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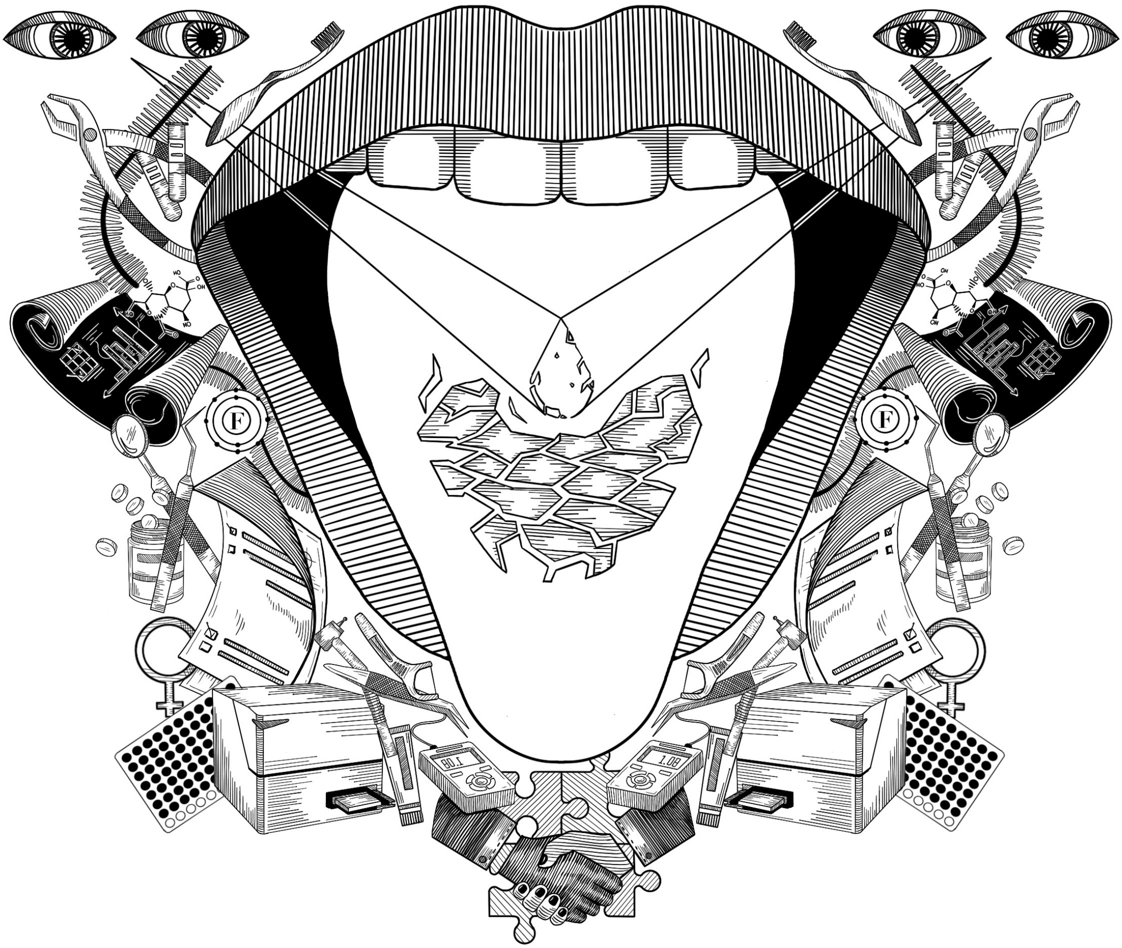

Amela Fišić

Oral dryness from different perspectives

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Thesis for Doctoral Degree (PhD)
By Amela Fisic

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Study I. Fisic, A., Aras, H. C., Almhöjd, U., & Almståhl, A. (2024). Dental care professionals' awareness of oral dryness and its clinical management: a questionnaire-based study. BMC Oral Health, 24(1), 45

Study II. Fišić, A., Franzén, C., Lindqvist, S., & Almståhl, A. (2025). The complexity of managing oral dryness in general dental care. Journal of Dentistry, 154, 105615.

Study III. Fišić A., Almståhl A., Lindqvist S., & Franzén C. Dental professionals' views of collaboration in the care of patients with oral dryness—a qualitative interview study. *Submitted for publication*

Study IV. Fišić A., Blomqvist M, Cevik-Aras H., Almhöjd U., Wickstöm C., Sheerin N., & Almståhl A. Exploring oral dryness in relation to salivary secretion and saliva composition. *Manuscript*

ABSTRACT

Oral dryness, encompassing an individuals' subjective experience of dry mouth (xerostomia) and objectively measured unstimulated and/or stimulated decreased salivary secretion (hyposalivation), can impair chewing and swallowing and increase the risk of oral diseases, affecting quality of life and well-being. Notably, an individual's subjective experience of dry mouth does not always align with their salivary secretion rate, suggesting that saliva quality could be of importance. Previous research has examined saliva composition; particularly mucin MUC5B, highlighting the importance of mucin structure for the experience of dry mouth. Findings have been inconsistent, largely because of variations in study populations, saliva and methods used for saliva analysis. This underscores the need for further research. Additionally, earlier studies have explored dentists' knowledge and clinical management of oral dryness; however, despite its acknowledged clinical relevance, research shows that oral dryness remains an overlooked condition among dental professionals. Research on how dentists and dental hygienists manage oral dryness in dental care in Sweden is limited. Therefore, the overall aim of this thesis was to explore dental professionals' experiences in managing oral dryness, and to explore associations between xerostomia, clinical signs, salivary secretion rate, and saliva composition in affected individuals. The thesis is based on four studies, where study I is based on a questionnaire, studies II and III are based on semi-structured interviews, and study IV is based on a questionnaire, clinical examinations, and laboratory analyses.

In **study I**, dentists' and dental hygienists' awareness and management of oral dryness were examined, as was the influence of length of professionals' experience on these aspects. Results showed that older adults were more often asked about their experience of dry mouth than were younger individuals. Dental hygienists encountered individuals with oral dryness more often, asked a larger age span about their experience of dry mouth, measured salivary secretion rate, and provided preventive measures more compared to dentists. Dentists showed greater awareness of saliva function, while dental hygienists showed greater awareness of the causes and complications of oral dryness.

The findings from study I were evaluated, and to some extent confirmed in studies II and III. In **study II**, dental professionals' experiences showed that managing oral dryness includes challenges like the heterogeneity of the patient group, barriers to measuring salivary secretion, vague routines, lack of treatment options

and a necessity to remain up-to-date of current research; however, dental professionals also applied a patient-centred approach in managing oral dryness, including tailoring questions to the individual, viewing the patient holistically, and engaging in sharing-decision-making. In **study III**, dentists' and dental hygienists' experiences collaborating with physicians showed hindrances to collaboration because of dental subsidy application issues, lack of contact pathways, and perceived limited knowledge among physicians. Dental professionals suggested measures to address these hindrances including taking over responsibility for dental subsidies and calling for physicians to improve the information they give to individuals with oral dryness. Collaboration between dentists and dental hygienists was defined by a resource-optimising approach and by clear roles, with dentists playing a coordinating role and dental hygienists playing the key role in the collaboration.

In **study IV**, saliva secretion, saliva composition (MUC5B, sialic acid, total protein concentration), clinically assessed oral dryness, and severity of xerostomia were explored and compared between two xerostomia groups with different aetiologies (Sjögren's disease and unspecific dry mouth) and controls. The Sjögren's disease group (n =16) and the unspecific dry mouth group (n =9) had significantly higher sialic acid levels, lower total protein output, and higher clinical oral dryness score (CODS). Xerostomia was more severe in the Sjögren's disease group compared to the unspecific dry mouth group. Very strong correlation was observed between CODS and both unstimulated and stimulated salivary secretion rates. In the unspecific dry mouth group, the severity of xerostomia showed a very strong correlation with saliva composition (sialic acid, MUC5B, and total protein concentration), whereas moderate correlations were observed between CODS and xerostomia severity, and between CODS and stimulated salivary secretion rate in the Sjögren's disease group.

This thesis concludes that managing oral dryness in dental care is challenging, but a patient-centred approach may be crucial. The findings indicate that saliva secretion rates, xerostomia severity, saliva composition, and clinically assessed dryness differ across groups with xerostomia of different aetiologies where individuals with Sjögren's disease appear to be more affected. However, further research is needed.

POPULÄRVETENSKAPLIG SAMMANFATTNING

Muntorrhet är ett vanligt problem som kan påverka både allmänhälsa och livskvalitet. Det handlar dels om hur torr munnen upplevs, dels om hur mycket saliv som faktiskt produceras. När salivmängden minskar kan det bli svårare att tugga och svälja, och risken för sjukdomar i munnen ökar. Det kan i sin tur påverka välbefinnandet och livskvaliteten. Känslan av muntorrhet stämmer inte alltid överens med den faktiska salivproduktionen. Det tyder på att salivens kvalitet, inte bara mängden, kan spela en viktig roll. Tidigare forskning har därför tittat närmare på salivens innehåll, bland annat proteiner och specifikt ett protein som heter MUC5B, som gör saliven trögflytande och hjälper till att fukta och smörja munnen. Studiernas resultat har varierat, vilket troligtvis beror på skillnader i analysmetoder för att analysera saliven och urval av deltagare till studierna. Därför behövs mer forskning inom detta område. En annan aspekt är tandvårdspersonalens roll. De få studier som finns visar att muntorrhet ofta förbises, trots att det är vanligt förekommande. Vi vet fortfarande ganska lite om hur tandläkare och tandhygienister i Sverige tar hand om personer med muntorrhet. Syftet med avhandlingen var att beskriva tandvårdspersonalens erfarenheter av att ta hand om personer med muntorrhet samt att undersöka möjliga samband mellan upplevd muntorrhet, salivmängd, kliniska tecken på muntorrhet och salivinnehåll.

Avhandlingen består av fyra delstudier. Tre av dem undersökte hur tandvårdspersonal tar hand om personer med muntorrhet och hur tandvårdspersonal samarbetar med hälso- och sjukvården kring personer med muntorrhet. Detta gjordes dels genom en enkät (Delstudie I) och intervjuer med tandhygienister och tandläkare (Delstudie II och III). I den fjärde delstudien har personer med muntorrhet orsakat av Sjögrens sjukdom (en kronisk autoimmun sjukdom som påverkar kroppens körtlar, framför allt saliv- och tårkörtlar, vilket leder till torra ögon och mun), personer med muntorrhet av oklar anledning samt personer utan muntorrhetsbesvär och med normal salivmängd (kontrollgrupp) inkluderats. Deltagarna besvarade frågor om sina muntorrhetsbesvär och torrheten i munnen undersöktes kliniskt. Salivmängden mättes och salivproverna analyserades med avseende på proteininnehåll, mucinet MUC5B och sialinsyra, som är en viktig del av muciner. Därefter undersöktes möjliga samband mellan salivmängd, salivens innehåll och kliniska tecken på muntorrhet i relation till upplevd muntorrhet.

Delstudie I visade att tandläkare och tandhygienister har god medvetenhet om salivens funktioner samt om orsaker och komplikationer vid muntorrhet. Tandhygienister visade sig ha en högre medvetenhet om orsaker och komplikationer av muntorrhet jämfört med tandläkarna, medan tandläkarna hade en högre medvetenhet om salivens funktioner. Resultatet visade också att äldre personer i högre grad tillfrågades om sin upplevelse av muntorrhet och att tandhygienister i större utsträckning tar hand om personer med muntorrhet. Tandhygienister träffar oftare personer med muntorrhet, tillfrågar personer i ett större åldersspann om deras upplevelse, mäter salivsekretion oftare och ger förebyggande vård i större utsträckning än tandläkare.

Delstudie II visade att omhändertagandet av personer med muntorrhet innefattar flera utmaningar, såsom stor variation i vilka som är drabbade av muntorrhet, vilket kan försvåra identifiering av drabbade, svårigheter att genomföra mätning av salivsekretionen, otydliga rutiner, brist på behandlingsalternativ samt ett ständigt behov att hålla sig uppdaterad inom området. Tandläkarna och tandhygienisterna tillämpade ett patientcentrerat förhållningssätt genom att anpassa frågorna till den enskilda personen, se patienten ut ett helhetsperspektiv och tillämpa gemensamt beslutsfattande.

Delstudie III visade att samarbetet mellan tandvård och hälso- och sjukvård inte alltid fungerar smidigt. Ett hinder är samarbetet med läkare, där ansökan om särskilt tandvårdsbidrag inte fungerar som den ska, begränsad kommunikation och upplevelsen av att läkare har otillräcklig kunskap om muntorrhet och dess koppling till oral hälsa. Studien visade samtidigt att tandvårdspersonalen har tydliga roller i omhändertagandet av personer med muntorrhet. Tandhygienisterna är oftast de som tar hand om dessa patienter, vilket innebär att de har en central roll i att upptäcka dem och ge rekommendationer och behandling för att förebyggande ohälsa i munnen.

Delstudie IV visade att det var tydliga skillnader både i salivens sammansättning och i upplevd muntorrhet mellan personer med Sjögrens sjukdom och personer med muntorrhet av oklar anledning. Båda grupperna hade högre nivåer av sialinsyra, lägre utsöndring av protein samt fler kliniska tecken på muntorrhet jämfört med kontrollgruppen. Svårighetsgraden av muntorrhet var störst hos personer med Sjögrens sjukdom. Det var samband mellan observerad klinisk torrhet i munnen och mängden saliv, både vilo- och tuggstimulerad saliv. Hos personer med Sjögrens sjukdom fanns samband mellan upplevd muntorrhet och kliniska tecken på torrhet i munnen, samt mellan observerad torrhet i munnen och mängden tuggstimulerad saliv. I gruppen med muntorrhet av oklar anledning fanns samband mellan svårighetsgraden av muntorrhet och salivens innehåll (sialinsyra, MUC5B och proteinmängd).

Sammanfattningsvis visar avhandlingen att tandvårdspersonalen upplever begränsningar som påverkar omhändertagandet av personer med muntorrhet, men att ett patientcentrerat tillvägagångssätt är viktigt för denna patientgrupp. Resultaten visar också att svårighetsgrad av upplevd muntorrhet, salivsekretion, salivens sammansättning och kliniska tecken på muntorrhet skiljer sig beroende på orsak till muntorrheten, där personer med Sjögrens sjukdom verkar vara svårast drabbade. Det behövs dock ytterligare forskning.

THESIS OVERVIEW

AIM	STUDY DESIGN	MATERIAL AND METHODS	CONCLUSION
Study I			
Describe and compare awareness among dental care professionals regarding saliva functions, potential causes and complications of oral dryness, and patient management. Investigate whether the length of professional experience influences these aspects	Quantitative cross-sectional survey study	Dentists and dental hygienists employed in public dental services across various regions in Sweden (n =496).	Compared to dentists, dental hygienists showed greater attentiveness to patients with oral dryness because they encountered them more often, asked more age groups about oral dryness, recommended more frequent preventive measures, and possessed a higher awareness of the causes and complications of oral dryness. Length of professional experience could improve both management of patients with oral dryness and understanding of its underlying causes, particularly among dental hygienists.
Study II			
Describe the experiences of general-practicing dental professionals' in managing oral dryness	Exploratory qualitative interview study	Dentists (n =4) and dental hygienists (n =9) working in public and private dental care across various regions in Sweden.	Managing patients with oral dryness is experienced as challenging. Adopting a patient-centred approach tailored to each patient's needs seems important for managing oral dryness in dental settings.
Study III			
Explore the experiences of dentists and dental hygienists collaborating with physicians and with each other regarding patients with oral dryness	Exploratory qualitative interview study	Dentists (n =4) and dental hygienists (n =9) working in public and private dental care across various regions in Sweden.	Collaboration between dental professionals and physicians may be hindered. Dental professionals propose ways of overcoming these hindrances. Within dental care, collaboration involves clearly defined roles, and the work is guided by a resource-optimised approach.
Study IV			
Explore salivary secretion rate, total protein, mucin MUC5B, sialic acid, and clinically assessed oral dryness, and how these factors correlate with the severity of xerostomia	Quantitative cross-sectional clinical study	Individuals experiencing dry mouth due to Sjögren's disease (n =16), or unspecified dry mouth (n =9), and sex- and age-matched controls (n =18)	The severity of xerostomia appears to be associated with the unstimulated salivary secretion rate and saliva composition in the unspecified dry mouth group, and seems to be connected to clinically assessed oral dryness and stimulated salivary secretion in the SjD group.

ABBREVIATIONS AND VOCABULARY

CODS – Clinical Oral Dryness Score

Hyposalivation – unstimulated salivary secretion rate ≤0.1 mL/min *and/or* a stimulated secretion rate ≤0.7 mL/min

kDa - kilodalton

MDa - megadalton

Mucin MUC5B – salivary glycoprotein

Oral Dryness – subjective experience of dry mouth and decreased salivary secretion rate

Sialic acid – monosaccharide, last attached on the oligosaccharide chains of mucins.

SjD – Sjögren's disease

XI – Xerostomia Inventory

Xerostomia – subjective experience of dry mouth

INTRODUCTION

In this section, oral health is described followed by descriptions of salivary glands, and salivary secretion and its composition. This is followed with oral dryness and its aetiology, diagnostics, and therapeutic approaches. Finally, it explores earlier studies about how dental professionals manage individuals with oral dryness in general dental care, including in collaboration with health care.

Oral dryness, dry mouth, xerostomia, and hyposalivation are sometimes used interchangeably by clinicians and in research (1, 2). Hereafter, the term ‘oral dryness’ will be used when referring to both xerostomia and hyposalivation, meaning the subjective experience of dry mouth and decreased salivary secretion.

Oral Health

Historically, oral health has focused on the biomedical perspective, meaning the absence of disease, condition, or disability. The professionals’ perspectives have been central, meaning that an individual’s experiences, perceptions, and values has been considered to be of little value. Research on oral health’s connection to overall health has showed that oral health is not just absence of disease, but is more complex and includes other perspectives as well as individuals’ experiences and perceptions. Given this, a new definition of oral health was necessary.

The latest definition of oral health is as follows:

> “Oral health is multifaceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow, and convey a range of emotions through facial expressions with confidence and without pain, discomfort, and disease of the craniofacial complex” (3)

Furthermore, oral health is of the utmost importance for overall health, and encompasses physiological, social, and psychological dimensions, all of which are essential for quality of life. Oral health contributes to both physical and mental well-being and is shaped by the values and attitudes of individuals and communities. Oral health can also develop over time through an individual's changing experiences, perceptions, expectations, and ability to adapt to new situations (3). This suggests that oral health is closely linked to various factors that must be considered for good oral health.

Oral health theoretical framework

A framework for oral health was developed during the creation of the latest definition of oral health. The framework outlines four main components of oral health: the core elements of oral health, moderating factors, driving determinants, and overall health and well-being. The framework was intended to present an comprehensive picture of the definition of oral health and clarify how the core elements of oral health are affected by moderating factors, driving determinants, and how these affect overall health and well-being (represented by arrows in Figure 1) (3).

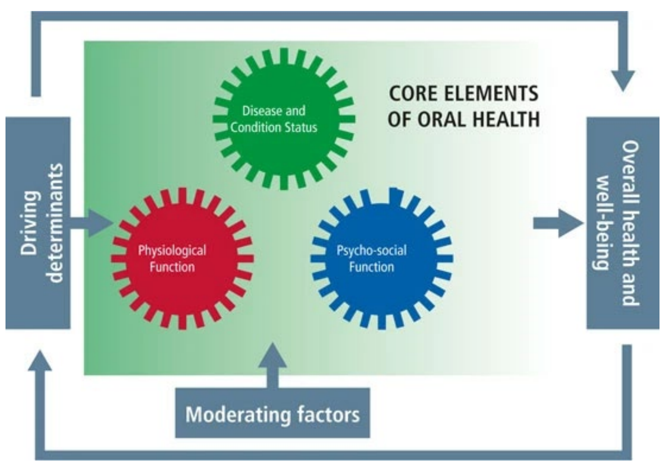

Figure 1. Oral health theoretical framework and included components, core element of oral health, moderating factors, driving determinants and overall health and well-being adapted from (3).

The core elements of oral health include disease and condition status, physiological function, and psycho-social function. 'Disease and condition status' refers to an individuals' current oral health status, including the presence, progression, and severity of a given disease or condition. 'Physiological elements' refers to the ability to perform daily activities such as chewing, swallowing, and talking. 'Psycho-social functions' refers to the ability to function in social and work contexts without feeling discomfort. 'Moderating factors' refers to how an individual values or scores their oral health, representing individual-related factors such as age, expectations, or experiences, among others. 'Driving determinants' are factors affecting oral health, including genetic, biological, social, and environmental factors, the physical environment, health behaviours, and access to care. The framework in Figure 1 shows how each element impacts overall health and well-being (3). Saliva plays an important role in maintaining good oral health and is essential for overall health (4-7), which will be described in more detail in this thesis.

Saliva and its role in oral health

The multiple functions of saliva are essential for maintaining oral homeostasis and are dependent on its properties and composition (8), as illustrated in Figure 2. Saliva plays a role in digestion and bolus formation, lubricates the oral mucosa, and maintains moisture. Saliva also helps buffer acids, supports teeth mineralisation, and many of its components are antiviral, antibacterial, and antifungal. Furthermore, it aids in wound healing (8-10) (see Figure 2.) To understand how these functions are maintained, it is essential to describe the origins and composition of saliva, beginning with the salivary glands.

Figure 2: Saliva functions, modified from Vila et al. 2015 and Roblegg et al. 2019 (7, 11).

Salivary glands

Saliva is produced by three pairs of major salivary glands and by hundreds of minor salivary glands (6, 11). The major salivary glands include the parotid, submandibular, and sublingual glands (6). The recently discovered tubarial glands, located in the posterior nasopharynx, share structural similarities with the minor palatine salivary glands, although their role in saliva production remains uncertain (12).

