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Diagnostic criteria for temporomandibular disorders—INfORM recommendations: Comprehensive and short-form adaptations for adolescents

EwaCarin Ekberg[1] | Ing-Marie Nilsson[1,2] | Ambrosina Michelotti[3] | Amal Al-Khotani[4,5] | Per Alstergren[1,5,6] | Paulo Cesar Rodrigues Conti[7,8] | Justin Durham[9] | Jean-Paul Goulet[10] | Christian Hirsch[11] | Stanimira Kalaykova[12] | Flavia P. Kapos[13,14] | Christopher D. King[15,16,17] | Osamu Komiyama[18] | Michail Koutris[19] | Thomas List[1,5] | Frank Lobbezoo[19] | Richard Ohrbach[20] | Tonya M. Palermo[21] | Christopher C. Peck[22] | Chris Penlington[9] | Claudia Restrepo[23] | Maria Joao Rodrigues[24] | Sonia Sharma[1,20] | Peter Svensson[25] | Corine M. Visscher[19] | Kerstin Wahlund[26] | Roberto Rongo[3] | International Network for Orofacial Pain and Related Disorders Methodology (INfORM)[27]

Correspondence
Roberto Rongo, Department of Neurosciences, Reproductive Sciences and Oral Sciences–University of Naples "Federico II", Via Pansini 5, 80131 Naples, Italy.
Email: roberto.rongo@unina.it

Abstract

Background: The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for use in adults is in use worldwide. Until now, no version of this instrument for use in adolescents has been proposed.

Objective: To present comprehensive and short-form adaptations of the adult version of DC/TMD that are appropriate for use with adolescents in clinical and research settings.

Methods: International experts in TMDs and experts in pain psychology participated in a Delphi process to identify ways of adapting the DC/TMD protocol for physical and psychosocial assessment of adolescents.

Results: The proposed adaptation defines adolescence as ages 10–19 years. Changes in the physical diagnosis (Axis I) include (i) adapting the language of the Demographics and the Symptom Questionnaires to be developmentally appropriate for adolescents, (ii) adding two general health questionnaires, one for the adolescent patient and one for their caregivers and (iii) replacing the TMD Pain Screener with the 3Q/TMD questionnaire. Changes in the psychosocial assessment (Axis II) include (i) adapting the language of the Graded Chronic Pain Scale to be developmentally appropriate for adolescents, (ii) adding anxiety and depression assessment that have been validated for adolescents and (iii) adding three constructs (stress, catastrophizing and sleep disorders) to assess psychosocial functioning in adolescents.

Conclusion: The recommended DC/TMD, including Axis I and Axis II for adolescents, is appropriate to use in clinical and research settings. This adapted first version for adolescents includes changes in Axis I and Axis II requiring reliability and validity testing in international settings. Official translations of the comprehensive and short-form to different languages according to INfORM requirements will enable a worldwide dissemination and implementation.

KEYWORDS
adolescents, diagnostic criteria, dysfunction, pain, temporomandibular disorders

1 | INTRODUCTION

Temporomandibular disorders (TMDs) are a collective term for a group of disorders characterised by pain, impaired function, or both of the masticatory system and related structures. Although the field developed through assessment and treatment of adults, adolescents have been found to suffer from TMDs as well. In 1999, TMD pain prevalence in adolescents was reported to be between 2% and 6%,[1] a more recent systematic review reported TMD prevalence to vary between 7% and 30% in adolescent populations when assessed with the Research Diagnostic Criteria for TMD (RDC/TMD) or the subsequent Diagnostic Criteria for TMD (DC/TMD). This systematic review found that the most common diagnoses in adolescents are myofascial pain and disc displacement with reduction.[2] Furthermore, prevalence of reported TMD pain among adolescents varied from 4% to 32% across studies using screening questions validated among adolescents.[3,4]

A large population-based study on 12–19-year-old participants reported a higher prevalence of TMD pain in girls (6%) compared to boys (2.7%).[4] Furthermore, the prevalence of TMD pain among girls showed a significant increase from 2.7% at age 12 to 7.9% at age 19. In contrast, this increase was only moderate for boys, from 2.0% at age 12 to 2.9% at age 19 and this gender pattern was also confirmed in a more recent study.[4,5] The risk factors for onset of facial pain and TMD pain in early adolescence are female sex, somatization, number of other pain complaints and life dissatisfaction, among others.[6]

TMD in adolescence is associated with emotional stress, depression, sleep and hormonal disturbances and functional consequences.[7–9] To cope with pain, adolescents just as adults, develop various pain management strategies and seek treatment to find an explanation for the cause of their pain.[10]

As adolescents with TMD, especially pain-related TMD, comprise a substantial group with an obvious treatment need,[11–13] it is important to identify these patients early and to offer care to these individuals in need of treatment. Since early diagnoses can influence therapeutic success, this can be relevant in general dental care and primary care as well as in specialised clinics. Adolescents with self-reported TMD pain have a three-fold higher risk of having recurring TMD pain as young adults, highlighting the importance of identifying these individuals when pain first develops.[14]

The RDC/TMD, the first comprehensive diagnostic system for TMD,[15] was developed for and widely used among adults in research and clinical settings. The system comprises two axes based on the biopsychosocial model of pain: Axis I for physical diagnoses and Axis II for the assessment of psychological status and pain-related disability. Axis I has been found to have good reliability in 12–18-year-old adolescents.[16] None of the Axis II instruments, however, were validated for adolescents at that time. Hence, the orofacial pain community have used a variety of instruments to assess psychosocial domains in adolescents.[6,7,13,17–19]

In 2014, the DC/TMD was published as a revision and further development was performed of the RDC/TMD, including validation of the most common diagnoses for use in the adult population. The DC/TMD has, so far, been translated into 21 languages in a formal forward–backward translation process for worldwide implementation.[20] It includes both comprehensive instruments and a simple screener for Axis I, allowing the identification of patients that will likely fulfil at least one TMD diagnosis.[21] Comprehensive and short-form assessments are available for Axis II. The short form of assessment is useful in general dentistry, primary care and dental specialties other than orofacial pain.

