

# Correlation of RDC/TMD axis I diagnoses and axis II pain-related disability. A multicenter study

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**Abstract** As part of an ongoing multicenter investigation involving four highly specialized tertiary clinics for temporomandibular disorders (TMD) treatment, retrospective analysis of Research Diagnostic Criteria for TMD (RDC/TMD) axis I and axis II data gathered on clinic and community cases were assessed with a twofold aim: (1) to search for a correlation between axis I diagnoses and axis II pain-related disability, and (2) to identify clinical (axis I) and psychosocial (axis II) predictors of high pain-related disability. Two samples of patients seeking treatment for TMD (clinic cases,  $N=1,312$ ) and a sample of general population subjects (community cases,  $N=211$ ) underwent a thorough assessment in accordance with the RDC/TMD version 1.0 [1] guidelines to receive both axis I and axis II diagnoses. Spearman's test was performed to assess the level of correlation between axis I diagnoses and Graded

Chronic Pain Scale (GCPS) pain-related disability. A stepwise multiple logistic regression model was used to identify the significant associations between 12 clinical and psychosocial predictors and the presence of high pain-related disability. Axis I findings were related with pain-related impairment (GCPS scores) in the overall study sample including both clinic community cases (Spearman correlation=0.129,  $p=0.000$ ), but the results of the correlation analyses performed on the clinic sample alone were not significant (Spearman correlation=-0.018,  $p=0.618$ ). Predictors for high disability were related to axis II findings (severe depression and somatization) or psychosocial aspects related to the pain experience (pain lasting from more than 6 months; treatment-seeking behavior), while none of the axis I diagnoses remained in the final logistic regression model. The final model predicted the level of pain-related impairment at a fair level ( $R^2=26.7\%$ ). The correlation between axis I diagnoses and pain-related impairment is not significant in the patients populations. Treatment-seeking behavior and other factors related with the pain experience are likely to be more important than the physical findings to determine the degree of psychosocial impairment.

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## Introduction

Since the time of their introduction, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) have received a lot of attention as a useful tool to

standardize TMD diagnosis for research purposes [1]. The RDC/TMD classification provides guidelines for a dual-axis assessment, with both a physical and a psychosocial appraisal, and it was adopted in many clinical investigations for epidemiological [2–6] and diagnostic homogeneity purposes [7–10]. Also, efforts have been made to translate the RDC/TMD guidelines in many languages in order to broaden the diffusion of a standardized taxonomy on TMD [11–13].

The main strength of the RDC/TMD lies in the importance given to the assessment of pain-related disability as well as of depression and somatization levels, which are all known to be key factors for TMD pain onset and clinical appearance [14, 15]. RDC/TMD axis II puts attention on such psychosocial symptoms, and it was used in several studies describing high levels of depression and somatization [16–20] as well as high prevalence of pain-related disability in social activities in TMD patients [21, 22]. Reportedly, the assessment tools included in the axis II are well-integrated and correlate with each other, viz., scores in pain-related impairment increases with those in depression and somatization scales [23] and that psychosocial factors are important predictors of treatment outcome [24, 25].

Notwithstanding, little information is available on the correlation of axis II psychosocial findings with physical diagnoses drawn from axis I, the assessment of which should be helpful to try identifying clinical predictors of high pain-related disability. Obtaining such information on the basis of data gathered over the years by using of the RDC/TMD assumes additional value if one considers the upcoming revision of the diagnostic guidelines, which will hopefully integrate knowledge on the prevalence and relationship of the different axis I and II diagnoses for a better usefulness during clinical decision making processes [26].

To this aim, and as part of an ongoing multicenter investigation involving four highly-specialized tertiary clinics for TMD and orofacial pain treatment, retrospective analysis of axis I and axis II data gathered on clinic and community cases were assessed with a twofold aim: (1) to search for a correlation between axis I diagnoses and axis II pain-related disability, the null hypothesis being that axis I and II findings are not related; and (2) to identify clinical (axis I) and psychosocial (axis II) predictors of high pain-related disability.

