

## SYSTEMATIC REVIEW

# Congenital cranio-facial abnormalities in paediatric population: a systematic review on temporomandibular disorders

Giuseppe Minervini<sup>1</sup>, Maria Maddalena Marrapodi<sup>2</sup>, Gabriele Cervino<sup>3</sup>,  
Rocco Franco<sup>4</sup>, Alessandro Lanza<sup>1</sup>, Marco Cicciù<sup>5</sup>, Fabrizio Di Francesco<sup>1,\*</sup>

<sup>1</sup>Multidisciplinary Department of Medical-Surgical and Odontostomatological Specialties, University of Campania "Luigi Vanvitelli", 80121 Naples, Italy

<sup>2</sup>Department of Woman, Child and General and Specialist Surgery, University of Campania "Luigi Vanvitelli", 80121 Naples, Italy

<sup>3</sup>Department of Biomedical and Dental Sciences and Morphofunctional Imaging, School of Dentistry, University of Messina, 98125 Messina, Italy

<sup>4</sup>Department of Biomedicine and Prevention, University of Rome "Tor Vergata", 00100 Rome, Italy

<sup>5</sup>Department of Biomedical and Surgical and Biomedical Sciences, Catania University, 95123 Catania, Italy

## \*Correspondence

Fabrizio.difrancesco@unicampania.it  
(Fabrizio Di Francesco)

## Abstract

The aim of this systematic review was to explore the prevalence of temporomandibular disorders (TMD) in patients affected by congenital craniofacial disorders (CCD). Out of 292 papers, 9 studies were included with 561 participants. The included studies analyzed at least 15 patients treated for temporomandibular disorders, evaluating at least one clinical outcomes such as orofacial pain and/or muscular diseases, malocclusion, skeletal abnormality and/or deformities concerning temporomandibular joint, upper/lower jaw bone malformations. These findings provide an evidence of an association between temporomandibular disorders and congenital craniofacial disorders. The evidence is supported by the findings of a small number of papers in the literature, some of which were of just fair quality. To be definitive in this regard, additional research with a sizable sample size and control group are required.

## Keywords

Cranio-facial abnormalities; Congenital; Orofacial pain; Pediatric; Temporomandibular disorders

## 1. Introduction

The temporomandibular joint is a bicondylar joint because of its morphological form, linked in all movements [1, 2]. Retrusion, protrusion and excursion are the three actions that make up the joint's mechanics. The articular surface of the temporomandibular joint, which is coated with avascular fibrocartilage, is what makes it distinctive [1, 3]. Compared to other human joints, the functional and anatomical structure is more complicated [1, 3–5]. The temporomandibular joint develops from two distinct nuclei during a lengthy period of ontogenesis, which sets it apart from other joints [6, 7]. This joint also develops much later than others. The temporomandibular joint and craniofacial development are both significantly influenced by the Meckel's Cartilage, emerging in stage 13 embryos (32 days) [8]. Growth disturbances of the mandible can be a symptom of congenital abnormalities of the temporomandibular joint (TMJ). Agenesis, dysplasia, hypoplasia or hyperplasia of the mandibular condyle are examples of joint structures that can exhibit either hyperplasia or hypoplasia in temporomandibular disorders. They might potentially show up as a cluster of symptoms with a congenital mandibular malformation. The origin and symptoms of temporomandibular joint diseases vary [4, 9–13]. The prevalence of temporomandibular disorders (TMD) ranges between 12 and 60%, according to the most recent literature reviews [14–16]. As a result, the

sampling methodology and diagnostic criteria used in the various studies have a significant impact on the results of those studies [17–21]. The following etiologic factors have been proposed for the development of TMD: (I) acquired causes like infection and trauma; (II) iatrogenic factors like surgery and radiation; (III) genetic mutations like osteogenesis imperfecta (OI) affecting the genes responsible for collagen type I production, Williams Syndrome, Fetal Alcohol Syndrome, Cranio-Maxillofacial dysplasia (IV) Habitual factors like bruxism and clenching the jaws, and (V) other variables like muscular spasm, occlusal interferences, stress, systemic disorders and immunological factors [17, 22]. However, there are several challenges in figuring out their genesis [17]. In 1992, the original Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) axis I diagnostic algorithms and Axis II instruments have been performed in order to carry out a TMD classification [23]. Then, in 2004, Schiffman *et al.* [23] reported a new dual-axis Diagnostic Criteria for TMD (DC/TMD) providing evidence-based criteria for the clinician in order to facilitate communication regarding consultations, referrals and prognosis. There are several disorders that coexist with TMD pain and represent shared etiologic causes and pain-processing pathways. These conditions include neuropathic pain disorders, connective tissue illnesses, joint disk dislocation, osteoarthritis, migraines and tension-type headaches [24–

