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Procedures performed by general dental practitioners, dental hygienists and prophylaxis assistants in oral healthcare practices in the Netherlands

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Abstract

Background Within Dutch oral healthcare practices, collaboration between general dental practitioners, dental hygienists and prophylaxis assistants is common practice. However, little is known about the precise procedures that the various professional groups involved carry out. The aim of this study was to map this collaboration through an analysis of the division of tasks, as shown in treatment records.

Materials and methods For the purpose of this study, a Dutch corporate dental company provided retrospective data on all procedures conducted in 32 affiliated practices in 2022. Separate datasets were created to analyse the data at the procedure, patient, care provider and practice level. The Chi-square test, the independent-samples T-test, and One-way ANOVA were employed. All analyses were performed using SPSS and an alpha level of 0.05 was used.

Results A general practitioner was involved in the treatment of 94.6% of the patients. All procedures except initial periodontal treatment were performed by at least 75% of the general dental practitioners. 80.5% of the dental hygienists performed initial periodontal treatment. Over 90% of the prophylaxis assistants performed procedures for oral hygiene education and calculus removal. Significant differences were observed between practices, particularly in preventive procedures.

Conclusions In general, the general dental practitioner performs a broad range of procedures, at least in the practices that are affiliated with the corporate dental company of this study. Dental hygienists proved to be an important executor in the field of periodontal treatments. The care provided by the prophylaxis assistant focused mainly on prevention. However, significant differences in the division of tasks were observed, even within this group of practices within one corporate dental company.

Keywords Dentists, Dental hygienists, Dental assistants, Dental clinics, Dental procedures, Task performance and analysis, Interprofessional relations, Oral health care delivery, Organizational affiliation, Group practice

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Background

Collaboration within Dutch oral healthcare practices (OHPs) has significantly increased in recent decades, similar to in other high-income countries [1, 2]. In the Netherlands, the three largest groups of oral healthcare providers involved in this collaboration are general dental practitioners (GDPs), dental hygienists (DHs) and prophylaxis assistants (PAs). These three types of oral healthcare providers have different authorizations and different tasks and responsibilities [3, 4]. GDPs are authorised to perform surgical procedures, application of local anaesthesia, assessment of intra-oral radiographs and prescription of medicines autonomously. DHs are authorised to perform supra- and subgingival dental cleaning without referral or delegation. DHs who graduated after 2006 can treat primary caries, administer anaesthesia, and expose and evaluate intra-oral radiographs according to a protocol, with a GDP's referral but without their direction or control. PAs can only perform delegated procedures, whereby the delegating oral healthcare provider (GDP or DH) must always be present to assist or intervene. In an international comparison, some Dutch DHs would be referred to as dental therapists, and the role of PAs shows great similarities to that of dental nurses [5, 6]. The increase in collaboration within OHPs has led to these practices becoming larger in the Netherlands over the past years [1].

Barriers and facilitating factors for collaboration

Collaboration within OHPs, where healthcare providers with different training, skills, tasks, and responsibilities are deployed, is also often referred to as skill-mix [7]. Previous studies have highlighted the perceived benefits of collaboration and skill-mix, including improved efficiency, cost reduction, employee satisfaction, better options for delivering desired care, increased patient comfort, and enhanced accessibility [4, 8–10]. Although collaboration in oral healthcare has increased, especially in high-income countries, it still lags behind the medical profession [2, 7, 11, 12]. This is particularly evident in the expansion of tasks and responsibilities of non-GDPs, the potential of which is often not fully utilized [13–15]. Various factors contribute to this underutilization [7]. Among them is the reluctance of GDPs, who refer to the protection of their professional identity, concerns about quality of care, and a general unwillingness to relinquish control over treatment as key reasons [12, 16, 17]. Conversely, other oral healthcare providers are not always eager to take on new tasks [12, 17]. Legislation and regulations, as well as the composition of the patient population, play a significant role [7, 17, 18]. At the same time, legislation and regulations can also have a stimulating effect, enabling motivated oral healthcare providers to expand their scope of practice [1, 7].

The development towards more collaboration and the restraint with regard to skill-mix described above may seem contradictory. This does not have to be the case. Collaborative practices are not all established for the same reasons. In addition to the aim of providing the best care and optimal attention to prevention, convenience for patients, efficiency, and the ability to oversee and monitor matters in practice are also cited as factors [4, 19, 20]. Limitations in the availability of oral healthcare providers. In the Netherlands, a shortage of GDPs in certain regions has been reported for years, and there are indications that this also applies to DHs and PAs [21, 22]. On the one hand, these perceived shortages can create demand for task delegation and referral options, while on the other, they can limit the possibilities for doing so. In any case, the Individual Healthcare Professions Act, which regulates how healthcare providers may treat individuals, offers ample opportunities for collaboration and division of tasks [3].

Although collaboration between GDPs, DHs, and PAs within OHPs in the Netherlands has existed for decades, little is known about the precise procedures that the various professional groups carry out within these partnerships. In internal research conducted by the Royal Dutch Dental Association (KNMT) between 1999 and 2016, GDPs were asked which procedures they refer patients to DHs for and which procedures they delegate to DHs and PAs [23, 24]. This information was assessed by GDPs, and the manner in which it was obtained made it impossible to determine whether these referrals and task delegations were incidental or structural. Studies on the skill-mix in oral healthcare, focussing on which treatments are performed by DHs and other oral healthcare providers – i.e. dental therapists and dental nurses – have traditionally relied on self-reported data from oral healthcare providers rather than on actual treatment records [8, 10, 13, 25–30]. Treatment records are expected to provide a more accurate reflection of the care provided than self-reported data. In one of the studies within the KNMT's so-called Data Stations Project, treatment records are used, though data on those performing the treatments are lacking [1, 31]. This underscores the need for more detailed insight into the actual division of tasks between different professionals within oral healthcare practices.

