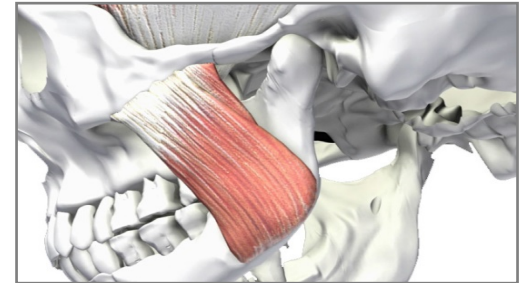


Committee on Temporomandibular Disorders (TMD): From Research Discoveries to Clinical Treatment
NAS Workshop. First Committee Meeting: January 29-30, 2019

Temporomandibular Disorders

Diagnosis, treatment, epidemiology, risk factors, and challenges



Richard Ohrbach, Professor
Oral Diagnostic Sciences, School of Dental Medicine
University at Buffalo

Roger Fillingim, Distinguished Professor
University of Florida College of Dentistry
Director, UF Pain Research and Intervention Center of Excellence

Supported by NIDCR U01-DE13331, U01-DE019784, and U01-DE17018 | No COI disclosures

Status of diagnostic methods and treatments

Early TMD Research Literature: A Selective Sample

- Costen (1934)
- Zicher (1949)
- Schwartz (1959)
- Ramfjord (1961, 1961)
- Laskin (1969)
- Posselt (1971)
- Geering (1974)
- Rugh & Solberg (1975)
- Guichet (1977)
- Farrar & McCarty (1979)
- Solberg (1979)
- Gelb (1980)
- ADA President's Conference (1983)
- Williamson & Lundquist (1983)
- Rugh, Barghi & Drago (1984)
- Zarb & Carlsson (1979)
- Von Korff (1988)
- Seligman & Pullinger (1989)
- Dworkin & LeResche (1992)
- Zarb, Carlsson, Sessle & Mohl (1994)
- Okeson (1996, and later editions)

Pro: occlusion or other structural problems → TMD

No evidence for occlusion problems → TMD

State of the science, 1990s
(causal attributed proportion)

- Structural models & ideal morphology
 - Occlusion (0%)
 - TMJ condylar position (0%)
 - TMJ disc displacements (0%)
- Specific structural impairments (DNK %)
- Regional injury (10-30%)
- Polyarthritic disease (5%)
- Generalized joint hypermobility (3-25%)
- Sleep bruxism (10-30%)
- Psychobiologic dysregulation (~72%)

Clark, Etiologic theory and the prevention of TMD, Adv Dent Res, 1991

(Mal)Occlusion → TMDs ?

Slide in centric or other interferences	Pain in TMJ or masticatory muscles	
	Yes (D+)	No (D-)
Yes (T+)	32	0
No (T-)	0	0
TOTALS	32	0

Ramfjord SP. Dysfunctional temporomandibular joint and muscle pain. JPD 11:353-374, 1961.

Few and only inconsistent associations
between malocclusion and TMD

Gesch et al. 2004, 2005



Vertical dimension

Loss of posterior support
> 4 missing posterior teeth
Mediotrusive interferences
Class II, Class III Angle's
Unilateral CR contact



Openbite/Overjet

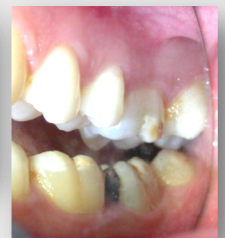
Lack of slide
Group function
Anterior open bite
Anterior cross-bite



RCP/ICP slide
Mandibular side shift



Crossbite



Occlusal
interferences

RESEARCH DIAGNOSTIC CRITERIA FOR TEMPOROMANDIBULAR DISORDERS: Review, Criteria, Examinations and Specifications, Critique

Edited by: Samuel F. Dworkin, DDS, PhD
Linda LeResche, ScD

Contributors

Samuel F. Dworkin, DDS, PhD	Richard Ohrbach, DDS, MS
James R. Friction, DDS, MS	Sandro F. Palla, Dr Med Dent
Lars Hollender, DDS, Odont Dr	Earl E. Sommers, DDS, MSD
Kimberly H. Huggins, RDH, BS	Christian Stohler, LDS, Dr Med Dent
Linda LeResche, ScD	Edmond L. Truelove, DDS, MSD
James Lund, BDS, PhD	Michael Von Korff, ScD
Norman D. Mohl, DDS, PhD	Charles G. Widmer, DDS, MS

Table 1 Evaluation Criteria		
Criterion	Description	Ratings
Methodological Considerations		
Sample method	Study design for testing diagnostic criteria	Case-series vs case control Cross-sectional vs longitudinal Prospective vs retrospective
Sample type	Source of subjects used in testing diagnostic criteria	Population Clinical Unknown
Research suitability	Whether criteria are stated in measurable terms	Yes No
IRR method	Interrater reliability (IRR) for evaluation methods, according to whether data are provided by the proponents of the system and whether all evaluation methods have IRR support	Internal-full Internal-partial External-full External-partial
Specificity	Whether diagnostic criteria of a system detect "disease" in a nonpatient population	Acceptable Unacceptable Unknown
IRR diagnosis	Interrater reliability (IRR) for whether different judges would make the same diagnostic assignment	Acceptable Unacceptable Unknown
Clinical Considerations		
Biological	Whether the system is compatible with current anatomical, behavioral, and physiological knowledge	Strong Moderate Minimal
Exhaustive	Whether the system can classify all known clinical presentations	All Major Minor
Multiple diagnoses	Whether multiple diagnoses are allowed	Yes No Unknown
Decision making	Whether system is organized to facilitate decision making	Good Poor

Methods

- Sample method
- Sample type
- Research suitability
- Specificity
- Inter-rater reliability
 - for examination
 - for diagnosis

Clinical considerations

- Biological
- Exhaustive
- Multiple diagnoses
- Decision-making

Translations

Arabic	Italian
Chinese	Japanese
Croatian	Korean
Danish	Malay
Dutch	Polish
Farsi	Portuguese (BR)
Finnish	Portuguese (PT)
French	Spanish
German	Swedish
Greek	Turkish
Hebrew	

Citations

SOURCE	2009	2015	2019
Science Citation Index	741	1695	2389
Google Scholar	866	2947	4059

J. Craniomandibular Disorders, Facial and Oral Pain, 1992

2007-2010

**International Consensus Workshop:
Convergence on an Orofacial Pain Taxonomy**
March 30 – April 1, 2009
Loews Miami Beach Hotel, Miami, Florida
Organized by the International RDC/TMD Consortium Network

Workshop Recommendations

Richard Ohrbach, Thomas List, Jean-Paul Goulet, Peter Svensson
January 6, 2010
[revised Nov 15, 2010 – see Errata, end of document]

2010

Contents

- I. Introduction
- II. Executive Summary
- III. Muscle Disorders (RDC/TMD)
- IV. TMJ Disorders (RDC/TMD)
- V. Biobehavioral Research (RDC/TMD)
- VI. Orofacial Pain (RDC/TMD)
- VII. Research
- VIII. List of Participants
- IX. Sponsors
- X. Core Literature

Journal of Oral Rehabilitation
Journal of Oral Rehabilitation 2010 37: 407-412

Recommendations from the International Consensus Workshop: convergence on an orofacial pain taxonomy

R. OHRBACH*, T. LIST†, J.-P. GOULET‡ & P. SVENSSON§
*University at Buffalo, Buffalo, NY, USA, †Malmö University, Malmö, Sweden, ‡Laval University, Quebec City, QC, Canada and §University of Aarhus, Aarhus, Denmark

2013

I. Introduction
The RDC/TMD approach, clearly diagnostic criteria based on nearly make the RDC/TMD has clinical, and pop the authors of the examine the pro range of active n of the RDC/TMD project – the RD concluded, and t led to the availa the RDC/TMD. workshop.

In reviewing the the RDC/TMD ra

SUMMARY This 2.5-day workshop was the International RDC/TMD Consortium International Association for Dental the Orofacial Pain Special Interest Gr national Association for the Study o participation was by invitation bas tion within the field, which include Network, the Orofacial Pain Specia the National Institute for Dental Research, American Academy of O European Academy of Craniomand and the International Headache disciplines included radiology, psyc and patient advocacy. The wor were divided into workgroups th literature describing the properties provided recommendations for

Introduction

The RDC/TMD
The Research Diagnostic Criteria for Oral Disorders (RDC/TMD; Dworkin 1992) is comprised of a dual-axis operationalized data collection procedure diagnostic criteria. Consequently, th contributed substantially, based on data, to TMD research. These core ch the RDC/TMD a model system for pain disorders, and the RDC/TMD ha been used in a wide range of exp and population studies around the v

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Orofacial Pain

GUIDELINES FOR ASSESSMENT, DIAGNOSIS, AND MANAGEMENT

The American Academy of Orofacial Pain

Edited by Reny de Leeuw, DDS, PhD, MPH
and Gary D. Klasser, DMD



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†

Eric Schiffman, DDS, MS
Richard Ohrbach, DDS, PhD
Edmond Truelove, DDS, MSD
John Look, DDS, PhD
Gary Anderson, DDS, MS
Jean-Paul Goulet, DDS, MSD
Thomas List, DDS, Odont Dr
Peter Svensson, DDS, PhD, Dr Odo
Yoly Gonzalez, DDS, MS, MPH
Frank Lobbezoo, DDS, PhD
Ambra Michelotti, DDS
Sharon L. Brooks, DDS, MS
Werner Ceusters, MD
Mark Drangsholt, DDS, PhD
Dominik Ettlin, MD, DDS
Charly Gaul, MD
Louis J. Goldberg, DDS, PhD
Jennifer A. Haythornthwaite, PhD
Lars Hollender, DDS, Odont Dr
Rigmor Jensen, MD, PhD
Mike T. John, DDS, PhD
Antoon De Laat, DDS, PhD
Reny de Leeuw, DDS, PhD
William Maixner, DDS, PhD
Marylee van der Meulen, PhD
Greg M. Murray, MDS, PhD
Donald R. Nixdorf, DDS, MS
Sandro Palla, Dr Med Dent
Arne Pettersson, DDS, Odont Dr
Paul Pinchon, DDS, PhD
Barry Smith, PhD
Corine M. Vissscher, PT, PhD
Joanna Zakrzewska, MD, FDSRCSI
Samuel F. Dworkin, DDS, PhD

Author affiliations are listed at the end of this article

Journal of Oral Rehabilitation
Journal of Oral Rehabilitation 2014 41: 2–23

Expanding the taxonomy of the diagnostic criteria for temporomandibular disorders

C. C. PECK*, J.-P. GOULET†, F. LOBBEZOO‡, E. L. SCHIFFMAN§, P. ALSTER-GREN¶, G. C. ANDERSON||, R. OHRBACH**†, of Dentistry, The University Academic Centre for Dental Amsterdam, Amsterdam, The of Dentistry, University of Malmö, Sweden, **Department of Dentistry, University of Minnesota, Minneapolis, MN, USA, ***Orofacial Pain Center, University of Federico II, Naples, Italy, ****Oral and Maxillofacial Radiology, Malmö University Hospital, Malmö, Sweden

SUMMARY There is a temporomandibular disorder (TMD) to include less common disorders. The immune consensus-based classification diagnostic criteria the utility for less common to establish a foundation system, that will still testing and further c group [members of Consortium Network Association for Dental of the Orofacial Pain of the International Association (IASP), and member societies] reviewed th clinical significance, diagnostic criteria an and study the criteria from the literature

In 1992, the seminal an nstic Criteria for Te (RDC/TMD) was pub content validity becau of temporomandibular di basis of empirical data an the literature. This review different TMD diagnostic at that time. However, the standard classification apposed a dual-axis assessm dard diagnostic criteria fo and was based on TMD d Axis II took the assessm assessment of psychosocia Axis I described the most and Axis II described ass

ABSTRACT

Eric Schiffman, DDS, MS; Richard Ohrbach, DDS, PhD

Clinical Review

The Evolution of TMD Diagnosis: Past, Present, Future

R. Ohrbach¹ and S.F. Dworkin²

Abstract

This review explores the principles and process associated with the diagnosis of temporomandibular disorders (TMDs). TMD diagnosis has been based solely on aberrations in oral structures, largely without consideration of the psychosocial context. The RDC/TMD were developed on core principles of 1) a dual-axis system to allow for both structural and psychosocial factors, 2) reliability, and 3) the allowance of multiple diagnoses. These principles, along with the current diagnostic system—the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), and the current diagnostic system—the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), as well as on diagnostic validity and protocols for assessing the contribution to taxonomy revision are described, particularly in the context of major research areas already underway that will support

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1–9
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DOI: 10.1177/0022034516653922
jdr.sagepub.com

2014

2014

2016

2016

	2009	January 2019	
SOURCE	RDC/TMD	DC/TMD	Exp DC
Science Citation Index	741	506	67
Google Scholar	866	888	158

using a comprehensive bil living the development of diagnostic methods for temporomandibular disorders

social factors, temporomandibular disorders

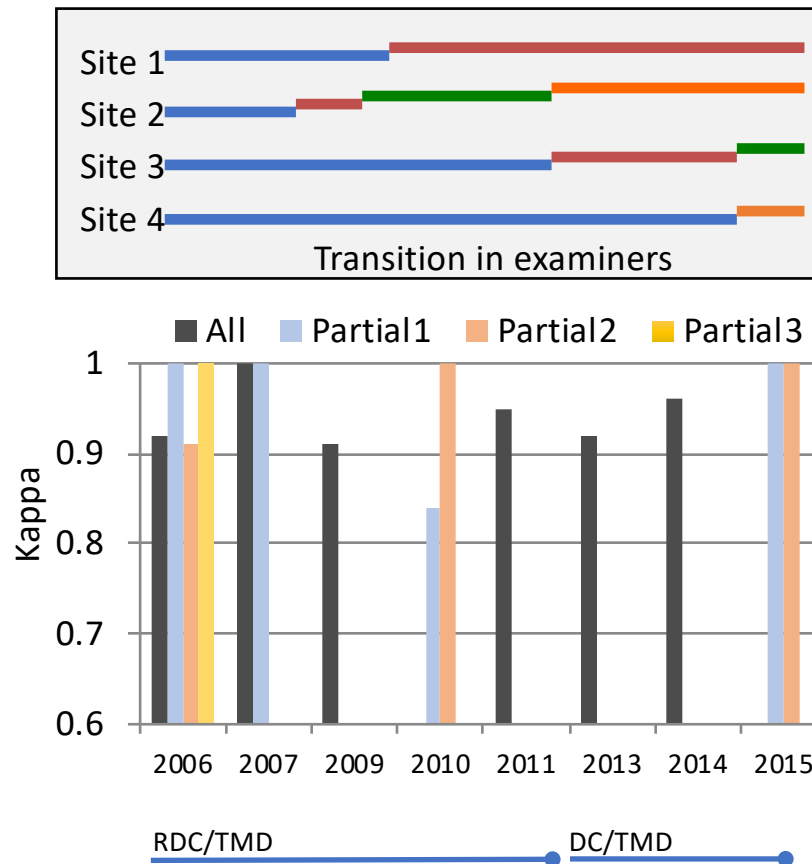
model for TMDs from biomedical, as predominately a biologic condition of the TMJ, to an integrated and multidimensional biopsychosocial model that shares common features with a cluster of associated musculoskeletal disorders that

RDC/TMD → DC/TMD: Rationale and Objectives

Create Diagnostic Criteria For Major Subtypes Of TMD	
RDC/TMD	DC/TMD
Biopsychosocial model used to assess and classify disease and illness	Biopsychosocial model maintained
Use epidemiologic data	Use standardized clinical data
Create a dual axis system: Axis I: Physical diagnoses * Axis II: Psychosocial profile *	Improve dual axis system: Axis I: Physical diagnoses * Axis II: Psychosocial profile *
Require operational definitions of terms: 1. Specifications for examination * 2. Protocols for reliability & validity *	Improved: 1. Specifications for examination revised * 2. New protocols for reliability & validity *
Require periodic evidence-based revisions	Revisions: Organized via INfORM

* Materials available on INfORM website: www.rdc-tmdinternational.org

Can pain disorder diagnoses be reliable?