27]. Epidemiological studies have supported the theory that TMD is also of a congenital character by demonstrating that its signs and symptoms may occur in people of all ages [5, 13]. In young children, TMD is not very common. It is accompanied by minor signs and symptoms if it is present. However, teenagers and adults experience a rise in its occurrence [4, 10]. Regarding the connection between congenital diseases and TMD, certain abnormalities may take place in utero, most notably at the end of the first trimester [1, 3, 9]. This systematic review focused on the congenital etiology of temporomandibular disorders, aiming to explore the prevalence and features of TMDs in patients affected by congenital craniofacial disorders (CCD).

## 2. Materials and methods

### 2.1 Eligibility criteria

According to the participants, exposure, comparison and outcomes (PECO) model, all papers were evaluated for eligibility:

(P) Participants consisted of patients with a diagnosis of congenital craniofacial disorders.

(E) The exposure consisted of the diagnosis of temporomandibular disorders associated with congenital craniofacial disorders.

(C) The comparison consisted of the patients suffering by diagnosis of congenital craniofacial disorders with no diagnosis of temporomandibular disorders.

(O) The outcome measures consisted of assessing the features of temporomandibular disorders in patients affected by congenital craniofacial disorders, *i.e.*, oro-facial pain and/or muscular diseases, malocclusion, skeletal abnormality and/or deformities concerning temporomandibular joint, upper/lower jaw bone malformations.

Only articles that provided data at the end of the intervention were included. The exclusion criteria were: (1) patients with a history of TMJ trauma; (2) patients with TMD secondary to iatrogenic causes; (3) studies written in a language other than English; (4) review; (5) case series; (6) case report; (7) *in vitro* studies; (8) full-text unavailability (*e.g.*, posters and conference abstracts); (9) studies involving animals.

### 2.2 Search strategy

The PubMed, Web of Science and Lilacs databases were systematically searched for articles published from 1980 until 21 December 2022. Search strategy included Medical Subject Headings (MeSH) terms: temporomandibular disorders OR congenital abnormalities OR craniofacial abnormalities was employed. This systematic review was conducted according to the guidance of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline and the Cochrane Handbook for Systematic Reviews of Interventions [28]. The systematic review protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with number CRD42022315908.

### 2.3 Data extraction

Data from the included studies were retrieved using a customized data extraction on a Microsoft Excel sheet by two reviewers working separately (F.D., G.M.). A third reviewer was used to obtain consensus in cases of dispute. The following information were reported: (1) First author; (2) Year of publication; (3) Study design; (4) Diagnosis of craniofacial congenital disorder (CCD); (5) Number of examined patients with diagnosis of CCD; (6) Number of patient suffering of TMD with diagnosis of CCD; (7) Clinical manifestations of temporomandibular disorders.

### 2.4 Quality assessment

The possibility of bias in the included study was evaluated by two reviewers independently and separately (F.D, G.M). Using the Newcastle-Ottawa Scale (NOS), nonrandomized clinical studies' quality was evaluated [29]. A study is rated on this scale using a star system based on three main criteria: the choice of the study groups (up to 4 points), the comparability of the groups (up to 2 points), and exposure or result of interest for case-control or cohort studies, respectively (up to 3 points). Studies were deemed to be of high quality if they received five or more Newcastle-Ottawa Scale scoring criterion. With the help of a third reviewer, any disagreements were resolved until an agreement was reached (A.L).