The salivary glands consist of acinar cells, duct cells, and myoepithelial cells. The acinar cells from acini, also called end-pieces. These end-pieces can contain mucous cells producing a viscous secretion, serous cells producing a watery secretion, or a mixture of both cell types. The parotid glands produce serous saliva; the submandibular glands produce a mixture of serous and mucinous saliva; and the sublingual glands, along with minor salivary glands (also called mucosal glands), except for the von Ebner's glands, produce mucinous saliva (6, 7, 13, 14). Watery serous saliva is rich in amylase, whereas mucous saliva is rich in glycoproteins, such as MUC5B (7).

There are three types of ducts in the major salivary glands (intercalated ducts, striated ducts, and excretory ducts), through which the primary saliva excreted from acinar cells passes before it is secreted into the oral cavity (8, 15). Striated ducts are absent in the sublingual glands (8). The function of ductal cells is to modify and transport saliva into the mouth (6, 8, 9). Saliva is modified as it progresses through the ducts. The saliva first passes the intercalated ducts without any modification. Most of the modifications occurs in the stratified ducts, where saliva is changed from an isotonic to a hypotonic fluid (containing lower concentration of salt) due to ion exchange. The saliva passes through the excretory ducts before entering the oral cavity (6, 9, 14, 15). The myoepithelial cells are wrapped around acinar cells and intercalated ducts and contract when stimulated, forcing the acini cells to compress and push saliva out into the ducts (8, 15).

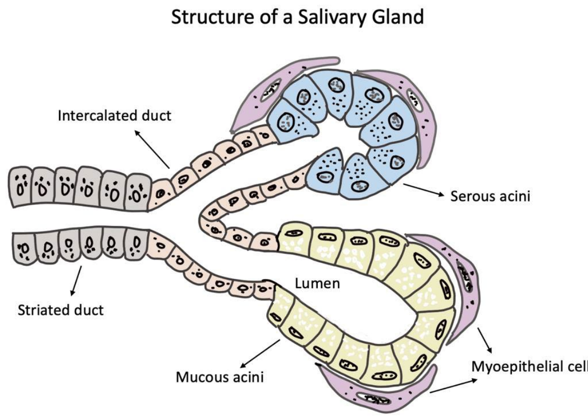

Figure 3: Schematic picture of the structures of salivary gland, mucous and serous acini (end-pieces), and myoepitheliial cells. Figure adapted from (16) Licensed under CC BY 4.0.

Salivary gland innervation and secretion

The major and minor salivary glands are innervated by nerves from both the parasympathetic and the sympathetic nervous system (7, 15). Saliva formation is regulated by the autonomic nervous system, and secretion is controlled through reflexes. After activation of the parasympathetic aspect of autonomic nervous system, a large amount of saliva is secreted which is rich in water but also contains proteins and electrolytes. On the other hand, activation of the sympathetic aspect of the autonomic nerve system results in protein-rich saliva (1, 8, 17). Both branches of the autonomic nervous system work synergistically, meaning that stimulation activates both the parasympathetic and sympathetic systems, contributing to an overall increase in saliva production (1, 18). The salivary glands are stimulated by mechanical stimulation (chewing) and by gustatory stimulation (activation of the taste buds). There are many factors affecting salivary secretion, including the degree of hydration, body position, circadian rhythm, gender, body weight, and gland size (6, 7, 14, 15, 19).

The major salivary glands produce approximately 0.5–1.5 L of saliva per day and account for 90% of the total volume of saliva (6, 7, 15). The minor salivary glands are distributed submucosally throughout the oral cavity, except on the anterior part of the palate. Minor salivary glands located on the tongue are called 'von Ebner's glands' (8, 17). Unstimulated saliva is mainly produced by the submandibular and sublingual glands (68%), followed by the parotid glands

(28%), and minor salivary glands (4%) (9). When the salivary glands are stimulated, the parotid glands produce 53% of saliva, followed by the submandibular and sublingual glands (46%), and minor salivary glands (1%) (9).

The unstimulated salivary secretion rate among healthy individuals is 0.3–0.4 mL/min, and the stimulated salivary secretion rate is 1.5–3.0 mL/min, but there is a large variation between individuals (19-21). Both unstimulated and stimulated saliva are essential for oral health; however, oral comfort is mostly dependent on unstimulated salivary flow. Stimulated saliva is essential for the clearance of food from the mouth (6). After outlining the structure and innervation of the salivary glands, and the secretion of saliva, the following section focuses on saliva composition.

Saliva composition

The saliva that enters the oral cavity is termed 'whole saliva' and contains 99% water and 1% electrolytes and proteins (6, 8, 19, 22, 23). There are several thousand proteins in human saliva (21, 24). The salivary proteins include amylase, proline-rich proteins (PRPs), glycoproteins (MUC5B and MUC7), agglutinins, immunoglobulins, cystatins, statherins, and histatins (23). The most common protein in stimulated saliva is the enzyme α amylase. Electrolytes found in saliva are mainly sodium, potassium, bicarbonate, phosphates, calcium, chloride, and magnesium (15, 23). The concentrations of electrolytes and proteins in saliva are affected by several factors, including gland origin, secretion rate, circadian rhythms, the type of stimulus, and the influence of various hormones (23). Saliva composition is highly determined by flow rate (6, 7), and the functions of saliva change based on its composition (25).

Salivary mucins

MUC5B and MUC7 are the main mucins in saliva (7, 10). MUC5B has a much higher molecular weight (1MDa) than MUC7 (150kDa) (10, 26). MUC5B and MUC7 differ in the structure of the attached oligosaccharides, where MUC5B has longer oligosaccharides compared to MUC7, explaining the higher molecular weight of MUC5B. Salivary mucin MUC5B forms a gel-like hydrophilic structure that covers the oral mucosa, providing lubrication and protecting the oral epithelium. MUC5B consists of a core protein rich in serine-threonine-proline (STP). The protein core of MUC5B allows oligosaccharides to attach, making up around 70%–80% of the total mucin molecular weight and varying in size and composition (7, 26, 27).

Sialylation and glycosylation are post-translational modifications of glycoproteins. In this process, sialic acid and glycans (carbohydrate chains including oligosaccharides) attach to proteins and/or carbohydrates (23). Sialic acid is a terminal monosaccharide of the oligosaccharide of mucins (17, 28, 29). The function of the sialic acid involves regulating interactions with the environment, which is possible because of its negatively charged attribute (30). Given the central role of MUC5B in maintaining lubrication and in moistening (28), alterations to and reduction of MUC5B have been associated with oral dryness, which will be described later in this section.

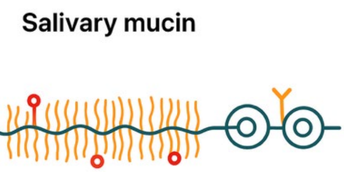

Figure 4: Mucin MUC5B with attached oligosaccharieds, the red dots represent the last attached monosaccaride sialic acid, adapted from (31).

Oral dryness

Oral dryness refers to the experience of dry mouth, which is due to reduced saliva production and/or changes in its composition (7, 8). The most commonly used terms in clinical settings are xerostomia and hyposalivation (6, 8). Xerostomia refers to the subjective feeling of dry mouth (6). Hyposalivation is diagnosed when the unstimulated salivary secretion rate is ≤0.1mL/min and/or the stimulated secretion rate is ≤0.7mL/min (32). Another definition of hyposalivation is a stimulated salivary secretion rate ≤0.5–0.7mL/min (2, 19, 20, 33). Research shows that there is no strong correlation between xerostomia and hyposalivation. An individual could experience xerostomia and have a salivary secretion flow within the normal range and individuals with salivary secretion rates below the normal range do not always experience xerostomia (6, 7, 34). A 50% reduction in the unstimulated salivary flow rate has been associated with an increased risk of xerostomia (20, 33).

Prevalence

Heterogeneous data have been presented on the prevalence of oral dryness because of the use of varying methods to evaluate oral dryness and different study populations (6). A systematic review from 2018 estimates the overall prevalence of oral dryness to be about 22% in the general population (35). The prevalence of xerostomia among individuals 18 years and older have been reported to be 22% in a study on a Swedish population (36). Furthermore, studies have shown that younger individuals, aged 18–55 years also report experiencing dry mouth (10%–30%) (37). There is a higher prevalence of xerostomia among women (37-41). Also, xerostomia is highly correlated with age (35, 39) and medication use (37).

Oral dryness aetiology

Oral dryness can be temporary and reversible if the cause is anxiety, acute infection, dehydration, heavy snoring, mouth breathing, or smoking (7, 33). In other cases, oral dryness is a chronic condition. One example is Sjögren's disease, which involves inflammation in the salivary glands (22, 32, 33). Another is radiotherapy for treatment of head and neck cancer (6, 7, 42), which can damage salivary glands (42) Other diseases affecting the salivary glands include endocrine diseases, such as diabetes mellitus types 1 and 2 (43, 44), and neurological diseases, such as Parkinson disease and Alzheimer disease (42). However, the most common causes of oral dryness are side-effects of medications (6, 7).

Medication-induced oral dryness

As mentioned above, the leading cause of oral dryness is the use of medications and especially polypharmacy (the simultaneous use of more than five medications) (7, 41). Over 500 medications list oral dryness as a side effect (45), including tricyclic antidepressants, anticholinergics, diuretics, hypoglycaemics, NSAIDs, and urinary antispasmodics (7). A population-based study showed that xerostomia was prevalent among individuals using medications involving diseases and disorders of the alimentary tract and metabolic system, nervous system, cardiovascular system, and respiratory system (41). Medications may either reduce salivary flow or change the composition of saliva (32, 46). Medications with anticholinergic effects block the neurotransmitter acetylcholine or inhibit muscarinic receptors, leading to decreased salivary secretion. The most common medications resulting in reduced salivary secretion are antidepressants, antipsychotics, and antihistamines (45). However, in most studies on the side-effects of medication, xerostomia is reported, but no measurement of salivary secretion rate has been performed (20, 45). This indicates that further research is needed, preferably research including both subjective experiences of xerostomia and measurements of salivary secretion rates.

Sjögren's disease

Sjögren's disease (SjD), previously known as Sjögren's' syndrome (47), is the second-most common cause of oral dryness (7). SjD is an autoimmune, chronic disease that primarily affects the exocrine glands, particularly the lacrimal and salivary glands (48, 49). SjD is more frequently observed in women (90%), especially women around 50 years old, and is estimated to affect 0.1%–1.0% of the population (49, 50). Its cause remains unknown, but immunological, genetic, hormonal, and environmental factors may interact and play a role (49). The disease includes a range of inflammatory changes that inhibit or damage the salivary glands, resulting in decreased salivary secretion. Common symptoms include dry eyes and mouth, fatigue, and joint pain (49, 50).

Oral dryness consequences

Individuals with oral dryness may experience oral discomfort and conditions such as fungal infections and halitosis (bad breath) (6), and an increased risk of oral diseases, especially caries (6, 7), which has been linked to mental disorders and depression (51). Oral dryness can also lead to functional impairments, such as difficulties speaking and eating due to impaired chewing and swallowing, which may cause malnutrition and negatively affect overall health (6-8). Additionally, oral dryness has been associated with sleep disturbances and an increased risk of depression and social isolation, further impacting overall health (52). This underscores that oral dryness affects not only oral health but also overall health, quality of life, and well-being.

Experience of oral dryness among affected individuals

As mentioned above, an individual's perceptions are important to consider when evaluating oral health (3). Individuals' perspectives and experiences of oral dryness have been described in few studies (53-55). Research including individuals with xerostomia showed that xerostomia has a devastating and debilitating impact on various aspects of well-being and quality of life (53), and that xerostomia can affect physical, emotional, and social functioning (54). Reported difficulties include eating and swallowing (53-55), restricted food choices, loss of taste (53, 55), disturbed sleep (54), and challenges in social interaction, often leading to isolation (53-55). Together, previous research emphasises the importance of individuals' subjective experience of the condition.

Saliva composition in individuals with oral dryness

Xerostomia cannot fully be explained by reduced salivary secretion. Research concerning the link between oral dryness and saliva composition is scarce and yields varying findings, because of the populations included in different studies, the measurement and analysis of varying types of saliva, and the different methods used to analyse saliva (30, 56-58).

In unstimulated saliva from individuals with various causes of oral dryness, such as Sjögren's disease (SjD), drug-induced dry mouth, and sialadenitis, the concentrations of MUC5B and MUC7 were comparable to those in controls (30). Similar findings were reported when comparing unstimulated saliva from individuals with SjD to controls (58). Glycosylation and sialylation of MUC5B and MUC7 were reduced in unstimulated saliva from individuals with oral dryness of various aetiologies (30, 58). Increased sialic acid levels in stimulated saliva among individuals with SjD and compositional changes in the O-glycans of mucins has been reported (56).

Total protein concentration in unstimulated saliva was higher in individuals with SjD compared to controls in some studies (30, 58), while another study reported lower total protein concentration in stimulated saliva in individuals with SjD compared to controls (56). Conversely, Vinke et al. found no significant differences in total protein concentration in stimulated saliva between individuals with SjD and controls (57). Total protein output was consistently lower in stimulated saliva from individuals with SjD compared to controls (56, 57). Protein output showed a weak negative correlation with subjective dry mouth and a positive correlation with both unstimulated and stimulated salivary secretion rates (56). Clinically observed dryness and subjective experience of dry mouth demonstrated weak but significant negative correlations with unstimulated saliva (30).

Taken together, previous studies suggest that qualitative changes in glycosylation and sialylation in MUC5B and changes in the composition of O-glycans (oligosaccharides attached to the protein core via O-glycosidic bonds) contribute to the experience of dry mouth. Further research is needed to understand how saliva composition is linked to oral dryness.

Diagnostic approaches for oral dryness

The diagnosis of oral dryness involves a detailed medical history (present symptoms, type and number of medications, systemic and oral diseases), extra- and intra-oral examination, and questions to evaluate presence and severity of xerostomia (20, 34).

Assessment of xerostomia

Since xerostomia is a subjective sensation, it can only be evaluated by asking the individual about their experience. There are several questions used to assess xerostomia; for example, a single yes/no question, which does not capture the severity and variability of xerostomia. A question like "how often does your mouth feel dry?" followed by time-related response options such as never, occasionally, frequently, and always, is therefore preferable (44). Thus, no consensus exists regarding which questions should be used to assess xerostomia (2, 32), especially in clinical studies (2).

The Xerostomia Inventory (XI) and the shortened Xerostomia Inventory (SXI), generate scores that help determine the severity of xerostomia. Xerostomia Inventory (XI) is a validated and frequently used questionnaire. It is comprised of 11 questions about the patient's experience over the past 4 weeks and is used to evaluate the severity of xerostomia. Five response options are provided on a 5-point Likert scale, from 'never' (1 point) to very often (5 points), resulting in a total score ranging from 11–55 points (59). It has been translated into many languages (60), but not yet into Swedish. SXI includes five questions related to dryness in the mouth in relation to eating and drinking. SXI is a condensed version of the XI, including five questions with only three answering alternatives (never, occasionally, and often) aimed at providing a quicker assessment when needed, such as in clinical settings (61).

A newly developed questionnaire, the Regional Oral Dryness Inventory (RODI), is used to determine differences in the experience of dry mouth across intra-oral locations. The questionnaire includes schematic illustrations of various locations in the upper and lower jaws (upper and lower lips, the posterior and anterior parts of the palate, the inside of the cheeks, the posterior and anterior parts of the tongue, and the floor of the mouth), on which individuals with oral dryness rate their experience of intra-oral dryness by using a Likert-scale ranging from 1 (no dryness) to 5 (severe dryness). RODI could be a valuable tool for early diagnosis of oral dryness, as it has been shown that RODI can differentiate between different dry-mouth groups with various causes of oral dryness (62).

Assessment of salivary secretion rate

Sialometry is the most common objective clinical method for determining salivary secretion rate and can be used to measure both unstimulated and stimulated salivary secretion rate (32) (25). The most common method to determine the unstimulated salivary secretion rate is the passive drooling method, where saliva is collected into a graded tube for 15 minutes while the individual is sitting in a relaxed position with the head slightly bent forward. The most used method for determining stimulated salivary secretion rate is the paraffin wax method. In this procedure, paraffin wax is chewed until it becomes soft, followed by a single swallow, chewing then continues, and saliva produced is spit out the into a graded tube for five minutes. Other less-common approaches for the determination of stimulated salivary secretion rate are gustatory stimulation with, for example, citric acid (33).

Clinical assessment of dryness in the mouth

To determinate dryness in the mouth, the Clinical Oral Dryness Score (CODS) where dryness in the mouth is rated by a healthcare professional can be used (33, 63). CODS involves a clinical and visual examination of different sites in the mouth. Features examined include, for example, whether saliva pools in the floor of the mouth and whether a dental mirror sticks to the tongue or buccal mucosa. Each positive observation scores 1 point, and the total score can vary from 0 to 10 points. Scores of 1–3 indicate mild oral dryness, 4–6 moderate oral dryness, and 7–10 severe oral dryness (63).

Therapeutic approaches of oral dryness

Dental professionals should base treatment recommendations on each individual's underlying condition or causes of oral dryness (2, 64). The primary treatment for individuals presenting with oral dryness involves dental professionals evaluating the aetiology of the dryness, followed by informing patients about their condition, including advising them to avoid dry, acidic, and salty foods; reduce the frequency of sugar and caffeine consumption; and to avoid smoking and alcohol (25, 64, 65). Additionally, instruction on how to maintain proper oral hygiene is vital (25, 65), including brushing twice daily with high-fluoride toothpaste, and using a mouthwash containing fluoride. Dental professionals should apply fluoride varnish and advise regular follow-up visits, and can recommend the use of saliva stimulants or saliva substitutes (65). Also, if oral dryness is caused by the side-effects of medication, contacting the patient's physician to discuss exchanging or adjusting an individual's medication can be considered (64, 66). Managing oral dryness is focused on preventive therapeutic approaches to reduce the risk of oral diseases.

Saliva stimulants and saliva substitutes

Individuals with functionating salivary glands should be recommended to use saliva-stimulating agents such as sugar-free gum or lozenges (64, 67). When salivary glands are no longer functioning, saliva substitutes such as gels, mouth rinses, and sprays should be recommended (64). Unfortunately, most products for relieving dry mouth have short-lived effects (64, 67). A recently published review and meta-analysis showed that for individuals with SjD, no effective topical therapies for the management of oral dryness are available (66). Accordingly, individuals with SjD reported adopting various coping strategies to manage the condition and its related symptoms (55). For individuals with mild symptoms, drinking water or sucking ice chips could provide sufficient relief (64).

Pharmaceutical treatments

There are also pharmaceutical treatments, such as Pilocarpine (68). Pilocarpine is a parasympathomimetic drug which acts on muscarinic receptors on salivary gland cells, stimulating saliva secretion (20). Significant improvements in salivary secretion rate and a reduced experience of oral dryness have been reported (43, 69). Also, pilocarpine has been shown to offer a longer duration of dry mouth relief compared to other methods including water, rinse, gel, or spray (20, 67). However, functional salivary gland tissue is required for pilocarpine use (20, 66). Pilocarpine has been shown to help patients with oral dryness, but it can have unwanted side effects, such as sweating, nausea, diarrhoea, headache, and chest pain (68, 70). Pilocarpine is contraindicated if patients have chronic respiratory, cardiovascular, or renal diseases (20, 64). In Sweden, Salagen is the only drug containing pilocarpine available on the market. Salagen can only be prescribed by physicians for managing symptoms of oral dryness caused by radiotherapy and SjD.

Management of oral dryness

In addition to the therapeutic approaches described above for management of oral dryness, it is essential to consider dental and healthcare professionals' views on managing affected individuals, as described in the following sections.

Dental professionals' management of oral dryness

Only a few studies have investigated dental professionals' awareness and approach in managing individuals with oral dryness. These studies were conducted in Sweden, Germany, England, and in several countries in Asia. (71-74). In an interview study, views on xerostomia were explored among healthcare professionals including physicians, dentists, dental hygienists, and district nurses (74). The study revealed that healthcare professionals perceived xerostomia to be a side effect of medication, which may have a negative impact on oral health and overall well-being. The healthcare professionals knew that xerostomia was common, particularly among older people, but was often neglected. The results also showed that healthcare professionals had insufficient knowledge of managing patients with the condition. Healthcare professionals pursued a holistic view and additional knowledge to achieve interdisciplinary collaboration in managing and supporting patients with xerostomia (74).

A survey examined general dentists' knowledge, attitudes, and clinical management of patients with oral dryness and the findings indicated that treating oral dryness is essential, but dental practitioners were unsure of how to effectively treat these patients (71). Another survey study explored dentists' attitudes, observations, and knowledge regarding the management of oral dryness. The results showed that while dentists were aware of the psychological and clinical implications of the condition, they lacked confidence in identifying and treating patients with oral dryness (72). A recent survey study conducted among dentists across several Asian countries found that only 34% had good overall knowledge of oral dryness. While 55.5% were aware of oral dryness management, 41.7% had poor knowledge, and 56.7% had moderate knowledge of the most useful diagnostic methods for assessing oral dryness. Regarding knowledge of clinical signs, symptoms, and the consequences of oral dryness, 75.5% to 84% appeared to have a good understanding. The dentists stated that they seldom (73.5%) or occasionally (21.3%) encounter cases of oral dryness. The study concludes that better education is needed concerning oral dryness, as well as how it is managed (73). In summary, oral dryness appears challenging to treat, and knowledge of its management (xerostomia and hyposalivation) is limited in dental care.

Healthcare professionals' management of oral dryness

Professionals outside dental care needs to become aware of and understand the importance of saliva for oral health, as well as the impact of oral dryness on both oral and overall health. This could aid in its early diagnosis, the prevention of its complications, and the treatment of the condition (6). It has been shown that individuals with xerostomia consult nurses and physicians for professional opinions on the underlying cause of their condition and seek support from them (74). General physicians lacked knowledge of oral dryness and rarely collaborated with dentists regarding this patient group, due to limited interprofessional communication. Physicians viewed xerostomia as more of an annoyance than a serious health concern (75). However, due to a lack of therapeutic products for managing oral dryness, healthcare professionals might consider the risk of either causing or worsening oral dryness when prescribing medications that list oral dryness as a side effect (64). If it is not possible to exchange or avoid the prescribed medication, individuals with oral dryness need to be informed about the side effects and the limited effect of products available to relieve xerostomia.