Aim of the study

The aim of this study was to map the collaboration in general OHPs through an analysis of the division of tasks between GDPs, DHs, and PAs, as shown in treatment records. To this end, the following three research questions were addressed.

- Which oral healthcare providers, i.e. GDPs, DHs and PAs, perform preventive and curative oral healthcare procedures in OHPs?
- How frequently do GDPs, DHs and PAs perform preventive and curative oral healthcare procedures?
- To what extent do OHPs differ depending on the performance by GDPs, DHs and/or PAs of preventive and curative oral healthcare procedures?

Methods

This study was conducted on the basis of retrospective data made available by a Dutch corporate dental company (CDC) on all procedures performed on patients in 32 affiliated practices in 2022. The data were anonymized before being made available for this study on April 18, 2023. Where applicable, in the analyses a distinction was made between young patients (17 years or younger) and adult patients (18 years or older). The care needs of these two groups differ, and the reimbursement for the costs of oral healthcare for these groups is also different in the Netherlands [19]. Young patients are reimbursed for almost all oral healthcare costs through the mandatory national health insurance. In contrast, only a very limited part of oral healthcare for adult patients is reimbursed by this insurance.

Type of data

The available data include information on the dental procedures performed, more specifically the codes of declared dental fees. The Netherlands has a fee-for-service system with fixed rates. A list of tariff codes, the Dental Fee List, is used for the declarations. This list, which is established annually by the Dutch Healthcare Authority, included 491 procedures in 2022 [32].

Each record of the primary data file consists, in addition to specific tariff codes for the procedures performed, of data about the oral healthcare provider performing the procedures and about the patient on whom the procedures were performed (`procedures-patient-performer combination'). For example, a record may describe all the procedures that provider 1 performed on patient A. If a patient was treated by multiple providers, this is represented in multiple records, with each record showing the procedures performed by a different provider on the same patient. Similarly, for oral healthcare providers who have treated multiple patients, their procedures for different patients are displayed on separate records.

Per procedures-patient-provider combination data was available on the profession of the oral healthcare provider who performed a procedure, the practice where this was done, the patient's gender and year of birth, their caries risk score and Periodic Periodontal Screening score (PPS score) as assessed by a provider in the practice. The caries risk profile, assessed as low, moderate, or high according to an internal system inspired by 'Gewoon Gaaf,' was determined based on the quality of oral hygiene, caries development, and the eruption of teeth and molars [33]. The PPS score was assessed according to a national guideline [34]. With a PPS score of 1, the gums were considered sufficiently healthy, a score of 2 indicated a tipping point from healthy to unhealthy and with a score of 3, extensive examination and periodontal treatment was usually necessary.

Data processing

In order to conduct the analyses to answer the research questions, four datasets were generated based on the primary data file.

1. A dataset obtained by aggregating the data per patient. This dataset contains information about all the dental procedures each patient received in 2022 from one or more oral healthcare providers. For each patient, it included background characteristics, the oral healthcare providers involved in their treatment, and the OHP where treatment took place.
2. A separate dataset was created for each type of procedure (e.g., routine dental examinations or fillings). In these datasets, each record represents one performed procedure, with added to it data about both the healthcare provider who performed the procedure and data about the patient on whom the procedure was performed. In other words, each individual treatment is recorded separately, even if the same treatment is performed multiple times on the same patient. For example, if a healthcare provider has performed three restorations on a patient, three separate records were included in the dataset.
3. A dataset obtained by aggregating the data per healthcare provider. This dataset contains information about the total care performed by each oral healthcare provider across various patients. For each provider, it contains data on the total number of times they performed each procedure on their patients.
4. A dataset obtained by aggregating the data per OHP. This dataset contains information on the dental procedures provided per OHP. For each OHP, it contains data on all procedures performed on all patients, with distinction according to the various oral healthcare providers. Furthermore, per OHP the percentage of female and male patients, the average age of the patient population, the percentage of patients with a high caries risk and the percentage of patients with a PPS score of 3 were added to this file. The OHPs were arranged in ascending order based on the proportion of GDPs relative to the combined

number of DHs and PAs. The OHP with the smallest proportion of dentists was placed first, and the practice with the largest proportion last.

A selection of nine procedures was made to cover a wide range of diagnostic, preventive, and curative oral healthcare. These procedures included: routine dental examination, make and evaluate intraoral radiographs, oral hygiene education per 5 min, calculus removal per 5 min, fluoride treatment, sealants per tooth, administration local anaesthesia, restorations, and initial periodontal treatment. Together, these procedures account for 788,951 (76.2%) of all 1,034,248 registrations. For procedures for which there was more than one code, the numbers of the different codes were summed. All codes per procedure are listed in supplement 1. Where applicable, a distinction was made in the analyses between two groups of patients based on their age as of the beginning of the selected period, December 31, 2021: young patients up to and including 17 years old, and adult patients aged 18 years and above.

Data analysis

The frequency distribution of the collected data was first presented using descriptive statistical measures. Subsequently, the differences between distinct groups distinguished by patient age and type of oral healthcare provider were examined. Depending on the nature of the data, the Chi-square test, the independent-samples T-test, and One-way ANOVA were employed. All analyses were performed using SPSS (version 28) and an alpha level of 0.05 was used.

Results

Of the total of 357,478 cases (procedures-patient-provider combinations), that appeared in the 33 CDC practices in 2022, a number were not taken into account. Firstly, one of the practices was not part of the target population, as it was not a general OHP but specifically focused on special care groups. By excluding this practice, 23,858 (6.7%) cases were removed. Furthermore, only cases where the oral healthcare provider was a GDP, DH or PA were included. In 19,127 (5.4%) cases the provider had a different profession: in 1,777 (0.5%) cases an orthodontist, in 5,647 (1.6%) cases a `specialist', in 11,488 (3.2%) cases `other', and in 215 (0.1%) cases the type of provider was unknown. Additionally, 1,882 (0.5%) cases were excluded because none of the declared procedure codes appeared in the Dental Fee List. This left 312,611 (87.4%) cases (procedures-patient-provider combinations), relating to 178,499 patients, who have been treated in 32 practices by a total of 481 healthcare providers: 212 (44.1%) GDPs, 123 (25.6%) DHs, and 146 (30.3%) PAs.