Can pain disorder diagnoses be valid?

Table 1. Validity Statistics of the RDC/TMD and DC/TMD Organized by Diagnoses within Each System.

Diagnosis	RDC/TMD		DC/TMD	
	Sensitivity	Specificity	Sensitivity	Specificity
Myalgia			0.90	0.99
With limitation	0.65	0.92		
Without limitation	0.79	0.92		
Myofascial pain with referral			0.86	0.98
Arthralgia	0.53	0.86	0.89	0.98
Disk displacement				
With reduction	0.38	0.88	0.34	0.92
With reduction, with locking			0.38	0.98
Without reduction, with limitation	0.22	0.99	0.80	0.97
Without reduction, without limitation	0.03	0.99	0.54	0.79
Osteoarthritis	0.15	0.99		
Osteoarthritis	0.10	0.99		
Degenerative joint disease			0.55	0.61
Subluxation			0.98	1.00

Statistics adapted from Truelove et al. (2010) and Schiffman, Ohrbach, et al. (2010).

DC/TMD, Diagnostic Criteria for Temporomandibular Disorders; RDC/TMD, Research Diagnostic Criteria for Temporomandibular Disorders.

Ohrbach & Dworkin, The Evolution of TMD Diagnosis: Past, Present, Future. J Dent Res 2016

RDC/TMD → DC/TMD: Comparing selected Axis I examination procedures

Clinical Procedure	RDC/TMD (1992)	DC/TMD (2014)
Pain location		
Identify pain location by complaint	✓	✓
Confirm pain location by complaint and report of familiar pain		✓
Identification of headache location		✓
Mobility		
Jaw-opening pattern	✓	Supplemental; Options reduced
Assess familiar pain with jaw mobility testing		✓
Muscle and TMJ Palpation		
Palpation with 1 or 2 lbs force	✓	
Palpation with 0.5 or 1 kg force & defined time period		✓
Calibrate examiners to required palpation forces		✓

Ohrbach et al, DC/TMD Clinical Examination Protocol, version Jan 6, 2014; www.rdc-tmdinternational.org

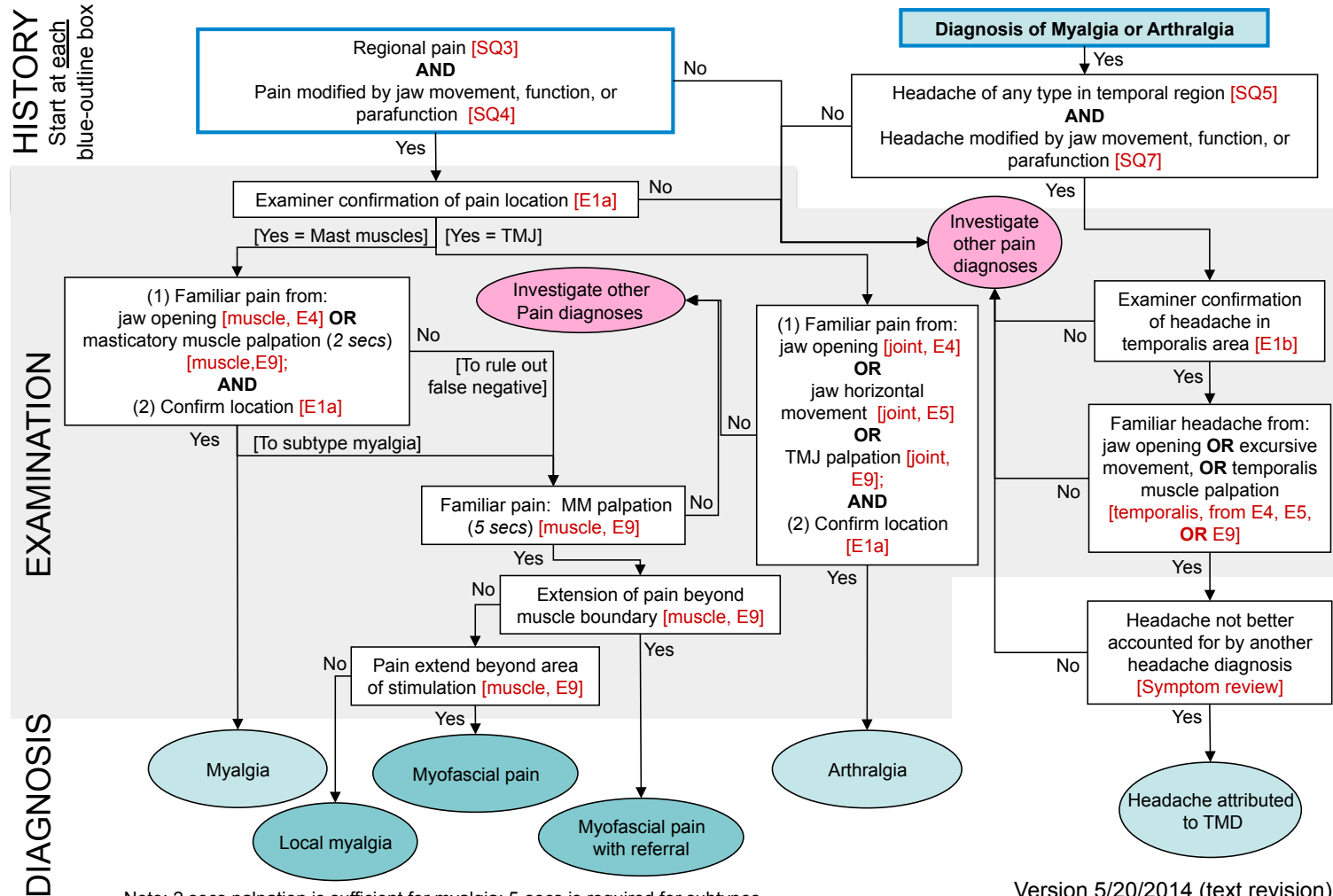
RDC/TMD → DC/TMD: Comparing selected Axis I diagnostic criteria

Criterion	RDC/TMD	DC/TMD
HISTORY (applicable to all pain-related TMD disorders)		
Presence of masticatory system pain	✓	✓
Headache of any type in temporal region		✓
Pain or headache modification with jaw movement, function, or parafunction		✓
EXAMINATION		
<i>Myalgia ("Myofascial pain" in RDC/TMD)</i>		
Confirmation of location of pain in a masticatory muscle		✓
Pain with muscle palpation (required sites)		
• Temporalis	✓	✓
• Masseter	✓	✓
• Posterior mandibular region	✓	
• Submandibular region	✓	
Pain with maximum unassisted or assisted opening	Exam-only	✓
Familiar pain with palpation or opening		✓

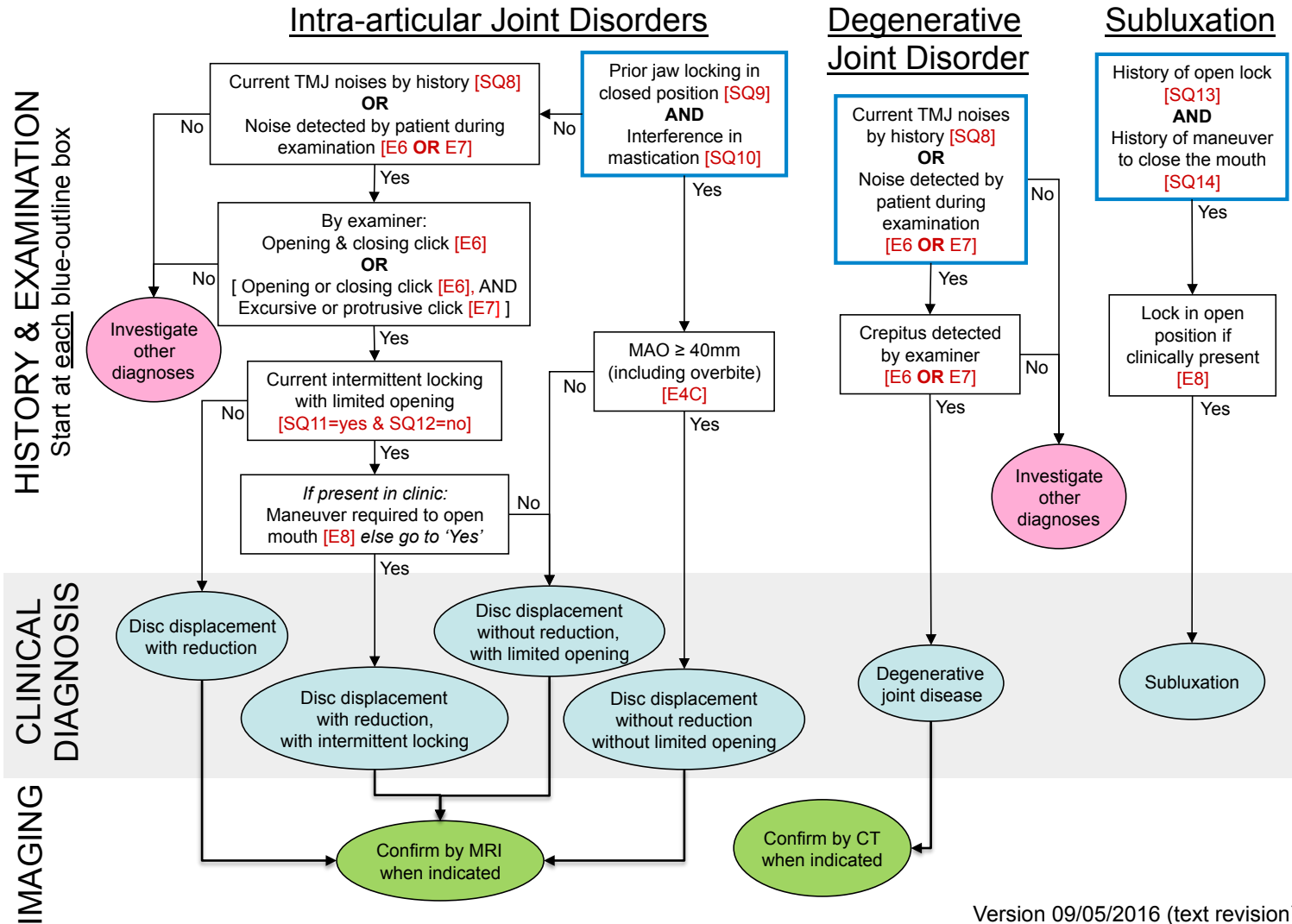
Ohrbach et al, DC/TMD Clinical Examination Protocol, version Jan 6, 2014; www.rdc-tmdinternational.org

Diagnostic Criteria for Temporomandibular Disorders (DC/TMD): Diagnostic Decision Tree

Pain-Related TMD and Headache



Diagnostic Criteria for Temporomandibular Disorders (DC/TMD): Diagnostic Decision Tree



Version 09/05/2016 (text revision)

Translations and implementation

Published

* Near completion

Other Resources » Translation Guidelines » RDC/TMD & DC/TMD translation support

February 27, 2015

Translation Support Documents for DC/TMD

	DC/TMD Instrument or Document	.docx or .pptx version	Translation
General Instructions	READ ME FIRST	----	----
	Translation and Adaptation of the DC/TMD	----	----
	Translation Team Agreement	----	----
Final document	Sample Title Page	open	----
Axis I Patient History	TMD Pain Screener	open	NA
	DC/TMD Patient History Questionnaire - Short Form	open	open
	DC/TMD Patient History Questionnaire - Long Form (avail TBA)	open	open
	DC/TMD Demographics	open	open
Examination	DC/TMD Complete Examiner Specifications	open	open
	DC/TMD Required Examiner Commands	open	open
	DC/TMD Examination Pain Interview	see required commands	open
	DC/TMD Examination Data Collection: International	open	open
	DC/TMD Examination Data Collection: North American	open	see Intern
	DC/TMD Decision Trees	open	open
	DC/TMD Diagnostic Criteria Table	open	none
	Graded Chronic Pain Scale Version 2.0	open	open
	PHQ-4	open	open
	PHQ-9	open	open
Axis II	GAD-7	open	open
	PHQ-15	open	open
	Oral Behaviors Checklist	open	open
	Jaw Functional Limitation Scale (20-item version)	open	open
	Jaw Functional Limitation Scale (8-item version)	open	open
	Pain Drawing	open	open

Arabic*

Chinese

Croatian

Daija

Danish

Dutch

Estonian

Farsi*

Finnish

French

German*

Greek

Hebrew

Hungarian

Hindi

Indonesian*

Italian

Japanese

Korean

Malaysian

Nepali

Norwegian*

Polish

Portuguese (Brasil)*

Portuguese (Port)