Some of the instruments in the DC/TMD for adults have not been validated in adolescents, since some concepts need to be developmentally adapted for the adolescent patterns of behaviour and lifestyle choices. In addition, standardisation of the clinical examination might need to be modified to facilitate implementation.[22]

Consequently, there is a need for both short and comprehensive forms of the DC/TMD that are valid for use with adolescents. Thus, a group of international experts in TMDs and pain psychology related to adolescents participated in a Delphi study to identify how to adapt the DC/TMD for adults to the examination of adolescent populations.[23,24]

The aim of the present article was to propose comprehensive and short forms of the DC/TMD Axis I and Axis II that are appropriate for use with adolescents in clinical and research settings.

2 | METHODS

Under the auspices of INfORM, the organising committee prepared a Satellite symposium "DC/TMD for children and adolescents" to

be held in conjunction with the 2018 annual meeting of the IADR in London, UK. As the first step, the Delphi method was used to achieve international consensus among experts in TMD who had experience of the DC/TMD.[25] Fifteen TMD experts, members of INfORM from around the world (AM, PA, CR, FK, SK, IMN, JD, ECE, RR, TL, RO, SS, MJR, MK, CCP), were invited to participate. Thereafter, another nine experts (PS, FL, KW, CV, JPG, AA-K, OK, CH, PCC) in the field were added, and the first Delphi round was created.[23] A facilitator (RR) developed a survey with 89 statements, including Axis I and Axis II and the 23 Delphi members were asked to respond to each statement on a five-item Likert scale ranging from "Strongly disagree" to "Strongly agree". The members were also encouraged to leave free-text comments. After the third round, four experts in pain psychology (CB, TP, CK, CP) in children and adolescents were invited to suggest instruments suitable for screening adolescents for depression, anxiety, sleep disorders, catastrophizing and stress to improve the DC/TMD Axis II screening tools.

The present paper includes both a comprehensive and a short-form version of the DC/TMD for adolescents (Appendix S1 and Appendix S2).

3 | RESULTS

3.1 | Overview

Per the Delphi panel consensus[23] the proposed adaptation of the DC/TMD was developed for individuals in adolescence, defined by the WHO as the phase of life between 10 and 19 years of age.[26]

Tables 1 and 2 present TMD diagnoses for adolescents in relation to the DC/TMD for adults. Two diagnoses, local myalgia and myofascial pain, were excluded for adolescents as no sensitivity and specificity have yet been established for adults. TMD-pain diagnoses include arthralgia, myalgia, myofascial pain with referral and headache attributed to TMD; intra-articular TMD included six diagnoses: disc displacement with reduction, disc displacement with reduction with intermittent locking, disc displacement without reduction with limited opening, disc displacement without reduction without limited opening, degenerative joint disease and subluxation. Changes in Axis I of the DC/TMD include (i) adapting the language of the Demographics Questionnaire and the Symptom Questionnaire to be developmentally appropriate for adolescents, (ii) adding two general health questionnaires, one for adolescent patients and one for their parents, (iii) replacing the TMD Pain Screener with the 3Q/TMD questionnaire for screening and (iv) replacing the mandatory commands in the clinical examination with detailed instructions that could be used more easily to explain DC/TMD concepts to this population (Appendix S1).

Changes in Axis II include (i) adapting the language of the Graded Chronic Pain Scale (GCPS) to be developmentally relevant for adolescents, (ii) adding anxiety and depression assessment validated for adolescents and (iii) adding assessment of three constructs (stress, catastrophizing and sleep disorders) to measure psychosocial functioning in adolescents.

The proposed adaptation of the DC/TMD, suggested by specialists and experts, includes a comprehensive version for use in clinical and research settings and a short version for use by general practitioners and other health care providers.

3.2 | Recommendations for Axis I

Clinical examination instruments can be seen in Tables 3 and 4.

1. The 3Q/TMD questionnaire (Appendix S1) was introduced as a screener for TMD pain and dysfunction. The instrument is easy to use and comprises three questions: two questions address pain in the temporomandibular area and one question addresses dysfunction. Both questions on pain were initially assessed for validity in adolescents [sensitivity 0.96 (95% CI, 0.85–0.99), specificity 0.83 (95% CI, 0.72–0.90)], and the reference condition was a TMD pain diagnosis according to RDC/TMD.[3] The complete 3Q/TMD has been validated in the general population in adults and showed fair to moderate validity. For the question 3 on jaw dysfunction sensitivity was 0.45 (0.38–0.52) and specificity 0.86 (0.80–0.90) and the reference condition was an intra-articular DC/TMD diagnosis.[27]

2. The Symptom Questionnaire (SQ) was modified from the adult version to be developmentally relevant for adolescents (SQ-A) (Appendix S1). Besides adapting of self-reported patient information on the history of pain characteristics, joint noises, jaw locking and headache, new questions on trauma and numerical rating scales for assessing TMD pain intensity and headache intensity were added.

3. The language used in the Demographics questionnaire was adapted to be developmentally relevant for adolescents. Questions on income and marital status were eliminated while questions on family situation, school attendance and lifestyle were added in the Demographics questionnaire to be more useful for adolescents. Also, two general health questionnaires concerning diseases and medication, one for adolescent patients and one for their parents, were included (Table 1).

4. The clinical examination protocol for adolescents is identical to the protocol for adults (https://ubwp.buffalo.edu/rdc-tmdinternational/). The mandatory commands are replaced by an explanation from the clinician of each examination procedure in an understandable way to the young individual. Explaining the meanings of familiar pain and referred pain is critical. Adolescents must understand that familiar pain is similar to what the individual reports in the patient history in the last 30 days and reproduced during the clinical examination; referred pain is the pain perceived by the individual at a site away from the provocation and interpreted by the examiner as beyond the boundary of the anatomical structure being palpated. When analysing range of motion, a cut-off of 40 mm for limited mouth opening capacity was set, as it was for adults.[28] Joint sounds are assessed during all mandibular movements, as in the DC/TMD for adults.[29,30] During the

TABLE 1 The most common pain-related temporomandibular disorders diagnoses in adults and adolescents according to the Diagnostic Criteria for TMD (DC/TMD). Diagnoses are based on the patient history *and* clinical examination.