Collaboration concerning individuals with oral dryness

Given the well-established link between overall and oral health, collaboration between dental and healthcare professionals seems important for managing individuals with oral dryness (76), and the need for collaboration has also been highlighted by the World Health Organisation (77).

Collaboration between dental and healthcare professionals

In Sweden, a dental subsidy (special dental care allowance) intended for preventive care is available for individuals with hyposalivation caused by, for example, long-term medication use or Sjögren's disease. The application process requires collaboration between physicians and dental professionals. Physicians need to complete a medical certificate form [issued by the National Board of Health and Welfare] confirming the individuals' condition or medication intake. This form is then provided to dental professionals, who are required to measure the individual's unstimulated and stimulated salivary secretion rates, a measurement paid by the individual. If the unstimulated salivary secretion rate is ≤0.1mL/min and the stimulated salivary secretion rate is ≤ 0.7mL/min, the individual qualifies for the dental subsidy (78).

Collaboration between healthcare and dental professionals is challenging, as both organisational and professional factors can influence collaboration. Organisational factors, such as the absence of structures for collaboration, different financing models, and non-integrated patient record systems are some factors mentioned in the Swedish governmental report aiming at mapping hindrances to collaboration between dental care and healthcare (79). Challenges on the professional level could include different views and expectations regarding collaboration, with dentists seeing benefits such as better patient outcomes and physicians failing to recognise the value of collaboration (80), but also poor communication and role ambiguity (81). Competition over specific work tasks or differing views as to what constitutes good patient care are factors that also could influence collaboration among professionals (82, 83).

In contrast, in some studies, collaboration between different professions has been proven to work. A study showed the importance of professionals with different roles (midwives, paediatric nurses, social workers, and dental hygienists or dental nurses) and how their competencies can complement each other when supporting first time parents in their homes (84). Another study showed that oral health care outcomes for patients with head and neck cancer can be improved through collaboration between healthcare and dental professionals (85). A concluding point is that collaboration concerning individuals with oral dryness can improve patient care through early detection and management, while also enhancing quality of life for patients.

Collaboration between dental professionals

Collaboration between dentists and dental hygienists is also important because professions possess different competencies (86, 87). Dental hygienists' primarily focus on preventive care (86), while dentists' competencies are needed when oral dryness progresses, causing complications such as caries, requiring treatment (87). Both sets of skills are required for comprehensive care.

Collaboration between dental professionals has been proven to face both barriers and facilitators. Prerequisites for collaboration might include communication taking place between dentists and dental hygienists (88-90). Effective communication could enhance patient satisfaction and improve oral health outcomes (88, 90). Understanding each other's roles, having a positive attitude toward collaboration, and interprofessional education during undergraduate studies are considered relevant for collaboration (89).

However, studies have shown that certain barriers can hinder collaboration (89, 91), such as dentists and dental hygienists working part-time, and not meeting each other on a daily basis, thereby affecting collaboration, as they do not have opportunities to consult each other (89). Other hindrances may include patients' preferences, differences in personality among dental professionals, or a shortage of dental hygienists, which affects task allocation (91). Conflicts regarding task division may also arise from variations in personal values, interests, and work experiences (92), as well as from an eagerness to perform identity-confirming tasks (93).

RATIONALE FOR THE THESIS

Oral dryness can lead to oral discomfort, an increased risk of caries, and altered taste sensation, among other complications. It also impacts overall health, since it can lead to difficulties eating and swallowing, which in turn can lead to malnutrition. The prevalence of oral dryness is likely to increase due to longer life expectancy, a growing population of older adults, and increasing use of medications affecting the salivary glands.

Current knowledge is limited regarding how individuals with oral dryness are managed in dental care, and research indicates that not only the amount of saliva but also its composition is important for the experience of dry mouth. The rationale for this thesis lies in the need to increase the knowledge of how individuals with oral dryness are managed in general dental care, as well as to enhance understanding of the associations between the experience of dry mouth, salivary secretion rate, clinically observed dryness, and saliva composition.

This thesis aims to provide insights that can be used to improve management of individuals with oral dryness in dental care, as better care may improve oral health and quality of life. Furthermore, by investigating saliva composition in relation to the experience of dry mouth, clinically observed dryness and salivary secretion rate could contribute knowledge and aid in understanding the mechanism behind the symptoms experienced by individuals, and, over the long term, contribute to the development of better treatment options.

AIMS

The overall aim of this thesis was to explore dental professionals’ experiences in managing oral dryness, and to explore associations between xerostomia, clinical signs, salivary secretion rate, and saliva composition in affected individuals.

To address the overall aim, four studies were conducted, with their specific aims outlined below:

- Describe and compare awareness among dental care professionals regarding saliva functions, potential causes and complications of oral dryness, and patient management. Investigate whether the length of professional experience influences this awareness (Paper I).
- Describe the experiences of general-practicing dental professionals’ in managing oral dryness (Paper II).
- Explore the experiences of dentists and dental hygienists collaborating with physicians and with each other regarding patients with oral dryness (Paper III).
- Explore salivary secretion rate, total protein, mucin MUC5B, sialic acid and clinically assessed oral dryness, and how these factors correlate with the severity of xerostomia (Paper IV).

MATERIALS AND METHODS

In this section, the studies' designs, populations, data collection, and analysis are described.

Design

This thesis is based on four studies including both quantitative and qualitative approaches, intended to provide a comprehensive description.

Studies I and IV are quantitative cross-sectional studies, meaning that data were collected at a single point in time (94). Studies II and III are exploratory qualitative interview studies aiming to generating new knowledge or to reassess existing understanding (95).

Study populations

Study I

In total, 2668 dental professionals (1727 dentists and 941 dental hygienists) in Sweden were invited to participate in a digital survey. Of these, 241 (13.9%) dentists and 257 (27.3%) dental hygienists completed the questionnaire. The inclusion criteria were general dentists and dental hygienists employed in general dental care.

Studies II and III

Dental professionals who answered the questionnaire were asked about their interest in participating in an interview study, and if so, provided their contact details. They were then contacted, and, if they were still interested, they were recruited. Dental professionals were also recruited through advertising in private dental professional groups on social media. Following inclusion criteria had to be met, general dentists and dental hygienists with at least two years of professional experience, working in either public or private dental care, and encountering individuals with oral dryness. First, purposive sampling was used. Variations in profession, gender, years of professional experience, university of education, and regions worked in were considered when contacting interested participants. During the evaluation of participants' characteristics, a shortage of male dentists was identified, so snowball sampling was used for further recruitment. One colleague helped recruit male dentists, who received the survey link and were contacted by AF. In total, 15 dental professionals were recruited. Two were excluded: one because the inclusion criteria were not met, and one because of technical problems with the recording file.

Study IV

The sample comprised individuals with xerostomia and controls with normal salivary secretion rates who did not experience xerostomia.

Individuals with xerostomia were recruited from the Malmö Sjögren's syndrome registry (MSSR) and through social media advertisements in private groups for individuals with Sjögren’s disease. Additionally, information about the ongoing study was provided at patient organisation meetings and on Malmö University's web pages. A total of 25 individuals experiencing dry mouth were included. Sixteen had Sjögren's disease (hereafter referred to as the SjD group), and nine had no diagnosis to explain their dry mouth (hereafter referred to as the unspecific DM group).

Controls

Individuals without xerostomia and with normal salivary secretion rates (controls) were also recruited through advertisements on the Malmö University webpage and through the University’s dental care facilities at the Faculty of Odontology, Malmö University. Furthermore, recruitment was also conducted at the public dental service in Region Västra Götaland. A total of 18 individuals were included in the control group. The individuals were gender-matched and were in the same ages.

Data Collection

Data collection was based on questionnaires, one-on-one interviews, clinical examinations, and laboratory analyses of saliva samples.

Study I

Questionnaire

The digital questionnaire consisted of 32 mandatory questions which took approximately 10 minutes to complete. The questionnaire was evaluated before it was distributed to the regions; first by sending it to colleagues and then by testing it among dental professionals working in general dental care. Minor revisions were made.

Table 1 outlines the five sections included in the questionnaire. The questionnaire ended with a final question, in which dental professionals were asked whether they wished to receive additional education on oral dryness and oral health.

Table 1: The content of the section included in the self-administered questionnaire

	Questions	Answer options
1	Demographics (n =11)	
2	Content of undergraduate education (n =5)	
3	Approaches used in clinical practice for the management of individuals with oral dryness (n =11)	Fixed answers: always, never, seldom, never and don't know
4	Awareness questions about saliva functions, causes of oral dryness, and complications related to oral dryness (n =4)	5-point scale: strongly agree–strongly disagree, and the answer option "Don't know" was included.
5	Self-evaluation of knowledge questions	4-point scale: very good, good, satisfactory, insufficient

Studies II and III

Semi-structured interviews were conducted using one-on-one interviews. All interviews were conducted online through Zoom Video Communications or via Microsoft Teams. The interview guide consisted of open-ended questions. See Table 2 for the questions used in the two studies. The interviews were recorded by a digital voice recorder and transcribed verbatim.

Table 2: Questions in the interview guide used in studies II and III

Questions in study II	Questions in study III
What do you do if a patient says that he/she experiences dry mouth?	Can you tell me about your role as a dental hygienist/dentist in the care and management of individuals with oral dryness?,
What do you do when you have a patient who you suspect has oral dryness?	What is your experience with the special dental care allowance (STB)?
What do you think about the routines for patients with oral dryness?	What is your opinion of collaboration regarding patients with oral dryness with healthcare and within dental care?
What factors do you think affect the management of patients with oral dryness?	
What do you think about your knowledge on the management of patients with oral dryness?	

Saturation, studies II and III

After nine interviews had been conducted, similar experiences regarding the management of individuals with oral dryness were repeatedly reported by the informants. This was discussed with the other authors, who had more experience conducting qualitative studies, and a decision was made to continue with additional interviews. To ensure that enough data was obtained to answer the research question, an additional four interviews were conducted. AF, who interviewed all dental professionals, considered data saturation to have been reached after 13 interviews, according to how data saturation is described by Saunders et al. (96).

Study IV

As outlined in Table 3, data collection included a clinical examination, observed clinical dryness, objective assessments of oral dryness, and all individuals were asked to complete Xerostomia Inventory. Stimulated saliva was analysed for total protein concentration, MUC5B and sialic acid.

The data collection was conducted by one dentist and three dental hygienists. Data collection for all individuals with xerostomia (n =25) and 8 controls was performed by AF at the Faculty Dental Clinic, Faculty of Odontology, Malmö University, Sweden. The remaining controls (n =14) were recruited via the Public

Dental Service in Gothenburg or the Public Dental Service, Stenungsund, Region Västra Götaland.

Table 3: Description of data collection, including subjective measurment, oral examination and clinically assessed oral dryness, objective measurements and saliva analyses.

Measurements	Description of the measurements
Subjective measurement: Xerostomia Inventory Questionnaire	11 questions with response options from very often (5 points) to never (1 point) resulting in total score varying from 11 to 55 points. Higher scores indicate more severe xerostomia
Clinical examination	Number of teeth, restored filled teeth, prosthetic constructions, bleeding on probing (BoP), pocket probing depths ≥5mm.
Clinical observed dryness Clinical Oral Dryness Score (CODS)	Clinical dryness was evaluated using CODS on 10 sites in the mouth, resulting in a total score of 0–10 points, indicating either mild dryness (1–3 points), moderate dryness (4–7 points), or severe dryness (8–10 points).
Objective measurements: Unstimulated salivary secretion rate, Stimulated salivary secretion rate	Unstimulated saliva was collected during 15 minutes Paraffin-wax stimulated saliva was collected for 5–10 minutes.
Analyses of stimulated saliva Total protein concentration ELISA ELLA	Measurement of total protein concentration, levels of MUC5B and sialic acid

Saliva analysis

Stimulated saliva was used for analysis, and a detailed description of the methods are shown in Paper IV.

Assessment of total protein concentration and output

Total protein concentration was analysed using PierceTM bicinchoninic acid assay (BCA) kit. First, saliva was diluted and placed into wells of a 96-well microtiter plate together with a standard solution containing bovine serum albumin (BSA). Next, a prepared reagent was added to each well. The plate was incubated at 37°C for 30 minutes. After the incubation, the colour change was measured using a plate reader. Total protein concentration was calculated in relation to the standard.

Assessment of MUC5B

MUC5B were analysed with an enzyme-linked immunosorbent assay (ELISA). In the first step, saliva was diluted and added to the wells of a 96-well microtiter plate. A coating buffer was used as negative control, and human salivary MUC5B was used as a positive control. The plate was then incubated at room temperature overnight. The next day, the plate was washed three times with a washing solution to remove unbound proteins. Afterwards, a blocking solution was added, and the plate was then incubated for one hour at room temperature. After incubation, the blocking solution was removed and a primary antibody—MUC5B 4A10-H2 diluted 1:1000 in blocking solution that binds to MUC5B—was added and the plate was incubated for two hours. After washing three times, a secondary antibody—Goat anti-Mouse IgG conjugated with horse radish peroxidase (HRP) diluted 1:1000 in blocking solution—was added, and the plate was incubated for one hour. The final step was to wash the plate three times again and add a colour-producing substrate. The colour change was measured at 450nm using a plate reader, both immediately and after 30 minutes.

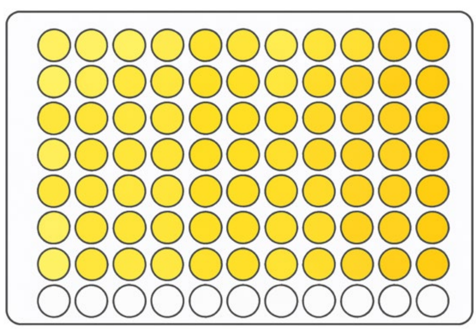

Figure 5: A 96-well microplate showing increase colour intensities, which means a higher absorbance levels of proteins.

Assessment of sialic acid

Enzyme-linked lectin assay (ELLA) was used to determine sialic acid levels. Saliva was diluted and added in the wells of a 96-well microtiter plate. The coating buffer was used as negative control and MUC5B was used as a positive control. After adding all saliva samples and controls, the plate was incubated at room temperature overnight. The next day, the plate was washed and a blocking solution was added. After one hour of incubation, the blocking solution was removed. The HRP-conjugated lectin *Maackia amurensis* was used to detect sialic acid it was added to each well. After another hour of incubation at room temperature, the plate was washed three times to remove unbound lectins. After this, a substrate solution was added, which led to the development of colour. The colour change was measured using a plate reader at 450nm. Measurements were taken immediately and again after 30 minutes (Figure 3).

Data analysis

Data analysis is described in this section.

Descriptive and analytic statistics (studies I and IV)

In study I, cross-tabulation and the chi-square test or Fisher's exact test were used to analyse differences in responses between the professions. In study IV, one-way ANOVA with Tukey's multiple comparisons test was used for comparisons between the three groups. Correlations were conducted through the Spearman's rank correlation coefficient (ρ) test. The protein output was determined with multiplying the concentration by the stimulated salivary secretion rate.

The statistical analysis in studies I and IV was performed using the Statistical Package for the Social Sciences (SPSS, IBM SPSS Statistics, versions 27.0 and 29.0; Armonk, NY: IBM Corp). P-values <0.05 was considered statistically significant.

Qualitative content analysis (studies II and III)

The data in studies II and III were analysed using qualitative content analysis following the approach by Graneheim and Lundman (97, 98). The approach involves a step-by-step, systematic analysis that includes de-contextualisation and re-contextualisation. The first step was to read through all the transcripts multiple times to gain an understanding of their content. In the second step, during the de-contextualisation phase, meaning units are identified and condensed. In other words, relevant meaning units for the study aim are extracted from the original interviews and shortened to enhance understanding while still preserving their core meaning. The third step involves assigning a code to each of the condensed meanings. These codes can be one word or several words. The fourth step, and the first in the re-contextualisation phase, entails identifying similarities and differences among the codes and categorising them into groups that fit together. These groups form categories, which are abstracted. The final step is to develop themes. In this concluding stage, categories are integrated, and a common thread is identified, allowing for the interpretation and abstraction of categories into a theme. Throughout the entire analysis process, there was movement between the original text, codes, meaning units, categories, and themes.

ETHICAL CONSIDERATIONS

All studies (I–IV) included in this thesis were carried out in accordance with the ethical principles outlined in the Declaration of Helsinki (99). Ethical approval was obtained for all studies from the Swedish Ethical Review Board, studies I–III fell under Dnr: 2021-01795, and study IV is under Dnr 2021-06733-01 and Dnr 2020-03094.

Participants in studies I–III (dental professionals) and study IV (individuals) were provided written information regarding the purpose of the study, procedure of the study and methods used, and the safeguards applied to ensure confidentiality. They were also informed that participation was voluntary, provided an explanation of informed consent, and were notified of their right to withdraw their participation at any time without further explanation. Consent to participate was obtained from all participants in all studies (I–IV), in accordance with the ethical principle of autonomy.

The management of personal data adhered to ethical principles of integrity and confidentiality and complied with the legal requirements of the General Data Protection Regulation (100, 101), to which all studies (I–IV) were subject. All data were securely stored, and results were presented in a way that ensures the anonymity of the participants.

Study IV involved the collection and processing of sensitive personal data, such as health-related information, and included a clinical examination, which constitutes a physical intervention. Therefore, the study was subject to the Swedish Act concerning research involving humans (102). Furthermore, biological material (saliva) was collected from living individuals. As saliva samples are traceable to individual participants, and the Biobank Act was also applicable.

RESULTS

The results in this thesis are based on data from four studies (I–IV) and are structured under three headings: first, the characteristics of the individuals included in the studies (I–III) are described; then, the main results from studies I–III are synthesised and presented. Finally, the demographics and main results from study IV are presented. For detailed results, see papers I–IV.

Studies I–III: Demographics

Study I

The response rate was 18.6% (n =498/2668), with 241 dentists and 257 dental hygienists completing the questionnaire. All respondents were dental professionals, employed in Public Dental Services, and working in Skåne, Stockholm, Västra Götaland, Dalarna, and Kalmar regions. Among the dental professionals, 50.2% had more than 10 years of professional experience. Mean age of dental professionals was 41.9 years (SD=11.7), and the majority were women (83.7%).

Studies II and III

A total of 13 dental professionals were included. The sample consisted of nine dental hygienists and four dentists. Nine worked in public dental care, and four worked in private dental care. Eight were women, and 12 had completed their undergraduate education in Sweden.

Studies I–III: Current management of oral dryness

Findings from studies I–III revealed that managing oral dryness entails challenges which are synthesised and presented below.

Identifying individuals with oral dryness

The results showed that dental professionals use indicators to identify patients with oral dryness. These include patients' current and past medication use, clinical examination of mucosa and tongues, and previous and current diseases. Additionally, 88.5% of dentists and 90.0% of dental hygienists reported asking patients about their experience of dry mouth during anamnesis.

In study II, under the theme *challenges in managing oral dryness*, dental professionals described that routines for managing patients with oral dryness were inconsistent and not clearly defined. This led dental professionals to adopt various approaches, often choosing to ask only selected patients about their experience of dry mouth. This selective questioning was based on specific parameters, such as medical conditions, medication intake, age, and clinical signs of oral dryness rather than applying a standardised routine to ask all individuals. However, some dental professionals described that they asked all patients.

The heterogeneous nature of the patient group was also found to be challenging. Dental professionals noted that oral dryness could affect patients across both genders, of all ages, with or without diseases, and both those using and not using medication. Dental professionals experienced that this is a huge group with increasing prevalence, especially among younger individuals taking medication.

Diagnosis

In study I, applications for dental subsidy were the primary reason for assessing salivary secretion rates. This was followed by clinical signs of oral dryness and patients' responses to the anamnestic question.

This was further evaluated in study II and in the theme *challenges in managing oral dryness,* where dental professionals described that assessing a patient's salivary secretion rate based on clinical signs, oral-dryness–related conditions, and medication use. However, measuring salivary secretion was associated with several challenges. One challenge was the costs associated with measurement that had to be covered by the patient, which could potentially influence their willingness to undergo the test. Dental professionals emphasised that patients would be more willing to undergo the measurement if it was free of charge.

Another difficulty arose when patients received results within the normal range, despite experiencing dry mouth, which not only caused disappointment but also rendered them ineligible for dental subsidies, thereby adding to their dissatisfaction.

Treatment options

Study I showed that the most frequently recommendations for patients with oral dryness were saliva-stimulating products (97.0%), meticulous daily oral hygiene (95.3%), and extra fluoride (90.3%).

Study II and the theme *challenges in managing oral dryness* described the limited available treatment options and their short-lived effects, which made dental professionals feel helpless and frustrated and wishing for more effective treatment options. Dental professionals also described that they did not recommend extra fluoride for individuals with oral dryness, but only for individuals with caries. Instead, they recommended toothpaste developed for patients with oral dryness, and dietary advice, including consuming foods rich in fibre and avoiding sugar and easily fermentable carbohydrates. Drinking plenty of water was also recommended.

The lack of continuing education

Study I showed that awareness of saliva functions and the causes and complications of oral dryness were generally good among dental professionals. Awareness of factors associated with oral dryness was better among dentists and dental hygienists with more than 10 years of professional experience compared to those with less than 10 years. The study also showed that 96% of dental professionals reported having gained knowledge about saliva and oral dryness during their undergraduate education, and 87% reported having had practical training in measuring salivary secretion rates during this period. Only 12% of the dental professionals reported having attended continuing education concerning saliva and oral health.

This was further explained in study II, in the theme *challenges in managing oral dryness,* where dental professionals explained that they continued to seek new information during their clinical practice but pointed out the lack of continuing education regarding saliva and oral dryness. They generally relied on the knowledge they had gained from their undergraduate education.

Furthermore, study I also showed that about 75% expressed a desire for further education regarding saliva and oral health. It was even more apparent among those with less than 10 years of professional experience compared to dental professionals with over 10 years of experience.