## Materials and methods

### Study design

Two samples of patients seeking treatment for TMD (clinic cases) and a sample of general population subjects (community cases) were recruited according to the modalities described below. All participants underwent a thor-

ough assessment in accordance with the RDC/TMD version 1.0 [1] guidelines to receive both axis I and axis II diagnoses. The Italian, Hebrew, and Finnish language versions of the RDC/TMD, as available on the RDC/TMD consortium website [27], were adopted in the Padova, Tel Aviv, and Helsinki samples, respectively.

Axis I diagnoses were based on the following diagnostic groups: group I ((a) myofascial pain, (b) myofascial pain with limitation in mouth opening), group II ((a) disk displacement with reduction, (b) disk displacement without reduction with limited opening, (c) disk displacement without reduction without limited opening); and group III ((a) arthralgia, (b) osteoarthritis, (c) osteoarthrosis).

Axis II diagnoses were based on scores of the following instruments: chronic pain grades, based on Graded Chronic Pain Scale (GCPS) scores (0, no disability; I, low disability, low intensity; II, low disability, high intensity; III, high disability, moderately limiting; and IV, high disability, severely limiting) [28]; depression levels, based on the so-called Depression Scale (DEP) of the Symptoms-Checklist-90R (SCL-90R) [29] (normal, moderate, severe depression); and non-specific physical symptoms (viz., somatization) levels, based on the so-called Somatization Scale (SOM) of the SCL-90R (normal, moderate, severe somatization). For a detailed description of diagnostic and scoring criteria, readers are referred to the original RDC/TMD publication [1] and to the successive studies [22, 30], some of which have raised concerns that should be taken into consideration when revising the current RDC/TMD guidelines [26].

### Clinic cases

The clinic cases consisted of a patient population attending either the TMD Clinic, University of Padova, Italy, during the period from January 1st, 2007 to June 31st, 2009 ( $N=803$ ; 79% females; mean age  $39.8\pm 15.4$ , range 18–81), or the Orofacial Pain Clinic, University of Tel Aviv, Israel, during the period from January 1st, 2001 to December 31st, 2004 ( $N=509$ ; 78% females; mean age  $33.3\pm 15.8$ , range 11–84) to seek treatment for TMD. Both centers serve as tertiary clinics for patients' referral from vast areas around their location, and investigators responsible for the RDC/TMD assessments have been involved in previous publications on RDC/TMD-related epidemiological and diagnostic issues [5, 6, 10, 31].

### Community cases

The community cases were recruited from among employees of the Finnish Broadcasting Company Ltd. in accordance to a strategy described in detail elsewhere [32, 33]. A total of 211 subjects (53% females; mean age  $46\pm 6$ , range 30–55) underwent an RDC/TMD assessment at the company's

dental clinic performed by a calibrated researcher from the Department of Stomatognathic Physiology and Prosthetic Dentistry, Institute of Dentistry, University of Helsinki, Finland. Subjects who received at least an axis I diagnosis were identified as community cases who did not seek for treatment, in contrast with the patients attending the two above clinics, who showed a treatment-seeking behavior and were thus considered clinic cases. The rationale for inclusion of a community group was to assess for the importance of treatment-seeking behavior as a predictor of pain-related impairment.

### Statistical analysis

For each sample, the prevalence of axis I and axis II diagnoses were described. Spearman's test was performed to assess the level of correlation between axis I diagnoses and GCPS pain-related impairment. Statistical significance was set at  $p < 0.05$ .

The study sample was then split into two groups, based on GCPS scores, which were assumed as markers of treatment need: subjects with high pain-related impairment (GCPS grades III and IV) and subjects with low disability or no disability at all (GCPS grade 0, I, and II). The thus created dichotomous variable was adopted as the dependent variable to be identified by the following predictors in a binary logistic regression model, performed on data from 821 subjects due to some missing data in some of the clinical records: sex; pain duration, viz., less than 6 months vs. equal to or more than 6 months; myofascial pain (axis I group Ia diagnosis); myofascial pain with limited opening (axis I group Ib); disk displacement with reduction (axis I group IIa); disk displacement without reduction with limited opening (axis I group IIb); disk displacement without reduction without limited opening (axis I group IIc); arthralgia (axis I group IIIa); osteoarthritis (axis I group IIIb); osteoarthritis (axis I group IIIc); depression levels (axis II SCL-DEP scores), viz., normal-moderate vs. severe depression; somatization levels (axis II SCL-SOM scores), viz., normal-

moderate vs. severe somatization; treatment-seeking behavior, viz., clinic sample vs. community sample.

