

RESEARCH ARTICLE



“The terrible dryness woke me up, I had some trouble breathing”—Critical situations related to oral health as described by CPAP-treated persons with obstructive sleep apnea

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Summary

Continuous positive airway pressure is a common and effective treatment for obstructive sleep apnea, but adherence remains an issue. Both obstructive sleep apnea and oral diseases are associated with cardiovascular diseases, and as oral dryness contributes to treatment abandonment, oral health is of importance for this patient group. The aim was therefore to explore how persons with continuous positive airway pressure-treated obstructive sleep apnea experience situations associated with their oral health, and which actions they take to manage these. An explorative and descriptive design was adopted using the critical incident technique. Based on a purposeful selection, 18 adults with long-term experience of continuous positive airway pressure-treatment were interviewed using a semi-structured interview guide. Both negative and positive situations were described. Negative situations consisted of challenges with breathing, including mouth-breathing, choking sensations, problems with night-time and daytime oral dryness, changes in the saliva composition, and deteriorating oral health. Positive situations included experiences of reduced mouth-breathing and oral dryness. The situations were often successfully managed by mimicking daytime movements, changing sleeping position, adjusting the CPAP-device and mask, increasing oral hygiene efforts, drinking water, using a humidifier or chinstrap, or contacting their oral healthcare clinic. Long-term experience of persons with continuous positive airway pressure-treated obstructive sleep apnea regard situations and actions from everyday life. Successful management can contribute to long-term adherence and decrease negative effects on oral health. More interdisciplinary collaborations could enable identification and adequate recommendations for persons who experience negative situations during their continuous positive airway pressure treatment.

KEYWORDS

adherence, experiences, humidification, management, patient perspective, qualitative

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1 | INTRODUCTION

Characterised by repetitive complete/partial upper airway collapses, obstructive sleep apnea [OSA], disrupts the breathing process during sleep causing sleep fragmentation and hypoxaemia (Gottlieb & Punjabi, 2020), and has been estimated to affect over 900 million persons globally (Benjafield et al., 2019). The severity of OSA is often estimated by the Apnea Hypopnea Index (AHI), but the effects on everyday life and clinical signs should also be considered. Common symptoms of OSA are excessive daytime sleepiness, morning headaches, and reduced daytime energy levels. The primary choice for symptomatic OSA is continuous positive airway pressure (CPAP) and adequate adherence to treatment >6 months can increase the quality of life and reduce daytime sleepiness (Gottlieb & Punjabi, 2020), however, barriers for CPAP adherence (e.g. technical problems and oral dryness, referred to as xerostomia within dentistry) have been reported (Borel et al., 2013; Broström et al., 2010). Previously, oral health-related side effects such as excess saliva, a shifting bite, oral dryness have been reported (Almeida et al., 2013) where the latter can contribute to CPAP abandonment during the first year (Ulander et al., 2014). Furthermore, both OSA and oral diseases have been associated with systemic inflammation, cardiovascular diseases, and obesity (Albandar et al., 2018; Gottlieb & Punjabi, 2020; Sanz et al., 2020). Due to adherence issues, oral health-related side effects, and the associations between oral diseases/conditions and OSA, oral health can be considered an important aspect of CPAP treatment.

According to the World Dental Federation (FDI), oral health is an integrated part of our health and well-being. It contributes to essential everyday functions such as eating and the ability to convey feelings without pain, discomfort, or diseases/conditions, in the orofacial complex, influenced by for example changing experiences or expectations, and ability to adapt to circumstances (Glick et al., 2017, p. 2). To our knowledge, the oral health perspective on OSA has mostly been focussed on periodontal disease or differences between oral appliances and CPAP. A few studies have described oral health-related experiences during CPAP treatment, showing that oral dryness and having to sleep with the mouth closed can affect adherence (Almeida et al., 2013; Broström et al., 2010) but also that CPAP treatment and humidification can reduce oral dryness (Hu et al., 2014; Soudorn et al., 2016). Within general healthcare, studies based on the patient perspective often report experiences of oral dryness but focus on, for example, the use or non-use of CPAP (Ayow et al., 2009), motivation (Matthias et al., 2014), adherence barriers or facilitators (Khan et al., 2019; Zarhin & Oksenberg, 2017), and support in the early stages of CPAP treatment (Elfström et al., 2012). As oral health-related side effects can contribute to treatment abandonment and adherence issues, exploring how oral health-related situations are experienced and managed can increase the understanding of oral health during long-term CPAP treatment and provide useful information for clinicians working with this group. The aim was therefore to explore how persons with CPAP-treated OSA experience situations associated with their oral health, and which actions they take to manage these.

