

Research Progress on Non-Pharmacological Interventions for Xerostomia in Older Adults

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Abstract

With the acceleration of population aging, oral health problems among older adults have become increasingly prominent. Xerostomia, a common symptom in older populations, is closely associated with malnutrition, swallowing dysfunction, and oral frailty, and has become an important factor affecting the quality of life of older adults. At present, interventions for xerostomia in older adults are mainly non-pharmacological; however, related studies have mostly focused on single intervention modalities, with a lack of unified standards for intervention protocols, differences in study design and evaluation indicators, and no systematic management model has yet been established. This article comprehensively reviews the epidemiological characteristics and assessment methods of xerostomia in older adults, with a focus on summarizing research progress in non-pharmacological interventions such as saliva replacement therapy, physical stimulation, maintenance of salivary gland function, lifestyle management, and comprehensive nursing models, and analyzes the main problems in existing research. In summary, non-pharmacological interventions are of positive significance in alleviating symptoms of dry mouth in older adults. Future studies should take into account the functional status of older adults and the characteristics of care settings to explore stratified and continuous management pathways, thereby providing a reference for the scientific prevention and treatment of xerostomia in older adults.

Full Text

• Review and Monograph •

Research Progress on Non-Pharmacological Interventions for Xerostomia in Older Adults

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【Abstract】 With the accelerated aging of the population, oral health problems among older adults have become increasingly prominent. As a common symptom in older adults, xerostomia is closely associated with malnutrition, dysphagia, and oral frailty, and has become an important factor affecting the qual-

ity of life of older adults. At present, interventions for xerostomia in older adults are mainly non-pharmacological measures; however, relevant studies have mostly focused on single intervention methods. Intervention protocols lack unified standards, differences exist in study design and evaluation indicators, and a systematic management model has not yet been formed. This article comprehensively reviews the epidemiological characteristics and assessment methods of xerostomia in older adults, focuses on summarizing research progress in non-pharmacological interventions such as saliva replacement therapy, physical stimulation, maintenance of salivary gland function, lifestyle management, and comprehensive care models, and analyzes the main problems existing in current research. In summary, non-pharmacological interventions have positive significance in alleviating xerostomia symptoms in older adults. In the future, stratified and continuous management pathways should be explored in combination with the functional status of older adults and the characteristics of care settings, so as to provide a reference for the scientific prevention and treatment of xerostomia in older adults.

【Key words】 Xerostomia; Older adults; Oral frailty; Non-pharmacological interventions; Review

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Research Progress in Non pharmacological Interventions for Xerostomia in the Elderly

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【Abstract】With the growing aging population, oral health problems among older adults have become an increasing public health concern. Xerostomia is a common oral symptom in older adults and is closely associated with malnutrition, dysphagia and oral frailty, and has become an important factor affecting the quality of life of older adults. Non-pharmacological interventions are important approaches for managing xerostomia in older adults. However, existing studies have mainly focused on individual intervention methods, lacking standardized intervention protocols, with differences in research design and outcome mea-

tures, and a systematic management framework remains lacking. This review summarizes the epidemiological characteristics and assessment methods of xerostomia in older adults, and systematically reviews the research progress of non-pharmacological interventions including saliva substitutes, physical stimulation interventions, salivary gland function preservation, lifestyle management and comprehensive care models, and discusses the main limitations of current studies. Non-pharmacological interventions may provide potential benefits in alleviating xerostomia among older adults. In the future, stratified and continuous management pathways should be explored according to the functional status of the elderly and the characteristics of care settings, to promote evidence-based prevention and management of xerostomia.

[Key words] Xerostomia; Aged; Oral frailty; Non-pharmacological interventions; Review

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With the continuous acceleration of population aging in China, health issues among older adults have become important topics in the field of public health. Data from the Seventh National Population Census show that the proportion of the population aged 60 years and above in China has reached 18.7%^[1], and the degree of aging continues to deepen. Oral health, as an important component of the overall health of older adults, directly affects nutritional intake, functional maintenance, and quality of life^[2]. Xerostomia is a common but easily neglected oral symptom in older adults; its prevalence among people aged 65 years and above is 30%-50%, and it shows an upward trend with increasing age^[3-5]. Studies have shown that xerostomia not only affects oral comfort, but is also closely associated with dysphagia and decreased quality of life, and may increase the risk of frailty progression and adverse health outcomes. In recent years, xerostomia has been incorporated as an important manifestation of oral frailty, and is highly correlated with declines in physical fitness, increased chronic disease burden, and elevated risk of death^[6-10].