A stepwise multiple logistic regression model was used to identify the significant associations between the predictors (independent variables: sex, pain duration, myofascial pain, disk displacement with reduction, disk displacement without reduction with limited opening, disk displacement without reduction without limited opening, arthralgia, osteoarthritis, osteoarthritis, depression, somatization, treatment-seeking behavior) and the outcome (dependent variable: high pain-related disability). Selection was made among the potential predictors of positive outcome using a backward stepwise selection method. Significance needed for removal was set at  $p \geq 0.10$  and significance for re-entry at  $p \leq 0.05$ . Nagelkerke's  $R$  square ( $R^2$ ) was obtained as an estimation of the total log likelihood explained by a summation of the significant clinical factors. The log likelihood in a logistic regression model is the analog of the variance in a linear regression model, and represents the amount that the independent variables can differentiate the dependent variable.  $R^2$  represents a numerical expression of the dependent variable's (high/low pain-related disability) variance accounted for by the model constituted of the significant predictors [34].

All statistical procedures were elaborated with the Statistical Package for the Social Sciences (SPSS 15.0, SPSS Inc., Chicago, IL, USA).

### Results

The most common RDC/TMD axis I diagnoses in the clinic sample were myofascial pain (47.7%), disk displacement with reduction (36.6%), and arthralgia (33.8%). About half of the patients received multiple axis I diagnoses. Significant differences emerged in the prevalence of axis I diagnoses between the two clinic groups (chi-square,  $p < 0.001$ ). Differences were marked in particular were shown for all group III diagnoses and for the prevalence of multiple diagnoses (Table 1).

**Table 1** RDC/TMD axis I diagnoses in the total clinic sample as well as in its constituent subsamples

RDC/TMD axis I diagnoses <sup>a</sup>	Total clinic sample	Padova	Tel Aviv
Ia	47.7	48.7	46.2
Ib	14.3	11.5	18.7
IIa	36.6	39.7	31.6
IIb	6.5	9.0	2.6
IIc	6.9	8.9	3.9
IIIa	33.8	48.1	11.2
IIIb	14.1	18.7	6.9
IIIc	7.2	9.4	3.7
Multiple diagnoses	48.8	59.2	35.0

Data available on 1,312 patients (Padova,  $N=803$ ; Tel Aviv,  $N=509$ )

<sup>a</sup> The total percentage exceeds 100% due to the possibility for each single patient to receive multiple diagnoses

As regards axis II disorders, findings from the GCPS were quite similar between the two clinic groups, with about 13% of patients showing high pain-related impairment (grade III or IV) in both samples. In the overall clinic sample, prevalence of severe depression and somatization were 25.4% and 35.9%, respectively, and the percentage of patients with long-lasting (more than 6 months) pain was up to 62.2%. Significant differences emerged between the two clinic samples as regards those three variables (chi-square,  $p < 0.001$ ; Table 2). For a discussion of the data gathered on the community sample, readers are referred to dedicated descriptive studies [32, 33].

Correlation analysis showed that, if all single and combined diagnostic groups are considered, axis I findings are related with pain-related impairment (GCPS scores) in the overall study sample including both clinic and community cases (Spearman correlation = 0.129;  $p < 0.001$ ). Subjects receiving axis I group II diagnoses or no diagnoses at all had a much lower prevalence of high GCPS ratings (0.5–1.2%) with respect to subjects receiving axis I group I diagnoses, alone or combined with other groups (16.6–21.9%). Notwithstanding, the results of the correlation analyses performed on the clinic sample alone were not significant (Spearman correlation = -0.018;  $p = 0.618$ ). Differences between axis I diagnostic groups in the prevalence of high GCPS ratings decreased, even though patients with group II diagnoses were those with the lowest prevalence of high disability (4.1%; Table 3).