## 3. Results

The Fig. 1 reported the flowchart of data selection. The electronic search produced 290 studies. The screening and selection of the studies were done by two separate reviewers (F.D. and G.M.). After analyzing all selected studies, 58 papers were included for reading the abstracts, whereas 9 duplicates were eliminated. The publications that were obviously ineligible were eliminated after the examination of abstracts, obtaining 49 full-text articles. The two independent reviewers applied the inclusion and quality-assessment criteria (F.D, G.M). Finally, 9 full-text articles were included. Features of the included studies are reported in Table 1. The included studies were performed in humans, including at least 15 patients treated for temporomandibular disorders, evaluating at least one clinical outcomes such as oro-facial pain and/or muscular diseases, malocclusion, skeletal abnormality and/or deformities concerning temporomandibular joint, upper/lower jaw bone malformations. There are heterogeneity concerning outcomes among included studies. Poon *et al.* [30], considering patients affected by Hemifacial microsomia (HM), showed over the 50% of patients affected by HM showed mildly hypoplastic mandibular ramus-condyle with functioning temporomandibular joint. Nevertheless, other four included studies analyzing coronoid locking, Arthrogyriposis Multiplex Congenital (AMC) and Fetal Alcohol Syndrome (FAS) reported under the 50% of patients affected by mentioned CCD suffer of TMDs, although patients presented coronoid process hyperplasia, upper/lower jaw bone malformations and limited mouth-opening [31–34]. Furthermore, Ferri *et al.* [35] in a retrospective studies analyzing 85 patients affected by cranio-maxillofacial dysplasia showed all patients showed

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

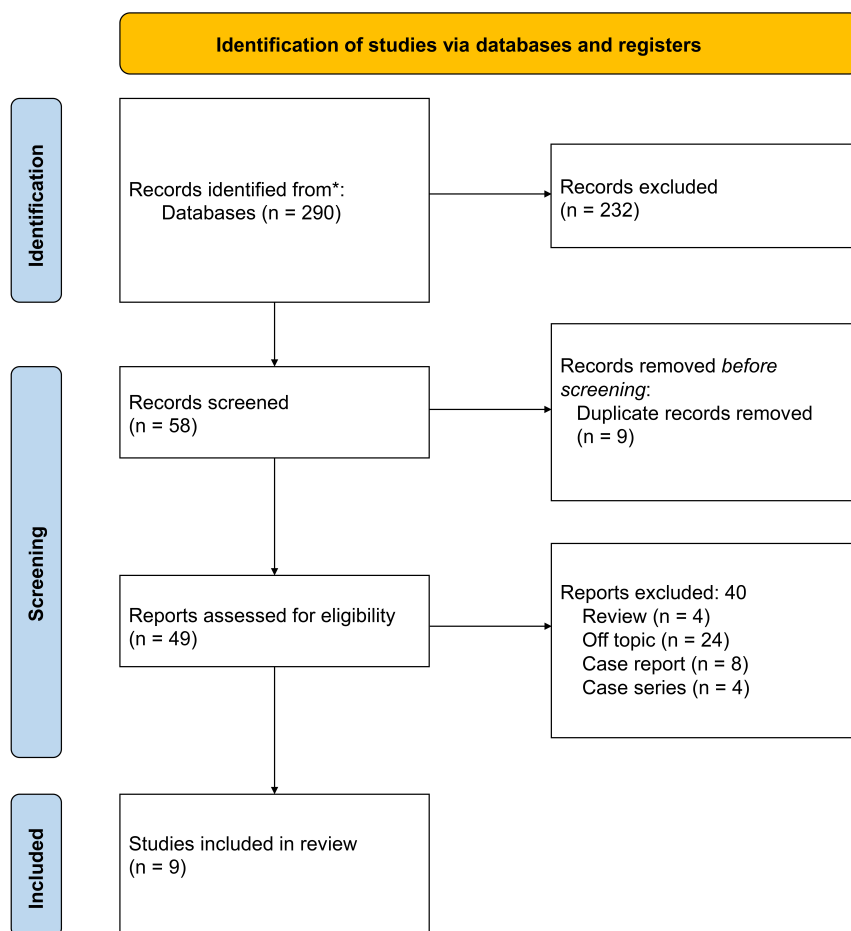


FIGURE 1. Flowchart of search strategy.

mandibular hypoplasia and dysplasia of the mandibular ramus, and consequently TMD disorders. Castro *et al.* [36] showed some patients affected by Williams syndrome present the phenotypic characteristics that include joint abnormalities. A hypothesis was that the temporomandibular joint of these individuals may be affected. A study showed reduced mandibular movements, functional changes in the TMJ, articular and muscle pains and Angle III class malocclusion [36]. In a cross-sectional investigation by Bendixen *et al.* [37] of temporomandibular disorders and dental occlusion in a sample of patients affected by Osteogenesis Imperfecta (OI), it was discovered that 25.0% of those with moderate-to-severe OI and 8.9% of those with mild OI had decreased jaw opening ability. It was suggested by Malgorzata *et al.* [38] that the significant incidence of disk displacement in asymptomatic TMJs may be a congenital normal anatomic variation. According to the current study, only children with OI type I had improved cervical spine and TMJ mobility, whereas children with OI types III and IV had restricted motion in both the cervical spine joints and the TMJ. The results of the research indicated that acoustic complaints from the TMJ occurred more frequently in children with OI than in healthy children; as a result, TMD preventive programs should include activities for tongue-mandibular synchronization in addition to cervical

spine stability exercises.

