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## Review

# Dry mouth – An overview



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### ABSTRACT

This paper presents an overview of dry mouth, an important condition in the older population. Dry mouth will first be defined, followed by consideration of its occurrence. There will then be an overview of the leading causes of dry mouth. Next, the impact of dry mouth will be discussed in order to explain why it is a significant condition. Lastly, there will be a brief description of the diagnosis and management of dry mouth.

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### Definition

There is some confusion about the definition of dry mouth in the literature because the terms “xerostomia” and “salivary gland hypofunction (SGH)” have been used interchangeably in relation to the subjective complaints and objective aspects of dry mouth [10,23,24]. Xerostomia is the subjective symptom of dry mouth (this could be a result of a qualitative change in saliva). It is a sensation that is assessed only by

directly questioning the individual [7]. On the other hand, the objective sign of dry mouth is salivary gland hypofunction, in which the quantity of saliva produced is lowered. It can be determined by sialometry [21].

### Measuring dry mouth

Determining the epidemiology of dry mouth is complex due to (1) unclear definitions for dry mouth being used; (2) the

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different methods for measuring dry mouth; and (3) the samples used in most studies tending to be institutionalised older people, who are often on multiple medications (which can confound its investigation). The measurement of xerostomia and salivary gland hypofunction will be discussed separately.

Xerostomia is subjective, and therefore questions must be used to assess xerostomia. The subjective symptom of dry mouth, xerostomia, can be measured by a (1) single-item question, or (2) multi-item approaches, including (a) batteries of items, or (b) summated rating scales. An example of a single-item question is "Does your mouth feel dry?" [20]. There are limitations to this method in capturing the severity and variability of xerostomia. Such a single-item question inevitably categorises a patient as xerostomic or non-xerostomic according to an arbitrary cut-off point [10]. Moreover, the respondent will be likely to wonder whether the question refers to "now", or "usually?" [35]. A better example of a single-item question is "How often does your mouth feel dry?", with a range of possible responses from 'ever' to 'always'. It is used as a validity check in the Xerostomia Inventory (XI), a summated rating scale [31]. The multi-item approaches include (a) batteries of items; and (b) summated rating scales. Batteries are a list of items with a 'yes'/'no' response format. These items are usually questions asked about the experiences with regard to dry mouth-related problems or behaviours undertaken to alleviate dry mouth. For example, Locker used a list of seven questions and a simple 'yes'/'no' response format to group nursing home residents into three categories: no xerostomia (0 positive responses); mild xerostomia (1-2); or marked xerostomia (3-7) [15]. Batteries of items can be useful for exploring the determinants of xerostomia. However, they may not relate to the experience of dry mouth with just a 'yes'/'no' response. A summated rating scale is a multi-item scale that is a more sophisticated refinement of the item battery. For example, the XI comprises 11 items (each response is given a numerical value ranging from 1 to 5 according to its severity) aimed to capture the broad experience of xerostomia [31]. So far, the XI is the most comprehensive measure that addresses the individual awareness and the consequences of xerostomia. Moreover, it has been translated into several languages and recently shortened into a validated 5-item scale [34].

SGH is an objective sign that can be measured clinically. The normal daily production of saliva is between 0.5 and 1.5 l. The three major salivary glands (parotid, submandibular and sublingual) contribute to 90% of total salivary flow. The minor salivary glands contribute to the remaining 10% of salivary flow [22]. The secretions of the parotid glands contribute mostly to stimulated saliva that is in the mouth for about 2 h each day for alimentary functions [28]. The submandibular and sublingual glands are the main contributors to the unstimulated salivary flow that is present in the mouth for the majority of each day to lubricate and protect the oral mucosa [12]. SGH can be estimated by measuring stimulated or unstimulated salivary flow. Salivary stimulation is commonly achieved using citric acid or chewing of a piece of paraffin. Unstimulated salivary flow is more representative of the *in vivo* situation. Salivary flow can be evaluated by collecting saliva from individual glands or by assessing whole

salivary flow (total secretions of major and minor glands). Whole salivary flow (usually using the spit technique) is a more practical method to collect saliva [32]. Because salivary flow varies throughout the day [5], the objective of salivary flow measurement is to replicate consistency within the same patient. A base reference recording to compare within patient is ideal [11]. An unstimulated whole salivary flow rate of <0.1 ml/min or a stimulated flow rate of <0.5 ml/min is considered to be less than normal [27].