In study II, within the theme *challenges in managing oral dryness,* dental professionals emphasised the importance of clinical experience in managing patients with oral dryness, as recognising the oral signs can be challenging for new graduates.

Lacking collaboration

In study I, only 30% of dentists and 15% of dental hygienists reported that they contacted their patient's physician to discuss medication exchanges due to side effects from medications.

This was further explained in study III, under the theme *hinders for collaboration with physicians*, where dental professionals explained that they lacked contact pathways for communicating with physicians, hindering collaboration. As a result, it was common for patients to become the link between the dental professional and the physician, and the patient takes on a role as a connector for assimilating information from dental professionals and communicating these details to their physician. Another hindrance to collaboration involved the application for the dental subsidy (special dental care allowance) for preventive dental care, where physicians need to fill out a medical certificate which the patients then had to bring to dental professionals. Dental professionals perceived that physicians had a limited understanding of what a dental subsidy is and how the application process works. Dental professionals also perceived that physicians lacked awareness of how oral dryness complications can affect oral health, and did not provide enough information to their patients about oral dryness as a side effect when prescribing medications.

Studies I–III: Improving management of oral dryness

A potential approach to addressing the encountered challenges is presented here by integrating the findings from studies I–III. The results of study IV are presented afterwards.

Overcome the hindrances

Study III included the theme *suggestions to overcome hindrances,* where dental professionals provided concrete suggestions for addressing the identified hindrances of dental subsidy application issues and the perceived limited knowledge of physicians. One proposal was making dental professionals responsible for determining patient eligibility for dental subsidies, thereby relieving physicians of this task. This proposal was intended to simplify the process and ensure that patients with oral dryness receive appropriate support. Another suggestion was that improvements were necessary concerning the information physicians give to patients with oral dryness, particularly regarding the connection between prescribed medications' side effects and their impact on oral health.

Dental hygienists having a key role

Findings from study I showed that dental hygienists more frequently encounter individuals with oral dryness. Also, significantly more dental hygienists (88.3%) than dentists (51.0%) reported that they measure patients' salivary secretion flow. Additionally, dental hygienists asked a broader range of individuals across different age groups about their experiences of dry mouth compared to dentists.

These findings are consistent with the results in study III, under the theme *dental professionals' clear roles.* Dental professionals described that dental hygienists are typically the first to encounter individuals with oral dryness. They often identify the condition and provide information and recommend preventive measures. Dentists confirmed that dental hygienists most often manage individuals with oral dryness and emphasised that dental hygienists possess the necessary knowledge regarding appropriate recommendations and management. Meanwhile, dentists maintain an overarching view and are responsible for planning the overall patient care. This division of responsibilities was described as being based on a resource-optimising approach, ensuring efficient use of professional competencies within the dental team.

Patient-centred approach

Dental professionals raised essential factors in managing individuals with oral dryness in study II, under the theme a patient-centred approach in managing oral dryness. Dental professionals described that an essential approach in managing this patient group is to see oral dryness within its broader context. Every individual has a unique story to share. The patients' stories are necessary for understanding the severity of the difficulties related to oral dryness, as well as for recommending the appropriate products to relieve dry mouth. Suggested questions could pertain to when dry mouth is experienced: is it during the day or night or during mealtimes? This information can be retrieved when dental professionals ask tailored and follow-up questions, and when they involve patients in decisions about suitable product recommendations. During these conversations with patients, demonstrating empathy and listening were raised as necessary, along with recognising the individual's whole situation. This involves taking the subjective experience of oral dryness seriously and complementing it with objective evidence by measuring salivary secretion rates. This appears to be important, as dental professionals have noted a lack of correlation between the observed clinical features and the patients' stories. They have also noted that individuals often experience dry mouth before it can be observed clinically.

Study IV– Objective and subjective oral dryness

Demographics

All individuals with xerostomia were women who had experienced xerostomia during the last six months, and all individuals in the control group were women without xerostomia The mean age was 59.0 ± 9.6 years in the SjD group (n = 16), 54.6 ± 7.2 years in the unspecific DM group (n = 9), and 54.5 ± 9.7 years in the control group (n = 18). Among the individuals in the SjD group, 81% reported taking medications; the most common were anti-rheumatics (25%) and proton pump inhibitors (25%). In the unspecified DM group, 89% reported taking medications, with the most common being tricyclic antidepressants (22%) and SSRIs (22%). In the control group, 17% reported taking oestrogen (17%). Only one individual in the SjD group reported smoking, and three individuals in the control group reported using snuff.

Subjective measurements

Xerostomia severity was measured with the xerostomia inventory (XI) questionnaire, and higher scores were observed in the SjD group (40.8 ± 9.3) than in the unspecific DM group (26.6 ± 4.5) (p <0.001). The individuals in the SjD group choose the answer alternative 'very often' more frequently than individuals in the unspecific DM group, as seen in Table 4.

Table 4: The most frequently selected response options (very often-never) in the SjD group and in unspecific DM group, with proportions shown.

	Questions in XI	SjD group	Unspecific DM group
1	How often does your mouth feel dry	very often (68.8%)	occasionally (56%)
2	I get up at night to drink	never (25%) and occasionally (25%)	never (56%)
3	My mouth feels dry when eating	very often (31%), never (31%)	never (56%)
4	I sip liquids to help swallow	very often (37.5%)	never (89%)
5	I have difficulties swallowing certain foods	occasionally (31%)	never (67%)
6	I have difficulty in eating dry foods	very often (44%)	never (44%)
7	I suck sweets or cough lollies to relive dry mouth	never (37.5%)	never (44%)
8	The skin of my face feels dry	very often (63%)	never (44%) often (44%)
9	My eyes feel dry	very often (69%)	occasionally (44%)
10	My lips feel dry	very often (50%)	occasionally (66.7%)
11	The inside of my nose feels dry	very often (44%)	occasionally (44.4%)

Objective measurements

Individuals with SjD had lower unstimulated and stimulated salivary secretion rates compared to individuals in the unspecific DM group and the control group (Table 5). Hyposalivation was present in 88% individuals in the SjD group and in 78% individuals in the unspecific DM group.

Clinical observations of dryness

Clinical observations of oral dryness using CODS showed significantly higher scores in both the SjD group, and the unspecific DM group compared to the control group (Table 5). In the SjD group, 56% had moderate dry mouth, 25% had mild dry mouth, and 19% had severe dry mouth, while 75% had mild dry mouth, and 25% had moderate dry mouth in the unspecific DM group. In the control group, only 11% had mild dry mouth.

Table 5: Unstimulated and stimulated salivary secretion rates, and CODS in SjD group, Unspecific DM group and control group. Mean ± SD are shown.

	SjD group	Unspecific DM group	Control group	p-value
Unstimulated salivary secretion rate (mL/min)	0.06 ± 0.14	0.07 ± 0.11	0.4 ± 0.2	<0.001 a <0.001 b
Stimulated salivary secretion rate (mL/min)	0.60 ± 0.59	0.98 ± 0.49	1.96 ± 0.8	<0.001 a <0.003 b
CODS	4.9 ± 1.9	2.6 ± 0.4	0.1 ± 0.3	<0.001 a <0.001 b <0.001 c

Statistically significant differences: a = between SjD group and control group, b = between unspecific DM group and control group, c = between SjD group and unspecific DM group. Analysed with ANOVA and Tukey's multiple comparisons test.

Analysis of saliva composition

Total protein concentration and output, MUC5B, and sialic acid levels were analysed in stimulated saliva. No significant differences in total protein concentration were found. Total protein output was significantly lower in the SjD group compared to control group. MUC5B levels showed no significant differences among groups, although the SjD group had the lowest levels. Significantly higher sialic acid was found in both the unspecific DM group and in the SjD group compared to the control group (Table 6).

Table 6: Total protein concentration and output, MUC5B and sialic acid. Mean±SD are shown.

	SjD group	Unspecific DM group	Control group	p-value
Total protein concentration	10.8 ± 9.1	9.1 ± 3.9	8.2 ± 4.2	n.s
Total protein output	4.7 ± 4.3	9.2 ± 7.2	14.7 ± 7.0	<0.001 a
MUC5B	0.77 ± 0.69	1.06 ± 0.94	1.01 ± 0.71	n.s
Sialic acid	0.59 ± 0.29	0.70 ± 0.34	0.35 ± 0.19	0.04 a 0.008 b

n.s not significant

Statistically significant differences: a = between SjD group and control group, b = between unspecific DM group and control group, c = between SjD group and unspecific DM group. Analysed with the ANOVA and Tukey's multiple comparisons test.

Correlation analysis

When both xerostomia groups and the control group were included in the analysis, negative correlations were observed between CODS and unstimulated salivary secretion rate ($\rho = -0.82$, $p = 0.001$), stimulated salivary secretion rate ($\rho = -0.78$, $p < 0.001$), and total protein output ($\rho = -0.67$, $p < 0.001$). Furthermore, stimulated salivary secretion rate was positively correlated with unstimulated salivary secretion rate ($\rho = 0.88$, $p < 0.001$).

CODS were positively correlated with XI score ($\rho = 0.61$, $p = 0.012$), negatively with stimulated salivary secretion rate ($\rho = -0.62$, $p = 0.010$), and stimulated salivary secretion rate was positively correlated with unstimulated salivary secretion rate ($\rho = 0.60$, $p = 0.021$) in the SjD group. In the unspecific DM group, the XI score was negatively correlated with sialic acid level ($\rho = -0.80$, $p = 0.010$), MUC5B level ($\rho = -0.82$, $p = 0.007$) and positively correlated with total protein concentration ($\rho = 0.80$, $p = 0.010$), and total protein output ($\rho = 0.82$, $p = 0.007$).

DISCUSSION

The discussion is divided into following sections: a discussion of the synthesised results from studies I–III and then study IV, followed by a discussion concerning the methodological aspects related to studies I–IV, and finally, a discussion on the oral health framework.

The overall aim of this thesis was to explore dental professionals' experiences in managing oral dryness, and to explore associations between xerostomia, clinical signs, salivary secretion rate, and saliva composition in affected individuals.

The main findings of this thesis indicate that dental professionals encounter challenges in managing individuals with oral dryness and have proposed suggestions to improve care management. Challenges include difficulties identifying individuals with oral dryness due to unclear routines as not all patients are routinely asked about their experience of dry mouth. Additional challenges involve diagnosing and measuring salivary secretion rates, as well as limited treatment options. A lack of continuing education also poses challenges to management, as dental professionals must rely on knowledge from their undergraduate studies and seek new information independently. Moreover, collaboration with physicians poses challenges due to physicians' limited understanding of oral dryness and the dental subsidy application process, as well as the absence of communication pathways. The proposed suggestions for improved management include dental professionals taking responsibility for determining patients' eligibility for dental subsidies, and for physicians to provide patients with more information about medication side effects. A patient-centred approach is also suggested to manage this group of patients. One division of responsibilities that appears well-functioning is for dental professionals to recognise their roles, with dental hygienists having a key role and dentists having a coordinating role.

Individuals with xerostomia caused by Sjögren's disease or unspecific causes had lower salivary secretion rates and total protein output, and higher levels of sialic acid and higher CODS compared to controls. Strong negative correlations between CODS and both unstimulated and stimulated salivary secretion rates were found when all individuals were grouped together (SjD, unspecific DM, and controls). For individuals with Sjögren's disease, a moderate positive correlation was identified between CODS and xerostomia severity, as was moderate negative correlation between CODS and stimulated salivary secretion rate. Within the unspecific DM group, xerostomia severity showed a very strong negative correlation with sialic acid and MUC5B, and a very strong positive correlation with total protein concentration and output.

Results discussion

Current management of oral dryness

Results from studies II–III showed that the current management approach includes challenges, including the identification, diagnosis, and treatment of affected individuals. These challenges could potentially lead to individuals with oral dryness going unidentified and undiagnosed as well as missing out on receiving appropriate preventive measures, which in turn may have implications for oral and overall health.

In study I, it was shown that dental professionals often asked the age groups (41–65 years and 65+) about their experience of dry mouth. Similar results were observed in another survey study conducted in Germany (72). In study II, dental professionals explained that it depended on patients' responses regarding medical conditions, medication, or whether clinical signs of dryness were observed, as to whether patients were asked about the experience of dry mouth. Dental professionals clarified that it was their decision regarding whether to ask all patients or not, due to lacking established routines. However, previous studies have shown that oral dryness also is prevalent among younger age groups (37). Furthermore, reports from Swedish Health and Welfare highlight the increased prevalence of prescribed medications for the treatment of mental health problems among individuals aged 10–24 years, even though a decline has been noted in the past year (103). For example, prescribed medications such as medications for depression or anxiety have oral dryness as a common side effect (45). The results could therefore indicate that younger individuals with oral dryness may be overlooked in general dental care.

A significant increase in the use of antidepressant medications has also been observed among individuals aged 65 years and older, indicating that this trend will likely continue (104). Additionally, life expectancy is expected to increase (105), and many older individuals retain their natural teeth into old age (105-107). The prevalence of oral diseases (105), chronic diseases (108) and medication use also seems to be rising (20). Over 500 medications have listed oral dryness as a side effect (45). Accordingly, in the future, the demand for dental care will most likely grow, as will the need for dental professionals, and their role in managing individuals with oral dryness will become increasingly important.

Recently, the Swedish National Programme for Caries has been developed (109). The program highlights oral dryness as one of the risk factors for caries development, especially among older adults (109). The program suggests that investigating the cause of caries includes measuring salivary secretion rate (109). However, measurement of salivary secretion rate does not appear to be part of routine clinical examination procedure (6, 23), which is in accordance with routines in Swedish general dental care settings. Results from study I showed that 70.3% of dental professionals reported having measured patients' salivary secretion rate primarily to determine their eligibility for a dental subsidy. This suggests that the salivary secretion rate is not commonly assessed. According to study II, dental professionals explained that they face barriers in measuring salivary secretion. Similar results were reported in a study conducted in Germany, where only 5.3% of 284 dentists measured patients' salivary secretion rate (72). Another study showed poor knowledge of the most useful diagnostic approaches for assessment of oral dryness, even though 76.1% recognised measurement of unstimulated whole saliva as a diagnostic approach (73), indicating that barriers to measuring salivary secretion rate are also present in other countries. Since salivary secretion rates vary within the same individual, between individuals, and over time, obtaining a baseline measurement of patients' salivary flow rates would be valuable, as it enables future comparisons (6, 20, 23). In comparison, physicians typically measure blood pressure to establish a baseline value for monitoring changes in case of future diseases or conditions (6). Measuring salivary secretion is crucial for managing oral dryness, guiding product recommendations and preventive measures (6).

Some authors argue that even though saliva is important for maintaining oral health, it gets little attention in dental schools around the world (21). Earlier studies have concluded that dentists are aware of the causes of oral dryness and clinical implications (71, 72) and possess good-to-moderate knowledge regarding management awareness (73). In study I, around 75% of dental professionals stated that they desired more education on saliva and oral dryness, even though the results of the knowledge questions indicated the opposite. This was further evaluated in study II, where dental professionals explained a lack continuing education for dental professionals on saliva and oral dryness. Similar findings have been reported where 67% of dentists reported that they had never attended continuing education concerning dry mouth (73). Dental professionals in study II also shared their experiences about how they searched for new information in different ways to remain up to date in the field. Taken together, these results indicate the need for improved continuing education for dental professionals. In Sweden, dentists and dental hygienists are licensed with no requirement for continuing education during their working life, in contrast to other countries, where dental professionals need to update their knowledge continuously.

Findings from study I also showed that few dental professionals consult their patients' physicians for medication exchange, which could result from difficulties collaborating with physicians because of a lack of contact pathways, as shown in study III. Similar results were seen in a study concerning individuals with prediabetes/diabetes, where only 7.3% of the dentists and dental hygienists contacted the patients' medical provider to discuss prediabetes-related questions, and 17.6% for diabetes-related questions (110). Furthermore, dental professionals in study III also perceived a lack of knowledge among physicians about oral dryness and its connection to medication use. Previous studies have highlighted knowledge gaps among physicians working in primary care regarding oral-health–related side effects of medications, as well as their failure to adequately inform patients about these effects (75, 80). For the individual, communication between dentists and physicians concerning their prescribed medication and its side effects is necessary when dental treatment is needed (45). Interprofessional education that integrates learning goals from different health professions may help address this knowledge gap and improve long-term collaboration challenges. This is supported by World Health Organisation (111) and previous studies (80, 112).

Study III showed that dental professionals perceive physicians as lacking sufficient knowledge about the dental subsidy application process, which provides financial support for preventive measures for individuals with hyposalivation. In cases where individuals get a dental subsidy, could indicated that they have been able to navigate a complex system and accessed information independently or with the help of dental professionals. However, the ones who need the subsidy the most may be unaware of it and may find it difficult to navigate the system. A Danish study shows that dental professionals are reluctant to assist patients in applying for additional subsidies (113). Also, individuals in Sweden report that the information they have received from their dental professionals is insufficient and that they want to be fully informed and obtain guidance from healthcare professionals, including dental professionals (114). Similar results were reported in a study on preventive measures conducted across several European countries, where patients expressed a desire for more guidance and reported feeling inadequately informed (115).

Improving management of oral dryness

The results of this thesis propose an improved management approach for individuals with oral dryness by synthesising findings from studies I–III. The approach suggests that dental professionals might adopt a patient-centred approach and that dental hygienists could have the primary responsibility for individuals with oral dryness.

In study I, it was shown that dental hygienists more often encounter individuals with oral dryness, more often measure their patients' salivary secretion rate, and ask more age groups about their experience of dry mouth compared to dentists. This was further evaluated in the results from study III, showing that dental professionals collaborate well; through their clearly defined roles, dental hygienists play a key role while dentists have a coordinating role in the management of individuals with oral dryness. This aligns with the results from another study, where dentists and dental hygienists stated and agreed that dentists have an overview of patient care (89). In line with this, a previous study reported that dentists valued skill mix as it allowed them to concentrate on complex treatments, however, they believed that preventive measures also should be provided by dentists (Legget et al 2021). This is in contrast to earlier studies, which showed that conflicts might arise between dentists and dental hygienists when dentists consider themselves to have exclusive rights concerning special tasks, such as performing oral examinations (92, 93). According to a previous qualitative study, patients have experienced that dentists do not prioritise prevention and believed they received insufficient advice concerning preventive measures (115), whereas several studies have shown that preventive work has been regarded as central task for dental hygienists, as described by dentists (92, 115). Dental hygienists also consider preventive work to be their expertise (89). Since there is a shortage of dental professionals in Sweden (116) a division of responsibilities seems necessary, as shown in the present thesis. For dentists and dental hygienists to work effectively in the management of individuals with oral dryness, it is essential that they understand each other’s roles, as shown in study III. This mutual understanding of roles has been shown to be important for successful collaboration (81).

Management of oral dryness, regardless of aetiology, symptoms, or objective salivary findings, appears not to be tailored at the individual level (67). Study II found that a patient-centred approach is commonly used to manage individuals with oral dryness, aligning with previous research (76). The care provided should prioritise an individual's preferences, needs, and values, as they know themselves best (Ginsberg, 2024). Individuals want to be involved in decision making processes concerning their oral health (117). Given the current challenges described by dental professionals in studies II and III, particularly the lack of effective treatments for oral dryness and oral dryness’ substantial impact on oral health, overall health and quality of life, a patient-centred approach seems appropriate. Moreover, earlier studies show that patients with oral dryness often feel that dental and healthcare professionals lack empathy and understanding of their condition, and do not take them seriously (53, 55). This also underscores the importance of adopting a patient-centred approach. Involving individuals in their dental care by discussing appropriate products and recall intervals was also considered important by dental professionals in study II, aligning with the results of an earlier study (113).

Study IV – objective and subjective oral dryness

The results included xerostomia severity assessed with the XI, and how the XI score correlates with clinically assessed oral dryness using CODS, and salivary secretion rates. The results showed that both CODS and XI scores were higher in individuals with xerostomia compared to controls, with the highest scores observed in the SjD group. These results align with those in other studies (30, 56, 57).

Furthermore, CODS showed a strong negative correlation with both unstimulated and stimulated salivary secretion rates when both individuals with xerostomia and controls were grouped together (n =43), which also aligns with results shown in earlier studies (118). When correlation analyses were performed separately for each xerostomia group, varying results were observed. In the SjD group, a positive correlation was observed between CODS and XI scores, whereas a negative correlation was found between CODS and stimulated salivary secretion rates. In the unspecific DM group, CODS was negatively correlated with unstimulated salivary secretion rates, and the XI score was negatively correlated with saliva composition (sialic acid, MUC5B) and was positively correlated with total protein concentration and output. However, CODS indicated particularly strong correlations with both unstimulated and stimulated salivary secretion, supporting its potential clinical applicability.

Neither CODS nor XI are used to evaluate oral dryness during clinical examinations in Swedish dental settings. Asking a question with dichotomous answer options is commonly used to evaluate xerostomia. However, the literature suggests using the question "How often does your mouth feel dry?" which includes several response options (never, occasionally, frequently, and always) (59). Furthermore, it is known that saliva composition and secretion rate can vary between individuals and within the same individual over time (118), making instruments like CODS and questionnaires like XI valuable in clinical settings. CODS have been shown to differentiate individuals with hyposalivation from those with normal salivary secretion rates (118). For the xerostomia inventory, XI scores greater than 23.5 can identify individuals with decreased salivary secretion rates (60). Neither CODS nor XI are time-consuming, and both seem to provide a valuable overview of the severity of oral dryness. These instruments may help to determine whether further actions are necessary, such as measuring salivary secretion.

Saliva is a complex fluid with several thousand proteins and many ions. The results showed no significant differences in MUC5B level, while both the unspecific DM group and SjD group showed an increase in sialic acid compared to controls. Similar results for sialic acid in individuals with SjD have been reported (56). In addition to being a structure of MUC5B, sialic acid is also present in MUC7, secretory immunoglobulin A and agglutinin. The increased sialic acid could therefore be related to an increase of these proteins. However, more research is needed to understand how sialic acid is related to oral dryness.

