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REVIEW

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Oral health-related quality of life in patients with osteoarthritis of the temporomandibular joint—Results of a systematic review

Wanchen Ning[1] | Gerhard Schmalz[2] | Ping Li[3] | Shaohong Huang[1]

[1]Stomatological Hospital, Southern Medical University, Guangzhou, China

[2]Department of Cariology, Endodontology and Periodontology, Leipzig University, Leipzig, Germany

[3]Department of Orthopedic Surgery, The Third Affiliated Hospital of Sun Yat-sen University, Guangzhou, China

Correspondence
Shaohong Huang, Stomatological Hospital, Southern Medical University, South Jiangnan Ave 366, Guangzhou 510040, China.
Email: hsh.china@tom.com

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Abstract

Objectives: The aim of this systematic review was to assess the oral health-related quality of life (OHRQoL) of patients with osteoarthritis (OA) of the temporomandibular joint (TMJ).

Methods: This systematic literature search applied the search terms "oral health-related quality of life AND osteoarthritis of jaw OR arthritis of temporomandibular joint AND oral health-related quality of life" in PubMed, Medline, Web of Science and Scopus. Eligibility criteria were publication until 31 August 2021, examination of children or adults with OA of TMJ, reporting of any OHRQoL measurement and a full text in English language. Two different, independent and experienced reviewers performed this systematic literature search. The analysis of respective data was qualitative. For quality appraisal, the available checklist from the Agency for Healthcare Research and Quality (AHRQ) was applied.

Results: Out of 102 findings, eight studies were included in qualitative analysis. Seven clinical investigations were performed in adults aged between 34 and 43 years. The other included study was performed on children. The quality of two studies was moderate, and six studies were evaluated as of high quality. Most studies applied the 14-item short form of the oral health impact profile (OHIP 14) for assessment of OHRQoL. OHIP 14 ranged between 9.24 and 38.86 points in means of sum score. Comparison with healthy individuals revealed worse OHRQoL of OA patients in two studies. Associations between OHRQoL with either oral health, general quality of life or disease-related parameters were rarely reported and heterogeneous. Five of the included studies reported subscales of OHIP 14, showing an impairment in all subscales.

Conclusions: There are hints that patients with OA of the TMJ show a reduced OHRQoL. More studies are needed, especially regarding oral health, disease-related parameters and pain intensity and its potential influence on OHRQoL.

KEYWORDS
oral health, oral health-related quality of life, osteoarthritis, systematic review, temporomandibular joint

1 | INTRODUCTION

Osteoarthritis (OA) of the temporomandibular joint (TMJ) is defined as a low-inflammatory arthritic condition of the TMJ, often leading to severe pain and complaints in the whole orofacial region.[1,2] Thereby, OA of TMJ can occur as a localised independent condition, or in context of auto-inflammatory diseases like rheumatoid arthritis of juvenile idiopathic arthritis.[3,4] The diagnostic and therapeutic management is of certain clinical relevance, because of the enormous disease burden of patients suffering from OA of the TMJ. On the one hand, OA is often diagnosed clinically based on the Research Diagnostic Criteria of Temporomandibular Disorders (RDC/TMD).[5] On the other hand, imaging-based diagnostic approaches including cone-beam computed tomography, radiographs or magnetic resonance imaging are available.[6] Therapeutic options are heterogeneous, ranging from rest therapy, pharmaceutical therapy, arthrocentesis/lavage with or without injection of hyaluronic acid up until alloplastic TMJ replacement surgery in the end stage.[7–9] Although much research is performed in this respect, there is still a lack of knowledge regarding the oral health conditions of patients with OA of TMJ, especially regarding the patients' perspective.