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## The epidemiology of dry mouth

Some studies assume that everyone who experiences xerostomia has SGH, and vice versa. The evidence suggests that the two are not necessarily concurrent. Prevalence estimates for dry mouth may vary and are dependent on factors such as the nature of the sample (age, gender, health etc.) and the case definitions used. The relationship between xerostomia and SGH is complex. Logically, xerostomia can occur due to a reduction in salivary flow in SGH, but both the subjective (xerostomia) and objective (SGH) components are known to occur independently of each other [14]. The few studies conducted on both xerostomia and SGH within the same population show that the two are largely separate conditions. In a systematic review, the prevalence of xerostomia prevalence ranged from 8% to 42%, while the prevalence of SGH prevalence ranged from 12% to 47%. The prevalence of both conditions existing together is only about 2% to 6% [10]. Similarly, in a longitudinal study of a population-based sample of 700 older South Australians, the prevalence of xerostomia was 21% and the prevalence of SGH was 22%, but only 6% of participants (or one in six of those with either conditions) had both conditions [30].

The variability in prevalence estimates for xerostomia due to different questionnaire formats and sample selection bias has been addressed in a systematic review by Orellana et al. (2006). Based on mainly elderly Scandinavian population samples, the reported prevalence of xerostomia has ranged from 0.9% to 64.8%. That variation may be explained as a consequence of differences in the measurement process and in case definitions. The review criticised the lack of consensus in the literature in the definition of xerostomia, and showed how the different types of single-item questions used may yield different prevalence estimates in the same population.

Even though it has been generally accepted that ageing has no significant impact on salivary flow rates, the prevalence of xerostomia is greater in older people. This may be at least partly due to the polypharmacy experienced with a concurrent increase in age-related medical conditions [37]. The misconception that xerostomia affects only older people has been challenged by findings from the Dunedin Multi-disciplinary Health and Development Study, a longitudinal study of health and behaviour in a complete birth cohort, where xerostomia was reported in 10% of the 972 participants at age 32 [33].

In older adults, there is a sex difference in xerostomia, whereby the reported prevalence of xerostomia is lower in men (10-26%) than in women (10-33%) [10]. There is no

apparent sex difference in younger adults, however [33]. This suggests that there may be some changes associated with menopause, resulting in a greater experience of dry mouth in older women [1].

In general, xerostomia and SGH affect a substantial minority of the population, especially in older people. As the global population continues to age [17], dry mouth will become an increasingly prominent problem in the future.

### The aetiology of dry mouth

The common causes of dry mouth include xerogenic drugs, radiotherapy to the head and neck for cancer, and systemic diseases such as various connective tissue disorders [9]. Xerogenic drugs are the most common cause of dry mouth investigated in epidemiological studies, and it is an area which has been accompanied by the greatest number of avoidable mistakes [35]. A look at dry mouth-inducing medications reveals an almost inexhaustible list. These drugs usually have anticholinergic or sympathomimetic actions that affect the neural control of salivary glands, a cytotoxic effect on salivary glands, or a diuretic effect that depletes fluids [25]. Sreebny and Schwartz identified more than 400 drugs in 42 drug categories which they asserted were capable of inducing xerostomia or SGH [27]. The utility of such broad lists may be limited because most of the categories of medication included are based on case reports and clinicians' opinions instead of the findings of clinical or epidemiological studies. There is no indication of whether the medications listed cause xerostomia or SGH, and there is a lack of information on the xerogenicity of each specific medication, whether alone or in combination. Analysing the xerogenicity of medications is complicated by the difficulties of capturing information on medication exposure and choosing the analytical approach to be taken. Furthermore, polypharmacy is common in older people, and dry mouth may be a side-effect of the underlying medical conditions being treated [32].

Irradiation for malignant tumours in the head and neck region can cause dry mouth by direct damage to the salivary glands. Systemic diseases such as diabetes mellitus and chronic renal failure can result in dehydration and hence dry mouth. Systemic diseases that affect the salivary glands can cause salivary dysfunction, resulting in dry mouth. These include sarcoidosis, hepatitis C virus infection, and Sjögren's syndrome. The common aetiology of dry mouth is summarised in Table 1 [9].