Xerostomia may be related to other proteins and their structures as and to level of ions in saliva. Research has shown that altered glycosylation and sialylation of glycoproteins, which are present to a higher extent in unstimulated saliva, may be associated with the experience of dry mouth (30, 58). Unstimulated saliva was not analysed in this thesis because many individuals had no or only a very small amount of unstimulated saliva. The sulphated groups on MUC5B are also of interest in relation to xerostomia, because they are negatively charged and facilitate holding water. Furthermore, the rheological properties of saliva are also essential for lubrication, bolus formation, mouthfeel, and taste perception (119, 120). Unstimulated saliva was shown to have significantly higher viscosity and viscoelastic properties compared to stimulated saliva, and a positive correlation was also found between viscoelasticity and both calcium and glycoproteins (120). Ions such as calcium, has been shown to be important for the unfolding of MUC5B increasing its ability to retain water (121). Exploring the levels of ions and functional properties of saliva from individuals with xerostomia might shed further light on the relation between saliva composition and xerostomia.

Methodological discussion

This thesis includes both quantitative and qualitative studies. Quantitative studies aim to test hypotheses, make predications, or establish causal relationships. The methodology typically involves surveys or experiments and usually includes a statistical analysis to identify patterns and correlations (122, 123). On the other hand, qualitative research aims to answer questions related to individuals' experiences, perceptions, or views, by exploring phenomena. Data collection may include individual interviews, focus groups, or observations and the result is often presented in themes, categories, and illustrative quotes (122-124). Accordingly, combining these two methods provide a deeper understanding of how oral dryness is managed in dental care.

Quantitative method: Study I

Using questionnaires to collect data is a common method, but it has limitations, such as the inability to ask follow-up questions, which can limit a comprehensive understanding of what is being studied. However, it remains a valuable method for collecting data from large samples (125). The response rate was low (18.6%), but comparable to previous studies on the same topic (72), as well as to studies in other fields of dentistry where the intention was to gather responses from dental professionals (126). This could indicate a general fatigue in answering questionaries.

The questionnaire used in study I was developed by the authors based on their knowledge, clinical experience in dental care, and on the unvalidated questionnaires used in previous studies (71, 72), but was adapted to fit the Swedish dental care context. The validity of a questionnaire concerns its accuracy, meaning whether it measures what it is intended to measure. Reliability refers to the consistency of the questionnaire (125). The validity and reliability of the questionnaire were not tested. The primary aim of the study was not to measure specific parameters, which is why validity tests were not conducted. Conducting a reliability test would have been valuable, given the low response rate and to increase certainty in the results, but since the plan was also to interview dental professionals to acquire a deeper understanding of the subject, a reliability test was not conducted. To enhance clarity and relevance, the questionnaire was first sent to four colleagues for evaluation before it was sent to dental professionals working in the Public Dental Service for testing. Minor revisions were made in accordance with the received feedback. In addition, it is likely that those most interested in the subject were the ones who chose to respond to the questionnaire. Given this background, the study results must be interpreted cautiously and cannot be generalised but still provide valuable results, since to my knowledge, this is the first survey study conducted in Sweden concerning management of oral dryness which includes both dentists and dental hygienists.

Qualitative methods: Studies II and III

Qualitative content analysis with an inductive approach was chosen for data analysis (97, 98). Qualitative content analysis is a well-used method in health, nursing and education research (97, 127, 128). It is appropriate when the aim is to explore experiences based on interviews as it allows identifying variations in a text on both manifest and latent levels (129). An inductive approach was considered appropriate given the limited knowledge regarding the management of individuals with oral dryness in dental care. The inductive approach involves developing categories and themes based on the data (127, 129). Like all methods, qualitative content analysis also has its challenges. During data analysis difficulties such as determining division of meaning units or deciding abstraction levels and interpretation degree when formulating categories and themes has been discussed as methodological challenges (129).

One-on-one semi-structured interviews of dental professionals were used for data collection in studies II and III, a data collection method found to be suitable when using qualitative content analysis with an inductive approach (97, 130, 131). Semi-structured interviews mean that an interview guide with predefined questions is used, ensuring that all informants receive the same core questions. The strength of using semi-structured interviews is that it allows flexibility, as informants can raise other topics they find relevant (124, 130). However, such flexibility can lead the interviewer to formulate questions shaped by their own preunderstanding, and researchers must remain aware of this possibility and guard against it.

Trustworthiness in studies II and III

Trustworthiness is an overarching concept and includes four concepts (credibility, confirmability, dependability, and transferability) which are essential to consider when assessing a study's trustworthiness (97, 129). Measures were taken to enchase the studies' trustworthiness.

Applying a purposive sampling method by interviewing dental professionals with different backgrounds contributed to capturing differences in their experiences and garnered a richness of data, which contributed to creditability, referring to confidence in the data (97, 129). Confirmability refers to the degree to which results of the study are grounded in data rather than in researchers' opinions. This was strengthened by involving several researchers—not with the aim of sorting categories and themes in the same way, as multiple realities exist—but to determine whether the researchers agree on the logic behind categorisations (97). Dependability, referring to the consistency and repeatability of the results (97), was also strengthened by involving several researchers with various backgrounds. Furthermore, dependability and confirmability may also be strengthened by previous studies, where similar findings were shown (74). This further strength both credibility and dependability, two test interviews were conducted to evaluate the interview technique, assess the relevance and structure of the questions, and assess the appropriateness of Zoom/Teams. This approach was considered important, because the first author (who also conducted all the interviews) had never previously been involved in a qualitative interview study, which should be taken into account (95, 132). Both studies included descriptions of the contexts, characteristics of the dental professionals, data collection, data analysis process and quotations, which helps ensure transferability, referring to how well findings fit other contexts (97). However, it is up to the reader to judge whether the findings are applicable in other contexts (133).

Saturation in studies II and III

Data richness is essential for credibility, as it determines whether the aim of the study can be answered. Saturation is a well-discussed concept in qualitative studies (95, 96, 132). Saturation can refer to various parts of the study, such as sampling through the development of theoretical categories; data collection regarding the extent to which new data repeats; and data analysis, which could include the development of categories or themes (96). Originally, saturation was a concept developed for use in grounded theory (134), but has also been applied in other methods (132). Another concept is information power (95), which assesses richness by evaluating the study's aim, sample specificity, theory use, dialogue quality, and the analytical approach. This approach acknowledges that data saturation is not solely determined by the number of individuals but rather by the depth and quality of the data obtained in answering the aim of the study (95). In the qualitative studies conducted in this thesis, data saturation was used as a criterion for terminating interviews, which relates to data collection and involves the repetition of data, leading to the end of interviews. However, relying on data saturation can have limitations, such as stopping data collection too early, and is a subjective decision made by the interviewer (96). However, at the end of each interview, the dental professionals were asked whether they had anything to add. Additionally, involving researchers with extensive knowledge and experience in conducting qualitative studies helped confirm that the data were rich.

Quantitative method: Study IV

Objective measurements of oral dryness conducted in study IV included measuring unstimulated and stimulated salivary secretion rates. For assessing clinical signs of dryness, CODS was used. CODS has been used in multiple earlier studies (30, 56, 58). The instrument was developed as an aid for dental professionals to evaluate salivary gland hypofunction (63) and it has been suggested that dental professionals use CODS alongside subjective measurements such as XI (118), as in study IV in this thesis.

For assessing the individuals' experience of xerostomia severity, the questionnaire XI (59) was used. XI is validated and translated in several languages (60), but has not yet been validated in Swedish. However, the translated Swedish version has been used in a previous study (37). The short version of XI, called SXI (61) is probably better suited to the Swedish dental context, as it is less time-consuming, which aligns with the shortage of dental professionals in Sweden (116).

The XI assesses symptoms related to xerostomia, symptom management approach, and functional limitations, meaning that XI dose not comprehensively measure all parameters important to oral-health–related quality of life (OHRQoL) (54), found to be associated with xerostomia. Assessing the presence of xerostomia and severity is not necessarily important for individuals with xerostomia, as xerostomia can affect other aspects of their lives, such as social functioning or emotional well-being (54), which have been shown to be under-represented in clinical research studies according to a systematic review (2). Preferably, XI should be used alongside other questionaries assessing OHRQoL (54). The initial plan was to interview the individuals included in study IV to gain a deeper understanding of their situations and to compare their experiences based on the origins of oral dryness and salivary secretion rates, but this was not feasible within the available time frame, however, interviews are planned for future studies. Furthermore, XI doesn't capture how individuals perceive their saliva, such as its stickiness. Individuals with xerostomia have described dry itchy feelings, a viscous saliva, no mucus, or sensation like burned asphalt or a sandpaper-like feeling (53, 54). Such knowledge could have been useful, since total protein concentration, MUC5B, and sialic acid are components that have previously been linked to dryness (30, 56-58). Combining the subjective experience of dry mouth measured with XI, clinically observed oral dryness measured through CODS, and objectively measured stimulated and unstimulated saliva has been proposed as an inclusion criterion in clinical research (135).

Discussion of the results in the context of the oral health theoretical framework

The studies included in this thesis were conducted without an initial theoretical framework. However, the oral health theoretical framework (3) was later identified as appropriate for interpreting the results.

Oral dryness is a condition that affects oral health. It may impair various physiological functions, such as swallowing, chewing, taste sensation, and speech. These impairments may also influence psychosocial aspects, such as the ability to participate in social or work environments—for instance, interacting with others and engaging in activities such as eating together. In this thesis, subjective experiences related to impaired physiological functions were evaluated using the Xerostomia Inventory questionnaire, completed by individuals in the SjD and unspecified DM groups. High scores indicated that many individuals suffer from severe xerostomia. Oral health was also assessed from a clinical perspective, including the registration of missing teeth, fillings, restorations, bleeding on probing (BoP), probing pocket depth (PPD), and oral dryness assessed according to CODS. High CODS scores were also observed in the groups with xerostomia.

Factors classified as driving determinants include genetic and biological aspects, the social and physical environment, health behaviours, and access to care. These factors may either support or hinder the maintenance of oral health. Oral dryness may be influenced by biological factors such as saliva production, which in turn can be affected by circadian rhythm and gender. Genetic factors also play a role; for example, in the risk of developing Sjögren's disease. Oral dryness is more common in women, and in this thesis, all individuals with Sjögren’s syndrome and those with unspecified causes of xerostomia were women, highlighting the biological component of oral dryness.

As noted, driving determinants also include access to care, which encompasses factors such as organisational structure and financial accessibility that influence an individual’s ability to obtain oral health services. In this thesis, this may relate to dental professionals’ experiences of collaborating with physicians. Such collaboration may impact access to care for these individuals. The results indicated that managing individuals with oral dryness presents challenges in collaboration with physicians. This may negatively affect access to care, as physicians might lack sufficient knowledge about the application process for dental subsidies for preventive measures and are perceived to have limited understanding of oral dryness. Effective collaboration could influence disease and condition status; however, early identification and improved treatment options are required. Dental professionals also reported barriers related to measuring salivary secretion, inconsistencies in asking patients about dry mouth, and a lack of treatment options. These issues may, in turn, affect access to care for individuals with oral dryness.

Moderating factors relate to how an individual perceives or values their oral health, as well as their expectations and experiences. The results in this thesis do not evaluate individuals’ values or expectations. However, their experiences of oral dryness may influence how individuals report symptoms to dental professionals. The patient-centred approach, described by dental professionals as important for individuals with oral dryness suggest that an individuals’ narrative may be essential for understanding the condition.

In summary, the findings of this thesis seem to align well with the oral health framework, although mainly approached from a dental professionals’ perspective rather than oral health itself.

FUTURE RESEARCH

Building on this thesis, which explored dental professionals' experiences of managing oral dryness, and their collaboration with physicians, future research should examine health professionals' (nurses or physicians) experiences and their perspectives on collaboration with dental professionals regarding individuals with oral dryness, using both questionnaires and interviews.

Saliva composition has been explored in relation to xerostomia severity, salivary secretion rate and clinically observed dryness. Future research should continue to explore these complex associations by examining saliva's rheological properties, specifically it's viscoelastic properties, and conducting proteomic analyses of saliva to achieve a comprehensive understanding of the saliva proteome in relation to aetiology and severity of oral dryness. This could be combined with analysis of ions considered important for the function of salivary proteins. Moreover, while this thesis captured individuals' perspectives through questionnaires, future research should prioritise in-depth interviews of affected individuals to gain richer insights into their experiences in relation to oral dryness aetiology and severity and objective measurement of their salivary secretion rate.

CONCLUSIONS

- Dental hygienists reported encountering patients with oral dryness more frequently, asking patients about xerostomia across a broader range of age groups, and recommending preventive measures more often than dentists. Longer professional experience was associated with greater awareness and improved patient management, especially among dental hygienists.
- Managing oral dryness in general dental care poses several challenges but a patient-centred approach is suggested for managing individuals with oral dryness.
- Dental professionals perceived several challenges when collaborating with physicians. In dental care, dental professionals have clear roles, with the dentist having a coordinating role and the dental hygienist playing a key role in their management of individuals with oral dryness.
- Differences in xerostomia severity, clinical signs of oral dryness, salivary secretion rates, and saliva composition were observed between individuals with Sjögrens disease and unspecific dry mouth group compared to controls. In the unspecified dry mouth group, xerostomia severity appeared to be associated with saliva composition, whereas in the SjD group, clinical signs of oral dryness were associated with xerostomia severity and stimulated salivary secretion rate. Furthermore, clinical oral dryness signs demonstrated strong correlations with both unstimulated and stimulated salivary secretion rates. Given the variability in observed associations across groups, further research is needed to confirm these findings and clarify underlying mechanisms.

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RESEARCH Open Access

Dental care professionals' awareness of oral dryness and its clinical management: a questionnaire-based study

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Abstract

Background Despite the high prevalence of oral dryness and awareness of its complications, there is limited research on the clinical management of patients with oral dryness in general dental care.

Purpose To (1) describe and compare awareness among dental care professionals regarding saliva functions, potential causes and complications of oral dryness, and patient management (2) Investigate if the length of professional experience influences these aspects.

Methods A digital self-administrated survey was sent to 2668 dental care professionals working in the general dental care, Public Dental Service, in Sweden. Twelve dental care professionals reviewed the questionnaire prior to its distribution. The questionnaire comprised 32 questions about patient management, awareness of saliva functions, causes and complications of oral dryness, and self-assessment queries.

Results The response rate was 18.6% (241 dentists and 257 dental hygienists). Older adults (65+) were asked more often about dry mouth (93.0%) compared to those aged 18–23 years (50.0%) and those under 18 years (24.9%). Dental hygienists encountered individuals with oral dryness more frequently (61.1%) than dentists (48.5%) ($p < 0.01$), and more often asked individuals in the age groups 18–23 years ($p = 0.003$), 24–40 years ($p = 0.045$), and 41–65 years ($p = 0.031$) about dry mouth. A higher proportion of dental hygienists (88.3%) than dentists (51.0%) had measured salivary secretion rate, ($p < 0.001$) and more often suggested preventive dental care 3–4 times a year, (42.5% vs. 30.5%) ($p < 0.007$). Dentists had a higher awareness of saliva functions, while dental hygienists had a higher awareness about causes and complications of oral dryness. Higher proportions of dentists and dental hygienists with over 10 years of professional experience had measured salivary secretion rate (69.1% vs. 95.7%) compared to their counterparts with less than 10 years of professional experience (35.9% vs. 79.5%) ($p < 0.001$ for both).

Conclusion Compared to dentists, dental hygienists were more attentive to patients with oral dryness as they encountered these individuals more often, asked more age-groups, suggested frequent preventive measures, and had higher awareness of the causes and complications of oral dryness. Length of professional experience could improve both the management of patients with oral dryness and awareness of its causes, particularly for dental hygienists.

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Keywords Dentists, Dental care, Dental hygienists, Dry mouth, Sunet survey, Questionnaire

Introduction

Saliva has several important functions essential to maintaining overall health, as well as oral health [1]. It is important for oral homeostasis with numerous functions, which include lubricating soft tissues, regulating pH levels, clearing food particles, antimicrobial function, and facilitating tooth mineralization [1–3].

Oral dryness is a complex condition [1, 4–6] encompassing both the subjective sensation of dry mouth (Xerostomia) and objective evidence of reduced saliva production (hyposalivation) [1, 3, 7]. Xerostomia can only be diagnosed by assessing the subjective symptoms of the individual, whereas hyposalivation is determined by measuring the salivary flow rate [8]. Hyposalivation is diagnosed when saliva secretion rate is reduced, for unstimulated saliva to ≤0.1 ml/min, and for stimulated saliva to ≤0.7 ml/min [1, 2]. The subjective sensation of dry mouth does not always correlate with hyposalivation, which suggests a change in saliva composition that may contribute to the perception of dry mouth [1, 2, 9].

Medications are the predominant cause of oral dryness because of their side effects. Sjögren's syndrome, radiation therapy of the head and neck region, and systemic diseases are other causes of oral dryness [1–3]. Individuals suffering from oral dryness often experience difficulties with eating, swallowing, speech, and taste alterations, as well as dental caries [1, 10, 11]. Oral dryness can significantly affect oral health, quality of life, and well-being negatively [1, 12, 13]. A careful examination including questions about dry mouth in different situations, extra- and intraoral examination and measurement of salivary flow rates aids in the diagnosis [1, 14]. There is no treatment of oral dryness, but saliva stimulating products and saliva substitutes (mouth gel or sprays) can reduce the symptoms [8]. Most products have only a short-lived effect [8, 15]. The consequences of oral dryness could be decreased with preventive measures. Dental care professionals have an important role in raising patient awareness and knowledge of oral dryness [8].

A systematic review with meta-analysis showed the prevalence of dry mouth is higher among older adults (25.3%) compared to younger adults (19.3%) [16]. In a Swedish study including adults aged 50–75 years old, the prevalence of xerostomia was 33.9% [17, 18]. A recently published study in primary health care in Sweden showed that xerostomia was a common problem among adults regardless of age, with an overall prevalence of 43.6% [19]. Oral dryness is more common among women than men [17–20].

With an increasing number of older people [21], oral dryness will likely be more frequent in the future. Exploring how dentists and dental hygienists in general dental care address oral dryness is important, but there are few studies on this subject. According to a German study, dentists were aware of the psychological and clinical consequences of dry mouth but were unsure of how to identify and treat the affected patients [22]. Similarly, another study showed a high awareness of the condition but uncertainty on how to manage and treat individuals with dry mouth [23]. Therefore, comprehensive knowledge of saliva functions and identification of patients with oral dryness is crucial to implement management strategies and individual treatment plans for such patients [10]. A Swedish interview study showed that healthcare professionals, including dentists and dental hygienists, lacked sufficient knowledge in managing patients with dry mouth [24]. However, to the best of this study's knowledge, no studies are currently available regarding the management of patients with oral dryness by dentists and dental hygienists in Sweden.

The aims of this study were therefore (1) to describe and compare awareness among dental care professionals regarding saliva functions, potential causes and complications of oral dryness, and patient management (2) Investigate if the length of professional experience influences these aspects.

Materials and methods

Ethical aspects

The Swedish Ethical Review Board has approved the study (Dnr: 2021−01795). A letter providing information about the purpose of the study, the confidentiality of participation, and that participation was voluntary was sent to all participants. All participants consented to take part by completing and returning the questionnaire. The responses from the questionnaire were handled confidentially.

Study design

This is a cross-sectional survey study including dental hygienists and dentists employed within the Public Dental Service in Sweden. STROBE statement checklist for cross-sectional studies were used to accomplish a comprehensive description of the study [25].

Sample selection

The survey was distributed to all 2668 dental care professionals, including both dentists and dental hygienists, working in general dental care, Public Dental Services in five counties in Sweden: Region Skåne (n=561), Region Stockholm (n=856), Region Västra Götaland (n=1029), Region Kalmar (n=100), Region Dalarna (n=122). The counties were selected based on convenience, as well as encompassing both cities and rural areas in Sweden. Inclusion criteria were general dentists and dental hygienists working in Public Dental Services. Exclusion criteria were dentists or dental hygienists working in the specialist dental care.

Questionnaire

The questionnaire encompassed four sections; (1) demographics (11 questions) (2) content of undergraduate education (5 questions) (3) approaches used in clinical practice for the management of individuals with oral dryness (11 questions), (4) awareness questions of saliva functions, causes and complications associated with oral dryness (4 questions) and (5) a concluding question where all participants were asked if they wish for further education on dry mouth and oral health.

To assess the respondents' levels of agreement regarding their awareness of saliva functions, factors that may cause oral dryness, and complications associated with oral dryness, the questionnaire utilized a 5-point scale ranging from 1 (strongly agree) to 5 (strongly disagree), with an additional option for "don't know". To capture the dental care professional approaches used in clinical practice for managing individuals with oral dryness, nine questions with fixed answer alternatives were used. Two questions focused on how information about oral dryness was provided, and one question evaluated the recommended treatment options. The response options for these questions included "always", "often", "seldom", "never", and "don´t know". For the three self-evaluation questions, a 4-point scale (very good, good, satisfying, insufficient) was used for the respondents to assess their knowledge levels regarding the consequences of oral dryness, clinical management, and treatment options for individuals with oral dryness. All questions were mandatory to answer.

Evaluation of the preliminary questionnaire

The preliminary questionnaire was distributed to four colleagues and revised according to their feedback. To further evaluate the effectiveness of the questionnaire, twelve dental care professionals (3 dental hygienists and 9 dentists), working in the Public Dental Service in Trollhättan, Sweden (Region Västra Götaland), completed the questionnaire. A few minor adjustments were made, i.e., reducing some of the response options in certain questions, as the respondents felt there were too many answer alternatives. Technical issues with the questionnaire were also corrected.

Procedure

The authors developed a self-administered, digital survey consisting of 32 questions. The survey was designed using web-based software called Artologik software for the web (Sunet Survey). The questionnaire was distributed via email from November 2021 to November 2022 and included an information letter and a link to the survey. A research-coordinator in the included region was responsible for the distribution, except in one region where AF handled the distribution. Two reminders were sent out at two-week intervals. The questionnaire took approximately 10 min to complete.