Dental patient-reported outcome measures (PROMs) are of increasing relevance and developed into a mandatory basis for evidence-based dentistry.[10,11] It has thereby been stated that the implementation of PROMs in surgical science and practice is necessary to reveal the patient perspective and to assess and increase patient satisfaction.[12] In this context, oral health can have substantial influence on patients' well-being and daily living, encouraging the concept of oral health-related quality of life (OHRQoL).[13] Considering the OHRQoL as a sub-aspect of general health-related quality of life addresses the necessity of a paradigm shift from a medical into a complex biopsychosocial model of oral health and diseases.[13,14] Generally, the OHRQoL of patients with TMD has been repeatedly studied in different clinical studies.[15–18] These studies revealed an impairment of OHRQoL of patients with TMD, especially related to disease specific as well as general parameters like (mal-)occlusion, sleep or psychological conditions.[15–18] However, there is still a lack of knowledge; a systematic review concluded that especially explicit TMD subtypes would require further research.[17] Thereby, OA as a specific diagnosis within the complex of TMD might be of particular relevance due to the respective complaints of patients suffering from OA of the TMJ.

Therefore, this systematic review was performed to reveal the OHRQoL of patients with OA of the TMJ. Thus, the aim was to assess the OHRQoL of respective patients and its potential relation to oral health and disease-related parameters. It was hypothesised that patients with OA of the TMJ show a reduced OHRQoL compared with healthy individuals.

2 | METHODS

Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA),[19] this systematic review was performed. Therefore, a systematic search was applied based on a PICO (patients, intervention, comparison and outcome) question. The whole process was done by two independent and experienced reviewers.

2.1 | PICO question

The PICO question was as follows: 'Do patients with Osteoarthritis of the temporomandibular joint show a reduced OHRQoL?'. Considering the distinct PICO elements, 'patients' were individuals with OA of the TMJ. No 'intervention' was defined, primarily expecting cross-sectional or case–control studies. For 'Comparison', a healthy control group should be considered, if applicable. The respective 'outcome' was any OHRQoL measurement. It was hypothesised that patients with OA of the TMJ would show a reduced OHRQoL compared with healthy individuals.

2.2 | Eligibility criteria

The following criteria were mandatory for inclusion in the current systematic review:

- publication until 31 August 2021.
- examination of children or adults with OA of TMJ.
- reporting of any OHRQoL measurement.
- full text in English language.

2.3 | Search strategy

In September 2021, two different, independent and experienced reviewers performed this systematic literature search. The search terms, which were used in PubMed, Medline, Web of Science and Scopus databases, were as follows: "oral health-related quality of life AND osteoarthritis of jaw OR arthritis of temporomandibular joint AND oral health-related quality of life". Based on the references of findings, a manual literature search was applied to complement the systematic search. As described in PRISMA guidelines, duplicates were removed. Subsequently, records were first screened, and then, potentially fitting full texts were checked for eligibility.

2.4 | Data extraction

The results of the systematic search were included in a qualitative data extraction. The following parameters where assessed:

- year of publication, number of participants, study type, age, gender.
- characteristics of a healthy control group, if applicable.
- OHRQoL assessment, including measurement and results.
- potential relationship between OHRQoL and general parameters, disease-related parameters or oral health findings, if applicable.
- subscales of the OHRQoL measurements, if applicable.

Only studies explicitly reporting OHRQoL of patients with OA of the TMJ were considered for this systematic review.

2.5 | Quality assessment

For quality appraisal, the available checklist from the Agency for Healthcare Research and Quality (AHRQ) for cross-sectional studies was applied.[20] This assessment includes an 11-item checklist and a respective rating as follows: answers 'no' or 'unclear' = 0, answer 'yes' = 1 point for each question. A resulting score helps to estimate the respective quality of the included studies. A sum score of 0–3 indicated low quality, 4–7 indicated moderate quality and a score of 8–11 indicated high quality of the respective study. The process of quality appraisal was performed by two independent reviewers. Potential disagreements were discussed and resolved in the whole author group.

3 | RESULTS

3.1 | Search findings and characteristics of the included studies

As a result of the systematic review process, eight studies were included in qualitative analysis. The results during the whole systematic process according to PRISMA guidelines are shown in Figure 1. An overview on excluded studies, of which the full text was checked for eligibility, is provided in Table S1.

Out of the eight included studies, seven were performed in adults aged between 34 and 43 years in mean.[21–27] The other included study was performed on children.[28] Across studies, the number of female participants was higher than of male participants, ranging between 53.1% and 100% female individuals. Only one study recruited a healthy control group for comparison of OHRQoL,[28] while one other study used a large national cohort from another study for comparison.[23] All respective criteria of included studies are shown in Table 1.