The results of the quality assessment of included studies are reported in Fig. 2. The analysis of the NOS reported scores ranging 5 to 9, whereas studies that met five or more of the NOS score criteria were considered as good quality. Apart from four papers [30, 31, 34, 37], all papers lost two points due to lack of control for age or other factors relating to comparability and outcome. Four studies were deemed to be at a low risk of bias overall [30, 31, 34, 37] and five were at high risk of bias overall [32, 33, 35, 36, 38]. The studies at high risk of bias had an overall NOS ranging from 5 to 7 [32, 33, 35, 36, 38] (Fig. 2).

#### 4. Discussion

The two main types of temporomandibular joint diseases are functional problems (such as tetany and myofascial pain syndrome) and anatomical abnormality [39]. Depending on which portion of the anatomy is most damaged (*e.g.*, muscles, mucosa and glands *vs.* joints and skeleton), anatomical illnesses are further categorized into soft-tissue or skeletal deficiencies [40]. An important portion of the viscerocranium illnesses are temporomandibular joint problems. An estimated one in five people worldwide experience some degree of tempo-

**TABLE 1. Main characteristics of the included studies.**

Authors	Publication Year	Study Design	Diagnosis of CCD	No. Examined Patients with diagnosis of CCD	No. patient suffering of TMD with diagnosis of CCD	Features of TMD relating to CCD
Malgorzata <i>et al.</i> [38]	2021	Prospective study	Osteogenesis Imperfecta	57	34	Myofascial pain with limited mouth-opening Disk displacement with reduction
Ferri <i>et al.</i> [35]	2021	Retrospective study	Cranio-Maxillofacial Dysplasia	85	85	Mandibular Hypoplasia Dysplasia of the mandibular ramus
Castro <i>et al.</i> [36]	2018	Retrospective study	Williams Syndrome	52	25	Articular pain Muscle pain Angle Class III malocclusion
Bendixen <i>et al.</i> [37]	2018	Prospective study	Osteogenesis Imperfecta	75	17	Myofascial pain with limited mouth-opening Disc displacement with reduction
Poon <i>et al.</i> [30]	2003	Retrospective study	Hemifacial Microsomia	65	37	Hypoplastic condyle Hypoplastic of the mandibular ramus
Church <i>et al.</i> [31]	1997	Retrospective study	Fetal Alcohol Syndrome	22	4	Upper/lower jaw bone malformations Limited mouth-opening
Steinberg <i>et al.</i> [34]	1996	Prospective study	Arthrogryposis Multiplex Congenital	23	5	Skeletal open-bite Mandibular Hypoplasia Limited mandibular opening
Isberg <i>et al.</i> [32]	1990	Prospective study	Coronoid Locking	19	8	Limited mandibular opening Coronoid process hyperplasia
Isberg <i>et al.</i> [32]	1987	Prospective study	Coronoid Locking	163	4	Limited mouth-opening Coronoid process hyperplasia

CCD: congenital craniofacial disorders; TMD: temporomandibular disorders.

mandibular joint dysfunction [41]. All illnesses that affect these structures are typically accompanied by excruciating pain and great discomfort. It's critical to have a thorough understanding of the temporomandibular joint illnesses' symptoms when practicing dentistry [42]. Church *et al.* [31], analyzing the FAS, showed TMDs can be associated with dental malocclusions, highlighting that the existence of TMDs was probably due to such jaw malformations. In fact, all four patients suffering of TMDs had class II malocclusions with overjets [31]. The relationship between dental malocclusions and TMDs has been reported by different articles [39–41]. However, a diagnosis of TMD has not been performed assuming only certain signs such as malocclusions, but a complete examination of the patient and the current diagnostic criteria have been carried out. Nowadays, the recommendation is to