Diagnosis axis I DC/TMD	History	Clinical examination	Adults (≥20 years)	Adolescents (10–19 years)[a]
Myalgia	Pain in the jaw, temple, in the ear, or in front of the ear AND Pain modified with jaw movement, function, or parafunction	Confirmation of pain location(s) in the temporalis and/or masseter muscle(s) Report of familiar pain in the temporalis or masseter with at least one of the following provocation tests: a. Palpation of the temporalis or masseter muscle(s) OR b. Maximum unassisted or assisted opening	√	√
Myofascial pain with referral	Same as for myalgia	Same as for myalgia AND Sustained palpation with identification of referral patterns	√	Comprehensive √ Short form No
Arthralgia	Same as for myalgia	Confirmation of pain location in the area of the TMJ(s) AND Report of familiar pain in the TMJ with at least one of the following provocation tests: a. Palpation of the lateral pole or around the lateral pole OR b. Maximum unassisted or assisted opening, lateral movements, or protrusive movements	√	√
Headache attributed to TMD	Headache of any type in the temple AND Headache modified with jaw movement, function, or parafunction	Confirmation of headache location in the area of the temporalis muscle(s) AND Report of familiar headache in the temple area with at least one of the following provocation tests a. Palpation of the temporalis muscle (s) OR b. Maximum unassisted or assisted opening, lateral movements, or protrusive movements	√	√

[a]Unless otherwise indicated, the results for the adolescent versions of the comprehensive and the short form DC/TMD are the same.

palpation of the masticatory muscles and temporomandibular joints, the amount of pressure (0.5–1 kg) and the time of palpation (2 s when omitting identification of referred pain and 5 s when including identification of referred pain) is identical to what is used in the DC/TMD for adults (Appendix S2). The TMD experts on the Delphi panel have recommended that future studies examine the validity of familiar and referred pain during muscle and TMJ palpation. Finally, supplemental muscle pain assessment with palpation for the posterior mandibular region, the submandibular region, the lateral pterygoid area and the temporalis tendon is optional. Mandatory palpation of these sites is generally unnecessary to reach a DC/TMD muscle pain diagnosis (Table 4), whose sensitivity and specificity for adults were based on palpation of temporalis and masseter muscles only due to very high prevalence of positive findings in these two muscles alone.

In the short form of the clinical examination, only opening capacity and presence of familiar pain during movement should be recorded. Clicking and crepitation in the TMJ should be recorded only when opening and closing the mouth. Asking about referred pain is excluded from the short form and palpation time is reduced to 2 s (Table 2).

3.3 | TMJ imaging

Referring an adolescent for TMJ imaging should only be done when more information may influence the management or prognosis. Indications for TMJ imaging include: uncertain diagnosis, follow-up on the lack of treatment effect and differential diagnosis of injuries that may involve the TMJ. If any of these indications are present, the experts agreed upon using magnetic resonance imaging and/or computed tomography (cone-beam or axial) as a supplementary test to the DC/TMD for adolescents.[23]

3.4 | Recommendations for Axis II

Instruments designed and validated to evaluate Axis II domains in 10–19-year-olds are needed. Instruments for pain-related disability and psychological status can be seen in Tables 3,5,6. The DC/TMD Axis II instruments assessing pain location, pain intensity and general physical functioning, physical symptoms and jaw parafunctional behaviours were adapted and rephrased while the depression and

TABLE 2 The most common temporomandibular disorders (TMD) diagnoses in adults and adolescents according to the Diagnostic Criteria for TMD (DC/TMD): Axis I, intra-articular TMD.

Diagnosis Axis I DC/TMD	History	Clinical examination	Adults (≥20 years)	Adolescents (10–19 years)[a]
Disc displacement				
with reduction	In the last 30 days, any TMJ noise(s) present with jaw movement or function OR patient report of any noise during the examination	Clicking, popping and/or snapping noise during both opening and closing movements, detected with palpation during at least one of three repetitions OR Noise as above during opening or closing AND noise detected with palpation during right or left lateral, or protrusive movements	√	Comprehensive √ Short form: only according to opening/closing movements
with reduction and intermittent locking	As above AND In the last 30 days jaw lock with limited mouth opening, even for a moment and then unlocks with a special manoeuvre	As above	√	Comprehensive √ Short form: only according to opening/closing movements
without reduction with limited opening	Jaw locked so that the mouth would not open all the way AND Limitation in jaw opening severe enough to limit jaw opening and interfere with ability to eat	Maximum assisted opening movement including vertical incisal overlap <40 mm	√	Comprehensive √ Short form: only according to opening/closing movements
without reduction without limited opening	As above	Maximum assisted opening movement including vertical incisal overlap ≥40 mm	√	Comprehensive √ Short form: only according to opening/closing movements
Degenerative joint disease	In the last 30 days, any TMJ noise(s) present with jaw function OR Patient report any noise present during the exam	Crepitus detected with palpation during at least one of the following: opening, closing, right or left lateral, or protrusive movement(s)	√	Comprehensive √ Short form: only according to opening/closing movements
Subluxation	In the last 30 days, jaw locking or catching in a wide-open mouth position, even for a moment, so could not close from the wide-open position AND Inability to close the mouth from a wide-open position without a self-manoeuvre	No exam findings are required	√	√

[a]Unless otherwise indicated, the results for the adolescent versions of the comprehensive and the short form DC/TMD are the same.

anxiety questionnaires in the DC/TMD for adults were replaced. Furthermore, for the comprehensive version, the Delphi panel recommended additional screening for stress, sleep disorders and catastrophizing.

1. The Pain Drawing is used to assess the self-reported locations of all pain complaints. It is included in the short and comprehensive protocols. The Pain Drawing is useful for distinguishing between localised and widespread pain.[31] DC/TMD Pain Drawing can be found at https://ubwp.buffalo.edu/rdc-tmdinternational/. For patients with widespread pain the recommendation is to use the comprehensive DC/TMD. In the adolescent version, images of the face, the mouth and the body illustrate preselected areas that facilitate the identification and reporting of locations of painful sites.