Romanian

Slovenian

Spanish

Swedish

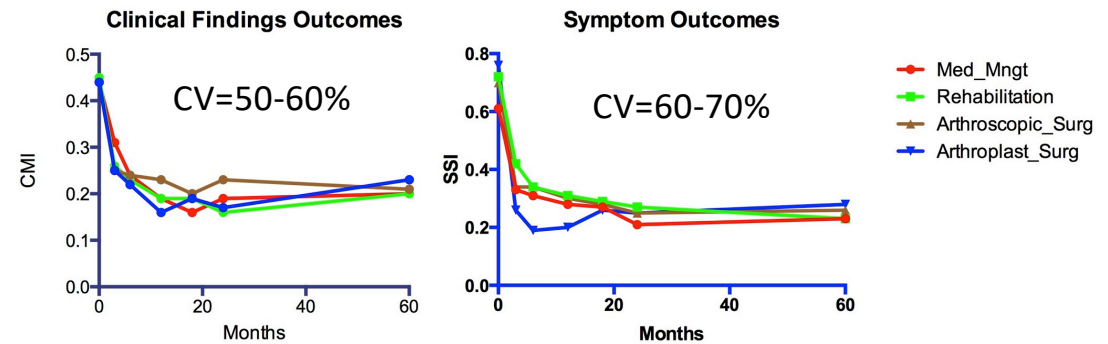
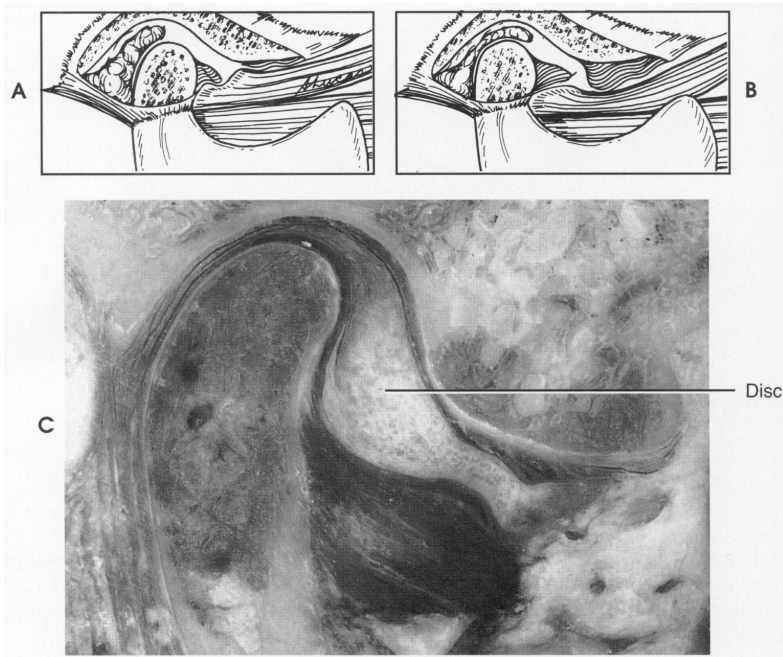
Thai

Turkish

Vietnamese

Jan 18, 2019

Limitations in DC/TMD



Schiffman et al, Randomized effectiveness study of four therapeutic strategies for TMJ closed lock. JDR 2008

Table 2. Estimated Fractions of Study Population with Diagnostic Progression or Reversal.

Temporomandibular Joint	Jaw Joint, % (95% Posterior Interval)	
	Right	Left
Hard tissue		
Progression	15.2 (10.5 to 20.8)	10.4 (6.5 to 15.1)
Reversal	8.2 (4.9 to 12.3)	7.8 (4.4 to 12.2)
Soft tissue		
Progression	9.0 (5.9 to 12.8)	11.0 (7.5 to 15.2)
Reversal	7.2 (4.4 to 10.8)	8.2 (5.1 to 12.1)

Schiffman et al, Longitudinal stability of common TMJ structural disorders. JDR 2017

Other diagnostic systems containing TMDs: AAPT for Chronic Pain



RESEARCH
EDUCATION
TREATMENT
ADVOCACY



PUBLISHED BY
ELSEVIER

The Journal of Pain, Vol 15, No 3 (March), 2014: pp 241-249
Available online at www.jpain.org and www.sciencedirect.com

Focus Article

The ACTION-American Pain Society Pain Taxonomy (AAPT):
An Evidence-Based and Multidimensional Approach to Classifying
Chronic Pain Conditions

Roger B. Fillingim,^{*} Stephen Bruehl,[†] Robert H. Dworkin,[‡] Samuel F. Dworkin,[§]
John D. Loeser,[¶] Dennis C. Turk,^{||} Eva Widerstrom-Noga,[#] Lesley Arnold,^{**}
Robert Bennett,^{††} Robert R. Edwards,^{‡‡} Roy Freeman,^{§§} Jennifer Gewandter,^{¶¶}
Sharon Hertz,^{|||} Marc Hochberg,^{##} Elliot Krane,^{***} Patrick W. Mantyh,^{†††}
John Markman,^{†††} Tuhina Neogi,^{§§§} Richard Ohrbach,^{¶¶¶} Judith A. Paice,^{||||}
Frank Porreca,^{####} Bob A. Rappaport,^{****} Shannon M. Smith,^{††††} Thomas J. Smith,^{††††}
Mark D. Sullivan,^{§§§§} G. Nicholas Verne,^{¶¶¶¶} Ajay D. Wasan,^{||||||}
and Ursula Wesselmann^{####}

- Current project organizational members:
- **ACTION** (Analgesic, Anesthetic, and Addiction Clinical Trial Translations Innovations Opportunities and Networks; includes funding from FDA and pharmaceuticals)
 - **APS** (American Pain Society)
 - **AAPM** (American Academy of Pain Medicine)

Five Dimensions
Core diagnostic criteria
Common features
Common medical comorbidities
Neurobiological, psychosocial and functional consequences
Putative neurobiological and psychosocial mechanisms, risk factors and protective factors

Body System	Pain condition
Peripheral and central nervous systems	Peripheral neuropathic pain Central neuropathic pain
Musculoskeletal	Osteoarthritis Other arthritides (e.g., RA, CT diseases) Musculoskeletal low back pain Myofascial pain Chronic widespread pain Fibromyalgia Other primary musculoskeletal pain
Orofacial and head	Headache disorders* Temporomandibular disorders Other orofacial pain disorders
Visceral, pelvic, and urogenital	Visceral abdominal pain Pelvic pain Urogenital pain
Disease-associated pains not classified elsewhere	Pain associated with: active cancer, sickle cell disease, Lyme disease, etc.

Other diagnostic systems containing TMDs: IASP & *ICD-11*

Narrative Review

Pain 2019

PAIN



The IASP classification of chronic pain for *ICD-11*: chronic secondary headache or orofacial pain

Rafael Benoliel^a, Peter Svensson^b, Stefan Evers^c, Shuu-Jiun Wang^{d,e}, Antonia Barke^f, Beatrice Korwisi^f, Winfried Rief^f, Rolf-Detlef Treede^{g,*}, The IASP Taskforce for the Classification of Chronic Pain

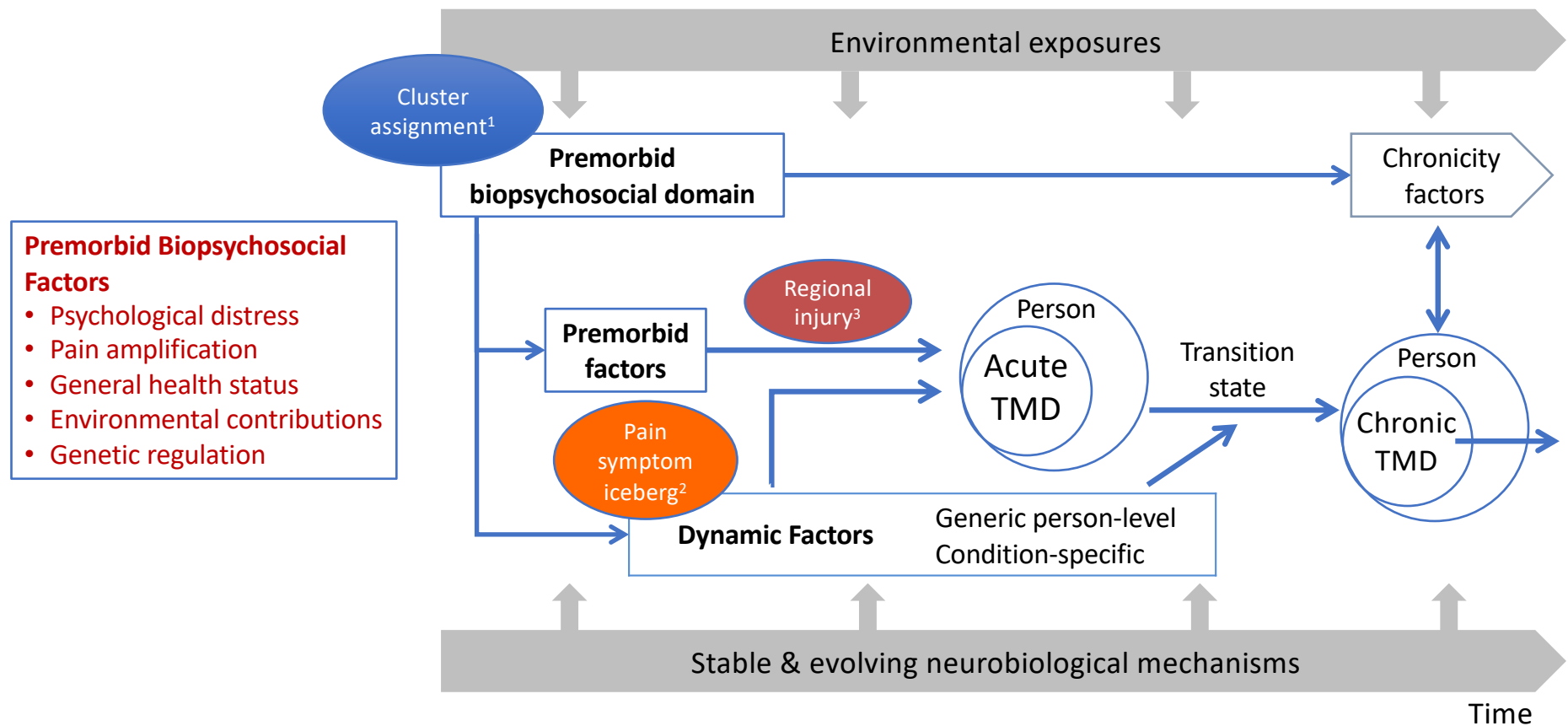
Affiliated with:

- World Health Organization
- International Headache Society
- IASP Orofacial and Head Pain SIG
- American Academy of Orofacial Pain
- International Network for Orofacial Pain and Related Disorders Methodology

International Classification of Orofacial Pain
(ICOP; In development)

1. Preface
2. Using ICOP
3. Classification
4. Primary and secondary orofacial pain
5. Psychosocial assessment
6. Definitions of terms
7. Pain terminology

OPPERA outcomes and proposed heuristic biopsychosocial model for development and persistence of musculoskeletal pain disorder



¹ Bair et al, Pain 2016; ² Slade et al, Pain 2013; ³ Sharma et al, in review

Ohrbach et al, in review

Status of current treatments for TMD

Treatment	Evidence	Effect size	Comments
Occlusal therapies (inc orthodontics)	High	None	Wide-spread use
Intra-oral appliances	High	Low	Wide-spread use
Analgesics and muscle relaxants	Mod	Low-Mod	Wide-spread use
Physical therapy	Low	Low-Mod	Wide-spread use
Simple self-management	Mod	Low	Wide-spread use
Comprehensive self-management	High	Mod	Academic centers
Biofeedback and relaxation therapies	High	Mod	Academic centers
Arthrocentesis and TMJ surgery	Low	Low	
Integrative with co-morbid disorders	None	Unknown	Minimal use

Summary of Diagnosis and Treatment of TMD

1. Diagnostic procedures exist for TMDs
 1. Highly reliable and valid: clinical diagnosis of painful TMD
 2. Moderately reliable and valid: imaging diagnoses of the TMJ
 3. Represent the standards internationally at the institutional level
 4. Poorly used in clinical settings
2. TMJ structural problems
 1. The most common are mostly benign
 2. Current diagnostic methods do not readily distinguish those that are clinically significant
3. Pain society initiatives in taxonomy include TMD (though sometimes with difficulty) and further advances are likely
4. Treatments remain simplistic; TMD is a complex disorder
5. Mechanical and structural causes for TMD are more attractive to many providers for both diagnosis and treatment

Collaborations and Acknowledgments

Research groups | Network meetings | Sponsors

Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Project Team(1990-1992)

- Samuel Dworkin, James Fricton, Lars Hollender, Kimberly Huggins, Linka LeResche, James Lund, Normal Mohl, Richard Ohrbach, Sandro Palla, Earl Sommers, Christian Stohler, Edmond Truelove, Michael von Korff, Charles Widmer
- NIDCR

International RDC./TMD Consortium (2000-2002)

- Mark Drangsholt, Samuel Dworkin, James Fricton, Jean-Paul Goulet, Kimberly Huggins, Mike John, Iven Klineberg, Linda LeResche, Thomas List, Richard Ohrbach, Octavia Plesh, Eric Schiffman, Christian Stohler, Keson Beng-Choon Tan, edmond Truelove, Adrian Yap, Efraim Winocur
- NIDCR

Validation Project (2001-2007)

- University of Minnesota: Mansur Ahmad, Gary Anderson, Quintin Anderson, John Look, Wei Pan, Eric Schiffman, Feng Tai.
- University at Buffalo: Yoly Gonzalez, Krishnan Kartha, Richard Ohrbach.
- University of Washington: Sam Dworkin, Lars Hollender, Lloyd Mancl, Earl Sommers, Jeff Sherman, Judy Turner, Edmond Truelove.
- NIH/NIDCR – U01-DE013331

OPPERA 1 (2005-2012)

- Luda Diatchenko, Roger Fillingim, Joel Greenspan, Charles Knott, Bill Maixner, Richard Ohrbach, Gary Slade, Bruce Weir.
- NIH/NIDCR – U01-DE017018

Miami Consensus Workshop (2009)