The mechanism of xerostomia in older adults is characterized by multiple factors and multiple pathways. In addition to degenerative changes in salivary gland function with aging, it is also associated with the accumulation of chronic

diseases, polypharmacy, and unhealthy lifestyles in older populations. Current studies have explored risk-factor identification, the application of assessment tools, and intervention strategies, including salivary flow measurement, subjective dry-mouth scale assessment, saliva substitutes, and stimulation-based interventions. However, most studies have small sample sizes and short intervention periods; outcome indicators lack unified standards; intervention programs and outcome indicators differ substantially across studies; and the comparability of research findings remains limited. Stratified studies targeting older adults with different functional status are also relatively insufficient. Unified standards for existing management models have not yet been formed either in China or abroad, and comparative studies of different intervention pathways are lacking, which to some extent affects the promotion and application of relevant intervention strategies in primary medical practice.

Given the clinical characteristics of multimorbidity and polypharmacy among older adults, pharmacological interventions for xerostomia have obvious limitations in terms of safety, drug interactions, and long-term adherence. Therefore, this article comprehensively summarizes the current status and progress of research on non-pharmacological interventions for xerostomia in older adults, reviews the applicable scenarios and implementation essentials of various measures, and aims to provide practical references for primary medical institutions to carry out individualized interventions for xerostomia in older adults, as well as research ideas for the subsequent establishment of stratified and continuous management pathways.

1 Literature Search Strategy

Computerized searches were conducted in databases including PubMed, Web of Science, Embase, China National Knowledge Infrastructure (CNKI), and the Wanfang Data Knowledge Service Platform. The search period was from database inception to January 2026. Chinese search terms included “older adults,” “xerostomia,” “reduced salivary secretion,” “non-pharmacological intervention,” and “oral function training”; English search terms included “elderly,” “older adults,” “xerostomia,” “dry mouth,” “non-pharmacological intervention,” “oral frailty,” and “salivary stimulation.” A combination of subject terms and free-text terms was used. Inclusion criteria were as follows: study participants were older adults aged ()60 years; the study involved non-pharmacological interventions related to xerostomia; subjective or objective outcome indicators related to dry mouth were reported; and the literature type was original clinical research, review, or systematic evaluation. Exclusion criteria were as follows: animal experiments; studies in which pharmacological intervention was the main therapeutic measure; literature for which the full text could not be obtained or the data were incomplete; and non-Chinese or non-English literature. This article is a narrative review focusing on measures centered on non-pharmacological interventions, including single non-pharmacological interventions and non-pharmacological combined basic oral-care regimens; studies

mainly based on pharmacological treatment were not included. The included studies covered healthy older adults and older populations with common chronic diseases, with the aim of comprehensively summarizing the evidence for non-pharmacological interventions in different populations. Ultimately, 75 articles were included.

2 Epidemiological Characteristics and Influencing Factors of Xerostomia in Older Adults

Xerostomia is a common oral health problem among older adults and refers to the subjective sensation of dryness and discomfort of the oral mucosa. Its occurrence is often related to decreased salivary gland function, reduced salivary secretion, or changes in salivary composition^[11]. Studies have shown that when the salivary flow rate decreases by 45%–50% from the normal level, most patients may develop obvious symptoms of xerostomia^[12–14]; however, some patients may experience dry-mouth discomfort even when the salivary flow rate is normal, which may be associated with increased salivary evaporation, abnormal neural sensation, or psychological factors^[15–16]. This suggests that xerostomia is characterized by incomplete consistency between subjective and objective assessments, and clinical evaluation should combine subjective symptoms with objective assessments for comprehensive judgment.