2. The GCPS includes questions for evaluating characteristic pain intensity (CPI) and pain interference with daily activities. Reliability

TABLE 3 Axis I (clinical examination) and Axis II (the pain-related disability domain) instruments, recommended for use in adults by the Diagnostic Criteria for TMD (DC/TMD) and the proposed version for adolescents aged 10–19 years by the International Network for Orofacial Pain and Related Disorders Methodology (INfORM).

	Adult version (ages ≥ 20 years)		Proposed adolescent version (ages 10–19 years)			
DC/TMD domains	**Comprehensive**	**Short**	**Comprehensive**	**Items (no.)**	**Short**	**Items (no.)**
Axis I: Clinical examination						
TMD screening	Pain screener	Pain screener	3Q/TMD	3	3Q/TMD	3
General Health‡						
Adolescents	–	–	newly developed	9	newly developed	9
Parents	–	–	SF-12	12	SF-12	12
Demographics	Demo-graphics	Demo-graphics	Rephrased & modified[a]	10	rephrased & modified[a]	10
Symptom Questionnaire	SQ	SQ	SQ-A SQ rephrased & modified[a]	18	SQ-A SQ rephrased & modified[a]	18
Axis II: pain-related disability						
Pain intensity	CPI	CPI	CPI	3	CPI	3
Physical functioning	GCPS	GCPS	GCPS Rephrased[a]	8	GCPS Rephrased[a]	8
Pain locations	Pain drawing	Pain drawing	Pain drawing incl preselected areas[a]		Pain drawing incl preselected areas[a]	
Limitations	JFLS-20	JFLS-8	JFLS-20	20	JFLS-8	8
Physical symptoms	PHQ-15		PHQ-15 Rephrased[a]	14		
Oral behaviours	OBC-21	OBC-21	OBC-21	21	Non-functional activity OBC	6

Abbreviations: 3Q/TMD, three questions for screening TMD; CPI, characteristic pain intensity; GCPS, graded chronic pain scale; JFLS, jaw functional limitation scale; OBC, Oral Behaviors Checklist; PHQ-15, patient health questionnaire-15; SF-12, the 12-item Short Form survey; SQ, symptom questionnaire.

[a]Same instrument as in the DC/TMD for adults.

TABLE 4 Axis I adaptations which the International Network for Orofacial Pain and Related Disorders Methodology (INfORM) workshop recommends for use in adolescents (Rongo et al.).[23,24]

Axis I: clinical examination	Adult version (ages ≥ 20 years)	Proposed adolescent version (ages 10–19 years)	
	Comprehensive	Comprehensive	Short
Commands	Mandatory†	Free explanations	Free explanations
Jaw movements	Full	Full	Opening movement only[a]
Limited opening capacity	Full	Full	Full
Pain on jaw movements	Full	Full	Opening movement only[a]
TMJ noises (at all movements)	Full	Full	Opening and closing movements only[a]
Muscle palpation (Incl. familiar and referred pain)	Full	Full	2 s only[a]
TMJ palpation (Incl. familiar and referred pain)	Full	Full	2 s only[a]

[a]As described in the DC/TMD for adults; full = the full examination as described in the adult version of the DC/TMD for that section.

TABLE 5 Axis II instruments for assessing psychological status, the Diagnostic Criteria for TMD (DC/TMD) recommend for adults and version the International Network for Orofacial Pain and Related Disorders Methodology (INfORM) recommends for use in adolescents.

Axis II instruments: Psychological status	Adult version (ages ≥ 20 years)		Proposed adolescent version (ages 10–19 years)			
	Comprehensive	Short	Comprehensive	Items (no.)	Short	Items (no.)
Depression	PHQ-9	PHQ-4	RCADS-SV	25	PHQ-4	4
Anxiety	GAD-7	PHQ-4	RCADS-SV	25	PHQ-4	4
Catastrophizing[a]						
Adolescents			PCS-C	13		
Parents			PCS-P	13		
Sleep quality[a]	PSQI	ISI	ASWS	10		
Stress[a]	PSS-10		PSS-C	14		

Abbreviations: ASWS, the 10-item adolescent sleep wake scale; GAD-7, the 7-item generalised anxiety disorder screener; ISI, the 5-item insomnia severity index; PCS-C, pain catastrophizing scale for children; PCS-P, pain catastrophizing scale for parents; PHQ-9, the 9-item patient health questionnaire; PSQI, the 9-item the pittsburgh sleep quality index; PSS-10, the 10-item perceived stress scale; PSS-C, the 14-item perceived stress scale for children; RCADS-SV, revised child anxiety and depression scale-short version.

[a]Additional instruments recommended by INfORM.

and validity of the GCPS in adults has been confirmed, and the psychometric properties of the 30-day version of the GCPS has been established in adults with TMD.[32,33] The adolescent version of the GCPS proposed here was developmentally adapted to adolescent activities, such that the pain interference questions were slightly rephrased. In cases of high pain, high interference and/or moderate to severe disability, the recommendation is to use the comprehensive protocol for a more accurate assessment due to the high impact of pain in the patient's life.

3. The 15-item Patient Health Questionnaire (PHQ-15) was retained for evaluating non-specific physical symptoms. It is also useful for assessing comorbidities and overall symptom reporting. The question related to sexual intercourse was removed.[34]

4. For assessing the frequency of oral behaviours, the Oral Behavior Checklist (OBC) was recommended for the comprehensive form of DC/TMD for adolescents. For a short-form adaptation of the DC/TMD for adolescents the frequency of non-functional activities, including six items chosen after confirmatory factor analysis, was recommended.[35,36] The OBC non-functional activities focus on tooth clenching-related wake-time behaviours (e.g. clenching, grinding, holding), found to be associated with painful and dysfunctional TMDs.[36] Future studies should validate the OBC non-functional activities among 10–19 year-olds.

5. Like in the DC/TMD for adults, disease-specific physical functioning in the proposed adolescent version is evaluated using the 20-item Jaw Functional Limitation Scale (JFLS-20) in the comprehensive protocol and the JFLS-8 in the short protocol.[37] The JFLS is a questionnaire based on self-reported jaw functional limitations, assessing three domains: jaw opening, chewing and communication. The Delphi panel recommended its use in adolescents with no modifications.