Patient characteristics

The personal background characteristics and oral health characteristics of the involved patients, divided into young and adults, are listed in Table 1, while information

Table 1 Background and general oral health characteristics of patients, by age group

	Children (<=17 years)		Adults (>=18 years)		Total		Statistical test
Gender							
male	48.9%		54.0%		53.1%		Chi^2 (1) = 268.1;
female	51.1%		46.0%		46.9%		$p < 0.001$
Age							
0–5	17.7%				3.1%		not applicable
6–11	39.7%				7.0%		
12–17	42.6%				7.5%		
18–39			32.7%		26.9%		
40–59			34.7%		28.6%		
60–75			24.9%		20.5%		
76 or older			7.7%		6.4%		
mean (standard deviation)	*10.2*	*(4.3)*	*49.7*	*(18.0)*	*42.7*	*(22.2)*	*not applicable*
Caries risk score							
low	69.8%		43.3%		48.0%		Chi^2 (2) = 7,313.8;
medium	9.1%		15.9%		14.7%		$p < 0.001$
high	21.1%		40.8%		37.3%		
PPS score							
1	20.9%		30.8%		29.0%		Chi^2 (3) = 48,694.,4;
2	3.1%		37.4%		31.3%		$p < 0.001$
3	0.1%		15.1%		12.5%		
not recorded	75.9%		16.7%		27.2%		
n (number of patients)	31,520		146,974		178,494		

about the oral healthcare they received is shown in Table 2.

Practice characteristics

On average, 15.0 healthcare providers per OHP performed at least one treatment in 2022, ranging from 5 to 51. On closer inspection, this involved an average of 6.6 GDPs (range 3–26), 3.8 DHs (0–20), and 4.6 PAs (0–13). The proportion of GDPs in the total number of oral healthcare providers varied from 27.3% (practice 1) to 60.0% (practice 32).The number of patients per practice varied from 1,202 to 20.521; the proportion of women in the patient population across the different practices from 51.2 to 56.8%. The average age of the patients as of January 1, 2022, spanned between 35.4 and 52.2 years, with the average age in two practices being under 40 years and in one practice exceeding 50 years. Furthermore, the proportion of patients with a high caries risk—as assessed by the oral healthcare providers—ranged from 22.8 to 60.4%, while the share of patients with a PPS score of 3 varied between 11.5% and 31.6%. A more detailed overview of the characteristics of the 32 practices is included in Supplement 2.

Oral healthcare provided

In the vast majority (94.6%) of patients, a GDP was involved in the treatment: in 49.8% of cases, the GDP was the only provider; in 23.0%, a DH also performed procedures; in 19.6%, a PA was involved; and in 2.2%, both a DH and a PA were involved. In the treatment of young patients compared to adults, a dentist was more commonly the sole oral healthcare provider, and a DH was less frequently involved. Furthermore, a vast majority (84.4%) of patients had undergone an routine dental examination: 91.3% of young patients and 82.9% of adults. Intra-oral radiographs were performed more frequently in adults than in young patients (44.0% vs. 23.5%). For preventive procedures, oral hygiene education, fluoride treatment, and sealants were administered more often to young patients than to adults (42.9% vs. 4.5%, 45.4% vs. 2.3%, and 1.0% vs. 0.3%, respectively). Conversely, calculus removal was performed more frequently in adults than in young patients (65.5% vs. 47.5%). Restorations were made in approximately one-third of the patients (31.2%), with a higher frequency in adults compared to young patients (34.4% vs. 16.5%).

Performing oral healthcare providers per procedure

Table 3 shows that the majority of routine dental examinations, intra-oral radiographs, local anaesthesia applications, and restorations were carried out by a GDP in at least 90% of the cases. Initial periodontal treatments were carried out by a DH in 96.3% of the cases. There was more variation in providers for preventive procedures. For example, GDPs, DHs, and PAs were all responsible for a substantial proportion of calculus removals (29.5%, 39.9%, and 30.6%, respectively) and oral hygiene education (48.3%, 18.0%, and 33.7%, respectively). All types of providers were involved in fluoride treatments and sealants, though to a lesser extent compared to calculus removals and oral hygiene education. For fluoride treatments, GDPs were the primary providers (82.3%), while DHs and PAs were involved to a lesser degree (10.2% and 7.5%, respectively). Similarly, for sealants, GDPs were most commonly responsible (72.3%), with DHs and PAs contributing less (6.5% and 21.2%, respectively). Routine dental examinations, oral hygiene education, calculus removals, fluoride treatments, and local anaesthesia applications were carried out by a GDP in more cases in young patients than in adult patients.

Oral healthcare provided per oral healthcare provider

Table 4 shows that 69.4% of healthcare providers carried out at least one routine dental examination in 2022. There are differences between professions: 96.2% of GDPs performed at least one routine dental examination, compared to 53.7% of DHs and 43.8% of PAs. The average number of these treatments also varied: GDPs performed an average of 1,016.3 routine dental examinations in 2022, DHs an average of 114.7, and PAs an average of 6.8.

In 2022 almost all procedures were performed by a vast majority of GDPs (≥75%), with initial periodontal treatment as the exception. This procedure was performed more frequently by DHs, with 80.5% of them carrying it out. In addition, the most treatments such as oral hygiene education, calculus removel, and application of local anaesthsia vast majority of DHs performed by the DHs-More than 90% of PAs performed oral hygiene education and calculus removal. There appears to be substantial variation in the frequency with which healthcare providers perform the selected procedures, as indicated by the standard deviations that are high relative to the mean. This is particularly true for PAs and DHs compared to GDPs.