The prevalence of xerostomia in older adults is influenced by factors such as study population, survey method, and research setting, and shows a certain degree of heterogeneity, but overall it remains at a relatively high epidemic level. Studies indicate that the prevalence of subjectively reported xerostomia among people aged 65 years and above is approximately 30%, and among institutionalized older adults it can reach 50%^[3–5]; among special populations such as those receiving long-term oxygen therapy, the prevalence may even exceed 70%^[17]. From the perspective of population distribution, the self-reported rate of dry mouth is relatively high among community-dwelling older adults and older adults in long-term care institutions^[18–20]. Demographic analyses show that xerostomia in older adults has marked age and sex differences. The risk of disease increases with age, and this effect often overlaps with factors such as multimorbidity and polypharmacy; the incidence is highest at 75–85 years of age^[21–23]. The prevalence among women is significantly higher than among men^[22–26], and the mechanism may be related to changes in hormone levels and differences in physiological regulation. In addition, socioeconomic factors are also closely related to xerostomia risk, with older adults who have low income and insufficient social support systems facing a higher risk^[27–30]. Some studies have also found that xerostomia shows differences between day and night rhythms, with nighttime symptoms being more pronounced^[31]. This characteristic may be related to factors such as the physiological reduction of salivary secretion during sleep and increased mucosal water evaporation caused by mouth breathing. In summary, xerostomia has the characteristics of high prevalence and multifactorial influence among older adults. Older women and older adults

with weak social support systems are key groups requiring attention. In primary medical care and community health management practice, active identification and early intervention for high-risk groups should be strengthened.

3 Assessment Methods for Xerostomia in Older Adults

The causes of xerostomia in older adults are complex, subjective symptom perception varies greatly, and individual heterogeneity is strong; therefore, a single assessment method is difficult to use to comprehensively reflect the actual condition. Current studies mostly adopt a model combining subjective evaluation with objective measurement.

3.1 Subjective Symptom Assessment

3.1.1 Xerostomia Inventory (XI) The XI was first developed by Thomson et al. [32] in 1999 and contains 11 items.

It was later revised by Dwipa et al. [33] to form the simplified Summated Xerostomia Inventory (SXI); He et al. [34] translated it into Chinese in 2013 for assessing the severity of subjects' subjective xerostomia. The SXI is a uni-dimensional scale containing 5 items and uses a 5-point Likert score, ranging from "never" to "always," scored 1-5 in order, with a total score of 5-25; higher scores indicate more severe xerostomia symptoms. A comparative study of the SXI and salivary measurement methods found that when the SXI score is >11 , salivary hypofunction can be diagnosed [33]. The Cronbach's α coefficient of this scale is 0.798.

3.1.2 Visual Analogue Scale (VAS)

Pai et al. [35] first introduced the VAS into the assessment of xerostomia experience in 2001. The core of this scale is a 100 mm linear ruler, with the two ends anchored as "no dry mouth" and "severe dry mouth," respectively. During assessment, subjects mark the corresponding position on the ruler according to their own experience; the distance from the marked point to the "no dry mouth" end is used for quantitative scoring. Higher scores indicate more severe xerostomia. Among these, a score ≥ 40 is defined as xerostomia, whereas <40 is judged as no obvious dry mouth [36]. This scale has the advantages of being easy to administer and easy for subjects to understand, with high compliance; however, the scoring results are susceptible to bias from individual subjective cognition, and it is not suitable for older adults with cognitive impairment.

3.1.3 Dry Mouth Scale (DMS)

The DMS was developed by Ito et al. [37] and includes three dimensions: xerostomia symptoms (3 items), accompanying symptoms (3 items), and other symptoms (3 items). A 7-point facial scale is used to grade each item. In clinical practice, a xerostomia severity exceeding grade 5 is used as the criterion for

determining dry mouth. Compared with the XI, the DMS can simultaneously assess xerostomia-related accompanying symptoms, including oral stickiness, taste disturbance, tongue pain, halitosis, etc. However, the current clinical application scope of this scale is relatively narrow, and its reliability and validity still require further validation and refinement through more clinical studies to improve its applicability and reliability in the assessment of xerostomia in older adults.

3.2 Objective Functional Testing

3.2.1 Measurement of Salivary Flow Rate

Measurement of salivary flow rate is the most direct and commonly used objective method for evaluating salivary secretory function. It reflects the level of salivary secretion by measuring the amount of saliva secreted per unit time, and is divided into unstimulated (resting) saliva flow rate (unstimulated saliva flow rate, USFR) and stimulated saliva flow rate (stimulated saliva flow rate, SSFR). When USFR <0.1 mL/min or SSFR <0.7 mL/min, xerostomia can be diagnosed; some studies have also proposed using USFR <0.2 mL/min as the threshold indicating low flow rate. Since salivary secretion is affected by many factors such as age, sex, medications, and health status, the results should be interpreted comprehensively in combination with individual characteristics [16,38]. USFR collection methods include the draining method, spitting method, suction method, and swab method. Among these, the suction method and swab method have relatively large variability and poor stability of results, and are not recommended for routine use [39]. SSFR collection methods may use mechanical stimulation (such as chewing paraffin wax) or chemical stimulation (such as specific gustatory stimulants), but they require a higher degree of cooperation from subjects and are not suitable for older adults with cognitive impairment or after oral surgery [40].