TABLE 6 Axis II instrument status description

		Proposed adolescent version (ages 10–19 years)				
Axis II instruments	**Comprehensive**	**Items (no.)**	**Status**	**Short**	**Items (no.)**	**Status**
Pain intensity	CPI	3	To validate	CPI	3	To validate
Physical functioning	GCPS Rephrased[a]	8	To validate	GCPS Rephrased[a]	8	To validate
Pain locations	Pain drawing incl preselected areas[a]		To validate	Pain drawing incl preselected areas[a]		To validate
Limitations	JFLS-20	20	To validate	JFLS-8	8	To validate
Physical symptoms	PHQ-15 Rephrased[a]	14	To validate			
Oral behaviours	OBC-21	21	To validate	Non-functional activity OBC	6	To validate
Depression	RCADS-SV	25	Validated	PHQ-4	4	To validate
Anxiety	RCADS-SV	25	Validated	PHQ-4	4	To validate
Catastrophizing[b]						
Adolescents	PCS-C	13	Validated			
Parents	PCS-P	13	Validated			
Sleep quality[b]	ASWS	10	Validated			
Stress[b]	PSS-C	14	Validated			

Abbreviations: 3Q/TMD, three questions for screening TMD; ASWS, the 10-item adolescent sleep wake scale; CPI, characteristic pain intensity; GCPS, graded chronic pain scale; JFLS, jaw functional limitation scale; OBC, Oral Behaviours Checklist; PCS-C, pain catastrophizing scale for Children; PCS-P, pain catastrophizing scale for parents; PHQ-15 patient health questionnaire-15; PSS-C, the 14-item perceived stress scale for children; RCADS-SV, revised child anxiety and depression scale-short version; SQ, symptom questionnaire.

[a]Same instrument as in the DC/TMD for adults.

[b]New domains included after the Delphi study.

6. In the DC/TMD for adults, the 9-item Patient Health Questionnaire (PHQ-9) and the 7-item Generalised Anxiety Disorder (GAD-7) screeners are used to assess depression and anxiety, but they have not been validated in adolescents. The Delphi panel recommended the Revised Child Anxiety and Depression Scale-Short Version (RCADS-SV) that consist of 25 items: 10 for major depressive disorders and 15 for anxiety; the RCADS-SV is validated for populations aged 7–18 years.[38,39] Adolescents are asked to indicate how often each item in RCADS-SV applies to them according to a 4-point rating scale (0 = never, 1 = sometimes, 2 = often, 3 = always). Normative scores for depression is ≤8, and normative scores for anxiety ≤12.[38] The sum of all 25 items is computed and represents the severity of general anxiety and depressive symptoms. Cronbach's alpha for RCADS-SV is $a = 0.93$ (sensitivity 0.84 and specificity 0.68).[38] In the short version of the DC/TMD for adolescents, the instrument recommended for assessing depression and anxiety is the Patient Health Questionnaire 4 (PHQ-4)[40] due to its brevity; however, it has not been validated in adolescents.

The Delphi panel suggested the introduction of new domains for measuring stress, catastrophizing and sleep disorders; these are the recommended areas to be investigated in the comprehensive TMD protocol.

7. The Perceived Stress Scale for Children (PSS-C) is a screening tool to capture an indication of perceived stress. The PSS-C is a 14-item instrument validated in subjects aged 5–18 years that can discriminate between those with and without stress. It consists of an ordinal scale (0 = never, 1 = a little, 2 = sometimes, 3 = a lot) with a maximum score of 39. Higher scores refer to higher stress perception, and normal value is ≤11 (mean 11.68, SD 3.5).[41]

8. Two instruments have been proposed to investigate pain catastrophizing in adolescents and parents. The Pain Catastrophizing Scale for Children (PCS-C) is a 13-item questionnaire for subjects aged 8–17 years,[42] and the Pain Catastrophizing Scale for Parents (PCS-P) is a 13-item parent-reported measure for describing the catastrophic thinking of the parent about their child's pain.[43] Both instruments include a 5-point scale (0 = not at all, 1 = mild, 2 = moderately, 3 = severe, 4 = extremely) for children and (0 = not at all, 1 = to a slight degree, 2 = to a moderate degree, 3 = to a great degree, 4 = all the time) for parents. Score range is from 0 to 52, and higher levels indicate greater catastrophizing. Cronbach's alpha for PCS-C is $a = 0.87$ in children with chronic or recurrent pain. This domain may indicate poor prognosis and possible pain persistence in adolescents. The PCS-P has been used with parents of children with general chronic pain,[44] but has not yet been used in parents of youth with TMD.

9. The Adolescent Sleep–Wake Scale (ASWS), which explores sleep quality in youth aged 12–18 years, is a proposed addition to the DC/TMD for adolescents.[45] The scale is a 28-item questionnaire with a 6-point response format (1 = always, 2 = frequently-if not always, 3 = quite often, 4 = sometimes, 5 = once in a while, 6 = never). Overall, internal consistency has been found to be good with a sensitivity of 0.80 and a specificity of 0.86 for the full scale.

Moreover, ASWS-S is a revised scale short form including 10 items, and this questionnaire is reliable (Cronbach's $\alpha = 0.80$) and the Delphi panel recommends using it in the adolescent population for sleep problems.[46]

4 | DISCUSSION

4.1 | Overview

There has been concern with tools for diagnosing TMD in adolescents.[2] General dental practitioners, TMD specialists, patients and their families need a diagnostic system that is easy to understand and manage in the clinical setting. The goal of the new DC/TMD Axis I and Axis II for adolescents was to meet this challenge.