In addition, there are physiological causes of dry mouth, such as anxiety (due to sympathetic activity), mouthbreathing, and (rarely) salivary gland agenesis [25]. Dry mouth in a patient can be due to more than one factor. For example, in a

patient with a chronic systemic disease such as Sjögren's syndrome, depression can be a commonly associated issue [38,39]. In such a scenario, dry mouth in the patient may be due to the salivary gland dysfunction, the anti-depressant-induced dry mouth, or the depression itself [2].

### The impact of dry mouth

With an understanding of the prevalence and aetiology of dry mouth, this next section will discuss the effects of dry mouth. These include physical, emotional, and social impacts. The function of saliva needs to be explained in order to comprehend the effects of chronic dry mouth. In healthy adults, up to 1.5l of saliva is produced daily. Salivary function can be organised into five major categories that serve to maintain oral health and create ecologic balance: (1) lubrication and protection; (2) buffering action and clearance; (3) maintenance of tooth integrity; (4) antibacterial activity; and (5) taste and digestion. Unstimulated saliva keeps the oral mucosa moist and maintains oral health. Stimulated saliva that is produced in response to sensory stimuli (together with mechanical chewing) aids in the digestion process. Saliva also facilitates speech, cleanses food residues in the mouth, enhances taste, and neutralises potentially damaging food acids [11]. The physical impact of dry mouth is drastic and can manifest in a range of signs and symptoms. These are summarised in Table 2 (Soto-Rojas and Kraus, 2002).

The impact of dry mouth extends beyond the oral cavity into the daily lives of sufferers. One way of assessing this is by examining the effect of dry mouth on the oral-health-related quality of life (OHRQoL) of sufferers [16]. A study of 225 institutionalised older people in Toronto [15] used two different OHRQoL scales the General Oral Health Assessment Index, or GOHAI; [3], and the short-form Oral Health Impact Profile, or OHIP-14 [26]. It found xerostomia be an important influence on the rOHQoL. In a study of a Swedish older population [8], both xerostomia and SGH were found to be significantly associated with OHRQoL. In the Dunedin study, xerostomia was found to be strongly and independently associated with poorer OHRQoL among 32-year-olds. This finding suggested that xerostomia is not a trivial condition for anyone, whether relatively healthy young adults or institutionalised older adults ([33]a). More investigation aimed at improving the understanding of the impact of dry mouth on people's daily lives is essential. Qualitative research is one approach to improve knowledge in this area because this paradigm of research is based on the in-depth understanding of a phenomenon. The qualitative methods (such as diaries and interviews) employed allow for insight into the patient experience of dry mouth.

**Table 1 – Causes of dry mouth (after [9]).**

Medications	Antihistamine, Antihypertensives, Antidepressants, Anticholinergics, Antipsychotics, Sedatives, Analgesics, Muscle relaxants, Diuretics, Anticonvulsants, etc.
Sjögren's syndrome	Primary and secondary
Connective tissue diseases	Rheumatoid Arthritis, Systemic Lupus Erythematosus, Systemic Sclerosis, Mixed connective tissue disease
Other conditions	Radiotherapy, Chronic Active Hepatitis, HIV, Graft vs Host disease, Renal Dialysis, Anxiety, Depression, Diabetes Type 1 and 2

**Table 2 – Signs and symptoms of oral dryness (after Soto-Rojas and Kraus (2002)).**

<b>Signs</b>
Dry, cracked, and peeling lips; dry and coarse tongue
Cracks in the corners of the mouth
Dental decay, cervical or atypical (such as in incisal and cuspal areas)
Dental erosion
Erythematous tongue
Swelling of the salivary glands
Mucositis
Oral candidiasis
Oral ulcers
<b>Symptoms</b>
Difficulties while swallowing and chewing dry foods
Sensitivity to spicy foods
Altered, salty, bitter, and metallic taste in mouth
Burning sensation
Lack of (or diminished) taste perception
Pain in salivary glands
Coughing episodes
Voice disturbances/speech difficulties
Increased liquid intake
Nocturnal discomfort

## Diagnosing dry mouth in the clinical setting

As mentioned, dry mouth has both a subjective (xerostomia) and an objective component (SGH), which are assessed using questionnaires and salivary measurements respectively. A recent Dutch study has shown that it does not seem possible to diagnose oral dryness by the mere visual inspection of photographed tongues. It recommended that the correct diagnosis of dry mouth required further clinical investigation of the oral cavity, along with saliva measurement [4].