3.2 | Quality assessment

The applied quality appraisal revealed two studies to be of moderate quality.[23,24] The six other studies were evaluated as high quality.[21,22,25–28] All results of quality assessment of the included studies according to ARHQ are presented in Table 2.

3.3 | OHRQoL measurements and results

The majority of studies applied the 14-item short form of the oral health impact profile (OHIP 14) for assessment of OHRQoL.[21,22,24–27] One study applied the 49-item version of OHIP (OHIP 49),[23] and the

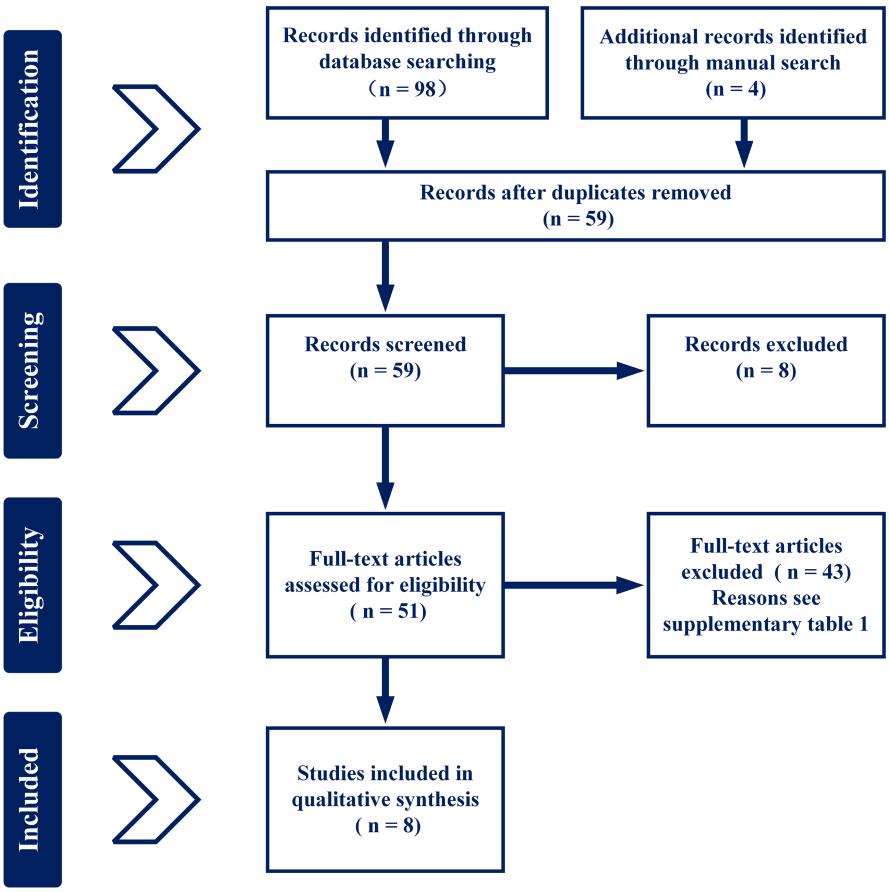

FIGURE 1 PRISMA diagram for the systematic review process in the current study[19]

TABLE 1 Overview of the included studies

Author, year	Country	No. of patients	Study type	Subjects mean age in years	Female (%)	Healthy control group for OHRQoL
John et al., 2007[23]	Germany	15	Multicentric cross-sectional	37.4 ± 16.2[a]	79%[a]	Yes, national cohort for comparison
Barros et al., 2009[21]	Brazil	7	Monocentric cross-sectional	36.5 ± 13.5[a]	83.1%[a]	No[b]
Su et al., 2014[27]	China	211	Monocentric prospective observational study	Median 34 (20–48)	82.5%	No
Su et al., 2016[24]	China	541	Monocentric cross-sectional	38.59 ± 15.52	75.2%	No
Catunda et al., 2016[22]	Brazil	7	Prospective, randomised, placebo-controlled, double-blind clinical trial	Placebo: 42.85 ± 14.55, ASU: 43.14 ± 15.34	100%	No
Su et al., 2018[25]	China	515	Monocentric cross-sectional	38.38 ± 15.10	74.6%	No
Su et al., 2019[26]	China	510	Monocentric observational	<45 years: 63%, 45–60 years: 25%, >60 years: 12%	75%	No
Isola et al., 2019[28]	Italy	32	Monocentric case–control	11.9 ± 2.3	53.1%	Yes, age 11.8 ± 2.2, 57.7% female, $n = 35$

Note: Values are presented as the mean values ± standard deviation, mean values (range) or percentages.