Performing oral healthcare providers per practice

Figures 1 and 2, and 3 show which healthcare providers are responsible for carrying out the selected procedures in each practice. Figure 1 illustrates that in almost all practices, GDPs are responsible for the majority of consultation and diagnostic activities, although in two practices, DHs also carry out a substantial portion of these activities. The differences between practices are more pronounced for preventive actions (Fig. 2). With regard to curative care, it appears that application of local anaesthesia and restorations are mainly the responsibility of GDPs in almost all practices, while initial periodontal

Table 2 Percentage of oral healthcare provided to patients in 2022, by age group and provider type

	Children	***Adults***	***Total***	***Statistical test***
	(< = 17 years)	***(> = 18 years)***		
Treated by				
GDP only	67.60%	45.90%	49.80%	Chi^2 (6) = 8,992.3;
DH only	1.60%	4.80%	4.20%	p < 0.001
PA only	1.30%	1.00%	1.10%	
GDP and DH	4.70%	26.90%	23.00%	
GDP and PA	23.10%	18.90%	19.60%	
GDP, DH and PA	1.60%	2.30%	2.20%	
DH and PA	0.10%	0.20%	0.10%	
Routine dental examination				
% of patients receiving	91.30%	82.90%	84.40%	Chi^2 (1) = 3,384.3;
% of patients not receiving	8.70%	17.10%	15.60%	p < 0.001
mean number (sd)	*1.5 (0.6)*	*1.4 -(0.5)*	*1.4 (0.5)*	*t = 26.0; p < 0.001*
Intra-oral radiograph				
% of patients receiving	23.50%	44.00%	40.40%	Chi^2 (1) = 4,510.4;
% of patients not receiving	76.50%	56.00%	59.60%	p < 0.001
mean number (sd)	*1.5 (0.8)*	*1.7 (1.0)*	*1.7 (1.0)*	*t = -18.8; p < 0.001*
Oral hygiene education				
% of patients receiving	42.90%	4.50%	11.30%	Chi^2 (1) = 38,005.9;
% of patients not receiving	57.10%	95.50%	88.70%	p < 0.001
mean number (sd)	*1.6 (0.9)*	*1.2 (0.5)*	*1.5 (0.8)*	*t = 45.8; p < 0.001*
Calculus removal				
% of patients receiving	47.50%	65.50%	62.30%	Chi^2 (1) = 3,555.8;
% of patients not receiving	52.50%	34.50%	37.70%	p < 0.,001
mean number (sd)	*1.6 (0.8)*	*1.5 (0.7)*	*1.5 (0.7)*	*t = 3.5; p < 0.001*
Fluoride treatment				
% of patients receiving	45.40%	2.30%	9.90%	Chi^2 (1) = 54,017.0;
% of patients not receiving	54.60%	97.70%	90.10%	p < 0.001
mean number (sd)	*2.8 (1.0)*	*2.4 (1.1)*	*2.7 (1.1)*	*t = 22.7; p < 0.001*
Sealant				
% of patients receiving	10.00%	0.30%	2.00%	Chi^2 (1) = 12,497.1;
% of patients not receiving	90.00%	99.70%	98.00%	p < 0.001
mean number (sd)	*4.7 (3.4)*	*3.4 (4.0)*	*4.5 (3.5)*	*t = 6.5; p < 0.001*
Local anaesthesia				
% of patients receiving	7.80%	19.10%	17.10%	Chi^2 (1) = 2,359.0;
% of patients not receiving	92.80%	80.90%	82.90%	p < 0.001
mean number (sd)	*1.8 (1.3)*	*1.8 (1.3)*	*1.8 (1.3)*	*t = 0.6; p = 0.523*
Restoration				
% of patients receiving	16.50%	34.40%	31.20%	Chi^2 (1) = 3,869.1;

Table 2 (continued)

	Children		*Adults*		*Total*		*Statistical test*
	(<= 17 years)		*(>= 18 years)*				
% of patients not receiving	83.50%		65.60%		68.80%		p < 0.001
mean number (sd)	*2.2*	*(1.9)*	*2.1*	*(1.9)*	*2.1*	*(1.9)*	*t = 2.6; p = 0.005*
Initial periodontal treatment							
% of patients receiving	0.00%		0.70%		0.50%		Chi^2 (1) = 203.9;
% of patients not receiving	100.00%		99.30%		99.50%		p < 0.001
mean number (sd)	*14*	*	*13.3*	*(7.3)*	*13.3*	*(7.3)*	*t = 0.1; p = 0.920*
n (number of patients)	31,520		146,974		178,494		

*not applicable, *n* = 1

treatments in almost all practices are primarily carried out by DHs (Fig. 3).

Discussion

This study shows that in the collaboration between GDPs, DHs, and PAs in OHPs for patient care, the GDP played a central role, at least within the 32 practices of one specific CDC. The vast majority of patients in these OHPs had visited a GDP in 2022, with or without a visit to a DH and/or PA. Routine dental examinations, intra-oral radiographs, anaesthesia, and restorations were primarily within the domain of the GDP. Initial periodontal treatments were mainly performed by DHs. Preventive procedures – including oral hygiene instruction, teeth cleaning, fluoride treatment, and sealants – constituted a substantial part of the care provided by all three oral healthcare providers. In the practices involved in the study, there was limited use of the option to engage DHs in intra-oral radiographs, anaesthesia, and restorations. One possible reason for this may be a cautious policy of the CDC or practice leaders, often GDPs, driven by practical reasons, fear of loss of control, lack of experience and concerns about quality of care [4, 15]. Such a reserved attitude has also been observed in several previous studies, as well as among DHs themselves, due to a lack of self-confidence and limited scope for task expansion due to existing work activities [12, 16, 17]. This suggests that while collaboration does occur, the opportunities for task delegation are not always fully realised in practice.