2 | METHODS

2.1 | Design

An explorative and descriptive design with an inductive approach was used. The critical incident technique (CIT), was used to gather information as it is described as a procedure for data collection that aims to obtain information concerning human behaviour in predefined situations (Flanagan, 1954). A critical incident is described as a retrospective event (i.e. the situation) which has generated an action, where the focus lies within the behaviour. The situation should also have a concrete positive or negative outcome (Fridlund et al., 2017). In this setting, the informants were asked to thoroughly describe real life oral health-related situations they had encountered and managed with or without CPAP treatment.

2.2 | Study population

The study population was derived from a longitudinal project investigating the prevalence of undiagnosed OSA among hypertensive persons in a primary care setting (Broström et al., 2012). The same population (N=366) was invited to a full dental examination between November 2018 and June 2019 performed by a dentist and a dental hygienist. The examination included probing pocket depth, saliva flow, and four to six radiographic bitewings to examine alveolar bone loss and approximal dental caries. After completing the dental examinations, a purposive selection was carried out in this population (n=121) to include hypertensive persons diagnosed with OSA, with experience of long-term CPAP treatment (>1 year) to gain a variation in sex, age, and oral health. The interview was designed to provide material for two qualitative studies on oral health with different aims: the present study and another study focusing on determinants of oral health (Ahonen et al., in manuscript). The final sample constituted 18 persons, most had >10 years of experience of CPAP treatment.

2.3 | Data collection procedure

A semi-structured interview guide (Table 1) was developed by the multiprofessional research group (e.g. dental hygienists and a nurse

TABLE 1 Examples of questions in the interview guide

Question
For example, specific events that have affected your view on your mouth and teeth. Can you tell me...
Who else was present?
When did it happen?
How did you feel when it happened?
How did you manage the situation?

TABLE 2 Description of the analytical process

Situation and action		Subcategory	Category	Main area
"But I know...Before this...I have an episode I must tell you. It was when I had the CPAP, and I was travelling. I did not bring the CPAP, then I woke up with a terrible dryness and I had trouble breathing".	Experience (negative)	Breathing problems during night caused by severe oral dryness	Oral health-related challenges with breathing	Oral health-related challenges with CPAP treatment
"And I know, I drank some water. But it was a very uncomfortable feeling. And what caused it, who knows? If it was the apnea that made it dry up if you put it like that".	Action	Using facilitating tools to reduce oral dryness	Management of oral dryness	Adapting to the circumstances in everyday life with CPAP

within sleep medicine) with extensive clinical and methodological expertise, and two pilot interviews were performed with persons in the early stages of their CPAP treatment (<1 year). The interview guide was adjusted according to the feedback received from the pilot interview informants, after which minor alterations were made (e.g. to the level of detail of follow-up questions). Before performing the interviews, the informants received both written and verbal information about the study. Data collection was carried out in November 2020 and January 2021 by the first author HA. The individual interviews were performed on one occasion, lasted approximately 1 h, and were recorded. Due to Covid-19 they were carried out by telephone. The informants were asked to describe specific oral health-related situations with either a positive or negative outcome before or during CPAP treatment. To get a more comprehensive description of how they experienced the situation and the actions taken, follow-up questions were asked. The recorded interviews were transcribed verbatim by HA and a research assistant.

2.4 | Data analysis

The transcripts (260 pages, Times New Roman 11 pt, space 1.15) were read by HA several times to get a sense of the whole. Guided by the aim, open coding was performed and meaning units were identified and highlighted in the transcripts. The meaning units were then extracted and divided into two data sets: (i) the situations and, (ii) the actions they took accordingly (Fridlund et al., 2017). During these steps, notes were written to describe all aspects of the content, and the meaning units were condensed and coded. Meaning units within each data set that described a similar experience or action formed subcategories, categories, and main areas (Table 2). Discussions within the research group were performed to confirm the categorisation and to minimise the influence of pre-understanding. The categorisation was considered finalised after consensus was reached, including 129 situations and 123 actions, divided into subcategories, categories, and main areas (Table 2). The findings include verbatim quotations to illustrate the findings. When necessary, they have been shortened (...) or clarified by using [...] around the addition.

3 | FINDINGS

The characteristics of the study population can be found in Table 3.

3.1 | Experiences of decisive situations

3.1.1 | CPAP treatment affects oral health

Both positive and negative oral health-related situations were described, originating from descriptions with or without CPAP treatment, Table 4 (subcategories are presented in italics in the following text). Beginning CPAP treatment could improve the informant's oral dryness or reduce mouth-breathing, but the oral health-related challenges could also begin with their treatment or occurred when they did not use their CPAP.