Abbreviations: n/a, not applicable; OHRQoL, oral health-related quality of life.

[a]These results were only available for the total cohort and not OA explicitly.

[b]Values were not compared with healthy controls, but patients with TMD without OA diagnosis.

study investigating children applied the child perception questionnaire (CPQ), respectively.[28]

The OHIP 14 ranged in respective studies between 9.24 and 38.86 points in means of sum score. Comparison with healthy individuals revealed worse OHRQoL of OA patients in two studies.[23,28] One study did not examine a healthy control, but compared patients with TMD in presence or absence of OA, showing no difference in OHRQoL.[21] Associations between OHRQoL with either oral health, general quality of life or disease-related parameters were rarely reported and heterogeneous (Table 3). Five of the included studies reported subscales of OHIP.[21,22,24,25,27] The respective results are given in Table 4.

The majority of studies used the research diagnostic criteria for RDC/TMD for diagnosis of OA. Only half of the included studies reported on the occurrence of pain and pain intensity related to OA, respectively.[22,24,26,28] Only two Chinese studies reported on a potential relationship between pain and OHRQoL: one study found correlations between Helkimo index domain scores and OHIP total scores and subscales,[24] while another study revealed TMJ pain on palpation to be a predictor for lower OHRQoL[26] (Table 5).

4 | DISCUSSION

This systematic review hypothesised that patients with OA of the TMJ would show a reduced OHRQoL compared with healthy individuals. After systematic search according to PRISMA guidelines,[19] a total of eight clinical studies were included in the qualitative analysis. Based on the revealed results, the study hypothesis was partly confirmed. In the following, the methodology, especially OHRQoL measurement of included studies, will be discussed, alongside with the results and potential practical consequences. A further focus will be set on recommendations for future research in the field, based on the remaining lack of knowledge on OHRQoL of patients with OA of the TMJ.

All studies, which included adult participants, applied the oral health impact profile (OHIP), which was originally developed in 1994.[29] This valid questionnaire consists of 49 (OHIP 49) or 14 questions (OHIP 14), assessing the impact of any complaints a patient perceived related to his/her orofacial system, including teeth, mouth or dentures.[29,30] Especially OHIP 14 was reported to be very suitable and recommendable for research questions.[11] Based on the OHIP findings in the included studies, a reduced OHRQoL of the included OA patients can be assumed, but not unequivocally proven. A 'classic' healthy control group was not recruited in any of the seven studies dealing with adults; however, one study used a reference cohort for comparison of the OHIP 49 values.[23] Similarly, reference values for healthy individuals answering the short form OHIP 14 questionnaire are available, ranging between 0 and 4 for dentate individuals.[31] Although this reference was confirmed for German population, these values can be used to interpret the findings of included studies. The average sum score of the included studies ranged between 9.24 and 38.86 points, which is higher than the reference, indicating a reduced OHRQoL of the patient collective. One study in children, using the CPQ, showed reduced OHRQoL of children with juvenile idiopathic arthritis combined with OA of TMJ.[28] This is a very special cohort, and no other comparable results were available, making a conclusion on the OHRQoL of children impossible.