The study contributes to the existing knowledge base by providing detailed insight into the actual division of tasks across professional groups in OHPs. While some studies have demonstrated the potential benefits of task delegation – such as increased productivity, efficiency, accessibility, and staff satisfaction – other research has shown that these opportunities are often underused in practice [8–10, 12, 15–17]. These findings reinforce this latter observation by demonstrating that, even in settings with longstanding collaborative structures, GDPs continue to carry out most procedures.

Furthermore, the study shows substantial variation within general OHPs of the CDC in the frequency with which DHs and PAs, in particular, performed certain preventive procedures. The fact that the standard deviation was sometimes considerably larger than the average indicates this [35]. These differences also emerge from the comparison between OHPs, where a face-value comparison did not immediately reveal relationships with practice characteristics. There are indications that CDCs influence processes in affiliated OHPs through central policies. Inquiries with the CDC affiliated with the practices in this study revealed that advice is provided, particularly on task division in the implementation of preventive treatments. This is not a binding policy,

Table 3 Distribution of oral healthcare providers based on the total number of procedures provided per oral healthcare procedure, by age group

	Children (< = 17 years)	Adults (> = 18 years)	Total	Statistical test
Routine dental examination				
general dental practitioner	96.9%	96.1%	*96.3%*	Chi^2 (1) = 65.2;
dental hygienist	2.9%	3.7%	*3.5%*	$p < 0.001$
prophylaxis assistant	0.2%	0.2%	*0.2%*	
n (number of routine dental examinations)	43,292	172,033	215,325	
Intra-oral radiograph				
general dental practitioner	98.4%	98.6%	98.5%	Chi^2 (1) = 2.9;
dental hygienist	1.,3%	1.1%	1.2%	$p = 0.232$
prophylaxis assistant	0.3%	0.3%	0.3%	
n (number of intra-oral radiographs)	11,383	110,890	122,273	
Oral hygiene education				
general dental practitioner	53.0%	35.0%	*48.3%*	Chi^2 (1) =
dental hygienist	11.6%	36.0%	*18.0%*	2,354.1;
prophylaxis assistant	35.4%	29.0%	*33.7%*	$p < 0.001$
n (number of 5-minute units of oral hygiene education)	21,712	7,766	29,478	
Calculus removal				
general dental practitioner	48.2%	26.6%	29.5%	Chi^2 (1) =
dental hygienist	11.7%	44.3%	39.9%	9,435.1;
prophylaxis assistant	40.1%	29.1%	30.6%	$p < 0.001$
n (number of calculus removals)	23,449	148,205	171,654	
Fluoride treatment				
general dental practitioner	85.5%	66.2%	82.3%	Chi^2 (1) =
dental hygienist	6.6%	28.4%	10.2%	3,479.1;
prophylaxis assistant	7.9%	5.4%	7.5%	$p < 0.001$
n (number of fluoride treatments)	40,647	8,019	48,666	
Sealant				
general dental practitioner	71.1%	84.3%	72.3%	Chi^2 (1) =
dental hygienist	6.3%	8.4%	6.5%	183.6;
prophylaxis assistant	22.6%	7.3%	21.2%	$p < 0.001$
n (number of sealants)	14,784	1,420	16,204	
Local anaesthesia				
general dental practitioner	99.1%	91.2%	91.9%	Chi^2 (1) =
dental hygienist	0.5%	8.2%	7.5%	344.0;
prophylaxis assistant	0.4%	0.6%	0.6%	$p < 0.001$
n (number of local anaesthesia applications)	4,361	49,578	53,939	
Restoration				
general dental practitioner	98.5%	99.5%	99.5%	Chi^2 (1) =
dental hygienist	1.0%	0.2%	0.2%	321.2;
prophylaxis assistant	0.5%	0.3%	0.3%	$p < 0.001$
n (number of restorations)	11,412	107,303	118,715	
Initial periodontal treatment				
general dental practitioner		0.4%	0.4%	Chi^2 (1) = 0.5;
dental hygienist	100.0%	96.3%	96.3%	$p = 0.762$
prophylaxis assistant		3.3%	3.3%	
n (number of initial periodontal treatments)	14	12,683	12,697	

as the CDC also values the retention of individual practices' local identities. In addition to differences in patient population and team composition, reasons for choosing a collaborative practice format may include the ability to provide the best possible care, the ability to focus on prevention of oral diseases, and the ability for patients to receive multiple treatments in one practice [4, 19]. Individual healthcare providers may also have different reasons for choosing to join a collaborative practice, including the ability to work as a team to prevent oral

Table 4 Whether or not selected procedures were performed in 2022 and if so, average number of procedures performed, per oral healthcare provider