- Gary Anderson, Sharon Brooks, Werner Ceusters, Terri Cowley, Don Denucci, Mark Drangsholt, Sam Dworkin, Dominic Ettlin, Charly Gaul, Louis Goldberg, Yoly Gonzalez, Jean-Paul Goulet, Jennifer Haythornthwaite, Lars Hollender, Rigmor Jensen, Mike John, John Kusiak, Antoon deLaat, Reny deLeeuw, Thomas List, Frank Lobbezoo, John Look, Bill Maixner, Marylee van der Meulen, Ambra Michelotti, Greg Murray, Don Nixdorf, Richard Ohrbach, Sandro Palla, Arne Petersson, Paul Pionchon, Eric Schiffman, Barry Smith, Peter Svensson, Corine Visscher, Joanna Zakrzewska.
- International RDC/TMD Consortium Network
- IASP Orofacial Pain SIG
- Canadian Institute for Health Research
- National Center for Biomedical Ontology
- Medtech

JOR-CORE Disability Workgroup (2009)

- Justin Durham, Anat Gavish, Jordi Martinez-Gomis, Richard Ohrbach, Yoshihiro Tsukiyama, Wataru Tachida
- Wiley-Blackwell

San Diego Consensus Workshop (2011)

- Workgroup 1: Gary Anderson, Reny deLeeuw, Jean-Paul Goulet, Rigmor Jensen, Frank Lobbezoo, Chris Peck, Arne Petersson, Eric Schiffman.
- Workgroup 2: Justin Durham, Dominic Ettlin, Ambra Michelotti, Richard Ohrbach, Sandro Palla, Karen Raphael, Yoshihiro Tsukiyama, Corine Visscher.
- Workgroup 3: Raphael Benoliel, Brian Cairns, Mark Drangsholt, Malin Ernberg, Lou Goldberg, Bill Maixner, Don Nixdorf, Doreen Pfau, Peter Svensson.
- International RDC/TMD Consortium Network
- IASP Orofacial Pain SIG
- Canadian Institute for Health Research

Iguacu Falls (Brazil) Workshop (2012)

- Workgroup 1: Reny deLeeuw, Jean-Paul Goulet, Frank Lobbezoo, Chris Peck, Eric Schiffman, Thomas List.
- Workgroup 2: Justin Durham, Dominik Ettlin, Richard Ohrbach.

TMJ Impact Study (2011-2014)

- Mansur Ahmad, Gary Anderson, Yoly Gonzalez, Lars Hollender, John Look, Krishnan Kartha, Richard Ohrbach, Eric Schiffman, Edmond Truelove.
- NIH/NIDCR U01-DE019784

OPPERA-2 (2012-2019)

- Luda Diatchenko, Roger Fillingim, Joel Greenspan, Christopher Lyu, Bill Maixner, Richard Ohrbach, Gary Slade, Bruce Weir.
- NIH/NIDCR – U01-DE017018

Seattle Symposium (2013)

- Raphael Benoliel, Brian Cairns, Werner Ceusters, Justin Durham, Eli Eliav, Ambra Michelotti, Richard Ohrbach, Karen Raphael.

Cape Town Symposium (2014)

- Per Alstergren, Jean-Paul Goulet, Frank Lobbezoo, Richard Ohrbach, Chris Peck, Eric Schiffman

Boston Workshop (2015)

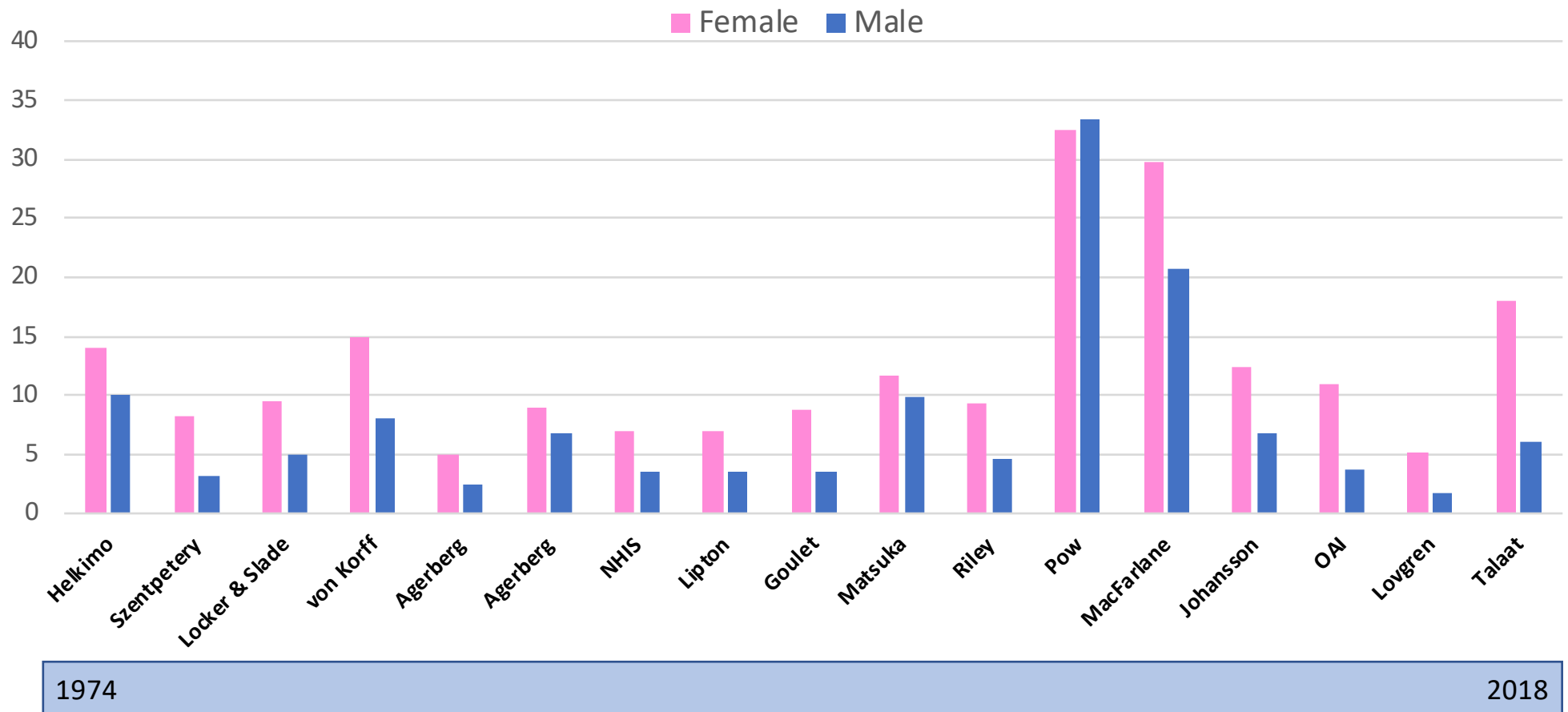
Seoul Workshop (2016)

San Francisco Workshop (2017)

London Workshop (2018)