3.1.2 | Oral health-related challenges with breathing

Difficulties with sensations of swallowing the tongue mostly occurred before starting their CPAP treatment but could also re-occur during periods without CPAP. During the event, the informants described how they woke up with a choking sensation, often related to snoring and breathing difficulties. *Breathing problems during the night were caused by severe oral dryness*, which also affected their ability to speak, woke them up, and disturbed their sleep. Breathing problems due to severe oral dryness were experienced both before and after they started their treatment and occurred both with and without their CPAP. Mouth-breathing was also described as a challenge and the *difficulties with mouth-breathing often caused oral dryness*. Sleeping on the back increased the oral dryness as the chin dropped, causing the mouth to open in this sleeping position, which also occurred during CPAP use. Mouth-breathing also made them experience involuntary sounds when sleeping on the back with the mouth open, but also changed the sensation in the mouth, which felt dryer and rougher. Sleeping without their CPAP, by choice or due to having a blocked-up nose, increased the mouth-breathing and thereby the oral dryness. For those with a nose mask, a blocked-up nose made it impossible to

TABLE 3 Description of the sample characteristics

General	(N = 18)
Self-reported sex, <i>n</i>	
Female	5
Male	13
Self-reported age in years, md (min – max)	73.5 (51–78)
Education within oral or general healthcare, <i>n</i>	
Yes	3
No	15
Use of anti-hypertensives/beta blockers, <i>n</i>	
1–2 medications	15
3–4 medications	3
Number of medications in total, <i>n</i>	
>5 medications	7
≤5 medications	11
Obstructive sleep apnea and CPAP treatment	
AHI before CPAP treatment, md (min – max)	23.9 (8.4–74.6)
Self-reported active CPAP user, <i>n</i>	
Yes	17
No	1
Adherence >4 h/night, <i>n</i> , missing <i>n</i> = 2	
Yes	15
No	2
Type of mask, <i>n</i>	
Nose mask	14
Full-face	3
Self-reported use of humidification, <i>n</i>	
Regular user	11
Non-regular user	4
Non-user	2
Oral dryness upon awakening before CPAP, <i>n</i> , missing <i>n</i> = 3	
Never or seldom	2
Sometimes	3
Often or always	10
Oral health	
Time since last oral healthcare visit ^a , <i>n</i>	
<1–1 year	15
>1 year	3
Planned visits/year to an oral healthcare clinic ^a , <i>n</i>	
<1	1
1	10
2 or more	7
Whole resting saliva, mL/min, md (min – max)	0.3 (0.0–1.7)
Stimulated saliva, mL/min, md (min – max)	1.7 (0.7–3.0)
Usually feels dry in the mouth, <i>n</i>	
Yes	1
No	17

TABLE 3 (Continued)

General	(N = 18)
Tooth-brushing frequency, <i>n</i>	
≥2 times/day	16
≤1 time/day	2
Interdental cleaning, <i>n</i> , missing <i>n</i> = 1	
Yes, every day	8
Yes, more than 3 times/week	7
Yes, but only when needed	2
Number of main meals/days, md (min – max)	2 (1–3)
Number of snacks/days, md (min – max)	2 (0–3)
Number of sugary containing beverages/foods/days, md (min – max)	2 (0–3)
Aesthetic satisfaction, <i>n</i>	
Yes, very satisfied	2
Yes, mainly satisfied	14
No, not mainly satisfied	2
Number of teeth, md (min – max)	25 (15–28)
Decayed surfaces, md (min – max)	0.5 (0–15)
Number of restorations, md (min – max)	13 (6–22)
Number of dental implants, md (min – max)	0 (0–4)
Number of dental crowns, md (min – max)	1 (0–7)
Visual plaque index ^b , md (min – max)	27.9 (4.0–93.5)
Number of periodontal pockets >4 mm, md (min – max)	8 (0–42)
Number of periodontal pockets >6 mm, md (min – max)	1.5 (0–19)
General description of tooth wear ^c , <i>n</i>	
Mostly mild tooth wear	11
Mild and moderate tooth wear	7
Total score OHIP-14, md (min – max), missing <i>n</i> = 1	81 (65–84)

AHI, Apnea Hypopnea Index (based on polygraph data); CPAP, continuous positive airway pressure (adherence based on reports from their CPAP device); md, median; OHIP-14, the Swedish version of the abbreviated Oral Health Impact Profile (summarised, response 1–6; higher score indicates less oral health-related impact, maximum value 84).

^aDue to Covid-19 restrictions some have postponed their visits. Planned visits/year refers to their normal visitation frequency.

^bVisible plaque index according to Silness and Löe.

^cBased on visual inspection of all tooth surfaces (none, mild, moderate, or severe).

use the CPAP, resulting in increased oral dryness due to forced mouth-breathing and a longer time for recovery.