apply various tests that will lead us to an accurate diagnosis in order to define a TMD, applying diagnostic criteria for TMD (DC/TMD) providing evidence-based criteria for the clinician in order to facilitate communication regarding consultations, referrals and prognosis, according to Schiffman *et al.* [23]. It is crucial to take into account a much larger variety of illnesses when diagnosing temporomandibular joint problems since they all exhibit symptoms that are comparable in the head and neck region [40]. First, it's important to determine whether intracranial pathologies and systemic disorders are present [43]. This method, which focuses entirely on treating temporomandibular joint disorders, is crucial from a therapeutic standpoint because it reduces the possibility of situations in which the dentist fails to notice life-threatening problems [44]. After cleft lip and palate, hemifacial microsomia (HM)



**Risk of bias domains**

	D1	D2	D3	OVERALL
Malgorzata et al				
Ferri et al				
Castro et al				
Bendixen et al				
Poon et al				
Church et al				
Steinberg et al				
Isberg et al				
Isberg et al				

D1: Bias due to Selection- Domain scoring:0-1(High); 2( Some concerns); 3+ ( Low)  
D2: Bias due to Comparability- Domain scoring:0-1(High); 2( Some concerns); 3+ ( Low)  
D3: Bias due to Outcome- Domain scoring:0-1(High); 2( Some concerns); 3+ ( Low)

**Judgement** High    Some concerns    Low

**FIGURE 2. Risk of bias assessment using Newcastle-Ottawa score Risk of bias assessment for each study according to NOS. Plots created using risk-of-bias visualization (robvis) tool.**

is the second most prevalent congenital facial skull deformity, resulting in mandibular and condylar hypoplasia [30]. Mandibular body and rami underdevelopment is frequently linked to condylar hypoplasia [45]. Mandibular hypoplasia or micrognathia, is characterized by an unusually tiny mandible [35]. It can happen as a deformity brought on by intrauterine mandibular compression, on the one hand, in most of the cases is asymmetrical. On the other side, it can also have a malformation-like quality. Poon *et al.* [30], considering patients affected by HM, showed that over the 50% of patients affected by HM reported mildly hypoplastic mandibular ramus-condyle with functioning temporomandibular joint with no diagnosis of TMD. This aspect reflects the dubious relationship between jaw malformations and TMD. Then, a typical congenital mandibular malformation may reflect correct joint function through musculoskeletal and dental compensatory mechanisms. However, jaw malformations must be identified

and intercepted at the earliest stage in order to have the possibility of intervening with an orthodontic-surgical approach. Condylar hypoplasia, which can be congenital or acquired, is described in the literature as abnormal mandibular condyle growth. Congenital condylar hypoplasia is linked to head and neck syndromes include hemifacial microsomia, oculo-auriculo-vertebral syndrome, and mandibulofacial dysostosis (Goldenhar syndrome). Agenesis of the whole condyle or branch (condylar aplasia) can be reported in the most severe cases. However, acquired condylar hypoplasia is brought on by issues with the condyle's growing growth center. The most frequent cause is condylar trauma during the early and second decades of life. Other reasons include infections, radiation therapy and rheumatoid or degenerative arthritis [35, 45]. On the other hand, condylar hyperplasia is an uncommon condition marked by an abnormal increase in bone mass [46]. The fovea, which adjusts to the aberrant shape of the skull,

might be negatively impacted by over-enlargement or less frequently distortion of the mandibular head. Most frequently, it happens unilaterally, which causes asymmetry. The most frequent cause for early-stage patient visits to the doctor is an unattractive look. Additionally, myofascial discomfort in the face, occlusion issues and pain around the temporomandibular joint are all brought on by unilateral hyperplasia. Overactive cartilage is mostly linked to the etiology. Injuries, genetic predispositions and endocrine problems are among the variables thought to increase the risk of condylar hyperplasia. Typically, excessive mandibular growth will stop after bone formation is complete [47]. Due to the physical complexity of the malformation, mandibular asymmetry is particularly challenging to diagnose and cure. Before arriving at a final diagnosis and treatment strategy, clinical findings must be supported by radiography. Determine whether growth is still occurring because the surgical and orthodontic therapies are influenced by the patients' growth [48, 49].