WHO has defined adolescence as the phase of life between 10 and 19 years of age, a wide range from prepubertal to young adulthood and a period spanning a wide range of cognitive ability in being able to understand and express one's own perspectives. Adding more complexity for the clinician, the same adolescent can demonstrate mature reasoning in one situation and less mature in another. During adolescence, abstract thinking, self-awareness and self-consciousness develop. The stage of development in these domains influences how adolescents react and cope with pain and jaw dysfunction. In clinical settings as well as in research settings, it can be difficult to interpret the signs and symptoms reported by an adolescent. Their cognitive development is an individual and an ongoing process, making it difficult for clinicians to estimate the level of cognitive maturity in their adolescent patients. While cognitive maturity affects how adolescents respond to both clinical interview and to self-report instruments the use of standardised assessment protocols in both clinical practice as well as research afford the greatest possibility for reliable and valid assessment.

PedIMMPACT is a recommended core outcome set for chronic pain clinical trials based on the Initiative on Methods, Measurement and Pain Assessment in Clinical Trials (IMMPACT) and designed for children and adolescents.[47] A consensus of experts identified core domains and measures for clinical trials of potential treatments for pain in the paediatric age group. A recent update of the core outcome set recommends the inclusion of pain interference with daily living, overall well-being and adverse events, in addition to pain severity. Emotional functioning, physical functioning and sleep are important but optional domains.[48] Therefore, use of validated instruments that can assess these constructs is a prerequisite in the assessment process. This is even more important in clinical research settings.

In Axis I of the DC/TMD for adolescents, only two of the four muscle pain diagnoses were included, that is, myalgia and myofascial pain with referral, because it is not yet known whether the mechanisms and clinical implications of diagnostic subtypes of myalgia (local myalgia and myofascial pain) differ. Furthermore, no sensitivity or specificity of these diagnostic subtypes has been reported in adults.[49]

The DC/TMD includes headache attributed to TMD with specific criteria for the diagnosis; in parallel, the International Classification of Headache Disorders, 3rd edition, defines headache attributed to TMD as a secondary headache.[50] Headache in adolescents is significantly associated with TMD pain, in both frequent headache (once a week or more) and moderate or severe headache and in most adolescents the onset of headache preceded TMD pain.[51] Consequently, the diagnosis of headache attributed to TMD should be retained in the proposed version of the DC/TMD for adolescents.

The short and the comprehensive version of the DC/TMD protocol for adolescents were created for different situations. The short version is intended for use in the initial assessment of clinical cases. Orofacial pain and its psychosocial impact are among the most frequent reasons for patients to seek treatment in dentistry,[52] which is why providing general practitioners with an easy and quick instrument for assessing both Axis I and Axis II is needed. The comprehensive version is suggested for research settings and for the evaluation of more complex clinical cases when more details and information are needed.

4.2 | Axis I

The longitudinal study of Nilsson and List showed that to prevent pain from developing and becoming chronic, adolescents with TMD pain must be identified as early as possible.[14] In a large group of adolescents who had been screened for TMD pain, adolescents with TMD pain presented a three-fold increased risk of self-reported TMD pain as young adults compared to adolescents with no history of TMD pain. A similar pattern has been found in a previous study, where history of chronic pain in childhood and adolescence was a predictor for pain in young adults.[53] Using screening questions for TMD pain and jaw dysfunction makes it easier for general dental practitioners, general practitioners and school healthcare services to identify adolescents in need of treatment.

The TMD screener 3Q/TMD includes two self-reported pain questions found to have very good reliability and validity in adolescents aged 12–19 years.[3] Lövgren et al. found the 3Q/TMD to be valid in adults aged 20 years and older for recognising patients in need of a clinical TMD examination.[27] Because the 3Q/TMD has not been tested in ages 10–19 years, the Delphi panel recommends reliability and validity testing for this aspect of the DC/TMD for adolescents. The 3Q/TMD is designed for detecting patients in need of further assessment with the short or the comprehensive form of the DC/TMD for adolescents.

The Symptom Questionnaire in the adult version of the DC/TMD was modified for adolescents (SQ-A) by adding a numerical rating scale to assess pain intensity and headache intensity, and a question on trauma history. The pain intensity scale is needed for patients with acute pain who would not be completing the GCPS, and it would help the clinician during follow-up of the patient. As jaw injury is strongly associated with incident TMD,[54] and adolescents with prior head and/or neck injury are more likely to report TMD

pain and to receive a TMD pain diagnosis,[55] a question on trauma was considered important.

Other modifications of the DC/TMD include the Demographic Questionnaire, entailing revision of the language and merging General Health Questionnaires for adolescents and their parents with the demographic items. The parental health questionnaire was the SF-12 version 2 health survey.[56] (Rand Health Care. 12-Item Short Form Survey (SF-12) Available from: https://www.rand.org/health-care/surveys_tools/mos/12-item-short-form.html). (Accessed 29 February 2020). The adolescent health survey was compiled by authors in this study. Both these health questionnaires query the presence of other symptoms, of disease, and of medication and of substance use. The introduction of these two surveys investigating general health aimed to detect the quality of patient's and parent's health, considering that general health is identified as risk factors for TMD development in the adult population,[57,58] and that parent's health influence on children's health; specifically, chronic pain in parents is associated with pain in their offspring, with pain intensity, with activity limitations and with coping strategies related to pain.[59]

The mandatory commands in the adult version were modified to include a list of detailed procedural instructions which the consortium provides the clinician. With adolescent patients, the authors suggest clinicians to use their own words to explain the examination, instead of using the mandatory commands. The mandatory commands may be a barrier to implementing the adult DC/TMD in general practice. In a general dentistry setting, the diagnostic reliability of pain-related TMD was unaffected in Swedish adults when the mandatory commands were not used.[60] The Delphi panel considered it important to clearly explain two concepts during the clinical examination: the meanings of familiar pain and of referred pain.

The consensus of the authors of Part 1 of the Delphi study is that TMJ imaging in adolescents should be performed only when needed.[23] CBCT and MRI with or without contrast can be very useful in the diagnosis and management of some joint-related TMDs. A recent systematic review with meta-analysis reported a high specificity (98%) of both RDC/TMD and DC/TMD for the diagnosis of disc displacement without reduction, however the sensitivity for the disc displacement with reduction and disc displacement without reduction were respectively 66% and 61% in adults.[61] Using the criterion standard of MRI improves diagnosis of these disc displacements, but costs and benefits of such tests needs to be assessed for each patient, particularly as this condition is common in asymptomatic patients (15%–32%).[62–64]

In 2020, the distribution of doses absorbed by adult and child phantoms during panoramic radiographs and cone-beam computed tomography of the TMJ has been compared. The bone surface and the salivary glands received the highest absorbed doses compared to other tissues, and the radiation burden on the adult phantom was generally higher than on the child phantom.[65] As growth and development varies considerably in adolescents, clinicians should consider carefully before referring an adolescent for TMJ imaging.