The logistic regression analysis allowed identifying some predictors of pain-related impairment. Predictors for high disability were all related to axis II findings (severe depression and somatization) or psychosocial aspects related to the pain experience (pain lasting from more than 6 months; treatment-seeking behavior), while none of the axis I diagnoses remained in the final logistic regression model. Among negative predictors, only disk displacement with reduction could be identified, possibly suggesting that

such diagnoses are the least compromising in terms of pain-related impairment. The final model predicts the level of pain-related impairment at a fair level ( $R^2 = 26.7\%$ ; Table 4).

## Discussion

The importance of psychosocial symptoms in TMD patients is well-recognized in the literature, with several studies showing an association between TMD pain and disorders such as depression, somatization, and anxiety [14, 15]. The RDC/TMD axis II provides useful assessment tools for a psychosocial appraisal of TMD patients and for a rating of pain-related impairment, viz., disability and limitations in an individual's everyday life [1]. Notwithstanding that, only a minority of studies addressing the issue of psychosocial disorders in TMD patients focused on the levels of pain-related impairment, because the vast majority of investigations described the levels of depression and somatization in patients with different TMD diagnoses [16–20], only few of them described the prevalence of GCPS ratings [22, 23, 35], and none of them investigated the relationship between physical findings and disability levels.

The present investigation is the first multicenter study attempting to describe the relationship of RDC/TMD axis I diagnoses with GCPS ratings, thus trying to identify predictors of disability levels in a sample comprising both clinic and community subjects. The clinic sample comprised patient populations recruited at two centers involved in several previous researches on TMD epidemiology [5, 6, 10, 31], and provided interesting data on the dual-axis RDC/TMD assessment. Some differences emerged between the Padova (PA) and Tel Aviv (TA) samples, mainly regarding the prevalence of axis I group III diagnoses (arthralgia, osteoarthritis, osteoarthritis). Such findings are partly explainable by the widespread use of imaging techniques to deepen insight into the condition of the

**Table 2** RDC/TMD axis II findings in the total clinic sample as well as in its constituent subsamples

RDC/TMD axis II diagnoses		Total clinic sample	Padova	Tel Aviv
GCPS <sup>a</sup>	0	19.3	13.7	22.5
	1	32.0	43.3	25.4
	2	35.5	29.2	39.1
	3	9.6	8.6	10.3
	4	3.6	5.2	2.8
SCL-DEP <sup>a</sup>	Normal	52.7	47.0	55.8
	Moderate	22.0	21.1	22.5
	Severe	25.4	31.9	21.7
SCL-SOM <sup>a</sup>	Normal	37.2	28.1	42.4
	Moderate	26.9	29.8	25.2
	Severe	35.9	42.1	32.3
Pain >6 months <sup>b</sup>		62.2	53.7	73.9

<sup>a</sup> Data available on 798 patients

<sup>b</sup> Data available on 884 patients

**Table 3** Percentage of patients with high pain-related disability (GCPS grade III or IV) for each RDC/TMD axis I diagnostic subgroup in the overall study sample, in the total clinic sample as well as in its constituent subsamples

RDC/TMD axis I diagnoses	Overall study sample <sup>a</sup>	Total clinic sample	Padova	Tel Aviv
0	0.5	3.3	0	4.3
I	21.9	23.9	17.3	25.7
II	1.2	4.1	13.7	1.7
III	9.6	10.1	14.8	0
I + II	8.9	9.1	12.9	8.0
I + III	17.3	17.6	16.6	18.6
II + III	8.7	8.7	9.6	5.5
I + II + III	16.6	16.6	16.2	17.6
Correlation coefficient	0.129 ( $p < 0.001$ )	-0.18 ( $p = 0.618$ )	0.028 ( $p = 0.639$ )	-0.56 ( $p = 0.210$ )