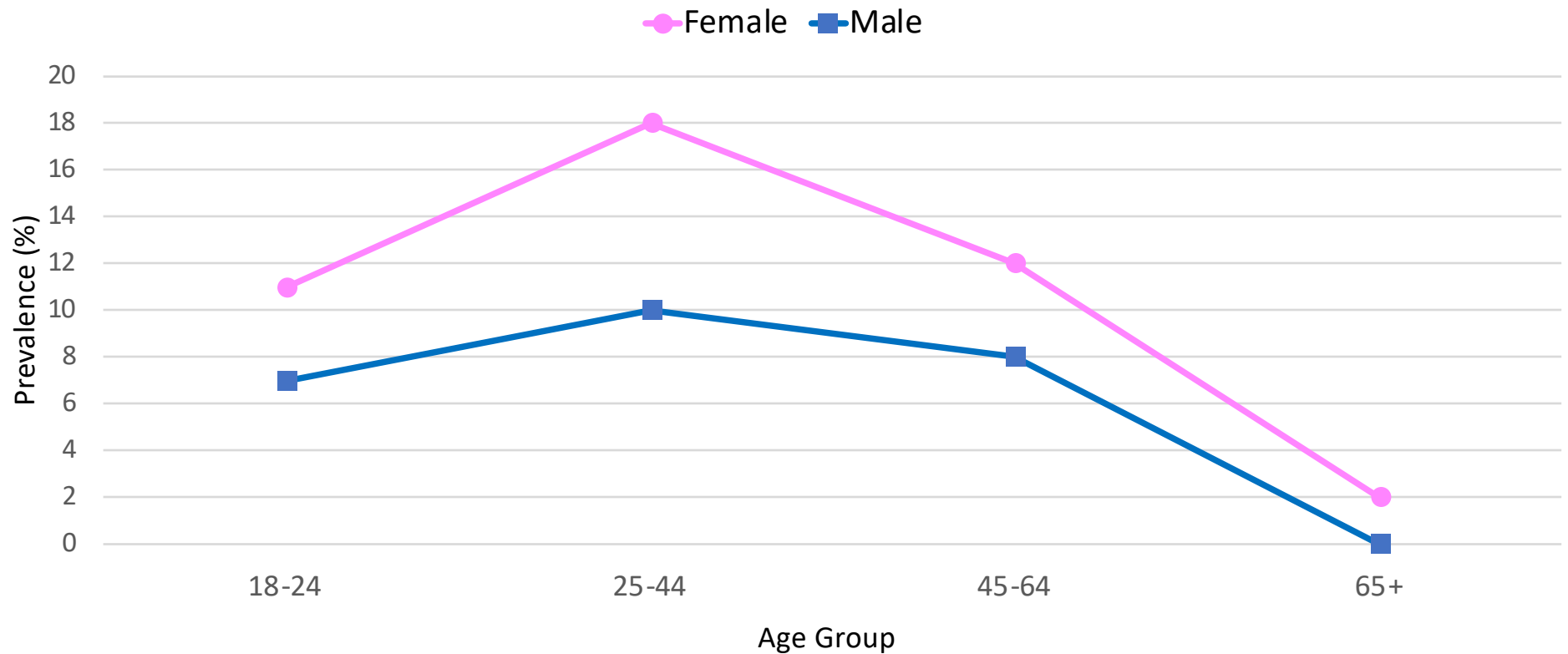
Epidemiology and risk factors

“TMD” Prevalence By Sex



TMD Prevalence by Age

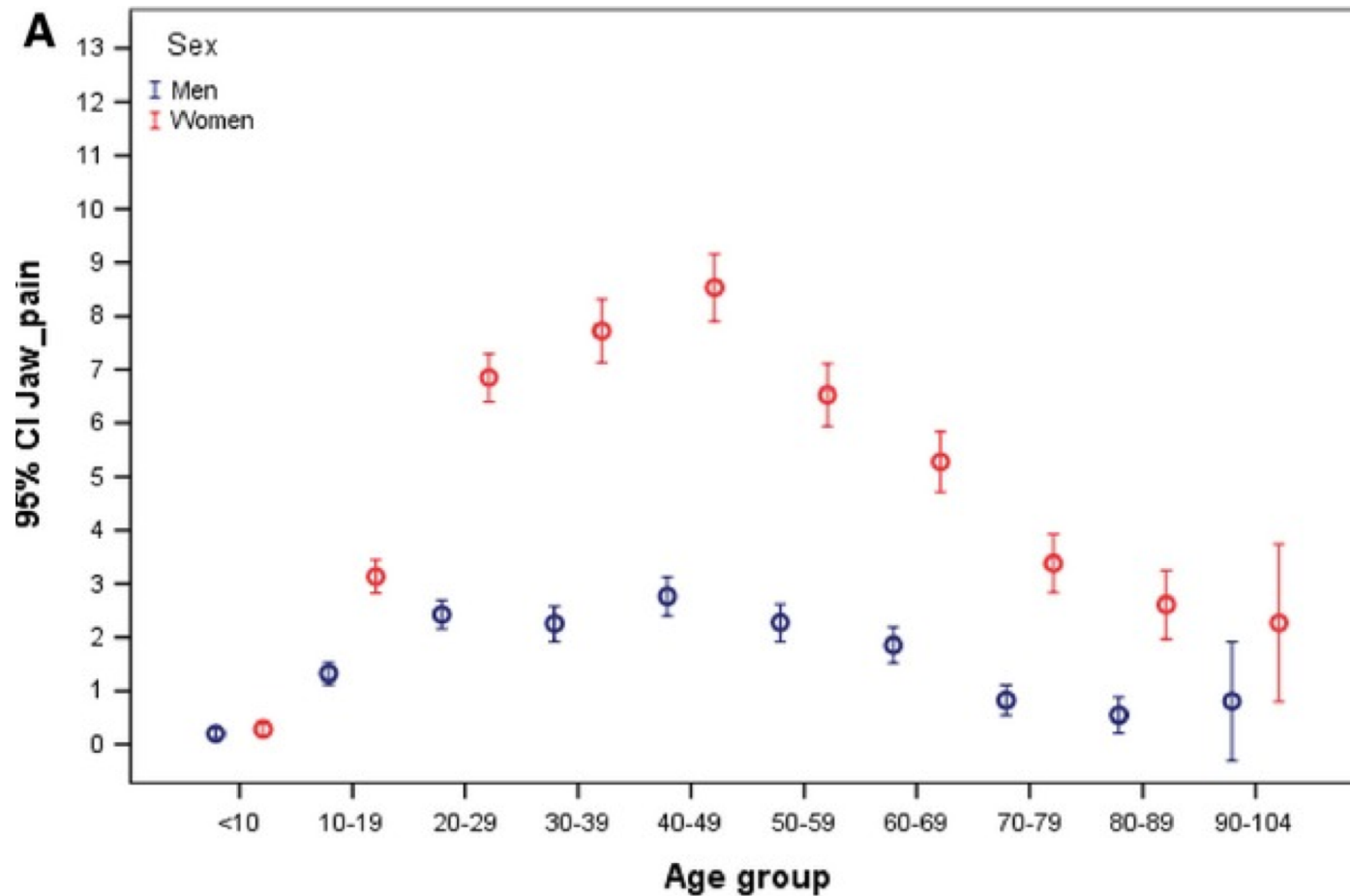
von Korff, et al 1988 Pain 32:173-83



Overall prevalence 12%

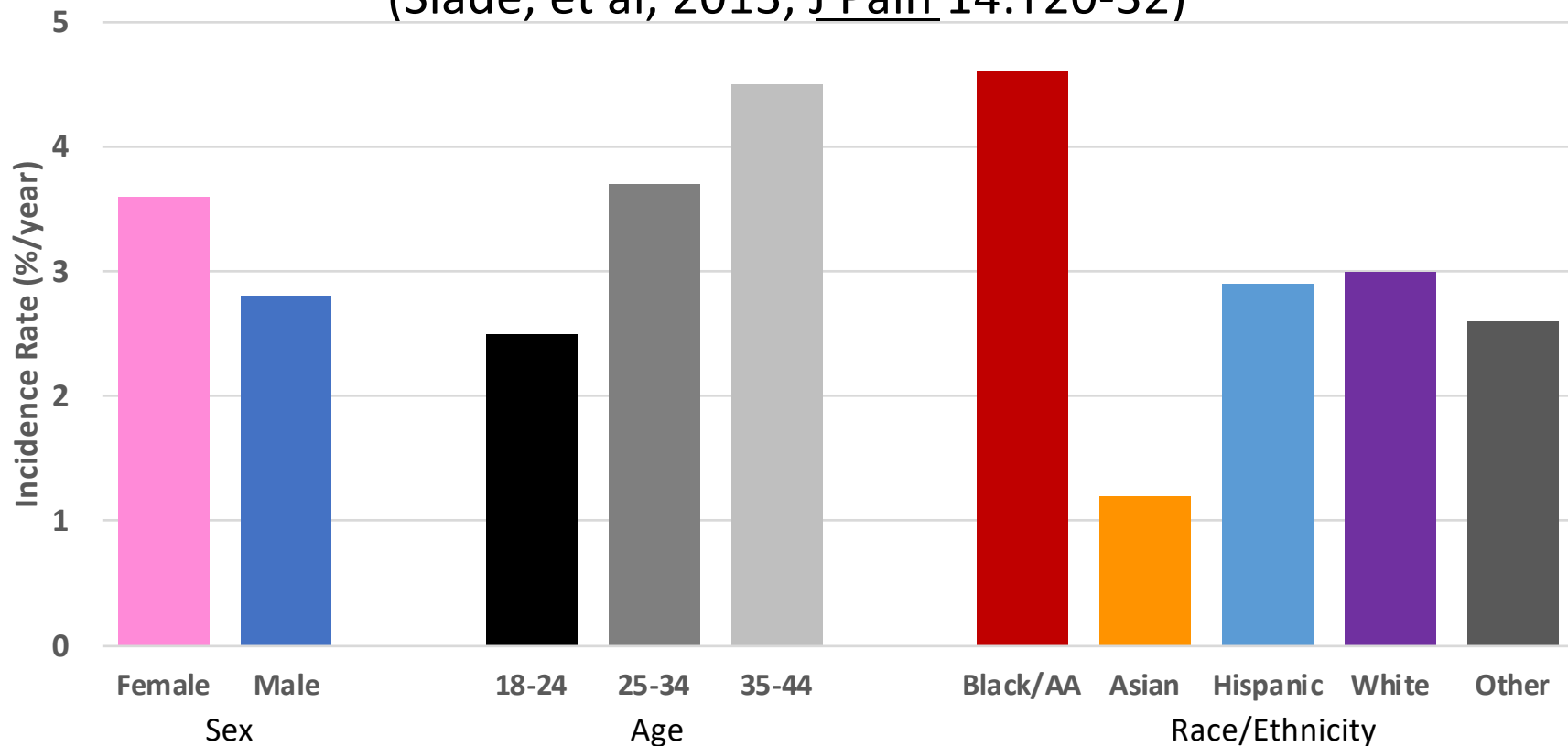
TMD Pain Prevalence by Age

Lovgren, et al, 2016, Eur J Pain 20:532-40



TMD Incidence Rates in the OPPERA Study

(Slade, et al, 2013, J Pain 14:T20-32)



Overall Incidence Rate=3.5% per year. Incidence was slightly higher in females ($p=0.051$), and significantly higher in older age groups ($p < 0.05$), and in Black/AA individuals ($p < 0.05$).

Transition from Acute to Persistent TMD

- Slade, et al (2014)¹: 49%
- Garofalo, et al (1998)²: 57%
- Epker, et al (1999)³: 71%

1. Slade, et al 2014 Pain 155: 2134-43; 2. Garofalo 1998 JADA 129: 438-47; 3. Epker, et al, 1999 JADA 130: 1470-75.

Natural History of TMD

- More than half of patients with painful TMD reported no pain or greatly improved pain 5 years later¹.
- Of people with TMD pain at age 50, less than half reported pain 10 years later².
- Patients with myofascial pain showed significant improvements in pain severity five years later³.
- In the OPPERA study, 76% of chronic TMD cases persisted as cases 5 years later, but pain was significantly lower at follow-up⁴.

1. Ohrbach & Dworkin 1998 Pain 74: 315-26; 2. Johansson, et al 2008 Acta Odont Scand 66: 50-57;
3. Rammelsberg, et al 2003 J Orofac Pain 17: 9-20; 4. Fillingim, et al 2018 Pain 159: 2403-13.

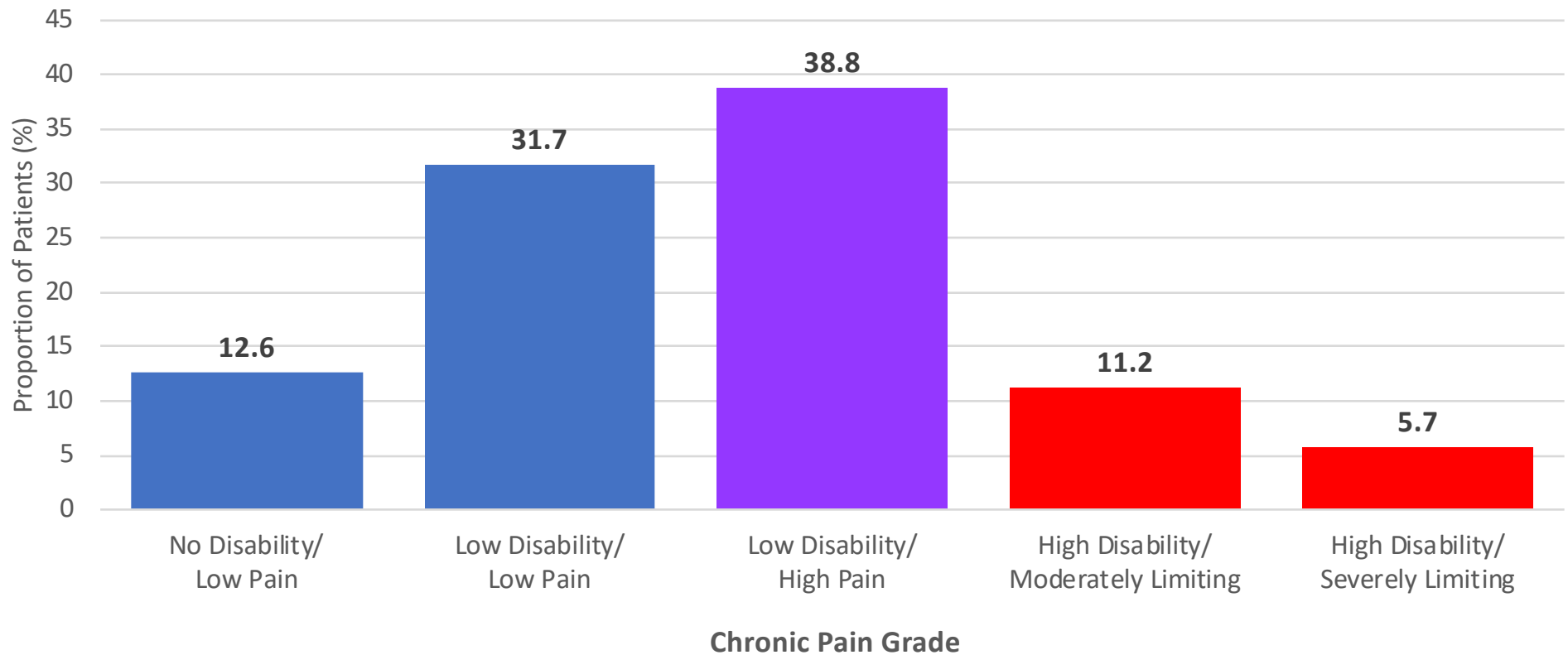
TMD Impact

- Among people reporting TMD pain, 17% reported interference with work or activities, and 46% sought treatment ¹.
- 1-3% of the general population sought treatment for TMD symptoms over a 9-month period ².
- Societal costs not known, but increased healthcare burden alone was estimated to exceed \$2 billion in 1998 ².
- TMD cases show higher levels of psychological symptoms, particularly depression and somatic symptoms, compared to pain-free controls ³.

1. MacFarlane, et al, 2002, Comm Dent Oral Epi 30: 52-60; 2. Drangsholt & LeResche, 1999 in Epidemiology of Pain (Crombie, et al (Eds); 3. Canales, et al, 2018 J Oral Rehab, 45:881-89.

Chronic Pain Grade in Treatment-Seeking TMD Patients

(Manfredini, et al, 2010, J Dent, 38:765-72)



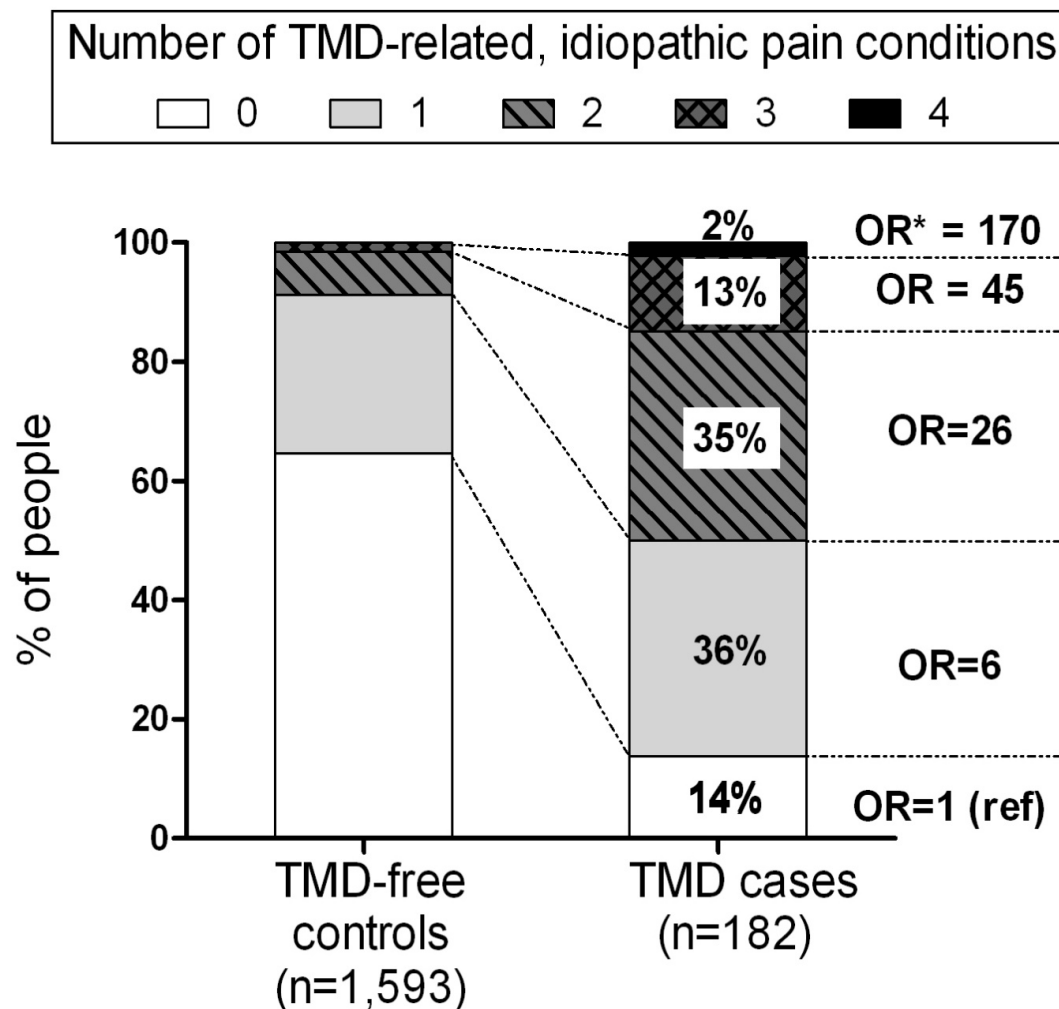
1149 patients from tertiary care centers in three countries (Italy, Israel, Netherlands)

Associated Conditions and Risk Factors

- Comorbid pain conditions
- Health-related factors
- Clinical-orofacial factors
- Psychosocial factors
- Pain sensitivity
- Genetic factors

