Prevalence of Oral Mucosal Diseases in Older Adults in Mainland China: A Meta-Analysis of Observational Studies

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Abstract: Oral mucosal disease (OMD) is a public health challenge globally, but the epidemiological findings in older adults have been inconsistent in China. Thus, this meta-analysis was carried out to explore the prevalence of OMD and its moderating factors in this population. An electronic literature search was conducted of both international (PubMed, PsycINFO, and EMBASE) and Chinese (China National Knowledge Infrastructure and WanFang) databases from inception to November 1, 2019. The Der–Simonian and Laird random effects model was used to synthesize the prevalence of OMD and its 95% confidence intervals (95% CI). Twenty-four studies covering 23,653 older adults were included. The pooled prevalence of OMD was 23% (95% confidence interval: 17.9%–29.0%) Subgroup analyses and meta-analysis revealed that the prevalence of OMD was significantly associated with the reporting sampling, year of publication, and survey (all \( p \) values < 0.05). This meta-analysis found that the prevalence of OMD among older adults in mainland China was significantly high. Early detection and effective intervention of OMD in older adults have public health and clinical importance.

Keywords: oral mucosal disease; older adults; meta-analysis; prevalence

1. Introduction

In China, the percentage of people in China aged 60 years or over is rising dramatically [1]; persons of increasing age are more likely to suffer from various oral problems [2]. At present, though a certain proportion of oral mucosal diseases (OMD) does not need active treatment, but there is some evidence that people with oral diseases are associated with various negative outcomes, such as poor quality of life, a heavy global burden on social and economic health, high risk of disability, and impaired physical function [3,4], particular in the elderly [5,6].

The prevalence of OMD in older adults in China ranges from 0.0% to 83.8% across studies [7,8]. For example, a study from Jiangxi province did not find any OMD patients in the older adult population [8]; however, in a study on the older adults in an urban community of Xinjiang Uygur Autonomous Region, the prevalence of OMD was 83.8%, higher in men (87.01%) than in women (75%) [7]. Another study on the oral health survey of Sichuan province between 2015 and 2016 found that 8.2% of participants aged 65–74 years had OMDs [9]. The mixed findings may be partly owing to the differences in survey time across studies, as well as in ethnic background, behavior, and lifestyles across the populations. To achieve a reasonable allocation of health resources, the right
policy development, implement effective preventive measures and treatments, and significantly reduce health outcomes of OMD in older adults, better comprehension of the OMD pattern is necessary.

To the best of our knowledge, no meta-analysis or systematic review on the prevalence of OMD in older adults has been published so far. Hence, we carried out a systematic review and meta-analysis of epidemiological studies to explore the prevalence and moderating factors (i.e., the sources of heterogeneity) of OMD in older adults. Following the previous findings from observational studies [9,10], we hypothesize that the prevalence of OMD in mainland China is relatively high in older adults to date.

2. Methods

2.1. Data Sources and Search Strategies

The meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist. Two investigators (N.Z. and X.Z.) extensively searched online international (PubMed, EMBASE, PsycINFO) and Chinese (Chinese National Knowledge Infrastructure, WanFang) databases from inception to 1 November 2019. The search terms were MeSH terms and text words linked to oral mucosal disease (salivary Gland Diseases OR xerostomia OR oral mucosal diseases OR Sjogren’s syndrome OR hyposalivation OR Asialia OR Asialias OR mouth dryness OR Dryness, Mouth), epidemiology (epidemiology OR cross-sectional OR prevalence OR rate), old people (old* OR elderly), China (China OR Chinese).

2.2. Study Eligibility

Two investigators (N.Z. and X.Z.) independently screened all titles and abstracts from the initial search results, as well as full-text articles identified from the first-stage screening (titles and abstracts), with discrepancies resolved through discussion or consultation via a senior investigator (Y.C.). The references of the included studies were additionally reviewed in order to collect any potential studies.

To meet analysis requirements and reduce selection bias, articles were eligible if (a) older adults aged ≥60 years, (b) cross-sectional or retrospective surveys, and (c) prevalence of OMD with or without providing relevant data were reported. Studies excluded (a) reviews, case reports, protocols, comments, (b) single disease from OMD, or (c) special populations (such as militants).