3.1.3 | Experiences of oral dryness

The difficulties with oral dryness during nightly use of CPAP often caused awakenings and included situations where they experienced

TABLE 4 Categorisation of the oral health-related situations and experiences, in total 129 situations (number in parenthesis indicate the number of situations)

Five categories of oral health-related experiences of CPAP treatment		
Categories	Subcategories	Meaning units
Oral health-related challenges with breathing (21)	Difficulties with sensation of swallowing the tongue before CPAP treatment (5)	<i>"So, it probably was snoring, it [the throat] closed, I felt that I swallowed my tongue. (...)"</i>
	Breathing problems during night caused by severe oral dryness (5)	<i>"Completely powder dry. I barely get air, [I] am so dry in the mouth I cannot speak either, it is very uncomfortable, it does not feel good."</i>
	Difficulties with mouth-breathing caused oral dryness (11)	<i>"(...) I do not get ill very often but when it happens, I cannot use the CPAP. Then you must face the consequences [xerostomia and headaches] and stick it out."</i>
Experiences of oral dryness (35)	Difficulties with oral dryness during nightly CPAP use (13)	<i>"(...) Wake up by being dry in the mouth, completely dry in the mouth (...)"</i>
	Daytime difficulties with oral dryness after sleeping with CPAP (8)	<i>"(...) It's a bit worse now, this time of the year, even if the mask has worked fine during the night, I can wake up in the morning and feel some dryness in the mouth. (...)"</i>
	Reduced physical problems with oral dryness (14)	<i>"Back then, you were always dry in the throat when you woke up, the whole mouth and on the inside of your teeth. The whole oral cavity was dry. Yes, it felt in the throat like you had been at a hockey game screaming all night. You felt in the throat that it was swollen."</i>
Experiences of changes in saliva composition (17)	Difficulties with changes in saliva composition during nightly CPAP use (8)	<i>"I think, for me, it depends a lot on the... this increased mucus is due to this lukewarm water, you know it's bathing temperature because it is warmed up. I do not think it's good for the mucus in the throat. (...) That this could influence the increased amount of thick mucus and all, in the throat."</i>
	Difficulties with changes in saliva composition after sleeping with CPAP (9)	<i>"Especially in the morning, I think it tastes bad in the mouth. But during the day I do not feel anything, it's in the morning, [it] feels a bit nasty. When I get up, that's when I feel a bitter or stale taste, that it feels a bit viscous (...)."</i>
Challenges with changes in the orofacial complex (39)	Problems with pain in one's orofacial complex (12)	<i>"It was when I woke up in the morning, it was a bit sore. (...) I guess so, or if it's just due to the CPAP that you get more tense [in the muscles]"</i>
	Thoughts around situations due to change of need for dental treatment (14)	<i>"(...) She [the dentist] looked in my mouth and then she took out the X-rays, became quiet and looked very pensive. It turned out that it [the CPAP] had worn down the teeth. (...) It's because you are supposed to sleep with your mouth closed when you have the nose mask. So, I've probably ground my teeth so damn well, so she [the dentist] was a little surprised."</i>
	Concerns about consequences of the CPAP treatment on one's oral health (13)	<i>"Then it's a little tedious, actually, to feel that. Plague or cholera, it's sort of like that, then I would rather have chosen the worst because I would rather have my CPAP. Because it gives me so much better quality of life. But then when you think about it, if I had known before, that this [oral health problems] could happen, then I'm not sure I would have started with it [the CPAP treatment]."</i>
Oral health-related challenges when adapting to the CPAP equipment (17)	Oral health-related difficulties with the humidification device during treatment (7)	<i>"I think, that for me, (...), with this mucus, it comes from that lukewarm water standing there, you know it is bathing temperature you could say because it is heated. (...) That it [the lukewarm water] can have some effect on my that [I] get a lot of mucus and such in my throat."</i>
	Oral health concerns when adapting to using the mask (7)	<i>"When it blew into your [my] mouth or over [the mouth]. With the mouth closed, it gets a bit cold. It might have been fine if the air had been warm, but it was easier to get used to."</i>
	Oral health-related anxiety when beginning one's CPAP treatment (3)	<i>"(...) It was a change, of course it was a pretty big change from sleeping in a normal way, and then all of a sudden you are supposed to have a mask covering the mouth (...)"</i>

decreased saliva production during CPAP use or increased salivary production when sleeping without their CPAP. The cause was related to sleeping on the back or mask leakage, but also to the air from the CPAP device. There were also experiences of *daytime difficulties with oral dryness after sleeping with CPAP*, where problems often occurred upon awakening. The oral dryness could be troublesome but often decreased when they had been awake for a while. Oral dryness upon awakening was affected by the physical environment such as air humidity, as sometimes the problem was less noticeable. Beginning CPAP treatment and the use of humidification could lead to *reduced physical problems with oral dryness* and using the mask could eliminate experiences of breathing problems due to severe oral dryness. However, during periods of sleeping without their CPAP, the oral dryness returned. Using nose masks reduced or made mouth-breathing impossible, and thereby reduced or eliminated their oral dryness. A nose mask could also make breathing through the nose more comfortable, and they then chose to breathe through the nose. CPAP treatment could also reduce or eliminate their snoring and thereby the experiences of oral dryness. After initiation of their treatment, the feeling of having a sore or swollen throat due to snoring was often eliminated.