## 5. Conclusions

According to this systematic review, temporomandibular disorders and congenital craniofacial problems are related. The findings of a small number of articles in the literature, some of which are of simply average quality because they lack a control group or have a tiny sample size are nonetheless, what the evidence is built on. However, given that nearly all of the studies showed a high prevalence of TMD in CCD patients, all medical physicians should be aware of this link in order to refer CCD patients to dentists for screening when they complain of symptoms suggestive of TMD. To clearly identify the relationship between congenital craniofacial deformities and temporomandibular disorders, future research with a significant sample size and a control group is required.

## AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article (and supplementary material).

## AUTHOR CONTRIBUTIONS

GM, MMM and MC—designed the research study. GM, FDF, GC and GM—performed the research. AL and MMM—analyzed the data. GM, MMM and FDF—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

## ACKNOWLEDGMENT

Not applicable.

## FUNDING

This research received no external funding.

## CONFLICT OF INTEREST

The authors declare no conflict of interest. Giuseppe Minervini is serving as one of the Editorial Board members of this journal. We declare that Giuseppe Minervini had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to GAF.

## REFERENCES

- [1] Sicard L, O'Hana D, Khonsari RH, Kaddour Brahim A. Bilateral dislocation of the temporomandibular joint in children. *Journal of Oral and Maxillofacial Surgery*. 2018; 76: 2307–2315.
- [2] Di Francesco F, Lanza A, di Blasio M, Vaienti B, Cafferata EA, Cervino G, *et al*. Application of botulinum toxin in temporomandibular disorders: a systematic review of randomized controlled trials (RCTs). *Applied Sciences*. 2022; 12: 12409.
- [3] Young A. Idiopathic condylar resorption: the current understanding in diagnosis and treatment. *The Journal of Indian Prosthodontic Society*. 2017; 17: 128–135.
- [4] Hodzic Z, Törnwall J, Leikola J, Heliövaara A, Suojanen J. Alloplastic temporomandibular joint reconstruction in congenital craniofacial deformities. *Journal of Craniofacial Surgery*. 2021; 32: e548–e551.
- [5] Manocha S, Farokhnia N, Khosropanah S, Bertol JW, Santiago J Junior, Fakhouri WD. Systematic review of hormonal and genetic factors involved in the nonsyndromic disorders of the lower jaw. *Developmental Dynamics*. 2019; 248: 162–172.
- [6] Minervini G, Del Mondo D, Russo D, Cervino G, D'Amico C, Fiorillo L. Stem cells in temporomandibular joint engineering: state of art and future perspectives. *The Journal of Craniofacial Surgery*. 2022; 33: 2181.
- [7] Wright JW Jr, Wright JW 3rd, Hicks G. Polytomography and congenital anomalies of the ear. *Annals of Otolaryngology, Rhinology & Laryngology*. 1982; 91: 480–484.
- [8] Pitirri MK, Durham EL, Romano NA, Santos JI, Coupe AP, Zheng H, *et al*. Meckel's cartilage in mandibular development and dysmorphogenesis. *Frontiers in Genetics*. 2022; 13: 871927.
- [9] Wolford LM, Perez DE. Surgical management of congenital deformities with temporomandibular joint malformation. *Oral and Maxillofacial Surgery Clinics of North America*. 2015; 27: 137–154.
- [10] Kaneyama K, Segami N, Hatta T. Congenital deformities and developmental abnormalities of the mandibular condyle in the temporomandibular joint. *Congenital Anomalies*. 2008; 48: 118–125.
- [11] Minervini G, Franco R, Marrapodi MM, Fiorillo L, Cervino G, Cicciù M. Prevalence of temporomandibular disorders (TMD) in pregnancy: a systematic review with meta-analysis. *Journal of Oral Rehabilitation*. 2023. [Preprint].
- [12] Fiorillo L, De Stefano R, Cervino G, Crimi S, Bianchi A, Campagna P, *et al*. Oral and psychological alterations in haemophilic patients. *Biomedicines*. 2019; 7: 33.
- [13] Minervini G, Franco R, Marrapodi MM, Mehta V, Fiorillo L, Badnjević A, *et al*. The association between COVID-19 related anxiety, stress, depression, temporomandibular disorders, and headaches from childhood to adulthood: a systematic review. *Brain Sciences*. 2023; 13: 481.
- [14] Quinzi V, Paskay LC, Manenti RJ, Giancaspro S, Marzo G, Saccomanno S. Telemedicine for a multidisciplinary assessment of orofacial pain in a patient affected by eagle's syndrome: a clinical case report. *The Open Dentistry Journal*. 2021; 15: 102–110.
- [15] Minervini G, Mariani P, Fiorillo L, Cervino G, Cicciù M, Laino L. Prevalence of temporomandibular disorders in people with multiple sclerosis: a systematic review and meta-analysis. *CRANIO®*. 2022; 1–9.
- [16] Ramly EP, Yu JW, Eisemann BS, Yue O, Alfonso AR, Kantar RS, *et al*. Temporomandibular joint ankylosis in pediatric patients with