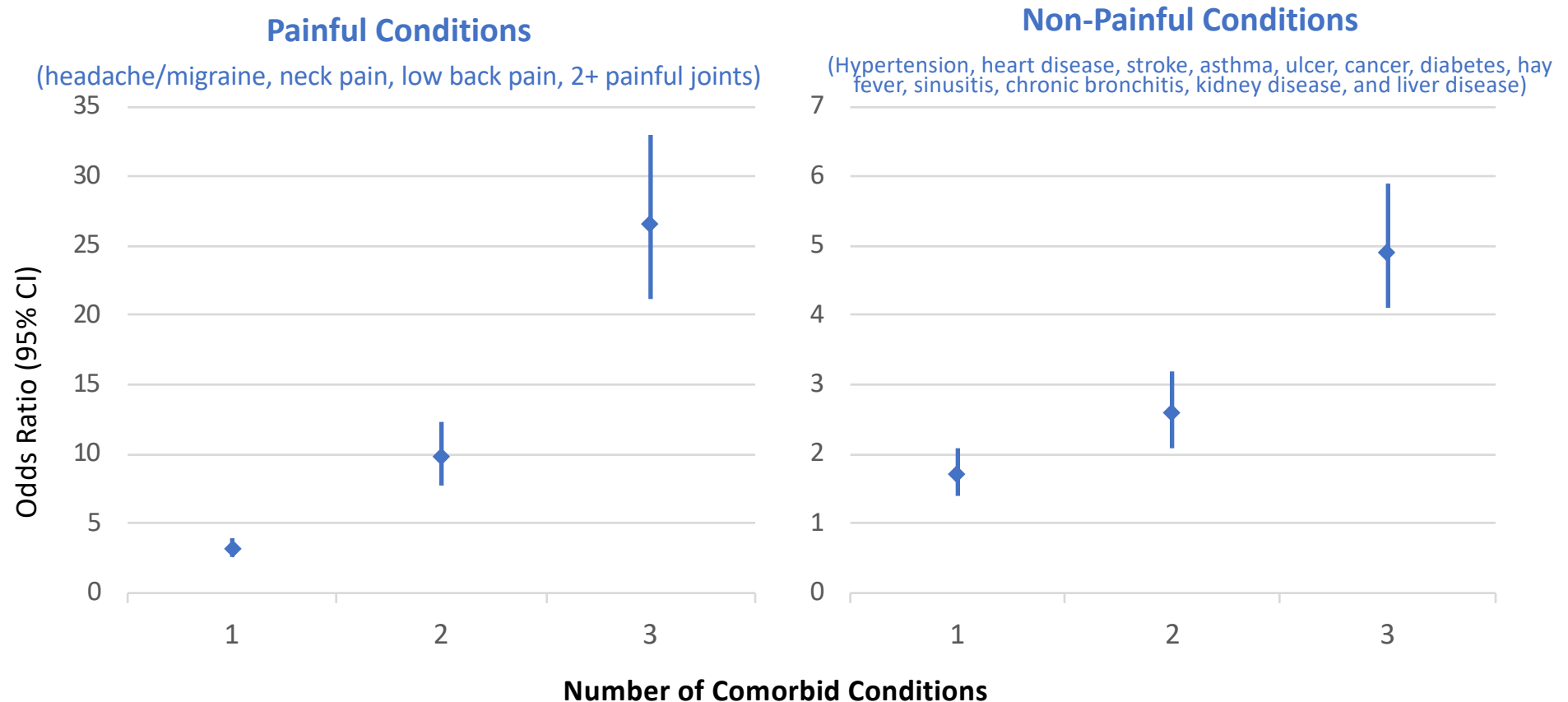
Odds of TMD Based on Number of Other Pain Conditions Present

Idiopathic pain conditions (IPCs) related to TMD in the OPPERA baseline case-control study. The 4 IPCs were: headache, low back pain, widespread pain and IBS. *OR = odds ratio for TMD in people with 1, 2, 3 or 4 IPCs relative to people with no IPCs



Odds of TMD Based on Number of Comorbid Conditions

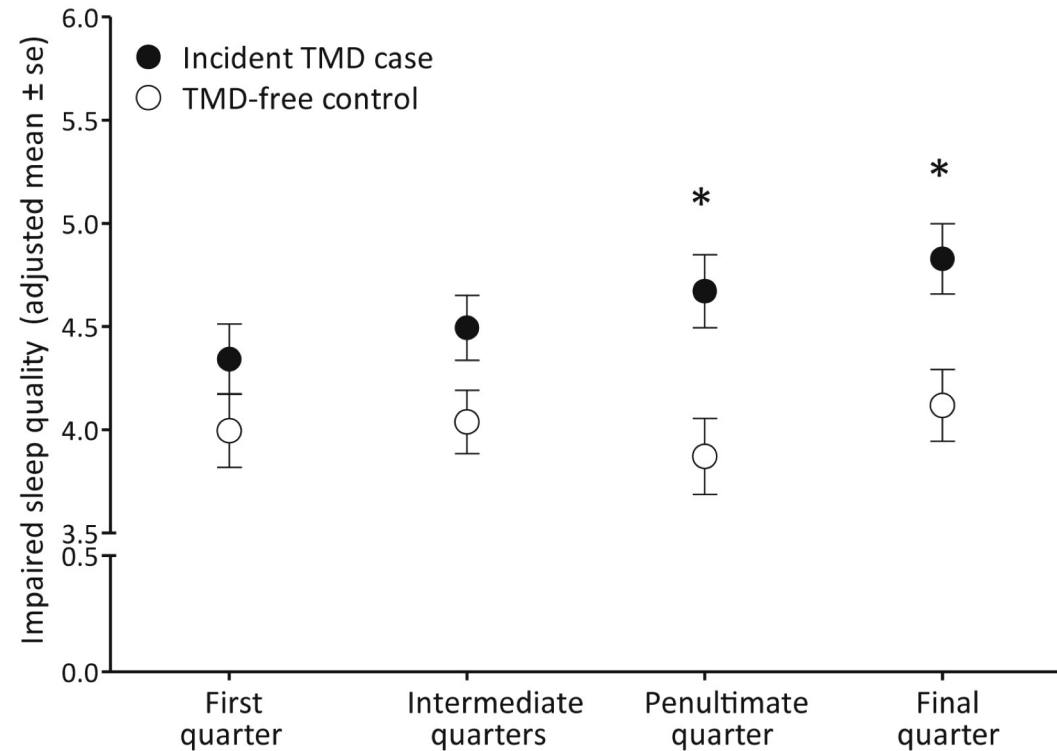
(Maixner, et al, 2016, J Pain 17:T93-107)



Data from NHIS 2009

Sleep and TMD

- Both sleep quality (PSQI) and sleep apnea symptoms were associated with increased odds of chronic TMD and increased risk for TMD onset ^{1,2,3}.
- Also, sleep quality deteriorated leading up to TMD onset⁴.



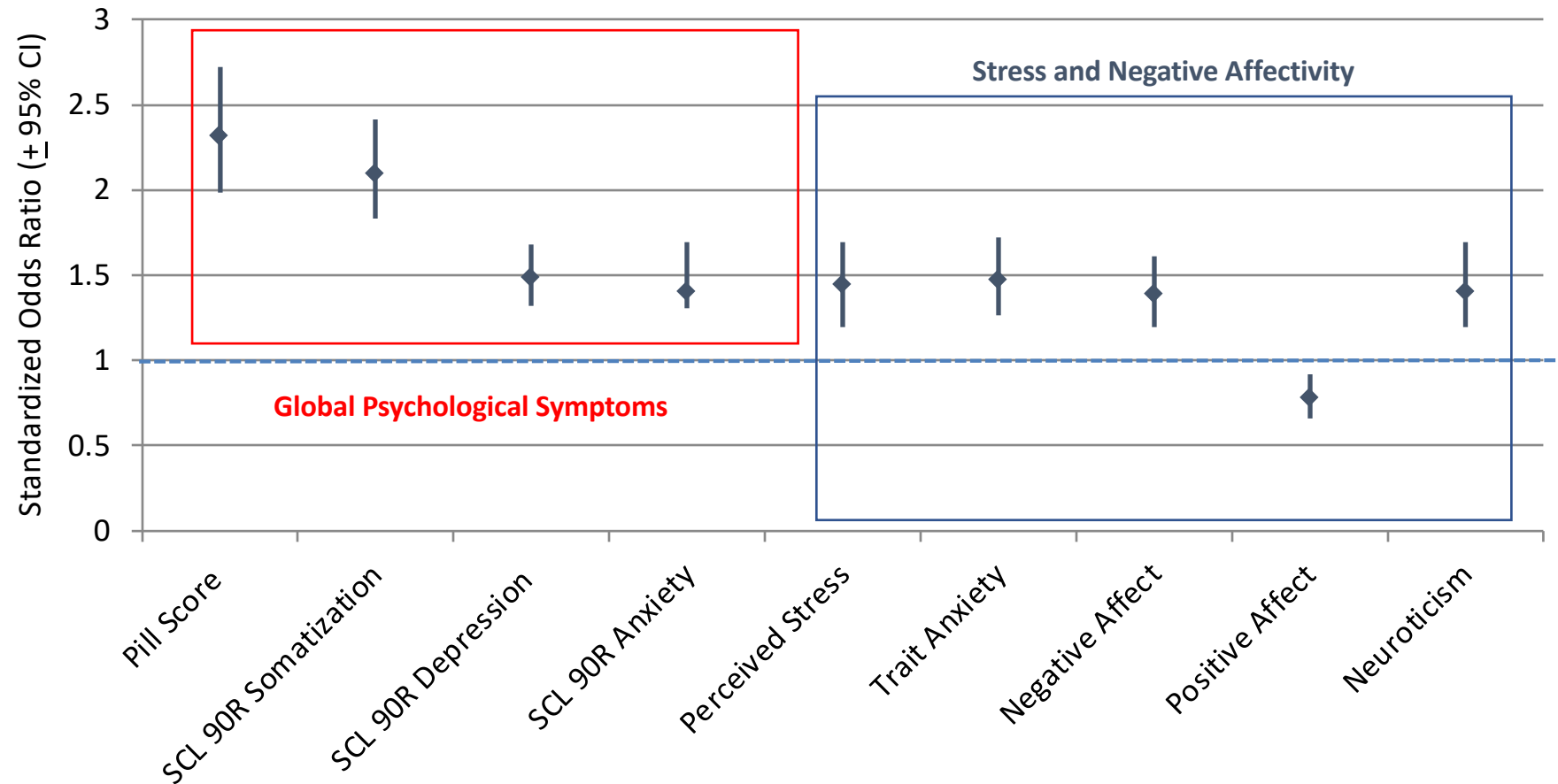
1. Fillingim, et al, 2011 J Pain 12:T46-60; 2. Sanders, et al, 2013 J Pain 14:T51-62; 3. Sanders, et al, 2013 J Dent Res 92:70S-77S; 4. Sanders, et al, 2016 J Pain 17: 669-77.

Clinical-Orofacial Factors Associated with TMD

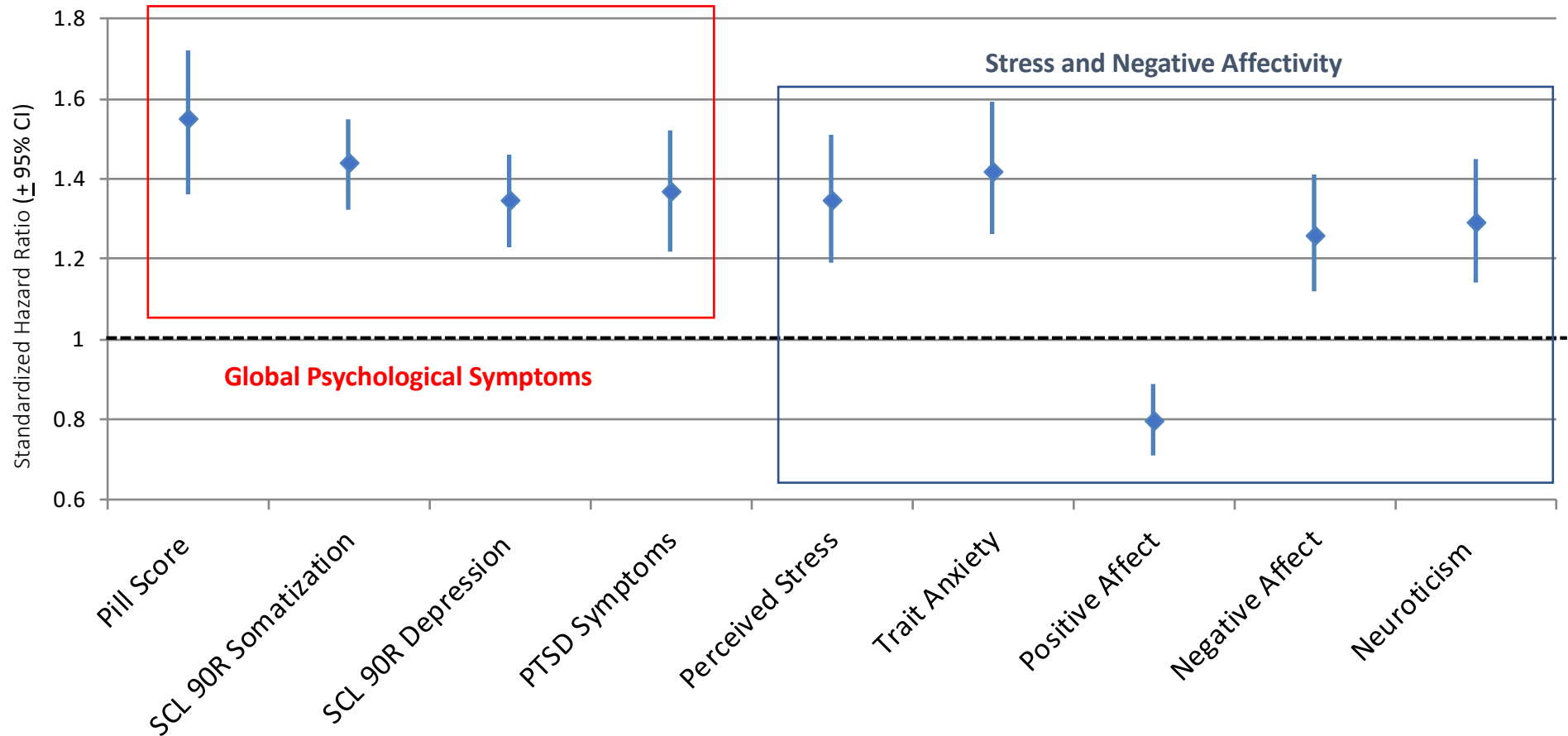
	Chronic TMD	TMD Onset
Non-specific orofacial symptoms	Yes	Yes
History of jaw injury	Yes	Yes
Parafunctional behaviors	Yes	Yes
Jaw function limitations	Yes	No
Body sites tender to palpation	Yes	Yes
Cranial sites tender to palpation	Yes	Yes
Pain on opening	Yes	Yes
Self-reported TMJ noises	Yes	Yes
Examiner verified TMJ sounds	Yes	No

Ohrbach, et al, 2011 J Pain 12:T27-45; 2013 J Pain 14: T33-50

Psychosocial Variables Associated with Chronic TMD (OPPERA Study)



Psychosocial Measures Predict First Onset TMD (OPPERA Study)



Pain Sensitivity Factors Associated with TMD

	Chronic TMD	TMD Onset
Mechanical Pain Threshold	Yes	No
Mechanical Pain Ratings	Yes	No
Mechanical Temporal Summation	Yes	No
Mechanical Aftersensation	Yes	No
Heat Pain Tolerance	Yes	No
Heat Pain Ratings	Yes	Yes
Heat Temporal Summation	Yes	?
Heat Aftersensation	Yes	?
Cranial Pressure Pain Threshold	Yes*	No
Non-Cranial Pressure Pain Threshold	Yes*	Yes

Greenspan, et al, 2011 J Pain 12:T61-74; 2013 J Pain 14: T61-74.