2.3. Data Extraction

The data extracted independently by two investigators (N.Z. and X.Z.), including study characteristics (e.g., first author, publication year, province, sample size), participant characteristics (e.g., mean age or age range, gender), main outcome (events or prevalence rate with corresponding 95% CI). Any disagreements were resolved by a discussion, consensus, or consulting another researcher (Y.C.).

2.4. Quality Assessment

Parker’s quality evaluation tool for prevalence studies was used to evaluate the methodological quality of the included studies [11]. The included studies were assessed by the definition and representativeness of the targeted population, sampling methods, response rate, the definition of the target symptom or diagnosis, and validation of the assessment instrument. Each item was considered as “1 (yes)” or “0 (no or unclear)”. Discrepancies were resolved by consensus with a third author (Y.C.).

2.5. Statistical Analyses

Due to the anticipated substantial heterogeneity, the random-effects model was utilized to calculate the prevalence of OMD with 95% CI. Heterogeneity across studies was tested by I$^2$ and Q statistics (I$^2$ >50% was regarded as significant heterogeneity; Higgins and Thompson, 2002 [12]). Publication bias was assessed by visual inspection of the funnel plots, Begg’s and Egger’s tests. Subgroup analyses were
stratified by publication language (English or Chinese), sampling (yes or no), and region according to the National Bureau of Statistics of China (west vs. east vs. middle). Year of publication, survey year based on end year, sample size, the proportion of males, and study quality were analyzed by meta-regression analyses based on unrestricted maximum likelihood in order to detect the main sources of heterogeneity [13]. Comprehensive Meta-Analysis Program version 2.0 (Biostat Inc., Englewood, NJ, USA) was used with a significant level of 0.05 (two-sided).

3. Results

3.1. Study Selection and Characteristics

A total of 24 articles fulfilling our review criteria were identified (Figure 1). Overall, the included studies were published between 1985 and 2018, involving 15 provinces: 14 studies in eastern China, 3 in central China, 7 in western China. The sample sizes in the included study ranged from 50 to 3349 participants, with a median sample size of 733. The detailed study characteristics and outcomes are presented in Table 1.

![Flowchart of literature selection](image-url)
Table 1. Characteristics of the studies included in the meta-analysis.