- craniofacial differences: causes, recurrence and clinical outcomes. *Journal of Craniofacial Surgery*. 2020; 31: 1343–1347.
- [17] Sadrabad MJ, Ameli N, Kianpour M, Ghorbani R, Sohanian S. The relationship of temporomandibular disorders with class II malocclusion as a risk factor. *APOS Trends in Orthodontics*. 2021; 11: 41–47.
- [18] Minervini G, Fiorillo L, Russo D, Lanza A, D'Amico C, Cervino G, *et al.* Prosthodontic treatment in patients with temporomandibular disorders and orofacial pain and/or bruxism: a review of the literature. *Prosthesis*. 2022; 4: 253–262.
- [19] Saccomanno S, Quinzi V, D'Andrea N, Albani A, Coceani Paskay L, Marzo G. Traumatic events and eagle syndrome: is there any correlation? A systematic review. *Healthcare*. 2021; 9: 825.
- [20] Pirttiniemi P, Peltomäki T, Müller L, Luder HU. Abnormal mandibular growth and the condylar cartilage. *European Journal of Orthodontics*. 2009; 31: 1–11.
- [21] Allori AC, Chang CC, Fariña R, Grayson BH, Warren SM, McCarthy JG. Current concepts in pediatric temporomandibular joint disorders: part 1. etiology, epidemiology, and classification. *Plastic and Reconstructive Surgery*. 2010; 126: 1263–1275.
- [22] Resnick CM. Temporomandibular joint reconstruction in the growing child. *Oral and Maxillofacial Surgery Clinics of North America*. 2018; 30: 109–121.
- [23] Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet J, *et al.* Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the international RDC/TMD consortium network\* and orofacial pain special interest group†. *Journal of Oral & Facial Pain and Headache*. 2014; 28: 6–27.
- [24] Özkan NC, Ozkan F. The relationship of temporomandibular disorders with headaches: a retrospective analysis. *Agri*. 2011; 23: 13–17.
- [25] Deregibus A, Ferrillo M, Piancin MG, Domini MC, De Sire A, Castroflorio T. Are occlusal splints effective in reducing myofascial pain in patients with muscle-related temporomandibular disorders? A randomized-controlled trial. *Turkish Journal of Physical Medicine and Rehabilitation*. 2021; 67: 32–40.
- [26] Di Francesco F, De Marco G, Capcha EB, Lanza A, Cristache CM, Vernal R, *et al.* Patient satisfaction and survival of maxillary overdentures supported by four or six splinted implants: a systematic review with meta-analysis. *BMC Oral Health*. 2021; 21: 247.
- [27] Duman S, Vural H. Evaluation of the relationship between malocclusions and sleep-disordered breathing in children. *CRANIO®*. 2022; 40: 295–302.
- [28] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, *et al.* The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021; 372: n71.
- [29] Wells A, Shea B, O'Connell D, Peterson J, Welch V, Losos M, *et al.* The newcastle-ottawa scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Available at: [https://www.ohri.ca/programs/clinical\\_epidemiology/oxford.asp](https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp) (Accessed: 17 February 2014).
- [30] Poon CC, Meara JG, Heggie AA. Hemifacial microsomia: use of the OMENS-plus classification at the royal children's hospital of melbourne. *Plastic and Reconstructive Surgery*. 2003; 111: 1011–1018.
- [31] Church MW, Eldis F, Blakley BW, Bawle EV. Hearing, language, speech, vestibular, and dentofacial disorders in fetal alcohol syndrome. *Alcoholism, Clinical and Experimental Research*. 1997; 21: 227–237.
- [32] Isberg A, Isacson G, Nah K. Mandibular coronoid process locking: a prospective study of frequency and association with internal derangement of the temporomandibular joint. *Oral Surgery, Oral Medicine, Oral Pathology*. 1987; 63: 275–279.