TABLE 2 Quality assessment of the included studies according to the Agency for Healthcare Research and Quality (ARHQ)[20]

Item	John et al., 2007[23]	Barros et al., 2009[21]	Su et al., 2014[27]	Su et al., 2016[24]	Catunda et al., 2016[22]	Su et al., 2018[25]	Su et al., 2019[26]	Isola et al., 2019[28]
(1) Define the source of information (survey, record review)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(2) List inclusion and exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to previous publications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(3) Indicate time period used for identifying patients	No	Yes	No	Yes	Yes	Yes	Yes	Yes
(4) Indicate whether or not subjects were consecutive if not population-based	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5) Indicate if evaluators of subjective components of study were masked to other aspects of the status of the participants	No	No	No	No	Yes	No	No	Yes
(6) Describe any assessments undertaken for quality assurance purposes (e.g. test/retest of primary outcome measurements)	Yes	Yes	Yes	No	No	Yes	Yes	Yes
(7) Explain any patient exclusions from analysis	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A
(8) Describe how confounding was assessed and/or controlled.	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes
(9) If applicable, explain how missing data were handled in the analysis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(10) Summarise patient response rates and completeness of data collection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(11) Clarify what follow-up, if any, was expected and the percentage of patients for which incomplete data or follow-up was obtained	N/A	N/A	Yes	N/A	Yes	N/A	N/A	N/A
Total Score	7	9	9	6	8	8	8	8

TABLE 3 Applied assessments for OHRQoL and relevant results for the included studies

Author, year	Assessment of OHRQoL	Results OHRQoL	OHRQoL worse than healthy control (HC)	Association/correlation between OHRQoL and oral health or general quality of life	Association and/or correlation between OHRQoL and disease-related parameters
John et al., 2007[23]	OHIP 49	Men: 39.5 (CI 95: 36.6–42.4), women: 39.8 (CI 95: 23.7–56.0)	Yes (OHIP 49 in HC: 15.8)	N/A	N/A
Barros et al., 2009,[21a]	OHIP 14	9.24 ± 4.70	No (absence of OA: 13.58 ± 4.41)	N/A	N/A
Su et al., 2014[27]	OHIP 14	19.18 ± 8.97	N/A	N/A	N/A
Su et al., 2016[24]	OHIP 14	16.10 ± 11.17	N/A	N/A	Helkimo Index associated to worse OHRQoL
Catunda et al., 2016[22a]	OHIP 14	Placebo: 38.86 ± 8.39, ASU: 36.71 ± 10.45	N/A	N/A	N/A
Su et al., 2018[25]	OHIP 14	16.09 ± 11.42	N/A	Higher OHIP associated with bruxism	N/A
Su et al., 2019[26]	OHIP 14	31% OHIP 14 = 0	N/A	Higher OHIP in bruxism and chewing side preference	Joint pain and history of mental diseases
Isola et al., 2019[28]	CPQ	No sum value provided	Yes	N/A	N/A

Abbreviations: CPQ, child perception questionnaire; n/a, not applicable; OHIP, oral health impact profile.

aOHRQoL values are summarised for Osteoarthritis and Arthralgia.

TABLE 4 Subscales of OHRQoL in the included studies, if applicable. The results are given as the mean values ± standard deviation or otherwise as percentages

OHIP 14							
Author, year, disease	**Functional limitation**	**Physical pain**	**Psychosocial discomfort**	**Physical disability**	**Psychological disability**	**Social disability**	**Handicap**
Barros et al., 2009[21]	0.67 ± 0.83	2.32 ± 1.04	2.37 ± 1.11	0.93 ± 1.01	1.39 ± 0.94	0.93 ± 0.98	0.77 ± 0.96
Su et al., 2014[27]	2.09 ± 2.15	4.61 ± 1.94	3.81 ± 1.98	2.33 ± 1.93	2.42 ± 2.05	2.26 ± 2.00	1.64 ± 1.63
Su et al., 2016[24]	1.28 ± 1.78	3.89 ± 2.28	2.51 ± 2.28	2.64 ± 2.28	2.36 ± 2.08	1.65 ± 1.88	1.77 ± 1.96
Catunda et al., 2016[22] (Placebo/ASU)	5.42 ± 1.61/3.85 ± 2.61	6.85 ± 0.89/6.28 ± 1.60	6.28 ± 1.79/6.00 ± 2.51	5.00 ± 2.70/5.42 ± 2.50	5.42 ± 1.71/4.57 ± 2.50	5.71 ± 1.97/5.14 ± 2.34	4.14 ± 2.79/5.42 ± 1.98
Su et al., 2018[25]	1.28 ± 1.80	3.83 ± 2.32	2.54 ± 2.29	2.62 ± 2.30	2.38 ± 2.09	1.67 ± 1.91	1.77 ± 1.98

Abbreviations: OHIP, oral health impact profile.