3.3 Clinical Observation

3.3.1 Clinical Oral Dryness Score (CODS)

The CODS assesses the degree of xerostomia through systematic clinical and visual examination of the oral cavity by the evaluator, based on multiple oral-dryness-related signs, such as foamy saliva, dry oral mucosa, and adherence of a mirror to the tongue or buccal mucosa. This scoring scale includes 10 oral feature indicators, with a total score of 10; higher scores indicate more severe xerostomia. This method is easy to perform, has good reproducibility, can reduce to some extent the subjective bias introduced by patient self-reporting, and is suitable for screening xerostomia in older adults [41].

3.3.2 Oral Mirror Sliding Test

The oral mirror sliding test evaluates the moistness of the mucosa and saliva coverage by observing the degree of resistance when a dental mirror slides over the surface of the oral mucosa. According to the magnitude of sliding resistance, it is usually classified into three levels: no resistance, slight resistance, and obvious resistance. No resistance indicates normal mucosal lubrication, whereas obvious resistance suggests reduced or insufficient saliva coverage on the mucosal surface [42]. This test is easy to perform, takes little time, can rapidly reflect the degree of dryness of the oral mucosa, and is suitable for clinical examination of xerostomia in older adults. However, the results are easily affected by operating technique and individual differences; therefore, in clinical application, it is recommended to combine it with objective assessment methods such as measurement of salivary flow rate for comprehensive judgment.

3.4 Imaging Examination

Salivary gland ultrasonography (SGUS) can observe glandular echogenicity, homogeneity, and boundary appearance through gray-scale ultrasound, and, combined with a semiquantitative scoring system, can achieve standardized assessment of glandular injury [43–45]. Shear wave elastography (SWE) can quantitatively detect glandular stiffness and provide auxiliary evidence for evaluating glandular fibrosis and structural degeneration [46–48]. Color Doppler ultrasound can assess blood-flow status within the salivary glands, thereby reflecting whether inflammatory reactions or compensatory changes are present in the glands [49–50]. In addition, imaging methods such as salivary gland scintigraphy, magnetic resonance imaging, and salivary gland sialography can also serve as important supplements for the assessment of xerostomia in older adults [49–52].

3.5 Other

With the rapid development of artificial intelligence technology, machine-learning large models have gradually penetrated the field of medical and health care. A study has, for the first time, applied machine-learning methods to research on xerostomia in older adults. By combining clinical features with salivary flow rate indicators, a predictive model was constructed that incorporated influencing factors such as sex, age, resting and stimulated salivary flow rates, number of systemic diseases, and medication use, enabling precise prediction of xerostomia status in older adults [29]. The optimal model had a prediction accuracy of 68%, making it suitable for early prevention of xerostomia in older populations. When used together with objective detection indicators, it can further improve predictive performance and provides a new technological pathway for early screening and evaluation of xerostomia in older adults.

For primary care and community screening, the XI and VAS are recommended

for convenient assessment; for diagnosis and evaluation of therapeutic efficacy, combined measurement of salivary flow rate is recommended; for rapid clinical screening, CODS or the oral mirror sliding test may be used as adjuncts.

4 Non-Pharmacological Intervention Strategies for Xerostomia in Older Adults

According to the core mechanisms of action of the interventions, non-pharmacological interventions for xerostomia in older adults can be divided into the following four categories. A summary of the clinical effects of different intervention strategies is shown in Table 1.