4.3 | Axis II

The Axis II instruments that the Delphi group recommended for revision were the GCPS, the Pain Drawing and the OBC. The GCPS grades pain intensity and pain disability according to predefined normative values for patients 18 years and older who have headache and TMD pain.[32] It has been validated for 30-day reference period. The language of the GCPS was developmentally adapted for adolescents.[33] In paediatric chronic pain an instrument similar to the GCPS has been used. This instrument for the grading of chronic pain, developed for adults by von Korff,[32] has been found to be a valid approach to classify severity grades of paediatric chronic pain.[66] A recent paper introduced the GCPS-Revised (GCPS-R), a 5-item instrument that is simple and valid for assessing chronic pain in adults.[67] The GCPS-R might be of interest in the future as a screener, in the short-form version of the DC/TMD for adolescents.

The Pain Drawing allows pictorial representation of the various pain locations. The proposed adaptation of the Pain Drawing for adolescents illustrates preselected areas focusing on common areas of body pain, making it easier for the clinician to localise the sites. The adolescent, however, is free to illustrate any pain outside of the selected areas that can be related to referred pain or other pain diagnoses not included in the DC/TMD for adolescents. Pain depictions outside of the preselected areas can also be an expression of comorbidity. Comorbidities of TMD pain in adolescents have already been identified for headache and other bodily pain.[12,13,68]

There is a strong association between oral overuse behaviours and the onset of painful TMD in adults.[36,58,69,70] In adolescents associations of TMD pain with daytime parafunction (for example grinding, clenching, gum chewing) have been found.[71,72] To evaluate oral overuse behaviours in adolescents, the OBC-21 adult version was chosen for the comprehensive version, and the six items version is included in the short version. The OBC-6 for adolescents focuses on non-functional activities such as tooth clenching related to wake-time oral behaviours. However, it can be questioned if the included items in both versions are easy to understand or not in adolescents and its validity will be tested.

On a psychological level, the Delphi panel supported the introduction of new instruments to Axis II for screening psychosocial health in adolescents.[24] Adolescents are faced with numerous stressors including seeking social acceptance, performing at school and in their leisure time and maintaining family relationships. A WHO-initiated project in first-year college students in eight countries found that at least one-third reported a history of at least one or more mental health disorders.[73] Life stress contributed substantially to the development of a wide range of health issues in adolescents,[74] including several pain conditions.[75,76]

Chronic pain in general is often associated with depression and anxiety, sleeping problems and reduced cognitive function in adults.[77,78] Similarly, use of screening instruments in Axis II can help clinicians to determine the impact of chronic pain on the lives of adolescents and how they have managed their pain. Screeners can also simplify clinical decision-making concerning TMD pain prognosis

and management. Furthermore, stress such as from challenges in school and in the family is commonly associated with TMD onset in adolescents.[7] LeResche (2007) identified negative somatic and psychological symptoms, other pain complaints and life dissatisfaction as risk factors for the onset of clinically significant TMD pain in adolescents.[6] These findings suggest that the development of TMD pain in adolescence may reflect an underlying vulnerability to musculoskeletal pain that is not unique to the orofacial region. Thus, an assessment of TMD pain should include psychological factors to depict a holistic view of the patient.

The Delphi group recommended the PHQ-4 for the short-form DC/TMD for adolescents and the RCADS-SV for the comprehensive form. The PHQ-4 is a screener easy to use in general dental practice to measure psychological distress; however, it has not been validated in adolescents.

Other questionnaires to screen for anxiety, depression and three other constructs (stress, catastrophizing and sleep disorders) to assess psychosocial functioning were included; these have all been validated in adolescents. The RCADS-SV is a 25-items questionnaire, tested in the ages 7–18 year and provides an efficient assessment of the general problem areas of anxiety and depression.[38] The RCADS-SV might help the clinician understanding the patient's pain experience and determining the most appropriate interventions.

To screen for catastrophizing, the Delphi panel recommended the PCS-C for adolescents and the PCS-P for parents. Pain catastrophizing is considered an important psychological correlate of pain chronicity and disability,[79,80] and catastrophic thinking about pain also occurs in adolescents and is a determinant of adjustment to pain.[81] Exploratory factor analysis with a random subsample of adolescents found that either the revised 11-item or the original 13-item PCS can be used with this population for calculating subscale scores.[42,82] To screen for stress, the Delphi panel recommended the PSS-C, an instrument that is found to be valid in evaluating stress in 5-18-year-olds.[41] Psychosocial distress is an etiological factor for developing painful TMD in adults,[77] and also an important factor to consider in adolescents.[75]

To screen for sleep disorders, the Delphi group suggested the ASWS-S, which has shown good, overall internal consistency, Cronbach's Alpha to be around 0.8, among ages 12–18.[45] Adolescents with comorbid musculoskeletal pain and sleep problems experience psychological distress and greater pain intensity compared to adolescents with no comorbidities.[83]

The present article presents the core assessment instruments at the time of publication. Interested clinicians and researchers should consult the INfORM website for up-to-date versions of instruments.

4.4 | Future directions

This first version of the DC/TMD for adolescents is a result of the Delphi process, and some of the instruments have not been validated in adolescents. We thus emphasise the need for reliability and validity testing in coming studies. A final DC/TMD for adolescents will be presented after consistency and validity of all instruments is completed. The Axis I and Axis II instruments are presently available in English. For those instruments that are part of the DC/TMD, currently existing translations of the DC/TMD will be amenable to relatively easy modification for a DC/TMD- Adolescent (DC/TMD-A). For those instruments that are not part of the adult DC/TMD, translation will be required for use in other languages according to INfORM recommendations.[84]

5 | CONCLUSION

The proposed DC/TMD protocol for adolescents is intended for use in all clinical and research settings. It includes instruments from simple screening of TMD, the clinical criteria for the most common TMD diagnoses as well as Axis II instrument screeners specific for adolescents, for assessing psychological status and pain-related disability. Validity and reliability testing of instruments are needed to finalise the first formal version of DC/TMD for adolescents.