<sup>a</sup>Data available on 1,009 subjects comprising subjects from both the clinic and community samples

temporomandibular joint in the PA patients population, which allowed depicting inflammatory-degenerative disorders with an increased frequency with respect to a clinical diagnosis alone. The high prevalence of group III diagnoses characterized several studies on Italian patients populations conducted at different tertiary clinics [4, 6, 36, 37], and may find an explanation in the Italian public healthcare system which facilitates the routine use of diagnostic imaging techniques [38]. With this in mind, it should be interesting to verify if the implementation of imaging diagnoses suggested for the upcoming updated version of the RDC/TMD will improve consistency of TMJ disorders findings across different centers [26, 39]. In the present investigation, myofascial pain diagnosis was the most common axis I finding, which is in line with literature data [2, 5, 40] and with suggestions that the original RDC/TMD facilitate establishing myofascial pain diagnoses [41]. Interestingly, about half of the clinic cases patients obtained multiple axis I diagnoses, thus confirming the importance to describe the prevalence of combined muscle and joint disorders, which are a clinically important reality.

Axis II assessment provided data in line with literature findings, showing that the prevalence of the most severe rate of pain-related impairment is about 2-8% [22, 28, 42, 43]. Prevalence of axis II-diagnosed depression and somatization was about 47% and 62%, respectively, with higher prevalence in the PA sample. Also these findings are comparable with those reported in other studies, which was about 39-65% [2, 3, 18, 40] for depression and about 45-66% [18, 40] for somatization. Despite such a high portion

of patients with positive scores for depression and somatization, the view can be supported that only a small portion of TMD patients developed disabling pain with negative influences on their daily activities and that only a minority of them felt severely limited by the presence of pain.

Findings from the community sample have been described extensively in dedicated papers [32, 33, 35]. Notwithstanding that, some interesting data are worthy to be discussed, the first of which being the non-negligible prevalence of axis I group I (myofascial pain, 14%) and IIa diagnoses (disk displacement with reduction, 18%), which confirmed that some RDC/TMD diagnostic subgroups are common also in non-patient populations. Interestingly, despite a 22-32% prevalence for depression and a 25-28% for somatization, which were almost comparable to some of the above findings on patients populations, no subjects reported high pain-related disability ratings (GCPS grade III or IV). Such findings may suggest that factors other than physical ones (viz., axis I) and psychosocial diagnoses (viz., axis II scales for depression and somatization) are important to get an individual seeking advice and/or treatment for TMD. The hypothesis that the individual perception of pain-related impairment is the basis for a treatment-seeking behavior is an important field of research, since such a feature may help further discriminating between patient and non-patient populations, as already suggested for other pain disorders [44].

In the present study, axis I diagnoses were correlated with GCPS scores, but findings showed that correlation

**Table 4** Backward stepwise logistic regression analysis

Significant predictor(s)	<i>P</i> value	Odds ratio (95% C.I.)	Final model's <i>R</i> <sup>2</sup> (%)
Pain duration >6 months	0.037	1.83 (1.03-3.23)	26.7
Severe depression	0.007	2.10 (1.23-3.58)	
Severe somatization	0.001	2.65 (1.52-4.53)	
Treatment seeking behavior (being a clinic case)	0.000	18.86 (N.A.)	
Disk displacement with reduction	0.002	0.041 (0.23-0.71)	

Predictors for pain-related disability

N.A. not applicable

described in the overall sample depends by the inclusion of the community sample in the analysis, since it was not shown in the clinic population. Thus, the null hypothesis that findings of axis I are not related with the level of pain-related impairment could be rejected only at the community level; not in the clinic populations.