4.1 Oral Moisturization and Environmental Management

4.1.1 Saliva-Substitute Therapy Artificial saliva and oral moisturizing agents (such as sprays, gels, and mouth rinses) can reduce friction of the oral mucosa, relieve burning sensations, foreign-body sensations, and dysphagia by simulating the lubricating and buffering functions of natural saliva, and are commonly used for symptom management of xerostomia in older adults. Studies have shown that saliva substitutes have certain clinical application value in improving older adults' subjective feelings of xerostomia and enhancing oral comfort

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. The effects of saliva-substitute preparations with different ingredients and dosage forms vary. Sprays containing salivation-promoting components such as malic acid, plant-extract preparations, and compound-enzyme oral moisturizing products can all improve symptoms of xerostomia to a certain extent

54-55

. Compared with liquid preparations, gels and jelly-like preparations, because of their stronger adhesiveness, can prolong the retention time of the preparation on the oral mucosal surface and have certain advantages in sustained symptom relief

56-57

. Overall, saliva-substitute therapy mainly alleviates symptoms by improving the local moist environment of the oral cavity and is more suitable for older adults with relatively obvious decline in salivary-gland secretory function. However, its effect on restoration of salivary-gland function is limited, and the sustained effects of long-term application still require further research and validation.

In addition, the rational selection of oral-cleaning products is also considered an important component of supportive intervention. The use of mild oral-cleansing agents with good buffering properties helps maintain stability of the oral microenvironment, reduce mucosal inflammatory irritation, and thereby indirectly

relieve xerostomia symptoms. In recent years, some naturally derived preparations (such as honey-based mouth rinses), because of their lubricating properties and potential bioactivity, have been tried for regulation of the oral microenvironment and have shown certain application potential in improving older adults' subjective discomfort from xerostomia

58–60

. However, existing studies generally have small sample sizes, and research designs and evaluation indicators are not yet unified; their actual effects in the management of xerostomia in older adults remain to be further confirmed.

4.1.2 Lifestyle and Environmental Management Lifestyle adjustment and environmental management are important components of long-term care for xerostomia in older adults. Guiding older adults through health education to develop the habit of drinking small amounts of water frequently, to avoid alcohol and caffeinated beverages and to quit smoking, while maintaining good oral-hygiene habits, can alleviate symptoms to a certain extent. Dry and low-humidity environments easily accelerate evaporation of oral moisture and aggravate oral dryness and discomfort. Therefore, reasonably regulating the humidity of living or ward environments, using humidifiers, and avoiding direct air-conditioning airflow can help improve oral moistness

61

. For older adults in institutional care or inpatient settings, strengthening caregivers' attention to oral moisturization and environmental management is particularly important. In addition, assistive devices such as night-time bite pads can reduce water loss caused by open-mouth breathing and improve xerostomia on waking

62

. Such measures are low-cost and highly operable, making them more suitable as basic intervention strategies in primary-level and family management.

4.2 Interventions for Regulating Salivary Secretion

4.2.1 Reflexive Salivation-Promoting Interventions Reflexive salivation-promoting interventions activate salivary-secretion reflex pathways through mechanical or sensory stimulation, thereby promoting secretion by residual salivary glands. Studies have confirmed that the vibration generated by electric toothbrushes can stimulate the oral mucosa and related reflex pathways, increasing salivary flow rate

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. Saleem et al.

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found that combining electric-toothbrush use with lip-function training significantly improved oral moistness and salivary-secretion levels. In addition, sugar-free chewing gum and acidic foods such as lemon and lime can promote salivary secretion through dual stimulation of chewing and taste; cold-stimulation methods can also enhance secretory responses

54, 65–66

. The effects of this type of intervention are closely related to residual salivary-gland function and are more suitable for older adults with mild to moderate xerostomia. If glandular function is severely impaired, the effect may be limited; therefore, functional assessment should be combined before application to make a reasonable selection.

4.2.2 Maintenance of Salivary-Gland Function and Oral Training

Salivary-gland massage and systematic oral training aim to promote restoration of glandular function and improve coordination of the oral muscle groups. Studies have shown that standardized massage of the parotid, submandibular, and sublingual glands can improve local blood circulation and promote salivary secretion

67

; randomized controlled studies have also confirmed that continuous massage training can increase salivary flow rate and reduce subjective xerostomia symptoms

68

. Oral functional training, through exercises of the lips, tongue, and facial muscle groups and swallowing-coordination practice, helps enhance oral-related muscle function and, while improving the sensation of oral moistness, may delay decline in oral function

69–71

. Compared with simple replacement or stimulation measures, this type of intervention places greater emphasis on functional maintenance and is consistent with the concept of preventing oral frailty in older adults. However, standardized operating procedures and long-term efficacy data are still lacking.