Statistical analysis

Descriptive statistics, including measures such as mean, standard deviation, and percentage, were used. The data was analysed through cross-tabulations, and differences in responses between the two professions were assessed using either the Chi-squared test or Fisher's exact test. Dentists and dental hygienists were divided into two groups based on their professional experience: less than 10 years or over 10 years. This cut-off was used to facilitate statistical analysis since the groups were similar in size. For the three questions regarding the functions of saliva, causes of oral dryness, and complications associated with oral dryness, the responses were dichotomized into two options; agree *(strongly agree, agree)* or disagree *(strongly disagree, disagree, don't know)*, since agreement is the only correct answer and indicates a high level of awareness.

For the questions related to providing information to individuals with oral dryness, the response alternatives: *always, often, rarely, never, don't know* were dichotomized into two response options; always/often *(always, often)* and other *(rarely, never, don´t know)* since most of the respondents answered often and rarely. The question regarding treatment options was also dichotomized into the same response options since few respondents used the response options; *never, don´t know*. The question regarding how frequently the dental care professionals met patients with oral dryness was dichotomized into; *several times/week or more often* and *once a week or less*. A p-value of <0.05 was regarded as statistically significant. The statistical analysis was performed using IBM SPSS statistics software version 28.0.1.1 (14).

Results

Participation rate and characteristics of the study participants

The response rate was 18.6% (Table 1). Twenty-four respondents (4.8%) stated that they did not work clinically (5.8% of the dentists and 3.9% of the dental hygienists) and were therefore excluded from all parts of the survey except Sect. 4. One respondent's answers to all the questions in Sect. 3 were excluded since they reported not meeting individuals with oral dryness.

Table 1 Age, gender, years, region, and years in the profession among the respondents

	Dentists	Dental hygienists	Total
Sent to: [n]	1727	941	2668
Participation rate [n (%)]	241 (13.9)	257 (27.3)	498 (18.6)
Age (years) (mean ± S.D)	40.5 ± 11.3	43.2 ± 12.0	41.9 ± 11.7
20–29	39 (16.2)	37 (14.4)	76 (15.3)
30–39	94 (39.0)	78 (30.3)	172 (34.5)
40–49	54 (22.4)	56 (21.8)	110 (22.1)
50–59	32 (13.3)	55 (21.4)	87 (17.5)
60+	22 (9.1)	31 (12.1)	53 (10.6)
Sex [n (%)]			
Female	173 (71.8)	244 (94.9)	417 (83.7)
Male	67 (27.8)	10 (3.9)	77 (15.5)
Don´t wish to state gender	1 (0.4)	3 (1.2)	4 (0.8)
Years in profession [n (%)]			
< 2 years	22 (9.1)	20 (7.8)	42 (8.4)
2–5 years	57 (23.7)	37 (14.4)	94 (18.9)
5–10 years	52 (21.6)	60 (23.3)	112 (22.5)
More than 10 years	110 (45.6)	140 (54.5)	250 (50.2)
Stockholm	47 (19.5)	29 (11.3)	76 (15.3)
Västra Götaland	140 (58.1)	155 (60.3)	295 (59.2)
Skåne	36 (14.9)	34 (13.2)	70 (14.1)
Dalarna	9 (3.7)	14 (5.4)	23 (4.6)
Kalmar	9 (3.7)	25 (9.7)	34 (6.8)

Table 2 The frequency at which dentists and dental hygienists reported encountering individuals with oral dryness

	Dentists [n (%)]	Dental hygienists [n (%)]	Total [n (%)]
Several times/day	17 (7.1)	18 (7.0)	49 (9.8)
Once/day	9 (3.7)	18 (7.0)	27 (5.4)
Several times/week	84 (34.9)	101 (39.3)	185 (37.1)
Once/week	57 (23.7)	45 (17.5)	102 (20.5)
Once/month	30 (12.4)	26 (10.1)	56 (11.2)
Less than once/month	29 (12.0)	25 (10.1)	54 (10.8)
Never	1 (0.4)	0	1 (0.4)
Total [n]	227	257	498

There was a similar proportion of dentists and dental hygienists among the respondents (dentists: 48.4%, dental hygienists: 51.6%). Most of both dentists and dental hygienists were women (83.8%). The mean age was 42 years (Table 1). A significant proportion of participants (86.3%) had completed their education in Sweden (73.4% dentists and 98.1% dental hygienists). Additionally, 96% stated they had received knowledge about saliva and dry mouth during their undergraduate studies, while 86.9% stated practical training in measuring salivary secretion during their undergraduate education. Only 11.8% reported attending continuing education related to saliva and dry mouth, while 14.9% had received an internal education at their clinic. Respondents reported encountering patients of all ages (3 years – 65 years and older).

Frequency of patients with oral dryness

Among the respondents, 52.3% stated that they met patients with oral dryness several times per week or more often (Table 2). A higher percentage of dental hygienists (61.1%) than dentists (48.5%) stated that they met individuals with oral dryness several times/weeks or more often ($p < 0.01$). There was no statistically significant difference in the frequency of meeting individuals with oral dryness based on the length of professional experience (< 10 years or > 10 years), for both dentists and dental hygienists.

Assessment of dry mouth

A total of 93.0% of dental care professionals reported asking individuals aged 65 and older about dry mouth. A lower percentage of dental care professionals, 50.0%, stated that they asked individuals 18–23 years old, and only 24.9% reported asking individuals younger than 18 years. Dental hygienists were found to ask significantly more age groups about dry mouth than dentists, including the age groups 18–23 years, 24–40 years, and 41–65 years (Fig. 1). There were no statistically significant differences regarding the age groups asked about dry mouth and the length of professional experience (< 10 years or > 10 years), for neither dentists nor dental hygienists.

When is a patient asked about dry mouth?

The most common answer by both professions was that they asked the patient about dry mouth during anamnesis (dentists 88.5% and dental hygienists 90.0%). Additionally, 75.9% of dental hygienists and 74.2% of the dentists asked patients currently on medication, about dry mouth For patients with existing diseases, 60.2% of the dental hygienists and 56.2% of the dentists asked about dry mouth. Significantly more dental hygienists (85.5%) than dentists (78.3%) asked patients about dry mouth based on clinical signs ($p = 0.047$). Dental hygienists with over 10 years (95.4%) of professional experience were more likely to ask about dry mouth during anamnesis than those with less than 10 years (83.6%) in the profession ($p < 0.002$).

Identifying individuals with oral dryness

The respondents were instructed to select three of the eight response options. The three most common indicators to identify individuals with oral dryness were patients' current and past medication use (92.9% dentists, 88.7% dental hygienists), clinical examination of mucosa and tongue (81.9% dentists, 79.4% dental hygienists), and previous and current diseases (63.7% dentists and 63.2%

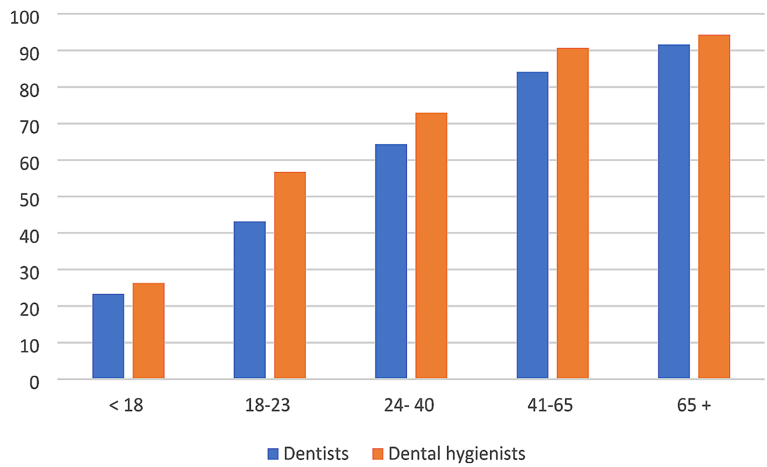

Fig. 1 Proportions who inquire about dry mouth in different age groups. Differences between the professions; <18 years ($p=0.455$), 18–23 years **($p=0.003$)**, 24–40 years **($p=0.045$)** and 41–65 years **($p=0.031$)**

Table 3 Indications for measuring salivary secretion rate and significant differences between the professions

	Unstimulated saliva			Stimulated saliva		
	Dentists [%]	*Dental hygienists* [%]	*p- value*	*Dentists* [%]	*Dental hygienists* [%]	*p-value*
Application for subsidy	65.0	86.6	**< 0.001**	64.2	86.6	**< 0.001**
Clinical signs of dry mouth	60.2	46.6	**0.003**	57.5	49.4	0.077
Answers to the medical-dental anamnesis	47.8	34.8	**0.004**	47.8	34.0	**0.002**
Upon patients' request	27.0	34.4	0.081	28.3	34.0	0.183

dental hygienists). There were no statistically significant differences observed neither between the professions nor between dentists/dental hygienists and length of professional experience (< 10 years or > 10 years).

Determining salivary secretion as a dentist or dental hygienist

A total of 350 (70.3%) stated that they had measured patients' saliva secretion. Among them, significantly more dental hygienists (88.3%) had performed this measurement, compared to dentists (51.0%) ($p<0.001$). Higher proportions of both dentists and dental hygienists with over 10 years of professional experience (69.1% vs. 95.7%) had performed salivary secretion rate determination, compared to those with less than 10 years (35.9% vs. 79.5%) ($p<0.001$ for both).

Indications for measuring unstimulated and stimulated salivary secretion rate

Most dental care professionals stated that Subsidy (special dental care allowance) was the most common reason for measuring the salivary secretion rate, with 76.3% for *unstimulated* saliva and 75.9% for *stimulated* saliva. Clinical signs of dry mouth were the second most common reason for determining the salivary secretion rate (53.1% for unstimulated and 53.3% for stimulated). This was followed by answers to the medical-dental anamnesis (41.0% for unstimulated and 40.6% for stimulated), and upon patients' request with 30.9% for unstimulated and 31.3% for stimulated, respectively.

Significant differences between the professions were seen, regarding indications for measuring the *stimulated* and unstimulated salivary secretion, as shown in (Table 3). Higher proportions of dental hygienists with less than 10 years in the profession reported measuring the *unstimulated and stimulated* salivary secretion "upon patients request" (43.4% vs. 45.1%), compared to those with over 10 years of professional experience (26.9% vs. 24.6%) ($p=0.007$ and $p<0.001$).

Recall interval for preventive dental care

The most common recall interval set by dental care professionals was twice a year 49.7%, followed by three times a year (19.7%), and four times a year (17.1%). A significantly higher proportion of dental hygienists (42.5%), compared to dentists (30.5%), suggested that patients with oral dryness should receive preventive dental care 3–4 times a year ($p<0.007$). A higher proportion of dental hygienists with over 10 years of professional experience (50.7%), compared to those with less than 10 years of professional experience (32.7%), suggested that individuals with oral dryness should receive preventive dental care 3–4 times a year ($p<0.004$). No statistically significant difference was seen for recall intervals between dentists and the length of professional experience.

Providing information about oral dryness

A total of 98.4% responded that they always or often inform patients verbally about oral dryness, 33% always or often provided written information, and 57.4% always or often handed out an information sheet with recommended product/s. A significantly higher proportion of dental hygienists (37.4%), compared to dentists (27.8%), stated that they always or often provided written information ($p=0.031$) and handed out an information sheet with recommended product/s (66.7% vs. 46.3%) ($p<0.001$). There was no difference between dental hygienists with over 10 years or less than 10 years in the profession. However, dentists with over 10 years of professional experience provided written information to a higher extent than those with less than 10 years (40.9% vs. 17.9%) ($p<0.001$).

Treatment options recommended by dentists and dental hygienists

The three most common recommendations to patients with oral dryness were saliva-stimulating products (97.0%), meticulous oral hygiene (95.3%), and extra fluoride (90.3%). There were differences between the professions in terms of recommended treatment options (Fig. 2). A higher proportion of dental hygienists with over 10 years' experience, compared to those with less than 10 years in the profession, recommended meticulous oral hygiene (98.5% versus 93.8%) ($p=0.049$), a diet that encourages chewing (46.3% versus 32.7%) ($p=0.031$), and extra fluoride (97.0% versus 88.5%) ($p=0.008$).

Awareness of the functions of saliva

Between 97.9% and 99.2% of both dentists and dental hygienists were aware with the functions of saliva. There were differences between the professions regarding awareness of saliva functions, as shown in Table 4. However, there were no statistically significant differences between dentists and dental hygienists, or between the lengths of professional experience, in their answers to these questions.

Awareness of factors associated with oral dryness

Dental care professionals were aware that the most common factors causing oral dryness are medications, Sjögren's syndrome, and radiotherapy to the head and

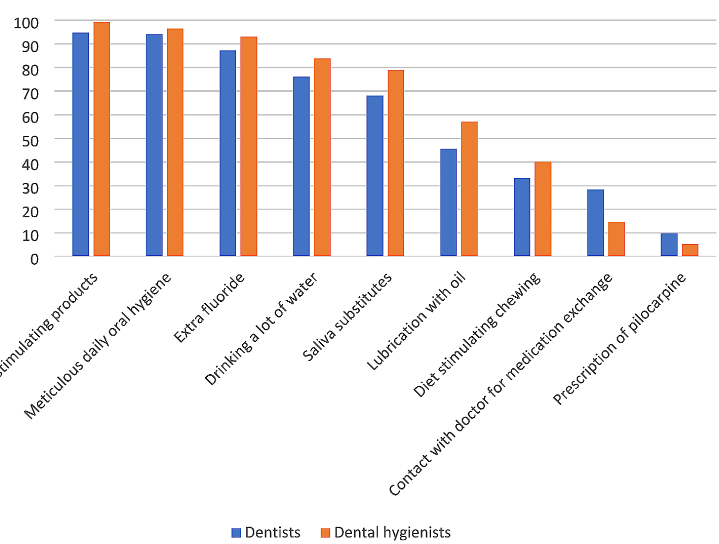

Fig. 2 Most (always/often) recommended treatment options provided by dentists and dental hygienists. Differences between the professions and the following treatment options: Saliva stimulating products **($p=0.004$)**, meticulous daily oral hygiene ($p=0.277$), extra fluoride **($p=0.029$)**, drinking a lot of water **($p=0.036$)**, saliva substitutes **($p=0.008$)**, lubrication with oil **($p=0.012$)**, diet stimulating chewing ($p=0.120$), contact with a doctor for medication exchange **($p<0.001$)**, prescription of pilocarpine **($p=0.064$)**

Table 4 Number and percentages who strongly agree/agree regarding the functions of saliva, factors which can cause oral dryness and consequences of oral dryness

Question	Dentists	Dental hygienists	p-value
	n (%)	n (%)	
What are the functions of saliva?			
Prevents dehydration of oral mucosa	239 (99.2)	255 (99.2)	1.000
Antimicrobial effect	223 (92.5)	216 (84.0)	**0.003**
Regulates pH	236 (97.9)	253 (98.4)	0.745
Affects oral microbiome	223 (92.5)	221 (86.0)	**0.019**
Has lubricating effect	239 (99.2)	256 (99.6)	0.613
Protects oral mucosa	237 (98.3)	255 (99.2)	0.437
Cleanses the oral cavity from food debris	218 (90.5)	**246 (95.7)**	0.020
Facilitates swallowing	238 (98.8)	256 (99.6)	0.358
Facilitates chewing	228 (94.6)	246 (95.7)	0.562
Affects articulation of speech	217 (90.0)	244 (94.9)	0.037
What can cause oral dryness?			
Sjögren's syndrome	240 (99.6)	253 (98.4)	0.374
Parkinson's disease	133 (55.2)	167 (65.0)	**0.026**
Diabetes Mellitus Type 1	116 (48.1)	149 (58.0)	**0.028**
Diabetes Mellitus Type 2	239 (99.2)	256 (99.6)	0.613
Medication	241 (100)	255 (99.2)	0.5
Radiotherapy head/neck	240 (99.6)	247 (96.1)	**0.008**
HIV/AIDS	84 (34.9)	104 (40.5)	0.197
Cystic Fibrosis	100 (41.5)	111 (43.2)	0.702
Depression and anxiety	187 (77.6)	226 (87.9)	**0.002**
Rheumatic diseases	156 (64.7)	175 (68.1)	0.427
What complications can oral dryness cause?			
Increased caries risk	241 (100)	256 (99.6)	1.000
Difficulty speaking	200 (83.0)	240 (93.4)	**<0.001**
Difficulty swallowing/chewing	228 (94.6)	251 (97.7)	0.075
Increased risk of oral mucosal changes	174 (72.2)	195 (75.9)	0.349
Difficulty in wearing dentures	239 (99.2)	256 (99.6)	0.613
Affects general health	184 (76.3)	215 (83.7)	**0.041**
Quality of life is affected	226 (93.8)	246 (95.7)	0.33
Affects well-being	216 (89.6)	242 (94.2)	0.063
Nutritional deficiency	126 (52.3)	155 (60.3)	0.071
Bad breath	213 (88.4)	242 (94.2)	**0.022**
Altered taste perception	224 (92.9)	235 (91.4)	0.532

neck (Table 4). Almost all dentists and dental hygienists were aware that Diabetes Mellitus Type 2 can be associated with oral dryness (Table 4). Significantly higher proportions of dentists with over 10 years of professional experience, compared with those with less than 10 years of professional experience, stated that the following factors were associated with oral dryness; rheumatic disease (75.5% compared to 55.7%%) ($p=0.001$), and depression and anxiety (84.5% compared to 71.8%) ($p=0.018$). Similar results were seen among dental hygienists, where a higher proportion of those with over 10 years of professional experience stated that rheumatic disease (79.3% compared with 54.7%) ($p<0.001$), and depression and anxiety (93.6% compared with 81.2%) ($p=0.002$), HIV/AIDS (46.4% compared with 33.3%) ($p=0.033$), and radiotherapy for head and neck cancer (99.3% compared with 92.3%) ($p=0.004$), were associated with oral dryness.

Awareness of Complications of oral dryness

The majority (99.8%) of the dental care professionals were aware that oral dryness leads to an increased caries risk. The respondents were also aware that oral dryness may lead to complications such as speech difficulties (88.4%), impact general health (80.1%), affect quality of life (94.8%), and well-being (92.0%). Regarding the possibility that oral dryness may lead to nutritional deficiency, 52.3% of dentists and 60.3% of dental hygienists were aware (Table 4). A significantly higher proportion of dental hygienists with over 10 years of professional experience, compared with those with less than 10 years of professional experience, stated that well-being can be affected by oral dryness (97.9% compared with 89.7%) ($p=0.006$).

Self-assessment questions

Overall, dental hygienists rated their knowledge slightly higher than dentists, except regarding the consequences of oral dryness, where the answers were similar (Table 5). Statistically significant differences were shown between the professions in all self-assessment questions (Table 5). Dental hygienists with over 10 years of professional experience were significantly more likely to rate their knowledge higher concerning clinical management (87.1% compared with 75.2%) ($p=0.014$), and treatment of individuals with dry mouth (80.7% compared with 69.2%) ($p=0.033$), compared to those with less than 10 years of professional experience.

Request for further education on saliva and oral health

A total of 75.4% of the dentists and 74.1% of the dental hygienists expressed a wish for further education regarding saliva and oral health. A higher proportion of dental hygienists with less than 10 years in the profession, compared to those with over 10 years of professional experience, expressed a wish for further education (83.8% compared with 66.4%) ($p=0.002$).

Discussion

The main results of this exploratory cross-sectional survey study revealed that the majority of dental care professionals (88.6%) inquired about oral dryness in individuals aged 65 and older, while significantly fewer inquiries were made among children, adolescents, and adults. This was seen despite their high exposure to individuals with oral dryness and dental care professionals' awareness

Table 5 Responses to self-assessment questions. Numbers and proportions of dentists and dental hygienists [n (%)]

	Very good		Good		Satisfying		Lack of	
	Dentists	***Dental hygienists***	***Dentists***	***Dental hygienists***	***Dentists***	***Dental hygienists***	***Dentists***	***Dental hygienists***
Consequences of oral dryness	49 (20.3)	92 (35.8)	128 (53.1)	123 (47.9)	54 (22.4)	40 (15.6)	10 (4.1)	2 (0.8)
Clinical management of individuals with oral dryness	25 (10.4)	76 (29.6)	115 (47.7)	134 (52.1)	77 (32.1)	40 (15.6)	24 (10.0)	7 (2.7)
Treatment of individuals with oral dryness	23 (9.5)	73 (28.4)	105 (43.6)	121 (47.1)	75 (31.1)	54 (20.2)	38 (15.8)	11 (4.3)
Dichotomization								
Dichotomization very good/good			*Dentists*	*Dental hygienists*	*p-value*			
Consequences of oral dryness			177 (73.4)	215 (83.7)	**0.005**			
Clinical management of individuals with oral dryness			140 (58.1)	210 (81.7)	**<0.001**			
Treatment of individuals with oral dryness			128 (53.1)	194 (75.5)	**<0.001**			

about the functions of saliva and the causes and consequences of oral dryness. Dental hygienists more often asked individuals about dry mouth, including individuals aged 18–65 years, compared to dentists even though both professions met individuals in all age-groups. This may be attributed to the fact that dental hygienists in the General Public Dental Service in Sweden now perform a greater number of oral examinations than in the past. Oral dryness is also prevalent in younger age groups [19], associated with the use of medications for asthma [26], neuropsychiatric diagnoses, and depression, which can increase the risk of oral dryness and accompanying problems [1, 27]. It is important to inquire about oral dryness in all patients, irrespective of age.

