider public health goals related to prevention, health equity, and reduction of avoidable disease burden. From a broader health perspective, recurrent caries in adults should not be viewed solely as a dental condition. Untreated or repeatedly treated caries is associated with pain, impaired sleep, difficulties with eating, and reduced capacity to function in daily life. Failure to deliver or document causal preventive care therefore represents a missed opportunity to prevent downstream impacts on general wellbeing and daily functioning, even if such outcomes were not measured in the present study.

The observed pattern is also consistent with literature indicating that preventive care in routine practice may be delivered inconsistently or without sustained, structured approaches [24, 26]. More broadly, systematic evidence suggests that dentists' provision of preventive measures can be influenced by contextual barriers and incentives within clinical systems [27]. While such factors were not examined directly in the present study, the findings are compatible with the idea that implementation of prevention-oriented care in routine settings remains challenging, even when guidelines provide clear recommendations [19, 27]. Several mechanisms may plausibly contribute to this pattern in routine adult care: limited appointment time for structured counselling, weak financial incentives for non-operative prevention, uncertainty about coding and reimbursement for preventive actions, and variable clinician confidence in behaviour change methods [27]. In addition, adult patients' out-of-pocket payment may

shape both clinicians' propensity to offer and patients' propensity to accept preventive visits beyond operative care [28–30].

An age-related pattern was observed, with older adults more likely to have documented preventive measures than younger adults, while no association was found with sex. The reasons for this age pattern cannot be determined from the available data and may reflect differences in clinical prioritisation, perceived vulnerability, comorbidity, or clinician–patient interaction. Notably, prior qualitative research has highlighted challenges in delivering preventive communication in everyday practice and variation in how dental professionals conceptualise and enact preventive counselling [17]. The higher documentation among older adults may reflect greater perceived vulnerability (e.g., comorbidity, xerostomia risk, restorative burden) or more frequent/longer visits, but these hypotheses require testing using visit-level data and clinician-level factors. Further research should examine whether preventive strategies are delivered and documented equitably across adult age groups and identify determinants of variation in preventive practice.

At the system level, Swedish national reports and evaluations indicate that preventive interventions and causal management are underused among adults receiving restorative care, reinforcing the broader relevance of the implementation gap identified here [13, 37]. These findings should be interpreted in light of contemporary public health frameworks that position oral diseases alongside other non communicable diseases driven by shared risk factors, particularly diet and sugar consumption. When preventive care is limited to general oral hygiene enquiry and fluoride advice without structured, behaviour oriented support, routine dental care risks reinforcing a cycle of restorative treatment rather than contributing to upstream prevention. Strengthening causal caries prevention in adult dental services should therefore be viewed not only as adherence to professional guidelines, but as part of broader efforts to reduce preventable disease burden and support prevention oriented health systems.

Taken together, the present findings provide a baseline description of documented preventive practice for a high-need adult population within public dental services and highlight specific areas where guideline-recommended strategies appear underused or under-recorded. Future studies should evaluate implementation approaches that support consistent delivery and documentation of targeted, patient-centred preventive care in routine practice, and assess whether such approaches reduce repeated restorative treatment needs over time [19].

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the retrospective design relied on routinely collected clinical records, which reflect documented rather than necessarily delivered care. Incomplete or inconsistent documentation may therefore have resulted in underestimation of preventive measures, particularly non-operative and behavioural interventions that are less consistently recorded in clinical notes.

Second, the study was conducted within the Public Dental Service in a large but single Swedish region, which may limit generalisability to other healthcare systems, funding models, or organisational contexts. However, the included clinics represent routine public dental care delivered across multiple sites, supporting the relevance of the findings for similar publicly funded dental services.

Third, the observational cross-sectional design precludes causal inference regarding relationships between patient characteristics and documented preventive care. The study aimed to describe patterns of care delivery and guideline adherence rather than to evaluate the effectiveness of specific interventions.

Finally, the data were collected during 2015–2016. Although national guidelines for caries prevention were already established at that time, changes in clinical practice may have occurred since then. The findings should therefore be interpreted as a description of practice during the study period, providing a baseline for evaluating subsequent implementation efforts.

Conclusions

In this retrospective review of public dental records, documented implementation of evidence-based caries treatment and prevention for highly caries-active adults was limited. Preventive care focused primarily on oral hygiene enquiry and fluoride advice, while guideline-recommended causal and behaviour-oriented strategies were rarely documented. These findings highlight a persistent implementation gap between evidence-based recommendations and routine adult dental care, with implications for prevention-oriented oral health systems.

Declarations

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Author Contribution

SB conceived the study, conducted the data extraction and analysis, and drafted the manuscript. OJ contributed to study design, interpretation of results, and critical revision of the manuscript. All authors read and approved the final manuscript.