| No. | First Author | Publication Year | Publication Language | Survey Year | Sampling | Sample Size | Male (N, %) | Urban (N, %) | Category of OMD | Number of OMD | Age (Mean ± SD) | Age Range | Province | Area | Quality Score | References |
|-----|--------------|------------------|----------------------|-------------|----------|-------------|------------|-------------|----------------|---------------|----------------|-----------|----------|------|--------------|-----------|
| 1   | Kang M. D. et al. | 1985 | CH | NR | No | 1949 | 754 (38.7) | 1531 (78.6) | WH, PM and others | 756 | NR | 60-104 | Henan | M | 2 | [14] |
| 2   | Xu K. L. et al. | 1985 | CH | 1983 | No | 50 | 12 (24.0) | 34 (68.0) | NR | 0 | 92.4 ± NR | 90-101 | Guangxi | E | 2 | [15] |
| 3   | Chen Y. N. et al. | 1987 | CH | 1982 | No | 217 | 121 (55.8) | 217 (100) | EM, LK, WH, PM and others | 85 | NR | 60-87 | Zhejiang | E | 3 | [16] |
| 4   | Sun Y. et al. | 1987 | CH | NR | No | 284 | 263 (92.6) | 284 (100) | LP, WE, CG, XS and others | 105 | NR | ≥60 | Liaoning | E | 2 | [17] |
| 5   | Cao H. K. et al. | 1988 | CH | 1986 | No | 3091 | 1230 (39.6) | 3091 (100) | FT, KA, AG, RAU and others | 905 | NR | ≥60 | Shanghai | E | 3 | [18] |
| 6   | Chen X. et al. | 1989 | CH | 1987 | Yes | 205 | 145 (70.7) | 205 (100) | OS, FK, WE, FT and others | 69 | NR | ≥60 | Ningxia | W | 5 | [19] |
| 7   | Lin B. C. et al. | 1989 | CH | NR | Yes | 2191 | 1086 (49.6) | 2004 (91.5) | OS, FK, WE, FT and others | 981 | NR | ≥60 | Beijing | E | 6 | [20] |
| 8   | Mi C. F. et al. | 1991 | CH | 1989 | No | 496 | 391 (78.8) | 496 (100) | LK, LP, RAU, XS, OS | 247 | NR | ≥60 | Ningxia | W | 2 | [21] |
| 9   | Shen L.Y. | 1995 | CH | 1994 | No | 765 | 649 (84.8) | 765 (100) | LK, LP and others | 40 | NR | 60-75 | Jiangsu | E | 2 | [22] |
| 10  | Li Y. L. et al. | 1996 | CH | 1994-1995 | Yes | 344 | 256 (69.8) | 344 (100) | MH, LP, RAU and others | 89 | 67.48 ± NR | 60-77 | Inner Mongolia | M | 5 | [23] |
| 11  | Qu H. S. et al. | 1996 | CH | NR | No | 105 | 77 (73.3) | 0 (0) | FT, LS, MP and others | 88 | NR | 100-135 | Xinjiang | W | 4 | [24] |
| 12  | Zhou X. J. et al. | 2000 | CH | NR | No | 722 | NR | 769 (100) | OS, FT, WE and others | 408 | NR | ≥60 | Beijing | E | 3 | [24] |
| 13  | Lin H. C. et al. | 2001 | EN | 1997 | Yes | 1515 | 759 (50.1) | 774 (51.3) | LP, RAU, FT and others | 298 | NR | 65-74 | Guangdong | E | 6 | [25] |
| 14  | Liu Y. et al. | 2001 | CH | 1999 | No | 1872 | 785 (41.9) | 1872 (100) | FT, WE, LK, LP and others | 438 | 67.8 ± NR | 60-91 | Chongqing | E | 4 | [26] |
| 15  | Chen Q.Y. | 2006 | CH | NR | No | 800 | 400 (50.0) | NR | RAU, LP, LK and others | 173 | NR | 60-95 | Jiangsu | E | 2 | [27] |
| 16  | Chen X. H. et al. | 2007 | CH | 2003 | Yes | 1154 | 519 (45.0) | 1154 (100) | KA, LP, LK and others | 215 | NR | ≥60 | Guangdong | E | 5 | [28] |
| 17  | Liu H. et al. | 2009 | CH | 2007 | No | 108 | 54 (50.0) | NR | NR | 11 | NR | 65-70 | Xinjiang | W | 5 | [29] |
Table 1. Cont.

| No. | First Author | Publication Year | Publication Language | Survey Year | Sampling | Sample Size (N, %) | Male (N, %) | Urban (N, %) | Category of OMD | Number of OMD | Age (Mean ± SD) | Age Range | Province | Area | Quality Score | References |
|-----|--------------|------------------|----------------------|-------------|----------|-------------------|-------------|-------------|----------------|-------------|----------------|-----------|----------|------|---------------|------------|
| 18  | Zhou H. J. et al. | 2009 | CH | 2005 | Yes | 791 (49.4) | 391 (49.4) | 419 (53.0) | LK, LP and others | 61 | 68.0 ± NR | 65–74 | Gansu | W | 5 | [30] |
| 19  | Qian L. et al. | 2011 | CH | 2009–2011 | Yes | 435 (31.0) | 135 (31.0) | 435 (100) | OC, SS, FT, KA and others | 189 | 79.22 ± NR | ≥60 | Jiangsu | E | 5 | [31] |
| 20  | Feng J. et al. | 2015 | EN | 2012–2013 | Yes | 3349 | NR | 3349 (100) | LK, LP, FT and others | 630 | NR | ≥60 | Shanghai | E | 5 | [10] |
| 21  | Zhang J. et al. | 2016 | CH | 2015–2016 | Yes | 1878 | 895 (47.7) | NR | LK, LP, and others | 136 | NR | 65–74 | Ningxia | W | 5 | [32] |
| 22  | Yin W. et al. | 2017 | EN | 2015–2016 | Yes | 744 | 362 (48.7) | 365 (49.1) | FT, RAU, LP and others | 61 | NR | 65–74 | Sichuan | W | 6 | [9] |
| 23  | Li Z. C. | 2017 | CH | 2015–2016 | Yes | 300 | 150 (50.0) | 150 (50.0) | NR | 0 | NR | 65–74 | Jiangxi | M | 6 | [8] |
| 24  | Zhang J. M. et al. | 2018 | CH | 2015–2016 | Yes | 288 | 144 (50.0) | NR | LK, LP and others | 16 | NR | 65–74 | Guangdong | E | 5 | [33] |