According to the results, dental hygienists more often encountered individuals with oral dryness. Preventive dental care for individuals with oral dryness is mainly provided by dental hygienists with frequent follow-ups and information about oral dryness and its associated risks to oral health. The study also shows that dentists with more professional experience provided written information to a higher extent, compared to those with fewer years in the field. Additionally, dental hygienists with over 10 years of professional experience planned more frequent visits for preventive measures and assessed their knowledge higher than those with less years in the profession. These differences could be attributed to the extensive experience of these dental care professionals in examining and treating persons with oral dryness and witnessing deteriorating oral health, thereby understanding the need for preventive and supportive oral health care. Another explanation could be that dentistry in Sweden has changed over the years. Factors such as a growing shortage of dental care professionals, and a greater demand for aesthetic dentistry, may have resulted in oral dryness being less prioritized. Studies have shown that there is a general lack of interest in prevention among dentists, where dentists perceived that prevention has a lower priority than treatment and is not part of their daily practice [28, 29]. It has also been shown that dentists consider preventive work to be a part of the dental hygienists' job task [29, 30]. Most of the dental care professionals (81.4%) who did not answer the questionnaire might have a low interest in preventive dentistry. Preventive dentistry should be encouraged among dental care professionals during their clinical practice.

In most regions in Sweden, it is common to include one yes or no question about a dry mouth in the medical-dental anamnesis. However, it could be doubted if this gives sufficient knowledge about the severity of a patient's oral dryness problems. It is possible that dental care professionals ask follow-up questions regarding oral dryness in various situations, but such questions were not included in the questionnaire used in this study. Existing literature suggests the use of validated questionnaires to assess the severity of oral dryness. One such questionnaire is the Xerostomia Inventory (XI), used in the assessment of chronic xerostomia severity [31]. A complete medical-dental history and diagnostic tests, e.g., salivary flow measurement, are appropriate patient assessments when diagnosing xerostomia or hyposalivation, to identify the underlying cause [32], as shown in the current study. However, it should be noted that the results did not provide information regarding specific diagnosis assessment between xerostomia and hyposalivation. The Clinical Oral Dryness Scale (CODS) is recommended in the literature to evaluate clinical signs of of oral dryness and grade its severity [33], though the Xerostomia Inventory or CODS is not used in daily practise by dental care professionals in Sweden.

Patients diagnosed with hyposalivation (as opposed to xerostomia) in Sweden are eligible to receive a special dental care allowance because of the increased risk of deteriorating oral health. For a diagnosis, both the unstimulated and the stimulated saliva secretion rate are measured. Individuals showing hyposalivation (indicated by an unstimulated saliva flow of ≤0.1 ml/min, and stimulated saliva flow of ≤0.7 ml/min) become eligible for the allowance and can receive 1200 SEK/year to be used for check-ups and preventive oral care [34, 35]. In the present study, the dental care allowance was the main indicator for measuring unstimulated and stimulated salivary secretion by both professions. It was performed by both dental hygienists and dentists, however, a significantly higher proportion of dental hygienists reported encountering patients with oral dryness more frequently compared to dentists.

Dry mouth is often a chronic condition. To relieve symptoms of dry mouth and decrease the risk of oral health problems, saliva-stimulating products (lozenges, chewing-gum and sprays) and saliva substitutes (gel, spray and oil) are used [36]. However, a Cochrane review shows no firm evidence for using topical therapies to relieve symptoms of dry mouth [37]. The present study shows that the three most recommended treatment options suggested by dental care professionals were stimulating products (97.0%), meticulous oral hygiene (95.3%), and extra fluoride (90.3%). While meticulous oral hygiene with fluoridated toothpaste is important in reducing the risk of both caries and periodontal diseases [38, 39], and extra fluoride in rinses or gels is recommended to reduce the risk of dental caries [40], neither options can effectively relieve dry mouth. The proportion of dental care professionals in the present study recommending extra fluoride was higher compared to a study from England, where only 10% of dentists prescribed fluoride rinse [23]. The explanation may be attributed to recommendations from the Swedish National Guidelines for Dental Care, where individuals with increased risk of caries should receive extra fluoride such as 0.2% sodium fluoride as a rinse, 0.42% fluoride gel in trays, fluoride toothpaste with 5000 ppm sodium fluoride, or fluoride varnish (22.6 mg/ml) at least twice a year [41, 42]. In the present study, 70–80% of the dentists and dental hygienists recommended frequent water intake for patients with dry mouth, which is in concordance with a German study [22]. However, patients with dry mouth report that water only provides temporary relief from their symptoms [15]. Water is inexpensive, easy to carry, and readily available, with no negative side-effects, which likely explains why it is a common recommendation.

This study shows that only 33% of dental care professionals provided written information about dry mouth, with 57.4% stating that they frequently distributed an information sheet with recommended products. A recent report has highlighted that patients have limited recall of verbal instructions provided during their dental visit, suggesting a risk of dental care professionals underestimating the patients' need for written information [43]. A literature review has shown that patients request digital, as well as oral and written information [44]. This study shows no statistically significant difference regarding the length of professional experience among dental hygienists and ways of providing information regarding oral dryness to patients. This could be attributed to the fact that providing information has always been an integral part of a dental hygienist's role, regardless of when they completed their education.

The dental care professionals participating in this study were aware of the complications dry mouth can cause. Both dentists (93.8%) and dental hygienists (95.7%) acknowledged that quality of life can be affected when experiencing dry mouth, which is in congruence with a previous study [23]. Similarly, awareness regarding the impact of dry mouth on general health was high in this study and in congruence with previous results [23]. A high proportion (75.9%) of the dental care professionals stated that they never or seldom consult with physicians to change medications because of adverse effects such as dry mouth. This may be attributed to the limited interprofessional collaboration between Public Dental Care and medical healthcare services, which impacts on the treatment options and preferences of dental professionals. Research conducted in other settings aiming to include dental care professionals in interprofessional teams has shown positive results with beneficial outcomes for patients' oral health [45].

Strengths and limitations

The strengths of this study were the similar numbers of dentists and dental hygienists answering the questionnaire, facilitating comparisons between the groups.

The survey was sent to five of the 21 regions in Sweden where the three largest cities, as well as rural areas, were included. Therefore, it can be argued that the included regions represent the whole of Sweden. The use of questionnaires as a research tool is well-documented and widely used in various settings. Online questionnaires are suitable when conducting a cross-sectional study, as respondents are contacted only once [46]. The authors of this study developed the questionnaire, which may have limitations in terms of validity and reliability. To the best of our knowledge, there are no validated questionnaires available on this topic. Only Public Dental Care organizations agreed to take part in this study, despite several Private Dental Care organizations being invited to participate. This might affect the results, as 60% of adults are treated in Private Dental Care clinics [47].

The response rate in the present study was low (18.6%), but comparable to an earlier study in the same field [22]. The low response rate might be attributed to lack of interest in oral dryness or high workload, because of a shortage of dentists and dental hygienists in most regions of Sweden [48], leaving limited time for tasks other than direct patient care. Oral dryness should be interesting for dental care professionals since they frequently meet patients with this condition. It is likely that respondents in the present study are those who are more interested in oral dryness or dental care of this patient group, which may be a potential bias. Efforts were made to minimize non-response, such as sending more than one reminder and the respondents could choose to re-open and continue to fill in the questionnaire at another time-point. Information regarding the characteristics of respondents and non-respondents was not available, therefore a non-response analysis was impossible. However, according to statistics provided by the Regions and by the Swedish National Board of Health and Welfare [49], similarities existed between the dental care professionals included in this study and all licensed dental care professionals in the respective Regions and the whole of Sweden, such as gender and age. The results should be interpreted with caution, since results cannot be generalized. Despite limitations, the results are valuable due to the lack of studies on managing oral dryness in general dental care in Sweden.

Future perspectives

It is important to improve the diagnosis of individuals with oral dryness regardless of age to provide preventive measures to reduce the risk of oral diseases. It is advisable to enrich the educational curriculum for dentist and dental hygienist students by incorporating not only a deeper understanding of pharmacology but also by providing continuing education focused on saliva and the management of oral dryness. In the future, it is important to include Private Dental clinics in the research, as they see larger proportions of individuals with dry mouth problems. Currently, a qualitative study is ongoing, involving interviews with dentists and dental hygienists in both the private and Public Dental Care sectors about their experiences with oral health care for individuals with oral dryness.

Conclusions

Compared to dentists, dental hygienists were more attentive to patients with oral dryness as they encountered these individuals more often, asked more age-groups, suggested frequent preventive measures, and had higher awareness of the causes and complications of oral dryness. Length of professional experience could improve both the management of patients with oral dryness and awareness of its causes, particularly for dental hygienists.

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Author contributions
The study was conceived and designed by: AF, AA. Data analysis was conducted by AF, AA. The manuscript was written and revised by all authors. AF and AA prepared the tables and figures. All authors reviewed and approved the final manuscript.

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Data availability
The datasets utilized and/or analysed during the current study can be obtained from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Swedish Ethical Review Board. All participants consented to participate by completing and returning the questionnaire and all methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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The complexity of managing oral dryness in general dental care

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ABSTRACT

Objective: To describe the experiences of general-practising dental professionals in managing oral dryness.
Materials and methods: The purposive selection of dentists and dental hygienists sought to create a cohort with varying years of professional experience, of both genders, and in dissimilar working regions and workplaces for one-on-one semi-structured interviews. Qualitative content analysis was used to identify themes and categories, where themes represented the interpretative aspect and categories, the descriptive aspect.
Results: Thirteen informants were interviewed (4 dentists, 9 dental hygienists; of these, 9 worked in the Swedish Public Dental Service; 4, in private dental care). Two themes emerged from the analysis. The first theme, "Challenges in managing oral dryness", comprised five categories: heterogeneity of the patient group, barriers to measuring salivary secretion, routines perceived as vague, lack of treatment options, and necessity to stay current. The second theme, "A patient-centred approach in managing oral dryness", had three categories: tailoring questions to the individual, viewing the patient holistically, and sharing decision-making.
Conclusion: Managing patients with oral dryness is challenging. The study suggests that a patient-centred approach, based on the individual needs of the patient, is crucial for managing patients with oral dryness in the dental situation.
Clinical implications: This study stresses the importance of a patient-centred approach in providing individual support for patients with oral dryness. Dental professionals should query all patients about perceived dry mouth. In cases of positive responses, determination of the salivary secretion rate is essential for a comprehensive diagnosis.

1. Introduction

Oral health is a multidimensional concept encompassing physical, psychological, emotional, and social aspects, all essential for overall health and well-being [1]. The most recent definition of oral health by the World Dental Federation (FDI) encompasses various functions, such as speech, smiling, chewing, swallowing, and the capacity to express emotions through facial expressions [1]. Saliva is vital for maintaining good oral health by protecting the oral tissues through lubrication and pH regulation, and contributing to remineralising tooth surfaces. Saliva also facilitates speech and oral processing involving digestion, bolus formation, and swallowing, functions that are important in daily life [2–4].

Xerostomia is defined as the subjective sensation of dry mouth, and hyposalivation as clinical signs of dryness in the mouth and reduced salivary secretion [2–4]. Reduced salivary secretion increases the risk of dental caries, mucosal infections, and halitosis. Other symptoms, such as problems with swallowing, speaking, and changes in taste, are also common [2,3,5]. Oral dryness is a common side effect of medication. Other causes are Sjögren's syndrome, radiotherapy treatment for cancer of the head and neck region, and diseases such as diabetes mellitus type 1 and 2 [2,3]. The literature reports a prevalence of xerostomia ranging from 19.3 % to 33.0 % [5–7], with higher prevalences in older age groups and women [4,5]. The most common way to relieve symptoms of oral dryness is to use salivary stimulantsor saliva substitutes, and drink water frequently [2], however the effect is often short-lived [8]. For

Abbreviations: CODS, clinical oral dryness score; COREQ, consolidated criteria for reporting qualitative research; FDI, world dental federation; DDS, doctor of dental surgery; PDS, public dental service; RDH, registered dental hygienist.

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individuals with oral dryness, preventive measures such as supportive oral care and frequent visits to the dental clinic are important in reducing the risk of oral disease and complications [9].

It is important to acknowledge that oral dryness affects the well-being and quality of life of the patient [3,4,10]. The condition requires careful evaluation to identify the underlying cause and give recommendations [2,11]. Currently, patients with oral dryness generally receive similar treatment and are advised to try various products to see what works best for them [9]. Lack of knowledge on how to manage and support individuals with oral dryness could have devastating consequences for the oral and general health of the patient.

In Sweden, the growing number of individuals with good oral hygiene habits who retain their teeth up into old age [12,13] and the rising rates of prescription medications that affect salivary secretion rates, such as psychotropic drugs [14], indicate that oral dryness will likely become an even more prevalent health issue. Thus, the role of dental professionals in managing patients with oral dryness will become even more important in the future, especially for those working in general dental care, as they regularly see most patients.

The study by Folke et al. [15] found that healthcare professionals, including dentists and dental hygienists, viewed xerostomia as a common condition, but tended to ignore the problem. In general, they considered xerostomia to be a trivial symptom and failed to understand its importance. They did recognise, however, that it could have a negative impact on oral health [15]. Other studies have shown that dental professionals are unsure of how to treat patients with oral dryness, even though they know that it is important [16,17]. Thus, previous research has focused on xerostomia and the views of dental professionals, assessing their knowledge, attitudes, treatment methods, and clinical observations [15–17]. The aim of the present study was to increase the understanding of how general-practising dentists and dental hygienists manage patients with oral dryness, not only xerostomia but also hyposalivation, in order to improve clinical management of this patient group.

2. Materials and methods

2.1. Study design

The present study followed an exploratory qualitative design [18] using an inductive approach [19]. This design is the most appropriate for investigating the experiential aspect—the goal of qualitative studies—of managing patients with oral dryness [20]. When knowledge about the phenomena is sparse, the inductive approach is preferred [19, 21]. Qualitative data underwent qualitative content analysis described by Graneheim and Lundman [22,23]. Qualitative content analysis is a systematic method including coding and identifying themes and patterns through the subjective interpretation of a text [19,22,24]. The reason for choosing this method was its ability to detect variations and similarities in a text. It also allows analysis of the manifest content, which is closely related to the text and results in categories, and the latent content, which is the interpretation resulting in themes. Thus, qualitative content analysis is appropriate for analysing interviews, as in the present study, where one-on-one semi-structured interviews were conducted [22,23].

This study used the consolidated criteria for reporting qualitative research (COREQ), a 32-item checklist, as a guide for comprehensive descriptions of participant experiences (see supplement 1) [25]. The Swedish Ethical Review Board approved the study (Dnr [daybook no.]: 2021-01795).

2.2. Reflexivity

The research group comprised four female researchers, all with clinical dental experience. AF is a Registered Dental Hygienist (RDH) and a Ph.D. student. CF is a Doctor of Dental Surgery (DDS), holds a Ph. D., and is an associate professor with several years of conducting qualitative research focusing on professional and organisational studies. SL is an RDH, holds a Ph.D., and works as a lecturer and researcher on the oral health of the elderly. SL also has experience in conducting qualitative studies. AA is an RDH, holds a Ph.D., and is an associate professor researching oral dryness and saliva composition.

2.3. General dental care in Sweden

The present study was carried out in the Swedish counties of Stockholm, Skåne, Västra Götaland, Dalarna, Jönköping, Blekinge, and Kalmar. The participants were either dental hygienists or general dentists employed in the Public Dental Service (PDS) or at private dental clinics. In Sweden, public dental care is free of charge for individuals aged 0–23 years [26]. Adult patients are mainly treated at private dental clinics [13], and a high proportion of the adult population has regular dental check-ups [12]. Patients with severe diseases such as cancer, with multimorbidity, or with cognitive impairment usually visit specialist dental care for treatment.

2.4. Sample selection

The inclusion criteria were dentists and dental hygienists with at least two years of professional experience, who worked in public or private general dental care, and who encountered patients with oral dryness. Purposive sampling, was used to select individuals who could provide informational descriptions of the study goals [20,27]. Eligible participants who, after responding to the digital questionnaire "Saliva and oral dryness" in aprevious study [28], were interested in joining this study were recruited. Participants were also recruited via social media, sharing a recruiting link in private groups for dental hygienists and dentists. Interested individuals provided their contact details, and AF contacted those who fulfilled the inclusion criteria. To ensure variation, participants with different professions, genders, and years of professional experience, and who were educated at different universities and worked in different regions, were invited to participate. At this point, there were no male dentists, so snowball sampling was applied. Snowball sampling is a purposive sampling method where participants are recruited through referrals [20,27]. One colleague assisted in recruiting male dentists, who were given the survey link and contacted by AF.

2.5. Interview guide

The interview guide was developed based on the authors' clinical experience and knowledge about saliva and oral dryness. The guide comprised eight open questions, five of which formed the basis of this study. The questions addressed in this study were "*What do you do if a patient says that they experiences dry mouth?", "What do you do when you have a patient who you suspect has oral dryness?", "What do you think about the routines for patients with oral dryness?", "What factors do you think affect the management of patients with oral dryness?*" and "*What do you think about your knowledge on management of patients with oral dryness?*" When necessary, the questions included probes, for example, *Can you tell me more? Can you elaborate on that*? *How do you mean?* Before the start of the study, the interview guide and the digital and interview techniques were pilot-tested with two informants. Data from the pilot test were not included in this study. The research group discussed the pilot interviews and whether any modifications of the interview guide were necessary. A few minor corrections were made, for example, adding more follow-up questions and changing the order in which the questions were asked.

2.6. Data collection

All interviews in this study were conducted one-on-one from March 2022 to May 2023. Because the study was conceived during the COVID-19 pandemic, participants were interviewed online via Zoom Video

Communications or Microsoft Teams. All participants, except for two, turned on their cameras. AF conducted all semi-structured interviews. Semi-structured interviews are an appropriate data collection method for qualitative content analysis, the method chosen for this study. Semi-structured interviews allow the informants to speak freely on the same topics, which were predefined in the interview guide [20].

The interviews lasted between 14.5 and 57 min (median = 25.5). Fifteen interviews were conducted, of which two were excluded. The reasons for exclusion were ineligibility (two informants) and technical issues with the recorded file (one informant). AF recorded the interviews with a digital voice recorder. To get an overview of the study cohort, the interviews began with an informal conversation about the informants' profession, previous education, and workplace, and a description of their daily clinical life.

2.7. Saturation

AF considered data saturation to have been reached when no new data were being discovered [29]. After conducting nine interviews, the informants' answers concerned the same experiences of managing patients with oral dryness. To get richer data and ensure that adequate information was obtained to answer the research question, an additional four interviews were conducted.

2.8. Data analysis

After each interview, AF made verbatim transcriptions. Some transcripts were made soon after the interviews and others, a few days later. Data underwent qualitative content analysis according to Graneheim and Lundman [22,23]. The process includes de-contextualisation and re-contextualisation. De-contextualisation is the breaking down of the text into meaning units, followed by the condensation and the coding of the meaning units. Re-contextualisation is the creation of new interpretative and abstract patterns from the original context [22,23]. After four interviews, the transcripts were read and coded to get a sense of the content. The interviews then continued. Data analysis occurred in tandem with data collection and involved all authors. In the first step of analysis, three of the authors read the transcribed interviews multiple times to get an overview of the content. They also discussed the text. In the second step, one author (AF) divided each interview into meaning units, and condensed the meaning units. In the third step, all condensed meaning units were given a code. Similar codes were merged to create sub-categories. Fourth, all sub-categories relevant to the study aim were extracted. Those with similar content were grouped to create the manifest level, which the authors discussed together. Fifth, the sub-categories were interpreted and abstracted into categories. When consensus was achieved regarding categories, the authors searched for the "red thread" through the categories and the underlying connections between them. The final step included interpretation and abstraction of the underlying latent content by creating themes. The analysis process included moving back and forth between the transcripts, the condensed meaning units, the codes, the categories, and the themes. The first author made the initial identification of codes, categories, and themes, followed by a discussion involving all authors until consensus was achieved.

3. Results

In all, 13 dental professionals participated in this study. Their overall work experience ranged from 3 to 44 years (median 7). Table 1 presents participant characteristics.

The experiences of managing oral dryness in general dental care, as described by dental professionals, consisted of two themes with categories that emerged from the analysis: (i) Challenges in managing oral dryness and (ii) A patient-centred approach in managing oral dryness. Table 2 presents the two themes and the underlying categories. Dental professionals face challenges in working with these patients, but they have also identified an approach for managing each patient as an individual.

Table 1
Participant characteristics.

Participant characteristics	Number
Profession	
Dentist	4
Dental hygienist	9
Gender	
Female	8
Male	5
Number of years in the profession, mean	12
Workplace	
Public dental care	9
Private dental care	4
Region	
Skåne	4
Västra Götaland	2
Dalarna	2
Kalmar	2
Stockholm	1
Blekinge	1
Jönköping	1
University of completed education	
Malmö University	3
Jönköping University	3
Dalarna University	2
Kristianstad University	2
Umeå University	1
University of Gothenburg	1
Abroad	1

Table 2
Themes and categories that emerged in the one-on-one, semi-structured interviews of 13 general-practising dental professionals on the management of patients with oral dryness.

Theme		Category	
1	Challenges in managing oral dryness	1.1	Heterogeneity of the patient group
		1.2	Barriers to measuring salivary secretion
		1.3	Routines perceived as vague
		1.4	Lack of treatment options
		1.5	Necessity to stay current
2	A patient-centered approach in managing oral drynesss	2.1	Tailoring questions to the individual
		2.2	Viewing the patient holistically
		2.3	Sharing decision-making

3.1. Theme 1: challenges in managing oral dryness

This theme highlights the challenges of managing oral dryness among the patients encountered in daily clinical practice. The challenges in managing oral dryness spanned identification, diagnosis, and treatment of the patient.

3.1.1. Theme 1 category 1: heterogeneity of the patient group

Patients with oral dryness were perceived as a heterogeneous group. The informants state that the group of patients with oral dryness is large and diverse. As one informant said:

> You can talk about oral dryness as a homogenous group, but I think that is wrong, rather, it can be very diverse (ID16—dental hygienist, PDS)

Several informants observed that a variety of patients are affected by oral dryness, including patients of different ages and genders; patients with and without diseases such as Sjögren's syndrome and diabetes mellitus; and patients with medications for various conditions, such as water retention (diuretics), high blood pressure (anti-hypertensive agents) and depression (antidepressants).