3.1.4 | Experiences of changes in saliva composition

The participants also described experiences of *difficulties with changes in saliva composition during nightly CPAP use*. They experienced that the saliva became more viscous and related this to reduced saliva production due to having the mouth closed. Some also woke up and felt a confined or stale taste in the mouth, or the mouth felt rougher. Decreased movement of the jaw, tongue, and lips made the viscous saliva form a lump in the throat, making it hard to swallow, or made them feel a need to cough during the night. Experiences of *difficulties with changes in saliva composition after sleeping with CPAP* were also described and were sometimes related to the humidification. The changes were described as having froth in the corner of the mouth, a remaining stale or confined feeling, bad taste, or increased viscosity of saliva; however, the difficulties upon awakening did not always remain during the day. As the difficulties often occurred upon awakening, they related them to decreased movement of the jaw, tongue, and lips, or decreased saliva production during the night. Dry air during the winter increased the problems and was less noticeable in other seasons. Even if most problems were reduced or eliminated quite rapidly after awakening, the increased viscosity of the saliva could cause an irritating cough that remained during the day.

3.1.5 | Challenges with changes in the orofacial complex

Problems with pain or discomfort in their orofacial complex, occurring before CPAP treatment were often related to the tongue, which previously felt swollen, less sensitive, or numb. Headaches before CPAP

treatment could be mistaken for symptoms of tooth clenching or grinding. During CPAP treatment, muscle pain in the temporomandibular region was related to nightly tooth clenching and a sore feeling upon awakening. Sharp edges on the front teeth due to tooth wear could lead to experiences of sores on the tip of the tongue. Uncomfortable feelings could also emerge from irritated skin, lips or around the mouth, fractured restorations, or perceived crowding of the frontal teeth. Their experiences also included positive feelings of getting written praise from their dentist due to improved oral health or oral hygiene, but also *thoughts around situations caused by a change of need for dental treatment*. Negative changes in oral health were often described as sudden, unexpected, or strange, and related to increased gingival inflammation, changes on the tongue, tooth movement, and extensive tooth wear. The experiences varied from deteriorated oral health in general to an increased need for more invasive or extensive treatments such as replacing restorations with crowns. Having to sleep with the mouth closed was related to excessive tooth wear during CPAP treatment, and tooth grinding was thought of as the cause of weird dreams about biting or chewing ability. They also described *concerns about consequences of CPAP treatment on their oral health* and effects on their quality of life. Sudden or unexpected negative changes in their oral health could make them start questioning their CPAP treatment. However, becoming more observant or aware, also raised concerns about a connection between their oral health problems and their CPAP treatment. Problems with fractured restorations or crowns caused concerns about how their CPAP treatment affected their oral health or whether their problems were due to ageing. Feelings of resignation occurred when experiencing an oral health problem during CPAP treatment, but also determination as they perceived that the benefits of CPAP often outweighed the perceived consequences.

3.1.6 | Oral health-related challenges when adjusting to the CPAP equipment

Situations including experiences of *oral health-related difficulties with the humidification device during treatment*, were mainly described to be due to excess water or problems with the temperature. If the humidification device broke, this increased the problems with oral dryness. Other difficulties were related to wetness of the face, around the mouth, or water running down their noses into the mouth or throat. Changes in the water temperature or to warm or lukewarm water, could also create problems in the oral cavity. The increased viscosity of saliva was perceived to increase due to the humidification device, and if the maintenance of the humidification device was perceived to exceed the perceived benefits this could lead to removal of the humidification device. At the beginning of their CPAP treatment, experiences of *oral health-related concerns when adapting to using the mask* were described. The concerns related to problems with the pressurised or cold air or uncomfortable air blow or pressure, in or around the mouth. Trouble with mouth-breathing when receiving a nose mask could cause difficulties with the air pressure, but problems getting used to nose-breathing when having to sleep with the mouth

closed were also described. Initial concerns often disappeared quite rapidly, and then sleeping without their mask was described as difficult; however, some never got used to it. The *oral health-related anxiety when beginning their CPAP treatment* included negative feelings ranging from being slightly uncomfortable to feelings of panic. The negative feelings were often due to difficulties in having to get used to a mask or because they felt trapped or constrained when the mouth was covered.