TABLE 5 Diagnosis of OA, pain intensity and potential correlations with OHRQoL in included studies

Author, year	Diagnosis of OA	Report on pain and pain intensity	Correlation between OHRQoL and pain
John et al., 2007[23]	RDC/TMD	N/A	N/A
Barros et al., 2009[21]	RDC/TMD	N/A	N/A
Su et al., 2014[27]	RDC/TMD	N/A	N/A
Su et al., 2016[24]	RDC/TMD, cone-beam computed tomography	HDI 1: 12.6%, HDI 2: 33.1%, HDI 3: 54.3%	Correlations between HDI domain scores and OHIP total scores and subscales[a]
Catunda et al., 2016[22]	RDC/TMD	VAS pain placebo: 7.1 ± 1.2, ASU: 7.4 ± 0.7	N/A
Su et al., 2018[25]	RDC/TMD	N/A	N/A
Su et al., 2019[26]	RDC/TMD	(Baseline) Pain in 1–3 sites: 19%, 4–6 sites: 15%, 7 or more sites: 10%, pain on palpation: 1 site: 38%, 2 sites: 35%, 3 or 4 sites: 27%	TMJ pain on palpation is predictor for lower OHRQoL
Isola et al., 2019[28]	Magnetic resonance imaging (MRI)	59.4% TMJ pain, 71.9% myofascial pain	N/A

Abbreviations: HDI, Helkimo index; n/a, not applicable; OA, osteoarthritis; RDC/TMD, research diagnostic criteria of temporomandibular diseases.
aThereby, all five domains of HDI were analysed separately, as well as an HDI domain score, combining all of the points from the five domains in sum (HDI 0 = 0 points, HDI 1 = score range, 1–4 points, HDI 2 = 5–9 points and HDI 3 = 10–25 points) was used for correlation analysis.

If a reduced OHRQoL of patients with OA of TMJ is taken as a basis, referring to the results of this systematic review, it is necessary to think about reasons and clinical consequences of this.

OA of the TMJ is a subgroup of TMD and included as a diagnosis within the RDC/TMD.[5] It is known that patients with TMD suffer from reduced OHRQoL.[15-18] This is related to both physical and psychosocial factors related to the TMD. This appears similar in patients with OA. As listed in Table 4, all subscales of OHIP 14 appear affected. Thereby, pain appears to be the predominantly affected sub-aspect. TMD are related to a very individual perception of pain.[29] Especially, OA of TMJ is closely related to (partly very severe) pain.[1] Therefore, this relation is plausible. Psychosocial complaints like distress or depression are similarly common in OA patients as in TMD patients in general.[32] Accordingly, the affection of this sub-aspect within OHRQoL is reasonable, too. This is supported by the findings of,[27] showing that an injection therapy with hyaluronic acid leads to an improvement in OHIP 14 sum score as well as all sub-aspects. Similarly,[22] showed that an injection therapy leads to increased OHRQoL in five out of the seven OHIP 14 subscales.[22] Thus, OHRQoL of patients suffering from OA appears reduced, caused by physical (pain) and psychosocial complaints related to the underlying disease, what can be positively influenced by the respective injection therapy. In interpretation of the subscales reported in the included studies, it must be mentioned that nowadays another dimensional approach is common.[11,31,33] Thereby, a four-dimensional structure is applied, including oral function, orofacial pain, orofacial appearance and psychosocial impact. It is clearly recommended that those dimensions are considered and a four-dimensional interpretation of OHRQoL is performed.[11,34] Therefore, reporting all seven subscales in OHIP is still recommendable to maintain the compatibility of the reported data; still, only four of these subscales are used in the new four-dimensional approach for interpretation, what requires consideration in future studies in the field. In addition, only one study in this systematic review performed magnetic resonance imaging for OA diagnosis.[28] Moreover, half of the studies did not report on pain and pain intensity, and only one quarter examined correlations between pain and OHRQoL, respectively. Although those two studies revealed a relationship between OHRQoL and the presence of pain,[24,26] this largely important issue in context of OHRQoL of OA patients appears understudied.