- [33] Isberg A, Eliasson S. A cephalometric analysis of patients with coronoid process enlargement and locking. *American Journal of Orthodontics and Dentofacial Orthopedics*. 1990; 97: 35–40.
- [34] Steinberg B, Nelson VS, Feinberg SE, Calhoun C. Incidence of maxillofacial involvement in arthrogryposis multiplex congenita. *Journal of Oral and Maxillofacial Surgery*. 1996; 54: 956–959.
- [35] Ferri J, Schlund M, Touzet-Roumazeille S, Sciote JJ, Nicot R. Temporomandibular joint dysplasia in cranio-maxillofacial dysplasia: a retrospective study. Guideline treatment proposal. *Journal of Craniofacial Surgery*. 2021; 32: 1014–1021.
- [36] Castro T, de Paula Martins Santos C, de Oliveira Lira Ortega A, Gallottini M. Oral characteristics and medical considerations in the dental treatment of individuals with Williams syndrome. *Special Care in Dentistry*. 2019; 39: 108–113.
- [37] Bendixen KH, Gjørup H, Baad-Hansen L, Dahl Hald J, Harsløf T, Schmidt MH, *et al.* Temporomandibular disorders and psychosocial status in osteogenesis imperfecta—a cross-sectional study. *BMC Oral Health*. 2018; 18: 35.
- [38] Małgorzata KM, Małgorzata P, Kinga S, Jerzy S. Temporomandibular joint and cervical spine mobility assessment in the prevention of temporomandibular disorders in children with osteogenesis imperfecta: a pilot study. *International Journal of Environmental Research and Public Health*. 2021; 18: 1076.
- [39] De Rossi SS, Greenberg MS, Liu F, Steinkeler A. Temporomandibular disorders. *Medical Clinics of North America*. 2014; 98: 1353–1384.
- [40] Gauer RL, Semidey MJ. Diagnosis and treatment of temporomandibular disorders. *American Family Physician*. 2015; 91: 378–386.
- [41] Ingawalé S, Goswami T. Temporomandibular joint: disorders, treatments, and biomechanics. *Annals of Biomedical Engineering*. 2009; 37: 976–996.
- [42] Türp JC, Strub JR. Prosthetic rehabilitation in patients with temporomandibular disorders. *The Journal of Prosthetic Dentistry*. 1996; 76: 418–423.
- [43] Plesh O, Curtis D, Levine J, McCall Jr WD. Amitriptyline treatment of chronic pain in patients with temporomandibular disorders. *Journal of Oral Rehabilitation*. 2000; 27: 834–841.
- [44] Ribeiro JAM, de Resende CMBM, Lopes ALC, Farias-Neto A, Carreiro ADFP. Association between prosthetic factors and temporomandibular disorders in complete denture wearers. *Gerodontology*. 2014; 31: 308–313.
- [45] Masotti C, Oliveira KG, Poerner F, Splendore A, Souza J, Freitas RDS, *et al.* Auriculo-condylar syndrome: mapping of a first locus and evidence for genetic heterogeneity. *European Journal of Human Genetics*. 2008; 16: 145–152.
- [46] Ozcelik TB, Pektas ZO. Management of chronic unilateral temporomandibular joint dislocation with a mandibular guidance prosthesis: a clinical report. *The Journal of Prosthetic Dentistry*. 2008; 99: 95–100.
- [47] De Boever JA, Carlsson GE, Klineberg IJ. Need for occlusal therapy and prosthodontic treatment in the management of temporomandibular disorders. Part II. Tooth loss and prosthodontic treatment. *Journal of Oral Rehabilitation*. 2000; 27: 647–659.
- [48] Mor N, Tang C, Blitzer A. Temporomandibular myofascial pain treated with botulinum toxin injection. *Toxins*. 2015; 7: 2791–2800.
- [49] Carlsson GE. Some dogmas related to prosthodontics, temporomandibular disorders and occlusion. *Acta Odontologica Scandinavica*. 2010; 68: 313–322.

**How to cite this article:** Giuseppe Minervini, Maria Maddalena Marrapodi, Gabriele Cervino, Rocco Franco, Alessandro Lanza, Marco Ciccù, *et al.* Congenital cranio-facial abnormalities in paediatric population: a systematic review on temporomandibular disorders. *Journal of Clinical Pediatric Dentistry*. 2023; 47(5): 12-18. doi: 10.22514/jocpd.2023.049.