4.3 Comprehensive Intervention Models

Single intervention measures often make it difficult to comprehensively improve xerostomia symptoms in older adults, and comprehensive intervention models are receiving increasing attention. Systematic nursing interventions centered on standardized oral cleaning, salivary-gland massage, application of moisturizing agents, and health education can synergistically improve oral-hygiene status and salivary-secretion levels, thereby alleviating related symptoms

72

. With the development of information technology, oral-health education and follow-up management models based on mobile applications have gradually been applied in older adults. Studies show that they can improve subjective sensations of xerostomia and increase unstimulated salivary flow rate

73-74

. Comprehensive interventions better fit the multifactorial characteristics of xerostomia in older adults and have good overall regulatory advantages, but their long-term effects and feasibility for dissemination still require support from more high-quality studies.

4.4 Nursing Interventions with Characteristics of Traditional Chinese Medicine

Traditional Chinese medicine theory holds that xerostomia is often related to factors such as insufficiency of body fluids and internal heat due to yin deficiency, emphasizing holistic regulation. At the level of non-pharmacological care, characteristic traditional Chinese medicine techniques such as acupuncture and auricular-point stimulation are gradually being applied in the management of xerostomia in older adults. Relevant studies show that implementing auricular-point stimulation nursing among older adults in institutional care can reduce subjective symptoms of xerostomia and improve oral moistness and salivary-secretion levels

75

. As a supplementary intervention, traditional Chinese medicine characteristic nursing has certain application potential in comprehensive management, but its mechanisms and standardized pathways still require further study.

Table 1 Effects of different non-pharmacological interventions for xerostomia in older adults

First author	Year of publication	Intervention subjects	Intervention protocol	Intervention effects
G´omez-Moreno [53]	2013	Older adults in nursing institutions	1% malic acid spray (containing xylitol and fluoride), used as needed, ()8 times/d, 2 weeks	XI scores decreased significantly; symptoms improved in 80.9% of patients; USFR and SSFR increased significantly

First author	Year of publication	Intervention subjects	Intervention protocol	Intervention effects
Gil-Montoya ^[55]	2008	Older adults in nursing institutions	After tooth-brushing, used an enzymatic system containing lactoperoxidase, lysozyme, and lactoferrin (rinsing ()30 s), 3 times/d; then applied approximately 1 cm of gel to the tongue and obvious symptomatic areas of the oral cavity, 4 weeks	Three indicators—OHIP-14 score, symptoms of dry mouth at the floor of the mouth, and the need to drink water when swallowing—improved significantly

First author	Year of publication	Intervention subjects	Intervention protocol	Intervention effects
Dalodom ^[56]	2016	Older outpatients with hypertension and/or diabetes who had been receiving medication for () 1 year	Oral moisturizing jelly (OMJ), 50 mL daily (10 mL × 5 times), 4 weeks	After 2 weeks of use, subjective symptoms of xerostomia decreased significantly; after 1 month, objective signs of dry mouth decreased significantly. Prevented a decrease in salivary pH and enhanced buffering capacity
Ghalwash ^[58]	2025	Older inpatients	Barley-cardamom honey mouthwash, 3 times/d, 4 weeks	After 1 month of use, SXI scores decreased significantly, salivary flow increased, and OHIP-14 scores were significantly lower than in the control group

First author	Year of publication	Intervention subjects	Intervention protocol	Intervention effects
Ibrahim ^[59]	2023	Older patients with kidney disease undergoing hemodialysis for ()3 months	Thyme honey mouthwash, 3 times/d, 8 weeks	Subjective and objective dry-mouth scores decreased significantly. After 1 month of use, USFR, salivary hydrogen peroxide level, and salivary pH all increased significantly

First author	Year of publication	Intervention subjects	Intervention protocol	Intervention effects
Saleem ^[61]	2019	Older patients in dental clinics	Lip trainer, 3 min/time, 3 times/d; sonic electric toothbrush, 2 min/time, 3 times/d, 24 weeks	The lip trainer significantly increased resting and stimulated salivary flow rates, and dryness of the tongue and buccal mucosa improved significantly compared with baseline; sonic tooth-brushing improved resting salivary flow rate, but had limited effects on stimulated salivary flow rate and improvement in moisture
Jeamanukulkij ^[65]	2023	Older patients with type 2 diabetes	Salivary-gland massage, 2 min/time, 3 times/d, 16 weeks	USFR and SSFR increased significantly; xerostomia symptoms, swallowing function, and oral hygiene all improved significantly