Another issue that needs to be addressed is the question regarding other relevant influential parameters. OA can occur in context of rheumatic diseases.[4,5] It is known that patients with rheumatic diseases have reduced OHRQoL, especially if the underlying disease leads to orofacial manifestations or symptoms.[35] Furthermore, patients with severe general diseases can show a 'response shift' in the perception of their oral status, and therefore, an OHRQoL that does not reflect their physical oral situation.[36] In this context, it needs to be mentioned that OHRQoL is a subjective perception and not mandatory equal with the physical oral conditions of a patient.[37,38] These factors need to be considered in the interpretation of the current study's findings, thereby a lack in knowledge appears relevant: There is very scarce information provided on the oral health situation of the respective patients (dental diseases, tooth loss and periodontitis). This limits the interpretability of the results, because it remains unclear whether the findings are a result of the OA, potentially related to worse oral health or a combination of both. Generally, in healthy individuals, tooth loss, caries and periodontitis affect the OHRQoL.[39-41] Moreover, patients with orofacial pain-related diseases, for example oral dystonia, show worse oral health and reduced OHRQoL.[42] Thus, this issue could also affect the OHRQoL of patients with OA. Clinically, based on this systematic review, OHRQoL should be one focus of diagnostic and therapy in those individuals, aiming in an improvement of this issue for the patients.

Based on this systematic review, several recommendations for future research can be provided. First, future studies should include a healthy control group for comparison of the findings or use national references for comparison. Second, these studies should consider diagnostic verification of the extent and severity of OA, for example by imaging, as this was only performed by one study until now.[28] Third, a comprehensive assessment of oral health conditions and disease-related parameters should be performed and examined in relation to the OHRQoL measurement. This appears particularly relevant with regard to the presence of pain and its intensity, what remains still understudied. Fourth, the assessment of subscales appears reasonable for OHRQoL assessment; thereby four subscales of OHIP questionnaire, that is oral pain, oral function, psychosocial impact and orofacial appearance can be considered.[34,35] Fifth, the examination of general health-related quality of life and its relationship with the OHRQoL of patients with OA of the TMJ could provide further information. Altogether, more clinical studies are needed to gain insight into the OHRQoL of patients with OA of TMJ.

4.1 | Strengths and limitations

This systematic review was performed according to PRISMA guidelines by two independent reviewers. The question is of clinical relevance and interest. The review included a quality appraisal of all included studies and comprehensively assessed the OHRQoL of patients with OA of the TMJ. However, several limitations need to be considered. In principle, the analysis was only qualitative, while no meta-analysis was performed additionally. Moreover, on the one hand, the included studies lacked several information, or they were only provided for a whole cohort of TMD patients and not for the OA patients explicitly. The four Chinese studies, which were included, based on a similar patient cohort, whereby many patients are expected to be part of more of those studies. Therefore, the findings of these four studies might be from the same patient collective. As mentioned above by providing recommendations for future studies in the field, there is still limited information from the included studies and a robust conclusion is difficult. Therefore, more studies will be needed to confirm the findings of the current systematic review article.

5 | CONCLUSIONS

Although hints for a reduced OHRQoL in patients with OA exist, which could be related to physical and psychosocial complaints, more studies are needed in the field. Those future examinations should consider physical oral health and disease-related conditions, especially pain, and its potential influence on OHRQoL. The OHRQoL should be one focus in diagnostic and one therapy aim for respective patients.

AUTHOR CONTRIBUTIONS

Ning, Wanchen contributed to conception, design, data acquisition, analysis and interpretation, drafted and critically revised the manuscript, and gave final approval. Schmalz, Gerhard contributed to conception, design, data acquisition, analysis and interpretation, critically revised the manuscript, and gave final approval. Li, Ping contributed to conception, data analysis and interpretation, and gave final approval. Huang, Shaohong contributed to conception and design, and gave final approval. All authors gave their final approval and agreed to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors have no conflicts of interest and no commercial relationships for publication of this manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in the supplementary material of this article.

ORCID

Wanchen Ning https://orcid.org/0000-0003-1075-997X

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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