	General dental practitioners	Dental hygienists	Prophylaxis assistants	Total	Statistical test
Routine dental examination					
% that performed	96.2%	53.7%	43.8%	69.4%	Chi^2 (2) = 131.2;
% that did not perform	3.8%	46.3%	56.2%	30.6%	$p < 0.001$
mean, 0 excluded	*1,016.3*	*114.7*	*6.8*	*644.7*	*F (2, 331) = 78.1;*
(sd)	*(863.4)*	*(209.7)*	*(24.8)*	*(825.6)*	$p < 0.001$
Intra-oral radiograph					
% that performed	97.6%	37.4%	37.0%	63.8%	Chi^2 (2) = 187.8;
% that did not perform	2.4%	62.6%	63.0%	36.2%	$p < 0.001$
mean, 0 excluded	*582.1*	*30.9*	*6.8*	*398.3*	*F (2, 304) = 58.9;*
(sd)	*(517.9)*	*(56.6)*	*(15.8)*	*(501.2)*	$p < 0.001$
Oral hygiene education					
% that performed	85.8%	92.5%	92.5%	89.8%	Chi^2 (2) = 6.6;
% that did not perform	14.2%	7.5%	7.5%	10.2%	$p = 0.037$
mean, 0 excluded	*78.1*	*46.2*	*73.6*	*68.2*	*F (2, 249) = 3.9;*
(sd)	*(122.2)*	*(70.4)*	*(86.3)*	*(100.4)*	$p = 0.021$
Calculus removal					
% that performed	93.9%	97.6%	99.3%	96.5%	Chi^2 (2) = 8.1;
% that did not perform	6.1%	2.4%	0.7%	3.5%	$p = 0.017$
mean, 0 excluded	*254.7*	*570.4*	*362.3*	*369.9*	*F (2, 462) = 27.1;*
(sd)	*(321.5)*	*(463.3)*	*(349.1)*	*(391.7)*	$p < 0.001$
Fluoride treatment					
% that performed	84.0%	64.2%	61.6%	72.1%	Chi^2 (2) = 26.6;
% that did not perform	16.0%	35.8%	38.4%	27.9%	$p < 0,001$
mean, 0 excluded	*225.2*	*62.7*	*40.4*	*140.2*	*F (2, 344) = 18.0;*
(sd)	*(371.1)*	*(92.2)*	*(65.4)*	*(284.8)*	$p < 0.001$
Sealant					
% that performed	75.0%	26.0%	54.8%	56.3%	Chi^2 (2) = 76.1;
% that did not perform	25.0%	74.0%	45.2%	43.7%	$p < 0.001$
mean, 0 excluded	*73. 6*	*32.9*	*43.0*	*59.8*	*F (2, 268) = 3.4;*
(sd)	*(131.2)*	*(43.0)*	*(54.2)*	*(106.9)*	$p = 0.035$
Local anaesthesia					
% that performed	97.2%	89.4%	21.9%	72.3%	Chi^2 (2) = 268.8;
% that did not perform	2.8%	10.6%	78.1%	27.7%	$p < 0.001$
mean, 0 excluded	*240. 6*	*37.0*	*9.6*	*155.0*	*F (2, 345) = 68.0;*
(sd)	*(210.7)*	*(53. 4)*	*(18.6)*	*(194.6)*	$p < 0.001$
Restoration					
% that performed	97.6%	17.9%	24.7%	55.1%	Chi^2 (2) = 278.6;
% that did not perform	2.4%	82.1%	75.3%	44.9%	$p < 0.001$
mean, 0 excluded	*570.3*	*12.2*	*10.9*	*448.0*	*F (2, 262) = 35.7;*
(sd)	*(501.7)*	*(19.1)*	*(21.5)*	*(500.1)*	$p < 0.001$
Initial periodontal treatment					
% that performed	4.7%	80.5%	3.4%	23.7%	Chi^2 (2) = 294.8;
% that did not perform					$p < 0.001$
mean, 0 excluded	*5.1*	*123.5*	*84.8*	*111.4*	*F (2, 111) = 2.7;*
(sd)	*(4.6)*	*(163.3)*	*(105.7)*	*(157.1)*	$p = 0.069$
n	212	123	146	481	

diseases and the opportunity for personal professional development [4]. Leadership style, whether directive or supportive, and the organization of practice management, with or without a specialized practice manager, also play a role [4, 19, 20]. Shortages of oral healthcare providers, which differ by region, may also influence these dynamics [36].

In this study, the differences between children and adult patients were examined where possible, as their oral healthcare needs and reimbursement structures

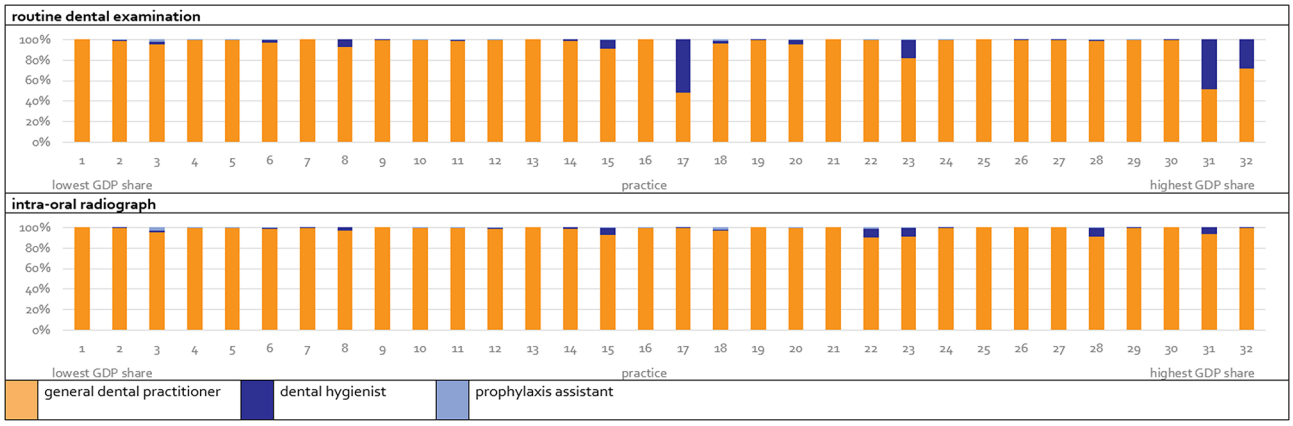

Fig. 1 Comparison of practices by performer for selected consultation and diagnostic procedures