AUTHOR CONTRIBUTIONS

Roberto Rongo, EwaCarin Ekberg, Ing-Marie Nilsson, Ambrosina Michelotti conception and design of study; Roberto Rongo, EwaCarin Ekberg, Ing-Marie Nilsson, Ambrosina Michelotti acquisition of data; Roberto Rongo, EwaCarin Ekberg, Ing-Marie Nilsson, Ambrosina Michelotti data analysis and/or interpretation; Amal Al-Khotani, Per Alstergren, Paulo Cesar Rodrigues Conti, Justin Durham, EwaCarin Ekberg, Jean-Paul Goulet, Christian Hirsch, Stanimira Kalaykova, Flavia P. Kapos, Christopher D. King, Osamu Komiyama, Michail Koutris, Thomas List, Frank Lobbezoo, Ambrosina Michelotti, Ing-Marie Nilsson, Richard Ohrbach, Tonya M. Palermo, Christopher C. Peck, Chris Penlington, Claudia Restrepo, Maria Joao Rodrigues, Roberto Rongo, Sonia Sharma, Peter Svensson, Corine M. Visscher, Kerstin Wahlund drafting of manuscript and/or critical revision Amal Al-Khotani, Per Alstergren, Paulo Cesar Rodrigues Conti, Justin Durham, EwaCarin Ekberg, Jean-Paul Goulet, Christian Hirsch, Stanimira Kalaykova, Flavia P. Kapos, Christopher D. King, Osamu Komiyama, Michail Koutris, Thomas List, Frank Lobbezoo, Ambrosina Michelotti, Ing-Marie Nilsson, Richard Ohrbach, Tonya M. Palermo, Christopher C. Peck, Chris Penlington, Claudia Restrepo, Maria Joao Rodrigues, Roberto Rongo, Sonia Sharma, Peter Svensson, Corine M. Visscher, Kerstin Wahlund approval of final version of manuscript.

AFFILIATIONS

[1]Department of Orofacial Pain and Jaw Function, Faculty of Odontology, Malmö University, Malmö, Sweden

[2]Center for Oral Rehabilitation, Norrköping, Sweden

[3]School of Orthodontics, Department of Neurosciences, Reproductive Sciences and Oral Sciences, University of Naples Federico II, Naples, Italy

[4]Dental Department, East Jeddah Hospital, Ministry of Health, Jeddah, Saudi Arabia

[5]Scandinavian Center for Orofacial Neurosciences, Malmö, Sweden

[6]Department of Dental Medicine, Karolinska Institute, Huddinge, Sweden

[7]Department of Prosthodontics and Periodontology, Bauru School of Dentistry–University of São Paulo, Bauru, Sao Paulo, Brazil

[8]Bauru Orofacial Pain Group, University of São Paulo, Bauru, Sao Paulo, Brazil

[9]Newcastle School of Dental Sciences, Newcastle University, Newcastle upon Tyne, UK

[10]Faculty of Dental Medicine, Laval University, Quebec, Quebec, Canada

[11]Clinic of Pediatric Dentistry, University of Leipzig, Leipzig, Germany

[12]Department of Oral Function and Prosthetic Dentistry, College of Dental Sciences, Radboud University Medical Center, Nijmegen, The Netherlands

[13]Department of Epidemiology, University of Washington, Seattle, Washington, USA

[14]Center for Child Health, Behavior and Development, Seattle Children's Research Institute, Seattle, Washington, USA

[15]Division of Behavioral Medicine and Clinical Psychology, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, USA

[16]Pediatric Pain Research Center (PPRC), Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, USA

[17]Department of Pediatrics, University of Cincinnati College of Medicine, Cincinnati, Ohio, USA

[18]Department of Oral Function and Fixed Prosthodontics, Nihon University School of Dentistry at Matsudo, Matsudo, Japan

[19]Department of Orofacial Pain and Dysfunction, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

[20]Department of Oral Diagnostic Sciences, University at Buffalo, Buffalo, New York, USA

[21]Department of Anesthesiology and Pain Medicine, University of Washington School of Medicine, Seattle Children's Research Institute, Seattle, Washington, USA

[22]Faculty of Medicine and Health, The University of Sydney, Sydney, Australia

[23]CES-LPH Research Group, Universidad CES, Medellin, Colombia

[24]Institute for Occlusion and Orofacial Pain, Faculty of Medicine, University of Coimbra, Coimbra, Portugal

[25]Section for Orofacial Pain and Jaw Function, School of Dentistry and Oral Health, Aarhus, Denmark

[26]Department of Orofacial Pain and Jaw Function, Kalmar County Hospital, Kalmar, Sweden

[27]International Network for Orofacial Pain and Related Disorders Methodology (INfORM), a Network within the International Association for Dental Research (IADR)

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author [RR], upon reasonable request.

ORCID

Ing-Marie Nilsson https://orcid.org/0000-0002-0550-8925
Amal Al-Khotani https://orcid.org/0000-0001-7168-9835
Paulo Cesar Rodrigues Conti https://orcid.org/0000-0003-0413-4658
Christian Hirsch https://orcid.org/0000-0002-3773-6623
Flavia P. Kapos https://orcid.org/0000-0002-6224-273X
Frank Lobbezoo https://orcid.org/0000-0001-9877-7640
Richard Ohrbach https://orcid.org/0000-0002-9266-9734
Chris Penlington https://orcid.org/0000-0002-2695-7041
Claudia Restrepo https://orcid.org/0000-0002-0695-7562
Sonia Sharma https://orcid.org/0000-0002-1887-7420
Corine M. Visscher https://orcid.org/0000-0002-4448-6781
Kerstin Wahlund https://orcid.org/0000-0003-2236-8546

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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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