## The management of dry mouth

Dry mouth is not an easy condition to manage. The management of dry mouth and its consequences will be discussed in this section. In general, the goals in managing dry mouth are to deal with the underlying systemic condition(s), alleviate symptoms, and institute preventive measures. This may involve increasing the amount of existing saliva or replacing lost secretions in order to control the development of caries and treat specific oral infections such as candidiasis [36].

In order to manage dry mouth, the underlying cause needs to be understood (and rectified if possible). For example, patients taking xerogenic medications may have the drugs changed for an alternative if possible. However, this may be impractical in view of the wide range of medications that induce dry mouth, and the polypharmacy that is especially common in the older population. Should the underlying cause of dry mouth be a systemic disorder (such as diabetes mellitus), treatment should be aimed at the systemic disease.

Synthetic saliva substitutes (such as dry mouth gel or sprays) contain carboxymethylcellulose, a mucopolysaccharide, glycerate polymer base or mucins; all of these can provide temporary mucosal wetting. More recently, 1% malic acid spray

has been shown to be an effective topical sialogogue to improve xerostomia in patients who are on antidepressants and anti-hypertensive medications [18]. Furthermore, an intra-oral electrostimulation device was found to alleviate oral dryness, discomfort, speech and sleeping difficulties, and to increase salivary output in Sjögren's patients [29]. However, this can work only with patients who have residual salivary gland function, and the comfort and practicality of using such devices need to be considered. Sugar-free candies and chewing gums that contain xylitol can be used to stimulate salivary flow. Patients with dry mouth can also make adjustments to their diet in order to avoid dry or acidic food, and they can sip water with (and between) their meals. Raising patient awareness is also important, so that they can avoid factors that may increase oral dryness (such as caffeine or alcohol), and keep the mouth moist. Sialogogues that are cholinergic drugs (such as pilocarpine) can be prescribed to promote saliva production [6,19]. These are effective only in patients with sufficient exocrine tissue, and may have adverse effects such as nausea, vomiting, and affect pulmonary and cardiac functions [37].

There are measures which can be taken to prevent the adverse consequences of dry mouth. These include adopting a non-cariogenic diet, a high level of oral hygiene, and the regular use of topical fluoride agents (toothpaste, gels, rinses, varnishes), and casein phosphopeptide-amorphous calcium phosphate. Dental examinations every 4-6 months (with accompanying radiographs) are also recommended, followed by any required treatment.

There is no cure for dry mouth; rather, there is only palliative management to alleviate the symptoms. Although acupuncture has been noted to be effective in the treatment of dry mouth after head and neck radiotherapy [13], further research needs to be done in this area. The measures to manage dry mouth are summarised in Table 3 [19].

**Table 3 – Overview of the management of dry mouth (after [19]).**

<b>Manage underlying systemic conditions</b>
Multidisciplinary management with other healthcare providers
<b>Management of symptoms</b>
Diet and habit modifications
Frequent and regular sips of water
Avoidance of dry, hard, sticky, acidic foods
Avoidance of excess caffeine and alcohol
Salivary substitutes and lubricants
Artificial saliva, gels, rinses, sprays, bedside humidifier (sleeping hours)
Sialogogues
Pilocarpine 5-10 mg orally TDS
Cevimeline 30 mg orally TDS
Acupuncture
<b>Management of the consequences of dry mouth</b>
Prevention
Increased frequency of dental examination
Topical fluoride application
Treatment of oral conditions
Dental caries – Restoration, topical fluoride
Oral candidiasis – Chlorhexidine rinse and antifungal medication
Poor-fitting prosthesis – Denture adhesives.



In Table 3, the management is divided into the underlying cause of dry mouth, the symptoms of dry mouth (diet and habit modifications, salivary substitutes, sialogogues, acupuncture) and the underlying consequences of dry mouth (prevention and treatment). The items in the Table act as a general guideline only, because there are different brands and medications available in different countries. Many of these strategies to alleviate the symptoms of dry mouth may only have a short-term effect. Moreover, it is imperative for clinicians to understand that each individual needs to tailor the management of dry mouth to suit their lifestyle and preferences.

## Conclusion

In conclusion, dry mouth is a complex condition that will become increasingly prevalent in view of the aging population. Much research has been done to quantify and understand the cause of dry mouth. Its impact on sufferers is pertinent in view of its negative effect on OHRQoL and the lack of cure. It is crucial for clinicians to recognise that dry mouth is not a trivial condition, and it is especially relevant to the older population.

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