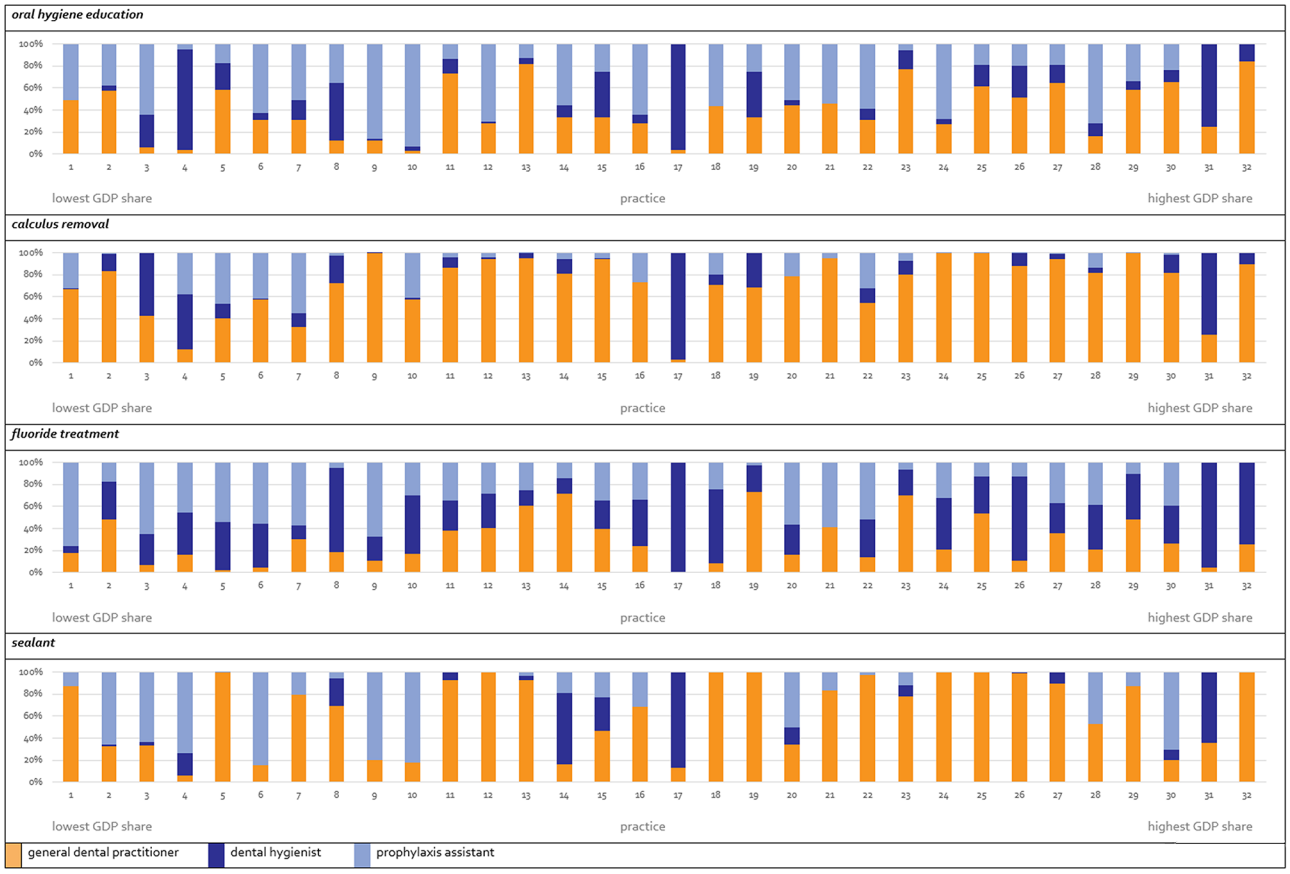

Fig. 2 Comparison of practices by performer for selected preventive procedures

differ. Children were treated by a GDP alone more frequently than adults, while they were treated by a DH less frequently. This is likely due to the fact that the treatment in which DHs are particularly involved, initial periodontal treatment, is not commonly performed on children. This is not unique to the OHPs in this study, but is a general trend [37]. When only preventive treatments are considered, a similar difference is observed. This may be because DHs do not have enough time to focus on children, given the substantial effort required for initial periodontal treatment [19]. Taken together, these findings highlight that the division of tasks in OHPs is shaped not only by professional competences, but also by organisational choices and broader contextual factors. While descriptive in nature, the study's findings may encourage reflection within OHPs on role distribution and the extent of task delegation. Future research could examine underlying motivations and conditions

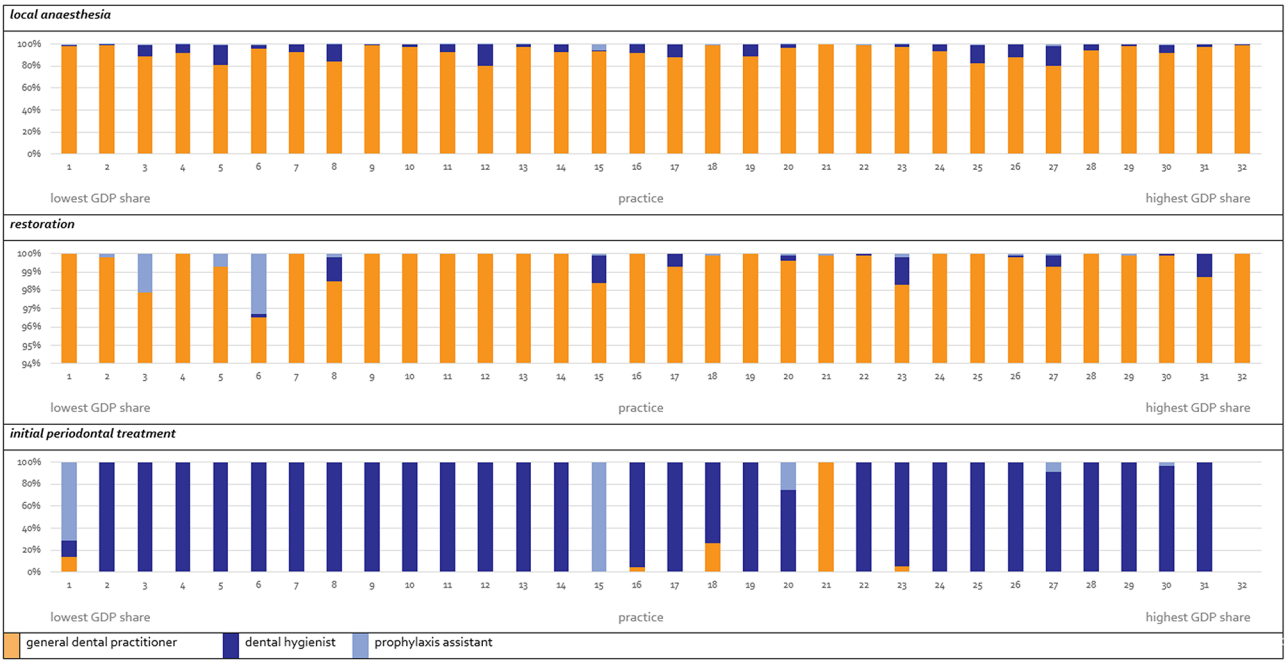

Fig. 3 Comparison of practices by performer for selected curative procedures

influencing collaborative balance, including how training programmes might enhance the efficiency and implementation of task delegation.