> It's Sjögren's, that is the big one, and *diabetes*. With that one, well, you can get a dry mouth if your sugar swings a lot, and that affects your saliva, and I think a lot about heart patients with heart failure and all of that, and their medication which can also make their mouths dry, like diuretics (ID2—dental hygienist, PDS)

Another patient group that was thought to be growing was patients who take antidepressants and patients who take medication for attention deficit hyperactivity disorder (ADHD), especially children, adolescents, and young adults.

> … everyone who takes antidepressants, all the young people—they are also a large group, where it is quite common to have oral dryness, but not all have it (ID12—dental hygienist, PDS)

Some emphasized that it is more challenging to manage younger patients than older patients. One informant described it this way:

> … young adults who take antidepressants, I do the same with these individuals, however, I think it is more difficult [managing young adults] (ID16—dental hygienist, PDS)

Despite the growing prevalence of oral dryness among young patients, the general experience was that oral dryness was still more common among older than younger adults:

> So, my view is that the majority who come and have dry mouth are 60 and over. So, it's like this, you take a lot of different medicines, or you have Sjögren's, or you have a breathing mask at night. (ID16—dental hygienist, PDS)

3.1.2. *Theme 1 category 2: barriers to measuring salivary secretion rates*

Signs of oral dryness include clinical signs (e.g., the mirror sticks to the mucosa, the mucosa is red and irritated, the incidence of dental caries has increased), oral dryness-related diseases (e.g., diabetes mellitus), certain medications (e.g., anti-depressants, diuretics, antihypertensives), or when patients use several medications. Dental professionals in this study use these signs to determine when it is indicated to measure a patient's salivary secretion rate. The informants stressed, however, that it is important that the patient shows interest in determining the salivary secretion rate and is willing to pay for or it or wishes to apply for a dental subsidy (financial support for preventive dental care).

> I reach an agreement with patients, it also costs to do a saliva test. So it is an agreement with patients, if they want to do it (ID8—dental hygienist, PDS)

Another barrier that dental professionals encountered was cost. Their experiences varied regarding measuring saliva secretion rate due to the cost.

> I think saliva tests are, well, good, it is good that they can get the Special dental care allowance but if the saliva testing should be performed on a regular basis, it is, as I said, quite expensive at our clinic (ID14—dentist, private dental care)

> In most cases, I think it is not difficult to convince them to pay the cost (ID5—dental hygienist, PDS)

Informants also emphasised that patients would be more willing to measure salivary secretion rates if it was free of charge, as one dental hygienist expressed:

> If it had been free, more would have wanted a saliva test (ID8—dental hygienist, PDS)

Patients who experience dry mouth are often upset if testing shows a salivary secretion rate within the normal range:

> They feel that their mouth is dry, and then they take two salivary secretion tests, which do not confirm oral dryness, which is necessary for them to receive a dental subsidy, and then they get upset: my mouth is dry, but not so dry that I can get a dental subsidy, and they [patients] get upset and they also have to pay for the test (ID11—dental hygienist, PDS)

Another barrier to measuring salivary secretion rates is when clinics lack the necessary equipment and must then refer patients to primary health care. One informant explained:

> Special containers that measure how much saliva they have are then needed, and we don't have those at the clinic … if it is something the patient is interested in, we send them there [a health centre] to do a saliva test (ID6—dentist, PDS)

3.1.3. *Theme 1 category 3: routines perceived as vague*

The informants had no established, written routines for the management of this patient group, which meant that they had to do what they were left was best for their patients.

> No one has written [recommended routines] so, instead, I think that each one does as they like. So there are no routines that say—if you get such a patient [with oral dryness] then you should do this and that, unfortunately! (ID10—dental hygienist, private dental care)

What is considered routine varies among the informants. It could be the criteria for applying for the Special dental care allowance (dental subsidy). One dental hygienist suggested using risk-assessment programs to determine recall intervals for preventive measures. This could be considered a routine, potentially eliminating the need for more established routines.

> Risk assessments are done when you do a clinical exam … having separate guidelines in addition to that is not something I miss (ID5—dental hygienist, PDS)

Other informants view the medical history form as a routine, specifically the question about whether the patient experiences dry mouth.

> … routines are like this, you ask questions in the medical history. (ID16—dental hygienist, PDS)

The informants said that established routines would be supportive and helpful for being able to provide dental care equitably. One dental hygienist said:

> I think care would have been better. Because you would have had a better idea that, yes, these are persons who need a little more prophylaxis, who perhaps need check-ups, follow-ups, more often (ID10—dental hygienist, private dental care)

However, without written, established routines, asking about dry mouth is up to the dental professionals. The approach can vary based on the patient's age, medical history, and clinical signs of oral dryness. Some dental professionals said that they ask all patients about dry mouth. One dental hygienist expressed:

> In general, I ask everyone if they experience dry mouth and even if I don't detect oral dryness when they come for an examination, I always ask if their mouth is dry or if they experience dryness [from time to time]. (ID13—dental hygienist, PDS)

Furthermore, some informants stated that they did not ask about dry mouth as a routine. They only asked older adults, patients with specific medical conditions, those on medication, or when they observed clinical signs of oral dryness

> You can't say that it is one of my standard questions, I wouldn't want to say that. I do it if I see what their list of medications looks like, if I

> see there are medicines that I know cause dry mouth, and if it is a long list of medications, I always ask. Then it is when I examine the patients, that I, if I see it [oral dryness], that I ask if they [ever] experience dry mouth? (ID2—dentist, private dental care)

Similarly, the informants only asked adolescents under 18 years old about dry mouth when they had medical conditions.

> I can say like this, that those who are under 18, I ask them the question only if there is some special diagnosis. And to all over 18, I ask the question, regardless of whether they have a diagnosis (ID13—dental hygienist, PDS)

3.1.4. Theme 1 category 4: lack of treatment options

Informants would suggest a variety of products, showing their willingness to assist the patient. They recommended, for example, saliva-stimulating products, saliva substitutes, or oral moisturising products to relieve dry mouth symptoms.

> I usually recommend a lubricant and that, more or less, is for all types of discomfort, even those who have problems with caries and so on (ID3—dentist, private dental care)

Another recommendation was to use toothpaste developed for dry mouth patients or toothpaste without sodium laureth sulphate.

> [I] ask them [the patients] to check which toothpaste they have … so that they have a toothpaste without this foam-building surfactant (ID2—dental hygienist, PDS)

Informants also recommend everyday tips like using sesame oil in their food or lubricating the mucosa, chewing the food longer to stimulate saliva secretion, eating a high-fibre diet, and drinking lots of water. These recommendations are cheaper than pharmaceutical products, and are frequently recommended. Other recommendations are physical exercise or Chi-gong:

> Drink water often, exercise, be extra careful with oral hygiene at home, use a fluoride rinse, sometimes a Duraphat® toothpaste (ID12—dental hygienist, PDS)

Prevention of dental caries is important, and informants recommended meticulous oral hygiene and products like, for example, toothpaste with 5000 ppm fluoride or rinses with 0.2 % sodium fluoride. Informants did not recommend extra fluoride when a patient was experiencing dry mouth; instead, informants recommended patients to avoid sugar and easily fermentable carbohydrates. According to one dentist:

> I usually don't advise a fluoride rinse if there isn't a problem, as in caries activity, possibly I sometimes say that it wouldn't hurt, but that I don't see the need. Avoid snacking, simple carbohydrates, too much of carbohydrates in general, things you can think about if you are experiencing dry mouth (ID3—dentist, private dental care)

A common experience among the informants was hearing that most patients consider the available products to have only short-lived effects. Thus, they found oral dryness difficult to treat:

> Some think that these saliva substitutes or saliva stimulating agents work well while some think, no, that was nothing. It was a waste of money because it didn't work at all, and then it is more difficult to continue. (ID16—dental hygienist, PDS)

Informants longed for better treatment options and recommendations for helping this patient group. They experienced a sense of helplessness because they felt thatnothing they suggested was helpful. They did their best with the available products and other recommendations. One dental hygienist expressed frustration about the lack of effective treatment:

> Right now, there are not very many treatments for it and that is the problem. (ID14—dentist, private dental care)

> So, it's that, like it feels so hopeless when all one really does is just talk with the patients? That yes, there are saliva stimulants, it's just that they don't work. It's as if you just shrug your shoulders and say: yes, I am sorry that you have oral dryness … and that the side effects are higher risks of gingivitis, and caries, and everything…It would have been good to've been able to offer some sort of treatment. (ID9—dental hygienist, private dental care)

3.1.5. Theme 1 category 5: necessity to stay current

The state of knowledge in management of oral dryness varied among the informants. Dental professionals relied on their undergraduate education on this topic due to the scarcity of continuing education. As new graduates they found it challenging to identify clinical signs of oral dryness, which was why clinical experience was highly valued for identifying patients with oral dryness. One dental hygienist described it this way:

> But I thought it was difficult when I was newly graduated because I didn't have the same clinical experience. We had heard that you will feel it in the mucosa when it is dry. But in the beginning, you didn't. I didn't really understand, but with clinical experience, I have picked up more and more. (ID5—dental hygienist, PDS

Others reflected on how years of clinical experience can lead to uncertainty or awareness of the unknown. One informant explained:

> But the more years you work, the more unsure you become. Or, you become more and more sure that you, that you can't (ID15—dentist, PDS)

Informants said that they desired more knowledge, particularly on new products to recommend for oral dryness, but also about new medicines. They were curious about product names and interactions. Informants who felt their knowledge was comprehensive also wanted information on recent findings in the area.

> So, I would have liked to know more, if there were articles on new aids for patients, new saliva-stimulating agents. I am confirming that now. That I am on the right track, and that I go to lectures and such, if possible, to stay current. But there are always new things, new medications being introduced on the market, there are always new names Sometimes, not much is known about the side effects (ID8—dental hygienist, PDS)

Because of insufficient knowledge, informants search for new information online and in journals for dental professionals, as well as discussing patient cases or new products with colleagues. Interviewing patients with oral dryness is another way to learn more:

> I read about it, have been looking, on the Internet and in the Swedish Dental Journal, the Swedish Dental Hygienist Journal, of course, and then, a little experience. I usually interview some of my patients—sometimes, and ask, like, how does it feel now? (ID2—dental hygienist, PDS)

Another way of acquiring new knowledge was to take courses:

> it is mostly during my education, then occasionally there are courses one goes to. (ID3—dentist, private dental care)

3.2. Theme 2: a patient-centred approach in managing oral dryness

This theme describes how dental professionals approach patients with oral dryness in everyday practice. This approach seems essential from the beginning, when a patient is identified, and necessary throughout the entire diagnostic and treatment process.

3.2.1. Theme 2 category 1: tailoring questions to the individual

Dental professionals emphasise the importance of follow-up questions. This helps them better understand the unique situations of their patients, which is crucial for getting a clearer picture of the underlying cause of oral dryness, assessing its severity, and customising management.

> How do I decide? [the degree of oral dryness], well, I base it on the patient's explanations and stories (ID11—dental hygienist, PDS)

Many ask follow-up questions about when patients experience dry mouth (e.g., during the day or at night). This helps the informants understand if the dryness is chronic or temporary:

> I ask how dry they feel their mouth is during the day or at night, when is your mouth dry? Then I just continue … you can always come up with follow-up questions (ID10—dental hygienist, private dental care)

> Usually, I also ask whether they feel their mouth is always dry, or is it only in specific situations, like when they wake in the morning? Is it at night? Do they need to get up and drink and so on (ID9—dental hygienist, private dental care)

Questions were also asked to determine if they experienced any difficulties at mealtimes:

> How is it with eating, with chewing? With swallowing? I don't ask about talking … I notice that myself, when they talk, if they have a lisp, and so on, if their lips stick to their teeth, if they have dry mouth. (ID13—dental hygienist, PDS)

3.2.2. Theme 2 category 2: viewing the patient holistically

The informants expressed the importance of looking at oral dryness in a broader context. They stressed the importance of listening to patients' stories and showing empathy, not only for their oral problems and symptoms, but also for their life situations. This is essential for delivering the best patient care. One dentist described it as follows:

> I think you have to have empathy. To listen to how difficult, on a scale of 1 to 10, their complaints are. And have they gotten worse, or are they the same? I think that being negligent or not listening…—if we look only at teeth and mucosa, we miss like 90 % of the value. Many times, stress, and stress at work, are also a very large reason for this, and family situations and such also, and that part you can't forget to consider either. (ID15—dentist, PDS)

Furthermore, patients' subjective experience of oral dryness, as well as how patients perceive their situation, is considered important. To see the whole picture, both objective measurements and subjective perceptions are necessary:

> … it is important to have both sides of this coin, because there is not only the subjective but also the objective oral dryness … so I look at how patients view their situation themselves, it is super important (ID10—dental hygienist, private dental care)

The informants had observed that there is not always an association between the amount of saliva in the mouth and perceived oral dryness. Thyexplained it like this:

> Some which you experience have severe dry mouth and some who, uhmm, say that they have dry mouth but you maybe don't notice it in the caries activity or that it feels dry orally, but they feel mouth dryness anyway (ID2—dentist, private dental care)

One dentist pointed out that patients often experience oral dryness before dental professionals can observe it clinically:

> I think that patients often experience their oral dryness before I can see it (ID14—dentist, private dental care)

3.2.3. Theme 2 category 3: sharing decision-making

The dental professionals in this study aimed to involve their patients in their dental care by discussing recommendations for products. One way of involving patients was to suggest products that the patients could easily incorporate into their daily lives:

> I would say that I don't have a set way, instead, I usually try to feel [what will work] with the patient, which varies from patient to patient, and what they are motivated to do themselves … each patient in the chair is, well, is not like the other. (ID9—dental hygienist, private dental care)

> It differs a bit, depending on what the patient says, what information is revealed, how to go on from there, what product you recommend, it varies widely. (ID11—dental hygienist, PDS)

It also appears that the informants based recall intervals on the physical and mental health conditions of the patients and their willingness to visit dental care. The following observation explains why it is important to involve the patient in decision-making.

> So partly, it's like, the patient's, that is, their condition, both physical and mental, for wanting to go the dental hygienist, to sum up the energy [to do so] … if, for example, tighter intervals are needed to prevent caries, if oral hygiene activation is needed, if saliva stimulation is needed, … then I need to offer it, and then it is up to the patient, actually, to say yes or no to the therapy suggestions (ID16—dental hygienist, PDS)

Additionally, the informants felt that how well the patient understands the importance of saliva for their oral health may have an impact on how much the patient chooses to be involved in decision-making:

> I think, in part, that it is a matter of the patient's understanding of how much saliva means and … that they themselves might actually want to participate in helping with that, which I also think that many do (ID9—dental hygienist, private dental care)

4. Discussion

The present study revealed that addressing oral dryness in the general dental care setting can be challenging for dental professionals, and a patient-centred approach appears to be essential in its management.

4.1. Discussion of results

This study identified several challenging factors, which, in the long term could have negative consequences for patients' oral health. This might mean failing to reach the goal of dental care: to strive for good oral health and equal dental care for the entire population [30].

An explanation for why dental professionals face barriers to measuring salivary secretion rate could be that they don't value measuring salivary secretion rates as informative for diagnostics. Thus, they don't give patients enough information about options for measuring their salivary secretion rate or explain why it is important. This is in line with a governmental report indicating that patients in general feel that they don't get as much information from dental professionals as they need in order to decide on the best treatment [31]. Other explanations could be the lack of treatment options for oral dryness or, the perception that disseminating information is time-consuming and not essential in their clinical practice [32]. The Mayer et al.study [17] reported that, only 5.3 % of 284 dentists determine the salivary secretion rates of their patients [17]. However, awareness of patients' unstimulated and stimulated salivary secretion rates is important for managing the condition. Patients with salivary glands that can produce saliva when stimulated may benefit from saliva-stimulating agents. This is why assessment of salivary secretion is useful when deciding which products to recommend [33].

Another issue that emerges from the findings in this study is the importance of being able to offer the patient treatment. This points up the need for research on the composition of saliva and its correlation with the subjective experience of oral dryness, which would contribute to the development of new treatment options [34]. The current products for relieving the feeling of dry mouth often have a short-lived effect [33]. Research on new treatment options for individuals with oral dryness is ongoing. For instance, Faruque et al. [35] found that using olfactory stimulation with mastic resin volatiles can provide relief of oral dryness in the posterior parts of the mouth [35]. Additionally, the stability and cytotoxicity of biopolymer-coated liposomes for oral use to relieve oral dryness are being investigated [36].

This study found the patient-centred approach to be central to the management of oral dryness. In this approach, the patient becomes the primary focus in decision-making and treatment during healthcare delivery, taking the patient's preferences, needs, and values into consideration. Patient-centred care has been shown to affect physical and psychological outcomes positively as well as enhance health status, reduce utilisation of care, and improve patient satisfaction [37,38]. Patient-centred care is also associated with higher work satisfaction for health professionals [38]. The Swedish national guidelines for dental care [39], as well as governmental reports [40], highlight involving the patient in their dental care, for example, by creating an individual health plan available to everyone connected with the patients' care [39,40]. Ginsberg reported that a patient-centred approach in managing individuals with xerostomia is important. Patients' stories reveal how oral dryness affects their quality of life. Thus, shared decision-making appears to be essential when encountering individuals with oral dryness [41]. The present study found the same.

Xerostomia is diagnosed by asking the patient about their subjective dry mouth experience, while hyposalivation is assessed by measuring salivary secretion rates. Dry mouth experience and hyposalivation are only weakly correlated [2,42]. The informants seemed to be aware that asking questions in order to evaluate the underlying cause of suspected mouth dryness was important. which is in congruence with Pedersen et al. study [4].

Patient questionnaires for identifying and evaluating oral dryness are available for the clinical setting [43]. However, none of the informants spoke of using these instruments. Questionnaires like the Xerostomia Inventory [44], and clinical instruments such as the oral dryness score (CODS) could be helpful for dental professionals.

The finding of this study, that dental professionals rarely asked their patients about experience of dry mouth is in line with the Folke et al. study [15] and indicates a need for continuing education. Earlier studies have found similar results [16,17,28]. Further, both this study and the Folke et al. study informants experienced increased prevalences of xerostomia among younger adults and also overall [15]. In view of this, undergraduate healthcare programmes should incorporate training in salivary secretion measurement in their curriculums. Sweden was the only country in Europe that trained their dental and dental hygiene students in salivary secretion rate measurement [45]. However, this study and the Folke et al. study do differ in some aspects [15]. The present study only included Swedish dental professionals, whereas Folke et al. included other Swedish healthcare professionals as well. Further, their study reported views of xerostomia, while this study queried experiences in managing oral dryness. To clarify, this study did not separate xerostomia from hyposalivation, and the focus was on management. To the authors' knowledge, this is the first study addressing management of this patient group.

4.2. Methodological considerations

Using Zoom for conducting interviews has been found to be successful among researchers and participants [46]. Two of the participants in this study chose not to use the camera, which is why some interviews are more comparable to a telephone interview. Telephone interviews also produce data comparable to in-person interviews [47]. Despite being unable to see participants' facial expressions, the present study considers the audio-only interviews to have had no affect on the data analysis or results.

Achieving trustworthiness in qualitative studies involves considering factors such as credibility, dependability, confirmability, and transferability [22,48,49]. To achieve credibility and dependability, data collection was continued until no new data was revealed and the amount of data could answer the research question. A sufficient number of participants to reach saturation and a purposive sampling method that included participants with varied experiences from different workplaces and regions and varied years of professional experience helped achieve the aim of this study. The research group comprised researchers with varying backgrounds and who participated throughout the process. Regular debriefing sessions in the group were held, which is essential for credibility, confirmability, and dependability since a text can have more than one meaning and multiple interpretations [19,50]. Confirmability was assessed by discussing the authors' pre-understanding beforehand and reflecting on it during data analysis. To facilitate transferability, a detailed description of the contexts, selections, and participant characteristics is provided. Readers themselves must decide if the findings can be applied to other contexts.

4.3. Strengths and limitations

A possible limitation of the study was that the terms xerostomia and hyposalivation were not used in the interview guide, nor were the dental professionals asked if they were familiar with these terms. The aim was not to make anyone feel uncomfortable, as the interview was not intended to assess their knowledge. The inclusion of both xerostomia and hyposalivation as a single concept may have influenced their answers. If these conditions had been addressed separately, the results might have offered a better understanding of how the informants assessed patients seeking treatment for xerostomia, or in a case of confirmed hyposalivation, how they are assessed separately [2–4,43]. Another possible limitation is that this study focuses solely on self-reporting rather than observed management of these patients. A strength of the study is that most participants were women, reflecting the gender distribution among dentists and dental hygienists in Swedish general dental health care [13].

4.4. Clinical implications

General-practising dental professionals should query all patients about oral dryness, as it can affect anyone. It is important to engage with the patient by expressing interest in their life situation through empathetic communication and acknowledging the importance of their subjective experience. Also crucial through individual communication is giving patients recommendations for products they can incorporate into their daily routine, involving them in decision-making, and explaining the importance of saliva testing for a comprehensive diagnosis. Additionally, it is essential to stay current in the field concerning new medications and treatment options.

5. Conclusions

This study added to knowledge on how dental professionals manage patients with oral dryness, highlighting that this is challenging because of the varying causes of oral dryness, difficulties setting a diagnosis, and lack of routines and effective treatments. A patient-centred approach could be essential in the treatment of patients with this condition. Understanding patients' experiences and needs is often necessary in order to alleviate their discomfort.

Ethics approval and consent to participate

All participants received written and verbal information about the study before consenting to participate. The information letter described the purpose of the study and explained that participation was voluntary and that participants could withdraw from the study at any time without explanation. They were also informed that all material was protected and handled confidentially. Each transcript was given a code to ensure confidentiality and was stored so that no unauthorised person could gain access.

Consent for publication

Yes.

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CRediT authorship contribution statement

Amela Fišić: Writing – review & editing, Writing – original draft, Visualization, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Cecilia Franzén:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation. **Susanne Lindqvist:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation. **Annica Almståhl:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jdent.2025.105615.

Data availability

The datasets generated and analysed in the current study are not publicly available but can be obtained from the corresponding author upon reasonable request.

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