PPTs Over Time in Persistent & Transient TMD Cases vs. Controls

147 New Onset TMD Cases

- 72 persistent
- 75 transient

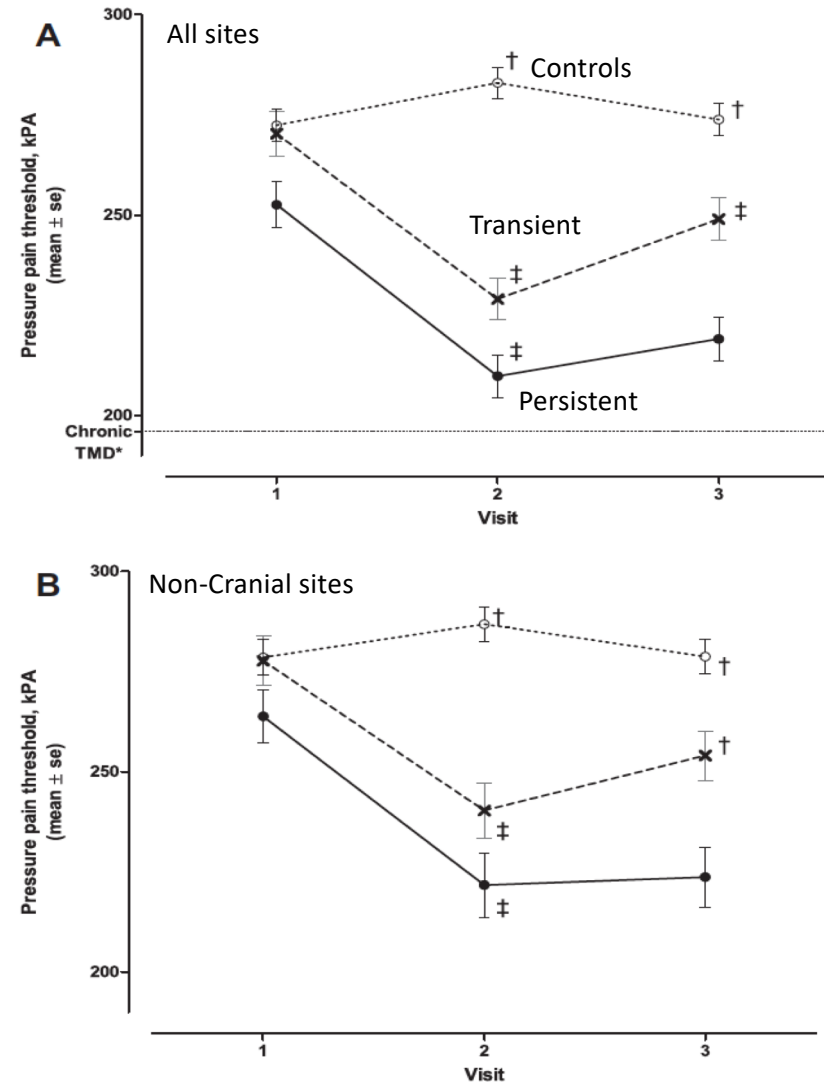
125 Controls

Data collected at:

- Visit 1: enrollment, before TMD onset
- Visit 2: at the time of onset
- Visit 3: six months after onset

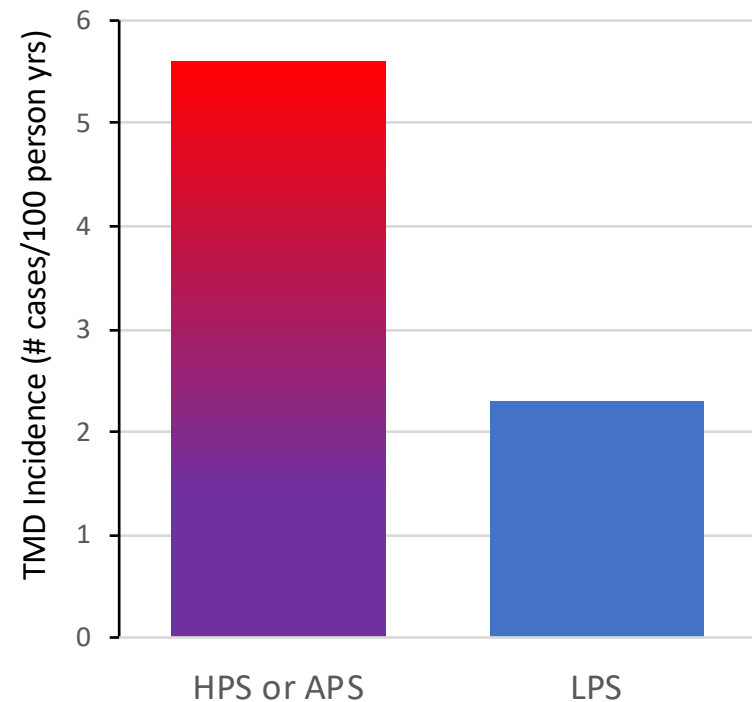
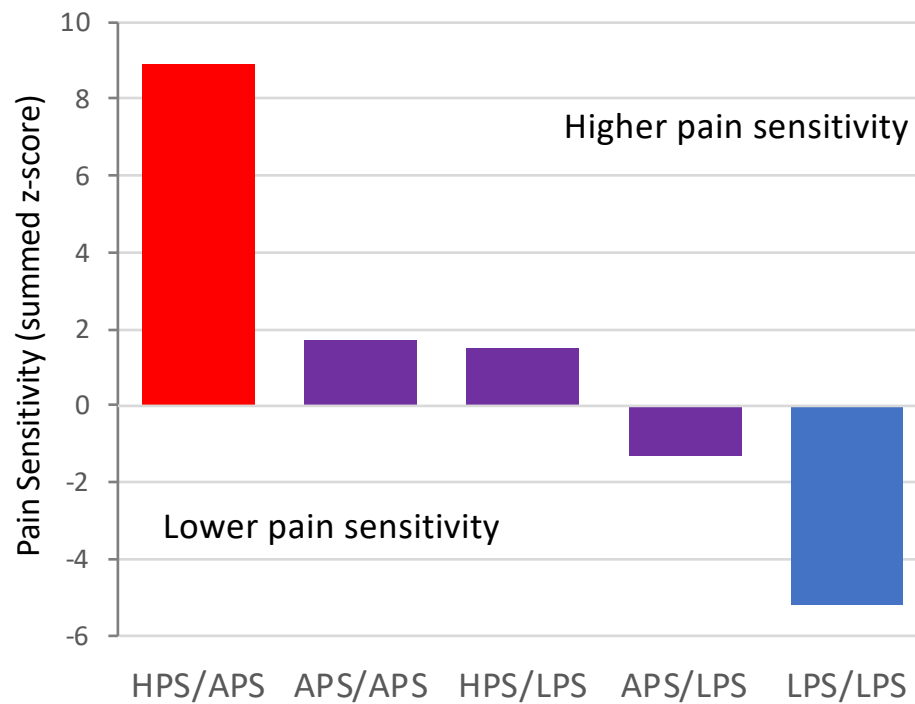
Slade, et al, 2014 Pain 155: 2134-43

G.D. Slade et al./PAIN® 155 (2014) 2134–2143



COMT Haplotype, Pain Sensitivity & TMD Incidence

(Diatchenko, et al, Hum Mol Genet 2005;14:135-143)



HPS=high pain sensitive; APS=average pain sensitive; LPS=low pain sensitive

Genetic Findings from OPPERA Data

Reference	Gene(s)	Findings
Smith, et al 2011 ¹	HTR2A (serotonin receptor gene) NR3C1 (glucocorticoid receptor gene) COMT (catechol-O-methyl-transferase) OPRD1 (delta opioid receptor gene)NR3C1	Associated with chronic TMD, but none beat strict Bonferroni correction
Smith, et al 2013 ²	SCN1A (sodium channel type 1, alpha subunit) ACE2 (angiotensin-1-converting enzyme 2)	Associated with nonspecific orofacial symptoms
	PTGS1 (prostaglandin-endoperoxide synthase 1) APP (amyloid precursor protein)	Associated with psychological symptoms
	MPDZ (multiple PDZ domain)	Associated with heat temporal summation
Martin, et al 2017 ³	EREG (epiregulin) EGFR (epidermal growth factor receptor)	Associated with TMD and with hyperalgesia in preclinical models
Smith, et al 2018 ⁴	MRAS (muscle RAS oncogene)	Associated with TMD in males only

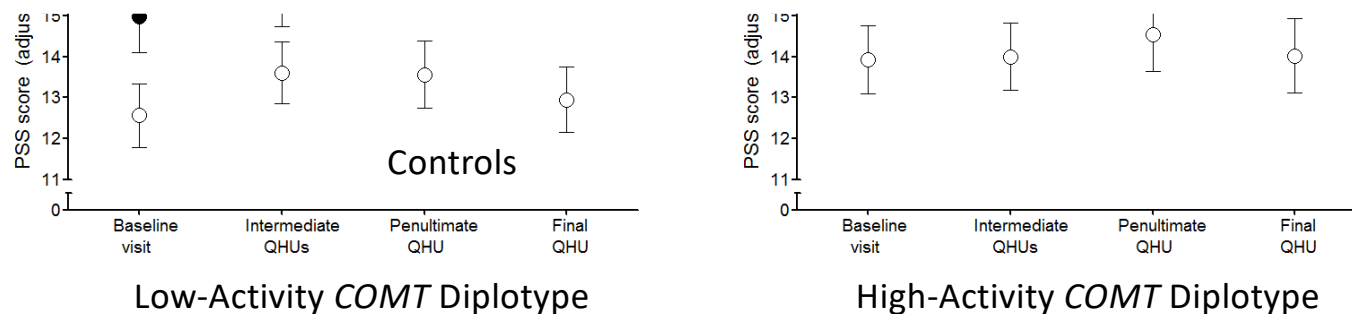
1. Smith, et al 2011 J Pain 12:T92-101; 2. Smith, et al 2013 J Pain 14: T91-101; 3. Martin, et al 2017 J Clin Invest 127: 3353-66; 4. Smith, et al 2018 Pain ePub.

COMT Diplotype Amplifies Effect of Stress on Risk of Temporomandibular Pain

New Onset TMD

G.D. Slade^{1,2,3}, A.E. Sanders^{1,2}, R. Ohrbach⁴, E. Bair^{1,5,6}, W. Maixner^{1,5}, J.D. Greenspan^{7,8}, R.B. Fillingim⁹, S. Smith^{1,5}, and L. Diatchenko¹⁰

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DOI: 10.1177/0022034515595043
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Both baseline stress and increases in stress (i.e. Perceived Stress Scale, PSS) during follow-up predicted incident TMD. However, changes in stress interacted with *COMT* diplotype in predicting TMD incidence. Each 1.0 SD increase in PSS scores more than doubled risk of TMD incidence in subjects with low-activity *COMT* diplotypes (hazard ratio = 2.35; 95% confidence limits: 1.66, 3.32), an effect not found in subjects with high-activity *COMT* diplotypes (hazard ratio = 1.42; 95% confidence limits: 0.96, 2.09).

Summary of Epidemiology & Impact of TMD

- Common, affects more women than men, prevalence peaks in 30s & 40s
- Personal and societal impact is high
- High comorbidity with other pain and non-pain health conditions.
- Orofacial signs/symptoms associated with chronic TMD & risk for onset
- Psychological symptoms increased in chronic TMD cases, but also premorbid predictors of TMD onset
- Chronic cases show increased pain sensitivity, but most pain sensitivity measures did not increase risk of onset.
- Genetic factors contribute to TMD in complex fashion, sometimes via interactions with psychological factors.

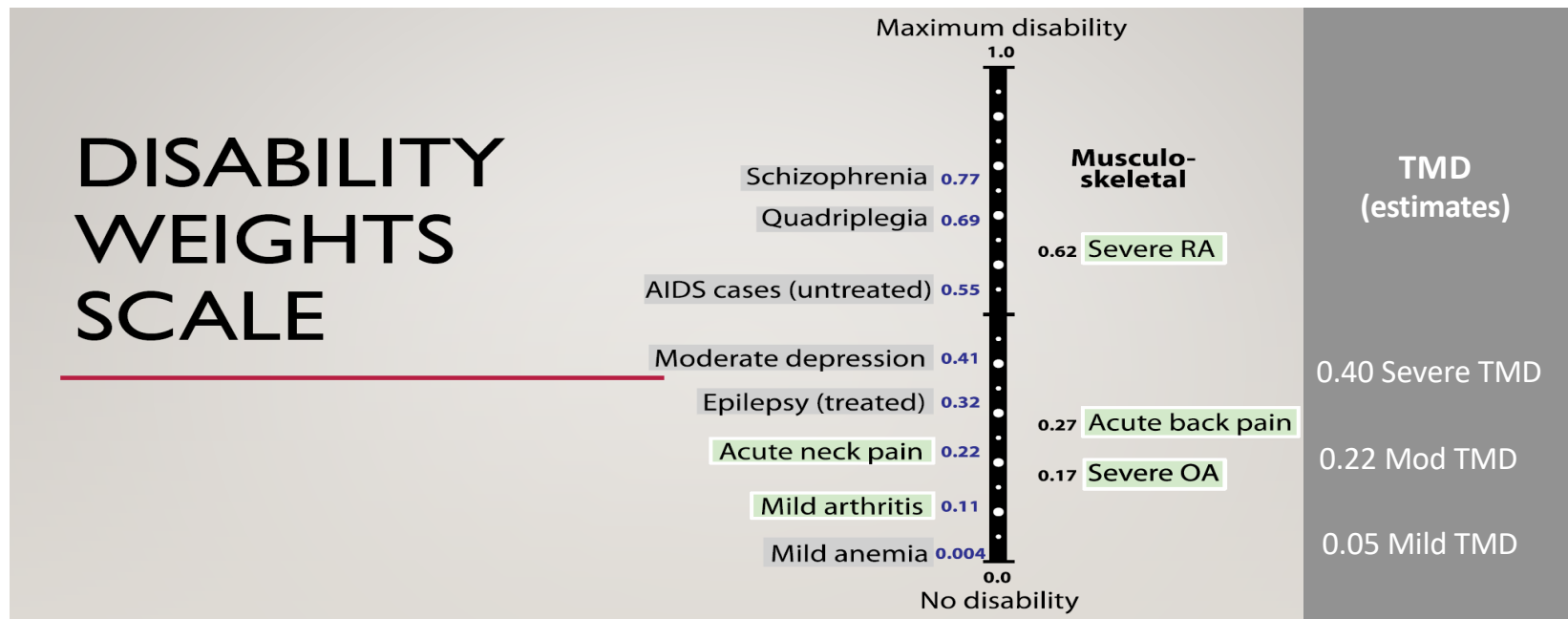
Challenges confronting the TMD field

Challenges Regarding TMD

1. Acknowledging the disorder
2. Patient assessment
3. Professional education
4. US TMD prevalence vs workforce
5. Clinical decision-making
6. Clinical practice
7. Research