Strengths and limitations

The size of the available data on oral healthcare provided, with a distinction between providers, is a strong point of this study. This is true both in absolute terms – covering 178,499 patients treated by 481 care providers in 32 practices – and in relative terms, as it includes all procedures performed on all patients over an entire year (2022), ensuring that the chance of selection bias is negligible. A weaker aspect, however, is that, apart from the presence of different care providers, no data are available on the background of the collaboration, such as the reasons for choosing a collaborative practice, the leadership style of the practice owner, or the role of a potential practice manager.

The practices in this study differ in team composition and patient population, but they all share the fact that they are affiliated with the same CDC, based on these data, it is not possible to determine whether the findings can be generalised to all OHPs in the Netherlands. CDCs standardize organizational and/or care processes to manage costs and ensure a certain quality standard [19]. In this specific CDC, a policy is in place, but the practices retain the freedom to maintain their own identity. Oral healthcare providers, particularly GDPs and DHs, also have the professional freedom to choose specific treatments in consultation with patients. This is evident from the differences found between practices. However, the results of this study, regarding the proportion of patients for whom certain procedures – such as routine dental examinations, intra-oral radiographs, calculus removal, and restorations – were performed, largely align with those of previous research into the care provided in general OHPs in the Netherlands [31, 38].

A further limitation concerns the available background characteristics of patients and oral healthcare providers. For patients, only sex and year of birth were available, and for oral healthcare providers, only profession was known. Furthermore, while the procedures patients underwent were recorded, data on the indications for these procedures were limited. The two characteristics available in this respect, caries risk and PPS, are not particularly suitable for this purpose, as both are primarily used for screening to determine whether treatment should be considered [34]. Additionally, when estimating caries risk, recently performed procedures are an important factor [39].

Furthermore, the training of the DHs in this study is unknown, and therefore their specific competencies are unclear. Initially, the training to become a DH in the Netherlands lasted two years, but it was extended twice – first to three years in 1995 and then to four years in 2002. Only those who had completed the four-year program, in addition to a broad range of preventive and periodontal treatments, were allowed to indicate intra-oral radiographs, apply anaesthesia, and treat primary cavities. As the data used in this study were from 2022, it is important to consider that some changes may have occurred since then.

Implications for practice

This study shows that there is a skill mix in general OHPs affiliated with a specific Dutch CDC. The various oral healthcare providers each have their own role: the GDP is the generalist, the DH primarily focuses on periodontal treatment and prevention, and the PA concentrates on preventive actions. At the same time, there appears to be potential within the OHPs to allocate more care tasks. In addition to the already mentioned reluctance among various oral healthcare providers, there may be other reasons why this has not yet occurred. In the Netherlands, at least regionally, there are shortages of GDPs, DHs, and assistants [21, 22]. These shortages pose an obstacle to redistributing tasks within practices – i.e., from GDPs to DHs and PAs, and from DHs to PAs. For optimal task distribution in the direct provision of oral healthcare, it is essential that the various groups of care providers are present in sufficient numbers and in a balanced proportion.

Conclusions

In general, the GDP is somewhat consistently active as the executor of all dental procedures, at least in the OHPs examined, which are affiliated with a specific Dutch CDC. The DHs primarily demonstrated their role as executor in the area of periodontal treatments, while the PA focused mainly on preventive oral healthWhen looking specifically at the care provided per practice, clear differences emerge in the division of tasks within this group of practices affiliated with the same CDC, indicating even higher variety of skill-mix within general oral healthcare practices in the Netherlands.

Abbreviations

CDC	Corporate dental company
DH	Dental hygienist
GDP	General dental practitioner
KNMT	Royal dutch dental association (in Dutch: koninklijke nederlandse maatschappij tot bevorderding der tandheelkunde)
OHP	Oral healthcare practice
PA	Prophylaxis assistant
PPS	Periodic periodontal screening
sd	Standard deviation

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Not applicable.

Author contributions

J.d.B. conceptualized the study, conducted formal analyses, developed the methodology, and prepared the original draft. J.B. contributed to conceptualization, methodology, and supervision, and participated in reviewing and editing the manuscript. W.v.d.S. and K.J. contributed to methodology and were involved in reviewing and editing the manuscript. All authors reviewed the final version of the manuscript.

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Data availability

The anonymous data for this research were made available by a corporate dental company to the KNMT (Royal Dutch Dental Association) under the condition that they may only be used for the purpose of this research. As a result, there are restrictions on sharing the data publicly. The coded data supporting the findings of this study can be requested from the Research Department of the KNMT (KNMT, Postbus 4141, 3502 HC Utrecht, the Netherlands or by e-mail via staatvandemondzorg@knmt.nl). The KNMT will verify whether the request is reasonable.

Declarations

Ethics approval and consent to participate

The study has been reviewed by the ACTA Ethics Committee under file number 2024–90068. The committee has determined that the study meets the required ethical standards of ACTA. A Data Sharing Agreement was drawn up between the CDC and KNMT to make the data available. According to the CDC's general terms and conditions, pseudonymised personal data may be shared for research purposes, meaning that informed consent was effectively obtained through these terms and was therefore not required separately for this specific study. The research was conducted in compliance with the ethical principles of the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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