OMD = oral mucosal diseases; WH = white hyperkeratosis; PM = pigmentation; EM = erythema; LK = leukoplakia; KA = keratosis albicans; AG = atrophic glossitis; RAU = recurrent aphthous ulcer; OS = oral smoke spots; OC = oral candidiasis; FK = friction keratosis; WE = white edema; LP = lichen planus; CG = chronic glossitis; XS = xerostomia syndrome; LK = leukoplakia; MH = mucosal hyperkeratosis; MP = mucosal plaque; FT = fissured tongue; SS = Sjogren’s syndrome; CH = Chinese; EN = English; NR = not Reported; SD = standard deviation; E = East area; M = Middle area; W = West area.
3.2. Prevalence of Oral Mucosal Diseases, Subgroup and Meta-Regression Analyses

The pooled OMD prevalence among older adults was 23% (n = 6001; 95% CI: 17.9%–29.0%), with a significant heterogeneity (I² = 98.87%; Figure 2). Subgroup analyses only found that pooled OMD prevalence in the reporting sampling method group (16.6%) was lower than that in the non-reporting sampling method group (31.0%; Table 2). Additionally, the meta-regression analysis found year of publication and survey significantly associated with the prevalence of OMD (both p values < 0.05; Table 3).

![Figure 2. Forest plot of the prevalence of oral mucosal diseases in older adults.](image)

Table 2. Subgroup analyses.

| Category          | Variables               | Classification | Sample Size | Effect Size  | 95% CI        | I²  | p Across Subgroup |
|-------------------|-------------------------|----------------|-------------|--------------|---------------|-----|-------------------|
|                  |                         | East area (3)  | 16,733      | 0.237        | 0.170         | 0.320 | 98.82             |
| Subgroup analysis| Region                  | Middle area (4)| 2593        | 0.209        | 0.087         | 0.421 | 94.70             |
|                  |                         | West area (1)  | 4327        | 0.222        | 0.137         | 0.338 | 99.13             |
|                  | Publication language    | EN (3)         | 5608        | 0.147        | 0.071         | 0.281 | 95.97             |
|                  |                         | CN (21)        | 18,045      | 0.247        | 0.191         | 0.312 | 98.78             |
|                  | Sampling                | Yes (12)       | 13,194      | 0.166        | 0.113         | 0.237 | 99.05             |
|                  |                         | No (12)        | 10,459      | 0.310        | 0.223         | 0.413 | 98.41             |

CH = Chinese; EN = English.
Table 3. Meta-regression analyses.

| Category         | Variables     | Slope  | S.E.    | 95% CI | t      | p       |
|------------------|---------------|--------|---------|--------|--------|---------|
| Meta-regression  | Year of publication | −0.060 | 0.019   | −0.096 | −0.024 | −3.24   | 0.001   |
|                  | Survey year   | −0.047 | 0.018   | −0.082 | −0.013 | −2.69   | 0.007   |
|                  | Sample size   | 0.0001 | 0.0003  | −0.0004| 0.0006 | 0.53    | 0.599   |
|                  | Study quality | −0.187 | 0.190   | −0.559 | 0.184  | −0.99   | 0.323   |
|                  | Proportion of male | 0.020 | 0.016 | −0.011 | 0.052  | 1.28    | 0.199   |
|                  | Proportion of urban | 0.002 | 0.010 | −0.019 | 0.022  | 0.15    | 0.880   |

S.E. = Standard Error; CI = Confidence Interval

3.3. Quality Assessment and Publication Bias

The median quality assessment score of the 24 studies was 5, ranging from 2 to 6. The Egger’s and Begg’s tests did not identify publication bias (Egger: $t = 1.18, p = 0.249$; Begg: $Z = −0.087, p = 0.552$), with a symmetrical funnel plot (Figure 3).