Acknowledging the disorder

Example of preliminary TMD Disability Weights



DALYs (Disability adjusted life years) = Death (years life lost) + Disability (years lived w/disability = prevalence x **disability wt**)

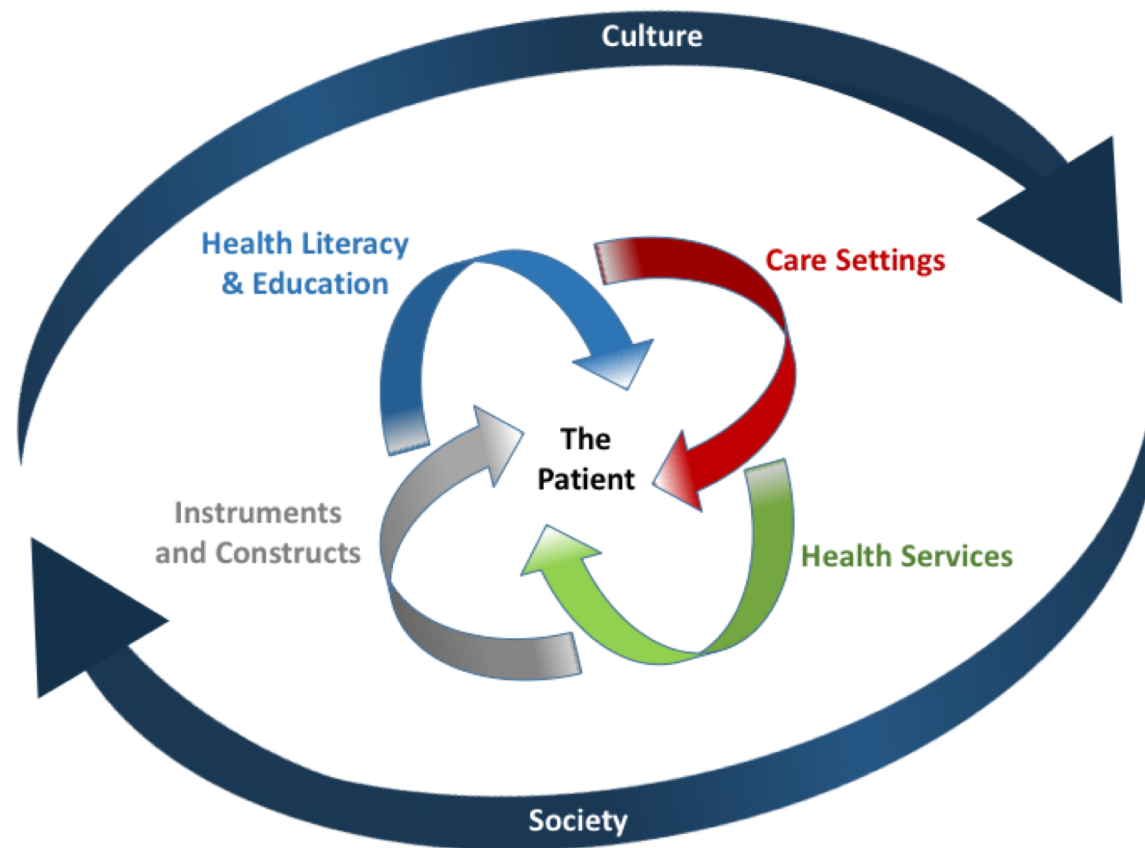
Murray & Lopez, 1996

Credit: Work in progress for GBD of TMD/OFP by Mark Drangsholt and University of Washington

DC/TMD Axis-2 Assessment model

Domain	Instrument	# items	Comp eval	Screen eval	Brief eval *
Pain locations	Pain drawing	1	✓	✓	✓
Pain intensity	Graded Chronic Pain Scale (GCPSv2)	3	✓	✓	✓
Pain persistence	Graded Chronic Pain Scale (GCPSv2)	1	✓	✓	✓
Physical function	Graded Chronic Pain Scale (GCPSv2)	4	✓	✓	✓
Limitation	Jaw Functional Limitation Scale-8	8		✓	
Limitation	Jaw Functional Limitation Scale-20	20	✓		
Distress	Patient Health Questionnaire-4	4		✓	✓
Depression	Patient Health Questionnaire-9	9	✓		
Anxiety	Generalized Anxiety Disorder-7	7	✓		
Physical symptoms	Patient Health Questionnaire-15	15	✓		
Parafunction	Oral Behaviors Checklist (OBC)	21	✓	✓	
TOTAL ITEMS			81	42	13

* Not part of published DC/TMD



Sharma S, Breckons M, Brönnimann Lambelet B, Chung J-W, List T, Lobbezoo F, Nixdorf DR, Oyarzo JF, Peck C, Tsukiyama Y, Ohrbach R. Challenges to Implementation and Utility of a Biopsychosocial Model for Assessment and Management of Orofacial Pain. In review.

Topic	Challenges	Recommendations	Challenges	Recommendations
Culture and Society	English version of instruments may embed cultural bias	*Configure translation teams to represent the culture and instrument and its guidelines to the setting	Multiple stakeholders hold different perspectives regarding adequate care	All stakeholders need to contribute to the solutions
	Stigma may influence illness behavior, affecting diagnosis and treatment	Investigate cultural and ethnic stigma regarding illness behavior and mental health, and improve health literacy	Patients, providers, and cultures have different perspectives about bio-behavioral assessment	Assess instrument validity cross-culturally, and develop empirical norms and policies whereby stakeholders can work within the value and assumptions of the culture for accurate evaluations
Settings	Psychosocial interpretation is culture-dependent	Develop within-culture interpretation guidelines	Psychosocial assessment is not native to dental settings; providers and patients are uneasy	Improve health literacy of the culture; improve biopsychosocial literacy of the health providers
			Cross-cultural research is hampered by culture-specific modes of data storage	Develop collaborations with regulatory agencies
Health Services	Behavior differences across different settings make it difficult to standardize the implementation of Aa-i	*Improve continuing education of providers Start implementing simple, common, standardized across settings for uniform assessment, and build capacity for improved frameworks	Widespread dental setting assumption is that dental care occurs in offices outside Aa-i constructs	Extend TMD research to include broader pain field Use simple self-report screens to gauge settings for and test the utility
				Implement comprehensive Aa-i in referral settings
	Whether Aa-i utilization could be expected to further health or increase costs due to provider demand is undetermined	Whether Aa-i utilization could be expected to further health or increase costs due to provider demand is undetermined	What extent of Aa-i information is effectively partitioned to high treatment needs?	Systematic research regarding individual measures, sets of measures, and matching patient profiles to outcomes from adaptive treatment designs is needed
	Effect of income disparity on access to higher-level health services	Develop accessible materials, especially for comprehensive advice	Inefficient and inadequate	Improve studies of TMD, especially linking treatment to risk determinants
Instruments and Constructs	Aa-i instruments need thresholds to classify, refer, and monitor expected progress	Develop infrastructure for provision of bio-behavioral care		
		Advocacy for improved health coverage		
	SCT/MO Aa-i protocol largely developed by experts from Europe and North America, which may bias construct for measurement vs. phenomenological experiences of pain that differ cross-culturally	*Continue WOMIM workshops with broad representation in order to continually assess Aa-i content and cross-cultural applicability and further tailor Aa-i instruments to cultural requirements	Unknown value of using Aa-i to treat orofacial pain diagnoses	*Further research regarding standardized assessment approaches, including incorporation of patient's expectations and cultural values into treatment decisions, and making care according to patient profiles
	Effects of intertwined factors on patient responses	Test cross-cultural validation with appropriate statistical results, and high-level clinician ability	Cannot map tailored treatment decisions to Aa-i	Qualitative research of TMD pain experience vs. instrumented assessment, informed by model pain processing models
Health Literacy and Education	Cultural differences in construct interpretation and replication	Use representative samples and methods (especially qualitative) to assess cultural fit of instrument	Experience of TMD is heterogeneous compared to standardized assessment	Threat level of assessment within dental field practices, using self-report assessment, comprehensive screens, and mental health interviews; research needed to document efficacy
	Different educational standards across cultures influence scope of dental training	*Use published standards from example programs for improving clinical science and biopsychosocial model training in undergraduate dental curriculum	No empirical data supports differential efficacy of Aa-i levels of severity	*Provide training of providers and improve knowledge regarding patient-defined outcomes and co-effectiveness of guidelines
	Limited provider education regarding pain and the biopsychosocial model leads to poor treatment outcomes	Assess provider model health to provide treatment experience in using Aa-i	Psychological interventions are underutilized even though strongly supported	Include all stakeholders in the implementation of guidelines
	Absence of treatment standards leads to misapplied treatment recommendations	Incorporate psychosocial factors into the behavioral management of chronic and complex psychosocial symptoms in TMD management		

High-priority items have been marked with an asterisk

Several core issues emerged

1. Minimizing the recognition of mental health influences recognition of illness
2. Training in use of validated multi-axial assessment protocols is essential, and
3. Clinical assessment must recognize that pain necessarily incorporates both sensory and emotional dimensions in order to adequately address illness.

These topics and issues will require action at multiple levels in order to improve patient care globally.

TMD/OFP educators and researchers need to:

1. Be sufficiently educated regarding the biopsychosocial model;
2. Develop evidence-based biopsychosocial guidelines for the assessment and management of orofacial pain conditions;
3. Ensure full implementation of this model in the undergraduate and postgraduate dental curricula; and
4. Be responsive to stakeholders, including regulatory authorities and practitioners.

Sharma et al, in review

Professional education	DDS education inadequate	• Pain • Clinical decision-making under uncertainty • Disease management • CODA principles contribute to this problem
	Medical education inadequate regarding TMD and jaw system	• Medical school • Residencies and specialties
	Specialty recognition within dentistry limits the field	• Graduate programs • Faculty development • Training of capable recognized specialists
	Advanced TMD education	• Vast differences in training within DDS and TMD/OFP specialty • American Board of Dental Specialties recognizes orofacial pain, but ADA does not
US TMD prevalence vs workforce*	Chronic TMD prevalence: 6.2%?	• Prevalence from true population studies [4.5 – 8.2%; mean ~6.2 %]
	Estimate of practitioners who diagnose AND manage TMD using evidence-based principles = 840	• Provider [Number] x [Full Time Equivalent %] x [% doing care] = total • Orofacial pain specialists = [500] x ~60% x 100% = 300 • Oral Medicine specialists = [300] x ~50% x 90% = 135 • General dentist w/ advanced TMD training = [~1000] x 50% x 50% = 250 • Oral Maxillofacial Surgeons = 5280 x ~100% x 4% = 280 • Physicians (all types) = 1,000,000 x ~100% x 0.01% = 100
	1 provider / 20,300 TMD Cases	• 1065 Providers vs 21,600,000 with TMD
	Provider qualifications	• Multiple types of providers: who is qualified? • Where are they located?

* Work in progress for GBD of TMD/OFP by Mark Drangsholt and University of Washington

Clinical decision-making	Orofacial pain conditions are complex	• Differential diagnosis challenging • No reliable technological tests or documented biomarkers for confirmatory TMD dx • Comorbid disorders add further complications
	Interpreting treatment response	• Positive or negative response misinterpreted: poor understanding of placebo, regression to the mean, natural sx fluctuations, pseudo-success of overtreatment • Errors in interpretation lead to either perpetuation of disability or unnecessary escalation of treatment
Clinical practice	Dentists want simplicity	• “Axis I is too difficult to learn, too time-consuming in practice” • Assessing person-level of pain requires time and different skills
	Financial	• Heavy marketing by “specialists” and financial incentive to sell unproven diagnostic modalities and radical treatments • Reimbursement for “diagnosis” on dental code inadequate • Exclusion of the TMJ/jaw on many medical insurance plans
	Physicians and other providers	• Physicians in general are willing to recommend initial simple self-care remedies for TMD, and a minority of physicians are willing to provide treatment for TMD, but most want dentistry to embrace this disorder that has more functional and diagnostic overlap with dental knowledge
	Impact of non-specialty	• Well-trained providers are often not well-known or identified in the community

Research: disorder- focused	Pain is a process	Reductive vs systems-level perspectives on pain as a process, embedded in both illness and disease
	What is chronic muscle pain?	Understanding muscle pain drives plausible peripheral (nociceptive?) vs central models regarding where treatment should be focused
	Local disorder vs co-morbidity	Definitions, models, measurement scales, statistics, scientific literacy...
	The role of structural pathology in TMD onset or maintenance	Untenable or unsupported dental-centric theories to date. Consequently, science discarded role of structure underlying TMD, and NIDCR patient guidelines highlight that dental structure does not cause TMD. Integration of any structural pathology with prevailing models of idiopathic pain will require overcoming a polarized landscape of 2 independent camps: complex multi-factor theory, vs traditional structural theory
	Severe TMJ pathology	Medical legacy, implants, training, devices...
Research: institutional and societal	Does “oral” health have a dental boundary?	FDI definition of oral health is inclusive and links to medicine, but the commonly accepted definition of oral health ignores orofacial pain and functioning of the masticatory system
	The body vs the health care system	Restrictions on treatment models imposed by limitations imposed by the health care payment system, and restrictions in access to care imposed by dividing the body into dental vs medical vs neither
	Acceptable clinical trials designs	Guidelines for clinical trial design supporting treatment efficacy studies – especially those that target modifiable risk factors
	Research funding	Research & treatment complexity are inversely related to seeming simplicity of the joint

Thank you for the opportunity to share our research