Such findings may suggest that a treatment-seeking behavior, which may be identified as the fact of being part of a clinic population, is the key factor to determine the degree of pain-related impairment and that, once a treatment-seeking behavior has established, the influence of the different physical axis I diagnoses on the degree of impairment is likely to be low. Findings from the logistic regression seem to confirm that pain duration and treatment-seeking behavior, viz., being a clinic case, along with depression and somatization scores, are the most accurate predictors of high pain-related disability, thus suggesting that psychosocial findings are much more relevant than physical ones to determine the level of chronic pain grades. Also, the exclusion of community cases from the logistic regression confirmed that only axis II variables are predictors for pain-related disability (data not shown). These data are in line with findings on a smaller subsample of the patients recruited for the present multicenter investigation [23], and lend a strong support to the hypothesis that axis II findings, and more in general, all emotional aspects related with the complex pain experience, are only weakly related with pain localization [18, 20, 45]. A major problem with the assumption that treatment-seeking behavior is the best predictor for high pain-related impairment is the risk for circular reasoning, viz., the risk that an alleged proof of a statement eventually involves the assumption of the statement being proved [46]. In the case under discussion, the validity of the assumption that being part of a patient population is an equivalent of having a treatment-seeking behavior and that this predicts the degree of pain-related disability needs to be tested with specific instruments for the assessment of treatment-seeking behavior, as to minimize the problem of circularity.

Notwithstanding that, the importance of the findings from the present investigation in the clinical setting should not be underestimated. The fact that the presence of pain, and not its location, is related with axis II GCPS findings is in line with what was described for depression and somatization disorders [18, 20, 45]. This provides further support to the biopsychosocial approach to TMD patients' treatment [47–49]. The success rates for TMD treatment are about 75–90% for almost all conservative and reversible approaches [50], thus suggesting that treatment effects may be partly unspecific [51]. Indeed, the majority of currently adopted therapeutic modalities share common objectives, by focusing either on the physical frames (viz., restoration of jaw function, achievement of dental and orthopedic

stability, and relief from pain) or the psychosocial frames (viz., improvement in quality of life, and reduction of psychological distress), and are almost equally applicable to both TMJ and muscle disorders, with the obvious exception of minor and major TMJ surgery procedures. Thus, it is likely that axis II findings, and in particular the degree of pain-related impairment, are actually the best predictors for treatment outcome and the most suitable assessment tools to provide tailored therapies to TMD patients, as shown by some investigations [24, 25]. In view of these considerations, it is suggested that future researches will be designed by taking into account axis II variables as key factors for treatment planning, in order to assess the relative importance of physical and psychosocial baseline assessment.

Despite the large sample size and the multicenter nature of the study, limitations of the present investigation lie in the potential lack of sociocultural and ethnic homogeneity across the samples recruited at the three tertiary centers. To avoid such occurrence, a twofold community and clinic sample should ideally be recruited for all the three centers, which is a study design with practical and logistic difficulties to be realized. Moreover, despite being all internationally recognized experts involved in previous RDC/TMD researches, calibration of the operators was not tested in this study, thus exposing it to the risk for diagnostic bias and lack of diagnostic homogeneity across centers. Future studies with calibrated operators are recommended to increase the external validity of findings, as suggested by literature data on the improvement of interexaminer reliability following calibration of the operators [52]. Also, the inclusion of other psychosocial disorders, such as anxiety and catastrophizing, in future models may help increasing the predictability of GCPS scores. Notwithstanding that, the findings are not surprising and, as described above, fit well with the present knowledge on TMD patients populations. Thus, despite the fact that the external validity of these findings need to be supported with future researches, it seems plausible that the hypothesis of a psychosocial, and not a physical, determinism of pain-related impairment may receive support from this investigation.

## Conclusions

The present multicenter investigation, performed by means of a retrospective analysis of RDC/TMD findings on two clinic samples and a community sample recruited at three tertiary centers for TMD and orofacial pain treatment, suggest that the correlation between axis I diagnoses and pain-related impairment is not significant in the patients populations. The significance of such relationship in the non-patient community sample may suggest that treatment-seeking behavior and

other factors related with the pain experience are more important than the physical findings to determine the degree of psychosocial impairment. Such suggestion was supported by a regression analysis performed on the whole sample, showing that predictors for high pain-related disability are to be found within the psychosocial sphere. The clinical impact of these findings has to be assessed with future investigations aiming to better identify both the physical and psychosocial predictors of treatment outcome.

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