Figure 3. Funnel plot of publication bias.

4. Discussion

To the best of our knowledge, this is the first meta-analysis to examine the prevalence of OMD in older adults in mainland China. The pooled prevalence of OMD was 23% (95% CI: 17.9%–29.0%) in older adults. A Chinese report of the development on aging reported that there were approximately 202 million old people in 2013 [34], which would equate to nearly 46.46 million old people experiencing OMD based on the current results. Common OMD could be due to several reasons. First, older adults may not have formed good oral health-related behaviors when they were young due to lack of financial resources, oral health awareness, and family oral education. Second, having difficulty getting about and memory decline are very common in the older population. Thus, maintaining oral health is not easy in the long term.

To date, some studies have examined the epidemiology of OMD, but the prevalence rates are inconsistent in older adults across studies. The prevalence of OMD in older adults aged 60 and above is relatively high, ranging from 29.0% in Iran, over 33.3% in Australia, 41.2% in the USA, to 53% in Chile [35–39]. The pooled prevalence of OMD in this meta-analysis is significantly lower than the corresponding figures (29%–53%) reported from most of the Western countries, but not all (2%–3% in South Africa) [37]. The discrepancy of the OMD rate between Chinese and Western studies in older
adults could be due to several reasons. On the one hand, this could partly be due to different sampling methods, definitions of OMD, or local clinical practice and guidelines. On the other hand, oral health may be viewed as a small matter in China and it is not recorded if subjects are not seriously affected in daily life, resulting in an underestimation of OMD.

Subgroup analyses indicated that the prevalence of OMD was higher in studies with no reporting sampling method (31.0% vs. 16.6%), which could be the fact that the findings of studies without reporting sampling method are relatively more unstable [40]. In addition, the findings from meta-regression revealed that the year of publication and survey were two moderating factors in the prevalence of OMD. One important reason is that with increasing attention on oral health and the implementation of some relevant health policies in China [41], people gradually began to maintain oral hygiene and prevent oral problems. Thus, studies conducted in recent years show lower prevalence rates.

Several limitations should be noted in this meta-analysis. First, similar to other meta-analyses of epidemiological studies [42,43], significant heterogeneity was identified, although random-effect models were carried out. The source of heterogeneity may result from some unreported factors, such as different ethnicities and comorbidity status (e.g., diabetes, hypertension, and hyperlipidemia). Second, the 24 studies involved only 15 out of 31 provinces, autonomous regions, and municipalities of mainland China, which restricts the generalizability of the findings. Third, the included articles were limited to only English and Chinese languages; thus, the findings may be biased. Fourth, a relatively small number of English papers was included. However, the Chinese population is our concern, and Chinese people get used to publishing Chinese papers in Chinese journals. Fifth, the prevalence of OMD by gender and region has not been reported because of the limited number of studies. Nevertheless, meta-regression did not find that the proportion of males and the proportion of urban dwellers would significantly impact the results. Lastly, important factors related to OMD, such as sub-classification, economic status, family background, and use of medicine, were not analyzed due to insufficient data.

In summary, our findings suggest that the prevalence of OMD in older adults is common in mainland China. Given the high prevalence of OMD in this population, screening and intervention for underlying OMD have significance in clinical settings and public health regarding OMD prevention and treatment. In addition, in order to reduce the high prevalence of OMD, oral knowledge should be strengthened, oral education should be delivered, and oral monitoring should be regularly conducted for the older population. Finally, longitudinal research about the associations between OMD and other demographic and clinical variables in the older population should be conducted in the future.

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