3.2 | Actions

3.2.1 | Adapting to the circumstances in everyday life with CPAP treatment

The informants' CPAP treatment led to a need for adaption to their treatment as the circumstances for oral health changed. They described how they adjusted or created new habits to adjust to their CPAP treatment or to handle side effects or discomfort. Successful adaption to new circumstances enabled them to continue their

treatment and to learn from previous experiences, see Table 5 (subcategories indicated in italics in the following text).

3.2.2 | Management of oral dryness

To *make changes in sleeping position* to handle oral dryness, often included avoiding sleeping on the back or changing sides. This was often enough, but sometimes they had to get out of bed to increase the salivary production by movement, or to eliminate breathing problems due to oral dryness. Being woken up by a partner could make them aware of mouth-breathing and thus they managed to change position before the oral dryness became too severe. Increased movement of the tongue, lips, or the jaw was described as *mimicking the daytime oral movements to increase saliva production* and reduced their problems. Licking the lips or trying to swallow more often was experienced as increasing the salivary production without having to remove the mask. By learning a new technique, they could enable mouth-breathing, and thereby managed to move the jaw, tongue, and lips, similar as during daytime. To *use facilitation tools*, was a common way

TABLE 5 Categorisation of the management of oral health-related experienced situations, in total 123 actions (number of actions in parenthesis)

Four categories of adapting to the circumstances in everyday life with CPAP		
Categories	Subcategories	Meaning units
Management of oral dryness (55)	Make changes in sleeping position to reduce oral dryness (7)	<i>"I sat up in the bed for a long time, until it [the xerostomia] calmed down, passed. What caused it, that I have never researched, so I do not know."</i>
	Mimic daytime movements to increase saliva production (14)	<i>"When you have learned the technique then you can open the mouth, then you can move the tongue and swallow in a different way. Then it becomes as in daytime. (...)"</i>
	Use facilitating tools to reduce oral dryness (34)	<i>"I had a glass of water on the nightstand, then I did not have to get up [to get water], (...)."</i>
Management of changes in saliva composition (18)	Keep the humidification device clean to reduce problems with saliva (7)	<i>"I do not dry it off, I leave it a bit wet because I think it feels quite nice actually. I imagine that it [leaving the mask a bit wet] eases this a bit, the froth, or if it gets worse, I do not know. (...)"</i>
	Clear one's throat from mucus (11)	<i>"Yes, in the morning. Maybe not always, but during the autumn, I have to clear the throat and get out of bed to cough a bit."</i>
Adjusting oral health behaviour to new circumstances (31)	Change one's everyday oral hygiene habits (12)	<i>"Back then, you could skip it [tooth-brushing], it was like, never mind, I just want to rest. Sleep deprivation affects your judgement, I am convinced of that. You even make wrong decisions."</i>
	Change one's everyday dietary habits (6)	<i>"It makes me more careful when I eat too. I do not buy caramels, tough caramels, or something like that, but I can take a piece of chocolate (...) I am more careful, I do not gnaw on bones or ribs, I do not expose myself to what I know is not reliable. (...) I do not really have a choice. (...)"</i>
	Contact one's oral healthcare clinic for help when needed (13)	<i>"Then it got changed to a hard dental splint which I have in the upper jaw, I use it. I do not have any pain in my jaws now anymore."</i>
Managing oral health issues with the equipment (19)	Choose the right mask to reduce one's oral health-related difficulties (12)	<i>"But the mask, then I chose the one which only covers the nose because then I feel freer, you know. (...) But just this feeling of freedom, that's probably what I felt, I felt that I just want the mouth free. (...)"</i>
	Reduce oral health problems by adjusting the equipment (7)	<i>"(...) I put the mask on and then I turn the tube upwards, so it goes back and down under, the tube comes from above. You learned that the tube should come from below, but then the air blow comes down towards the mouth. If you turn the tube upwards, then it blows upwards, and you do not get bothered by it (...)."</i>

to handle oral dryness, and several different facilitating tools such as water, humidification, chinstraps, tablets, and nose-sprays were used. Keeping water by the bed made them feel safer and allowed them to drink or rinse the mouth while in bed. However, wanting to leave the bed to go to the bathroom to rinse the mouth and spit, could make them disinclined to have water nearby. A sip of water during the night or drinking in the morning was often enough, but there were also descriptions of having to drink a lot of water or drinking several times. The humidification device often reduced or eliminated the oral dryness, but when the chinstraps moved, they had to be repositioned before going back to sleep. To enable breathing through the nose, they could use a nose-spray, which often worked immediately. However, they sometimes had to try several products before they found the right one for them. Commonly, if the facilitator did not reduce their oral dryness, they stopped using it.