First author	Year of publication	Intervention subjects	Intervention protocol	Intervention effects
Kim ^[66]	2012	Community-dwelling older adults	Oral health exercise, 25 min/time, 3 times/week, 8 weeks	Significantly increased salivary secretion in older community-dwelling women, relieved xerostomia, and reduced halitosis
Lee ^[67]	2020	Older adults in nursing institutions	Tongue-holding swallowing training, 10 times each session, 3 times/d, 3 d/week; tongue-press resistance training, 30 times each session, 3 times/d, 3 d/week, 8 weeks	Both types of training enhanced oral muscle strength and increased salivary flow; tongue-press resistance training was more effective in improving salivary flow, but neither exercise improved subjective oral health
Yamamoto ^[70]	2008	Older outpatients in oral clinics	Wearing an occlusal splint at night, 2 weeks	Nocturnal xerostomia symptoms improved significantly

First author	Year of publication	Intervention subjects	Intervention protocol	Intervention effects
Ki [73]	2021	Community-dwelling older adults	Use of the OHEMA mobile application (including videos on oral exercises, oral massage, etc.), 50 min/time, once/week, 6 weeks	Significantly increased salivary flow and tongue pressure, relieved dry mouth, and improved swallowing-related quality of life
Yu [74]	2023	Older adults in nursing institutions	Auricular acupuncture therapy, 8 weeks	Subjective xerostomia symptoms (speaking, swallowing, dry mouth, etc.) improved significantly, and salivary secretion increased

Note: XI = Xerostomia Inventory; OHIP-14 = Oral Health Impact Profile-14; USFR = unstimulated salivary flow rate; SSFR = stimulated salivary flow rate; SXI = Summated Xerostomia Inventory; OHEMA = oral health education based on a mobile application.

5 Summary and Outlook

As an important strategy for the management of xerostomia in older adults, non-pharmacological interventions are of great value in relieving oral dryness symptoms, maintaining oral function, and delaying the progression of oral frailty. According to differences in mechanisms of action, current non-pharmacological interventions can be divided into four categories: oral moistening and environmental management, regulation of salivary secretion, comprehensive intervention models, and nursing interventions with traditional Chinese medicine characteristics. The applicable scenarios and action characteristics of each type

of measure are clear: oral moistening and environmental management focus on improving local moisture status and reducing water evaporation; interventions regulating salivary secretion maintain and stimulate the body's own secretory function through reflexive promotion of secretion, salivary-gland function maintenance, and oral training; comprehensive intervention models exert overall regulatory effects through the synergy of multiple approaches; and nursing interventions with traditional Chinese medicine characteristics serve as supplementary methods from the perspective of holistic regulation.

However, research in this field still has certain limitations. Most studies have small sample sizes and short intervention periods, and lack long-term follow-up data, making it difficult to evaluate the sustained effects of interventions. At present, evaluations of intervention efficacy mostly rely on subjective symptoms and salivary secretion function as the main indicators; the application of imaging methods such as salivary-gland ultrasonography is insufficient, making it difficult to objectively reflect improvements in glandular structure and function after intervention, and the evaluation system is not sufficiently comprehensive. In addition, stratified studies based on comprehensive geriatric assessment remain relatively limited, and the implementation pathways of relevant intervention strategies in primary medical institutions and long-term care facilities need to be further clarified. Nursing interventions with traditional Chinese medicine characteristics and natural preparations have shown certain potential value, but their mechanisms of action and standardized implementation protocols still require further validation through more evidence-based studies. In the future, multicenter, large-sample, and long-term follow-up studies can be conducted to improve the quality of evidence and establish a unified evaluation system. At the same time, stratified intervention strategies can be constructed on the basis of comprehensive geriatric assessment, integrating xerostomia management with chronic disease management and comprehensive geriatric care, and exploring a continuous management model suitable for community and institutional care settings, so as to promote the development of standardized management of xerostomia in older adults.

Author contributions: ZHANG Ying was responsible for study design, overall topic planning, manuscript guidance, and funding support; LI Jiawei and JING Mingfang were responsible for literature retrieval and manuscript drafting.

drafting; Chen Xiaoyi was responsible for reviewing and revising the manuscript; Zhang Xinyan and Xu Yinyi were responsible for checking and revising the manuscript for compliance with standards.

The authors declare no conflicts of interest.

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