Acknowledgement

Special thanks to Pia Gabre, Senior Dentist in Orofacial Medicine and Professor of Cariology at the University of Gothenburg, for her encouragement and guidance. We also thank Johan Lutman, the IT consultant in RVG, for technical assistance with the data collection from the Public Dental Service database, Thomas Karlsson and Anders Muszta for their statistical support, and Proper English for revising the English text.

Data Availability

The datasets used and analysed during the current study are available from the corresponding author on reasonable request, subject to regional data protection regulations.

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Figures

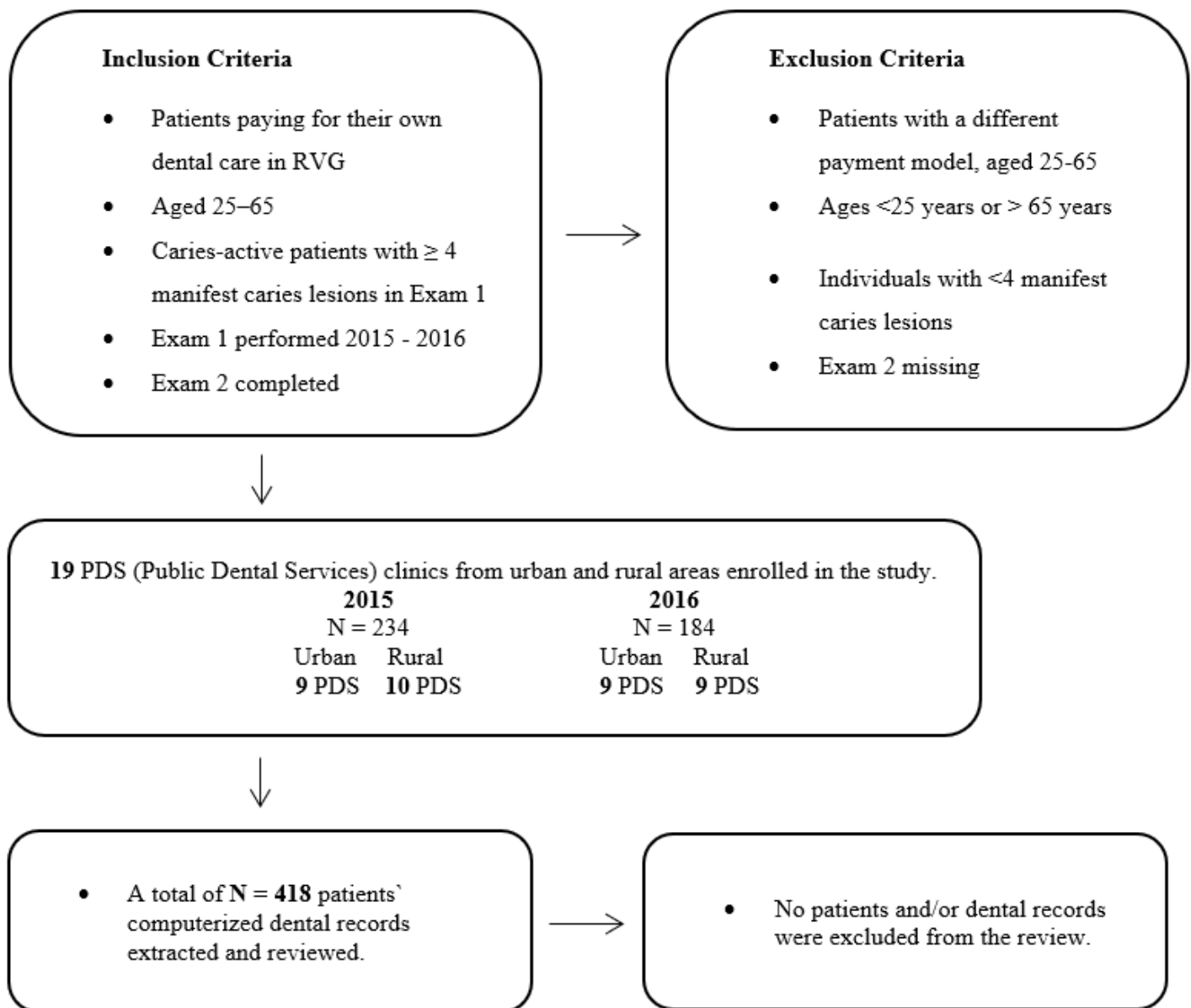


Figure 1

Flowchart showing the study design, inclusion and exclusion criteria, and some characteristics of the patients enrolled in the study.

Supplementary Files

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