3.2.3 | Management of changes in saliva composition

Keeping the humidification device and mask clean was a way to handle increased viscosity of the saliva and in some cases also oral dryness. The manufacturer's recommendations for cleaning the device by using boiled water and conducting regular water changes was described as sufficient, but vinegar was also used, and a clean humidification device was perceived to improve problems with coughing and froth. After cleaning the humidification device and mask, they often left it a little damp as it felt more comfortable. Handling excess mucus or viscous saliva by *clearing the mouth or throat* or coughing was described. Sometimes, they had to clear their throat during the night and got out of bed to cough and spit; others swallowed the viscous saliva or excess water from the humidification device while in bed. Mouth-rinses were used to reduce the viscosity and to clear the throat before they went to bed and in the morning, but sometimes also during the night. During the day, some kept tissues with them and tried to avoid coughing among other people.

3.2.4 | Adjusting oral health behaviour to new circumstances

They made *changes in their everyday oral hygiene habits* when experiencing an increased risk for oral health problems. As the CPAP treatment made them more observant or aware, they were more careful or thorough with their oral hygiene and started to use interdental cleaning aids or brushed their teeth more frequently. They also described changes in attitudes towards oral hygiene as they felt less tired, which improved their oral hygiene habits. Moreover, even if they fell asleep in front of the TV, they forced themselves to brush their teeth before going to bed. They also described how they *changed their everyday dietary habits* as they had more energy and were less sleepy and thus stopped drinking sugar-containing beverages and energy drinks or eating candy. Experiencing an increased risk for oral

health problems made them more careful about their choice of foods. This choice could be perceived as necessary as they did not feel safe and included choosing softer or other types of foods or starting to drink water more frequently. When experiencing an oral health problem, *contacting their oral healthcare clinic for help when needed* was described as one way to handle the situation. They could also change clinic to improve availability if needed. Others tried to get help but described difficulties related to the organisational separation between general and oral healthcare, which sometimes resulted in not getting the help that they might have needed from either one. Experiences of discomfort or concerns could be somewhat diffuse, but after contact with their oral healthcare clinic, the specific problem was identified by oral healthcare professionals. After making contact, problems, for example with oral dryness, tooth wear or pain in the temporomandibular area, were often eliminated or reduced.

3.2.5 | Managing oral health issues by making changes to the equipment

As the CPAP mask could contribute to negative feelings such as feeling trapped or constrained when the mouth was covered, the possibility to *choose the right mask reduced their oral health-related difficulties*. Trying different masks or changing the mask was described as a facilitator for adherence and was commonly done with support from health care professionals regarding the choice of mask. Changing one's mindset, making it a task, or gradually getting used to the mask by controlling their feelings of panic were described as ways to manage adaptation to the mask. Leakage causing problems in the oral cavity could lead to a change of the type of mask, often from a face mask to a nose mask. Those who experienced problems with oral dryness, excess water in the mouth or throat, or discomfort due to temperature or the pressurised air, often *reduced their oral health problems by adjusting the equipment*. Leakage causing oral dryness was handled by tightening or changing the straps, adjusting the humidification device, or shaving one's facial hair to improve the mask fit. Excess water in the mouth from within the mask was handled by taking the mask off and shaking it. Problems with the CPAP equipment could also be solved by not using the humidification device or changing the way they used the mask.

4 | DISCUSSION

The study showed that participants experienced situations of oral health-related challenges with breathing, oral dryness, changes in saliva composition and orofacial complex, and with adjusting to the CPAP equipment. The actions they took included using facilitators to reduce oral dryness and adapting to everyday life with their CPAP treatment. Adapting to treatment could be difficult as challenges could emerge at any time, but their previous experience provided useful tools to manage similar situations. Also, oral health-related problems could be reduced or eliminated by their CPAP treatment, which

they experienced as improving their oral health. Our findings concerning barriers and facilitators for CPAP adherence correspond to findings in previous research in other fields. Previously, CPAP users have reported factors such as wanting to prevent adverse outcomes (Hu et al., 2014; Matthias et al., 2014), CPAP-related discomforts (Hu et al., 2014; Khan et al., 2019), and side effects, to be influential on their CPAP adherence (Hu et al., 2014; Khan et al., 2019; Zarhin & Oksenberg, 2017). This study provides further support for oral health as a changeable and integral part of general health, as the participants' oral health was influenced by their personal experiences and ability to adapt to circumstances, corresponding to the FDI's definition and framework (Glick et al., 2017). But, to the best of our knowledge, this is the first study performed from an oral health perspective focussing on experienced situations and actions as described by CPAP users. Therefore, this study provides useful knowledge for CPAP practitioners and oral healthcare professionals working with this patient group.

Situations related to experiences of oral dryness and changes in the saliva composition were commonly described, which is in line with previous research on CPAP treatment (Almeida et al., 2013; Chai-Coetzer et al., 2013; Ulander et al., 2014). Alterations in saliva composition were related to the viscosity of saliva and increased mucus in the throat, which possibly could be another way to describe oral dryness as the alterations could have been caused by a reduction of salivary flow. Even if the study participants related their oral dryness to their CPAP treatment, other factors can contribute such as medication use, older age, other systemic disease (Murray Thomson, 2014; Niklander et al., 2017), and circadian rhythm (Lopez-Jornet et al., 2016). These risk factors were present in the study population and could have contributed. Irrespective of the causal mechanism leading to oral dryness, reducing this condition is important as it can affect sleep and adherence to CPAP treatment (Ulander et al., 2014), increase the risk for oral diseases/conditions, and affect the quality of life (Murray Thomson, 2014; Niklander et al., 2017). As oral dryness is a commonly reported side effect of CPAP treatment, both CPAP practitioners and oral healthcare professionals should be able to identify signs of oral dryness and tailor recommendations accordingly. The ways in which the informants handled xerostomia correspond to strategies described previously: drinking water, using mouth rinses (Villa et al., 2014), applying chinstraps or using humidification (Bachour, 2004; Nilus et al., 2016). Clinical recommendations by oral healthcare personnel, i.e. use of oral lubricants, saliva substitutes, or stimulants (Villa et al., 2014), could contribute to a reduced level of oral dryness. However, chewing gum should be used with caution in the presence of pain in the temporomandibular region. In collaboration with oral healthcare professionals, CPAP practitioners could also reduce the increased risk for dental caries by optimising CPAP users' oral hygiene routines, recommending the avoidance of products containing carcinogenic ingredients (i.e. fermentable carbohydrates, sugar), and the use of additional fluoride (Hopcraft & Tan, 2010; Pitts et al., 2017). However, to be able to improve the oral health in this patient group, oral healthcare professionals must be aware of possible oral health-related problems that may occur during CPAP treatment and how to adequately address them.

Identifying persons who use CPAP is important, and dentists' knowledge and clinical experience of patients with OSA seems to have increased (Vuorjoki-Ranta et al., 2016). But recently, a study showed that oral healthcare professionals might not be aware of the possible associations between OSA, CPAP treatment, and oral health (Berggren et al., 2021). To our knowledge, research regarding experiences of CPAP treatment from an oral healthcare perspective is limited. Besides oral dryness, the persons in the current study described experiences of tooth wear, muscular pain in the temporomandibular region, and shifting bite, which corresponds to previous research (Almeida et al., 2013; Tsuda et al., 2010; Wetselaar et al., 2019). To manage those challenges, several of them had contacted their oral healthcare clinic and received treatment. Therefore, having acquired adequate knowledge and experience to identify possible oral health-related problems during CPAP treatment is of importance for CPAP practitioners and oral healthcare professionals. However, if oral health-related concerns are raised, assessing the cause, severity, and treatment need might be difficult for CPAP practitioners. Hence, it is important for CPAP practitioners to know how and when to refer a patient to their oral healthcare clinic. Increased interdisciplinary collaboration among CPAP practitioners and oral healthcare professionals could improve the possibility to provide adequate care for persons in this patient group.

Some considerations regarding trustworthiness (e.g. transferability and credibility) should be noted. Through a purposeful selection, we invited persons with experience of CPAP treatment. The interview guide was pre-tested to capture situations and actions, while allowing flexibility. The material and the analytic process were discussed within the multiprofessional research group until consensus was achieved, aiming to provide detailed information about the research process, study participants characteristics, and study context, as some findings could be dependent on the Swedish context. In CIT, retrospective events are explored which can entail some recall-bias (Flanagan, 1954). Hence, the descriptions were thoroughly reviewed before inclusion and the final number of meaning units were considered sufficient for a CIT study. Finally, the described negative changes in the orofacial complex rely on the person's experience and do not imply causality in this study.

In conclusion, OSA and CPAP treatment can affect the oral health in a positive or negative direction, and it is important to manage negative experiences in an adequate way. Successful management may enable long-term CPAP adherence and several easily available facilitators can be used such as tap water, humidifiers, and mouth rinses. By listening to patients with experience of CPAP treatment and increasing interdisciplinary collaboration, it is possible to identify and adequately assist persons who experience negative situations during their CPAP treatment.

AUTHOR CONTRIBUTIONS

H.A., A.B., E.I.F., and U.L. conceived the ideas; H.A. collected the data; H.A., M.N., A.B., and U.L. analysed the data; H.A. led the writing; U.L., M.N., A.B., and E.I.F. critically revised the manuscript. All authors have approved the final version of the article.

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CONFLICT OF INTEREST

Declarations of conflicts of interest H.A.: none, A.B.: none, E.I.F.: none, M.N.: none, & U.L.: none.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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