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TMJ

Correlation between age, gender, and the number of diagnoses of temporomandibular disorders through magnetic resonance imaging: A retrospective observational study

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ABSTRACT

Objective: The aim of this study was to evaluate the correlation among age, gender and the number of temporomandibular disorder (TMD) findings.

Methods: The records from 228 patients with TMD were analyzed for the presence of these findings: morphological changes, disc displacement with reduction (DDWR) and without reduction (DDWOR), bone edema, effusion, and avascular necrosis. Statistical analyses were conducted using multinomial regression with a 5% significance level.

Results: DDWR was the most frequent finding. Group 1 was composed of 94 patients (41.22%), Group 2, of 67 patients (29.38%), and Group 3, of 67 patients (29.38%). Men were significantly less likely to belong to Group 3 than women ($p = 0.5517$). Older patients were slightly more likely to fall in Groups 2 and 3 than in Group 1.

Discussion: Women were shown to be more susceptible to developing a higher number of concomitant conditions than men, and the number of findings tended to increase with age.

KEYWORDS
Magnetic resonance imaging; temporomandibular joint; clinical study; diagnosis; temporomandibular joint syndrome

Introduction

Excessive forces can cause irreversible structural and morphological changes in the temporomandibular joint (TMJ), resulting in temporomandibular disorders (TMDs) [1]. This widely used term denotes a pathological dysfunction that affects a large part of the population; these disorders are considered the leading causes of orofacial pain of non-dental origin, with a prevalence in the world population reported to range from 16 to 88% [2–4]. This condition can come with or without clinical signs such as crackles and clicks in the TMJ and, in some cases, pain and limitations to opening the mouth [5,6].

TMD diagnosis is usually conducted by clinically examining the TMJ structural characteristics of each patient [7,8]. Magnetic resonance imaging (MRI), which is non-invasive, high precision, and non-ionizing, has gained prominence and has been the most used method for assessing the TMJ [6,9,10]. There is, therefore, a consensus among authors for the use of MRI to study the TMJ and its disorders [10–14]. Studies showed a sensitivity of 80% and a specificity of 97% using MRI for the assessment of the TMJ [15], in addition to providing an accuracy of 95% for the diagnosis of disc displacement and 93% for disc morphology and bone changes [16].

Scientific evidence has demonstrated that disc displacement is the most common condition to affect TMD patients, and the female gender aged between 20 and 40 years [3,6,12,17] is the most affected. Other changes that may occur in the TMJ include changes in the shape of the mandibular condyle, inflammation, osteoarthritis, and degenerative changes [10,15]. However, there are no conclusive reports in the literature regarding the age mostly affected by these conditions. Thus, the presence of TMDs follows a bell-shaped (Gauss) curve, in which the most

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severely affected patients are between 35 and 45 years old, with no significant incidence among younger and older individuals [4,18,19]. Studies are also inconclusive regarding the peak age for the onset of TMDs. Disc displacement has been shown to be more common in the 2nd and 5th decade of life [4,12,19], while osteoarthritis is more common in the 4th and 5th decades of life [3,4,12,19].

It has previously been suggested that further investigation is still required to elucidate the differences in diagnosis of patients with different ages [3,4,13]. Although several studies on patients with TMD have been performed, no attempt has been made to correlate patients' gender and age with the number of TMD imaging findings.

Therefore, the aim of this study was to evaluate whether there are any correlations among age, gender, and the number of TMD findings identified with MRI assessment. The hypotheses tested were: (I) the number of imaginologic findings will increase with age; and (II) females will present a greater number of imaging findings regardless of age.

Materials and methods

This observational cross-sectional analytical study, using secondary data, was approved by the Ethics Committee for the Research Involving Human Beings (Number 727595).

Sample

The sample comprised MRI records from 228 patients of both genders evaluated between 2005 and 2014, totaling 456 TMJ exams, collected randomly from the data of the Oral Pain and Deformity Center (CENDDOR). All subjects were clinically evaluated and diagnosed in CENDDOR, and the examinations were made by a TMD and orofacial pain specialist, according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) [17]. Clinical information was collected at that time, including the recorded painful symptoms, assessed by means of the virtual analog scale (VAS), for each TMJ.

The cases were drawn from individuals over 18 years old referred for MRI of the TMJ because of a history of clinical signs and symptoms of TMJ dysfunction, such as TMJ pain (acute or chronic, unilateral or bilateral); and/or mandibular deviation-deflection; and/or the presence of limited interincisal distance or limited mouth opening; and/or joint noise/clicking during mouth opening and closing. Patients with a clinical history of rheumatoid arthritis, agenesis, hyperplasia, hypoplasia, and/or malignant neoplasms of the mandibular condyle, bone ankylosis, as well as previous TMJ and/or any type of surgery of the face, which might interfere with image analysis, were excluded from the sample.

MRI examinations of the TMJ

MRI examinations were performed with a 1.5-T imaging system (General Electric Signa HDxt, Milwaukee, WI, USA) with the use of dual surface coils, 9 cm in diameter. Sequences were performed with T1-weighted images, employing a repetition time of 567 ms and echo time of 11.4 ms. For the T2-weighted images, a repetition time of 5200 ms and an echo time of 168.5 ms were used. The T1-weighted data were collected on a 288 x 192 dots/cm matrix, NEX = 3, whereas the T2-weighted data was collected on a 288 x 160 dots/cm matrix, NEX = 4, with a field of view (FOV) of 11 × 11 cm. The T1 weighted images can reveal anatomic details with more clarity than the T2 weighted images. Nevertheless, the T2 imaging aims to identify the possible existence of changes in the TMJ, such as the presence of edema and effusion [20].

It is important to use T1-weighted images to evaluate disc alterations; these images feature proper spatial resolution, overall providing excellent anatomical detail. This is due to an abundance of proteoglycans that will display the articular disc with a different contrast. On the other hand, the images in T2-weighted provide poor anatomical details but are indicated when aiming to diagnose joint effusion and edema [21].

T1-weighted and T2-weighted images with 3 mm slices were obtained from each TMJ in the oblique sagittal plane, perpendicular to the axis of the mandibular condyle in maximum intercuspation and maximum mouth opening. Moreover, images of the TMJ were also obtained in the oblique coronal plane, in maximum intercuspation only. In order to locate the image of the mandibular condyles (scanogram), an axial section was previously performed to obtain a parallel image to the axis of the mandibular condyle.

An individual non-ferromagnetic intermaxillary device was used in order to keep the patient relaxed, minimize movement, and maintain the maximum mouth opening previously identified in the clinical examination. The average time for the scanning procedure was 30 min.

The analyses were made in a low light environment by the same experienced radiologist, who was completely blind to the clinical diagnosis received by patients, based only on the findings on MRI. Image analyses were conducted according to the criteria defined by Larheim et al. [22] and Ahmad et al. [23].

In the images obtained from each TMJ, the presence or absence of following conditions were assessed: (1) morphological changes of the mandibular condyle and/or articular tubercle; (2) disc displacement with reduction (DDWR); (3) disc displacement without reduction (DDWOR); (4) bone edema; (5) effusion; and (6) avascular necrosis. For each patient involved in the study, the sum of the different findings was individually conducted and the data pooled together (Figures 1–4).

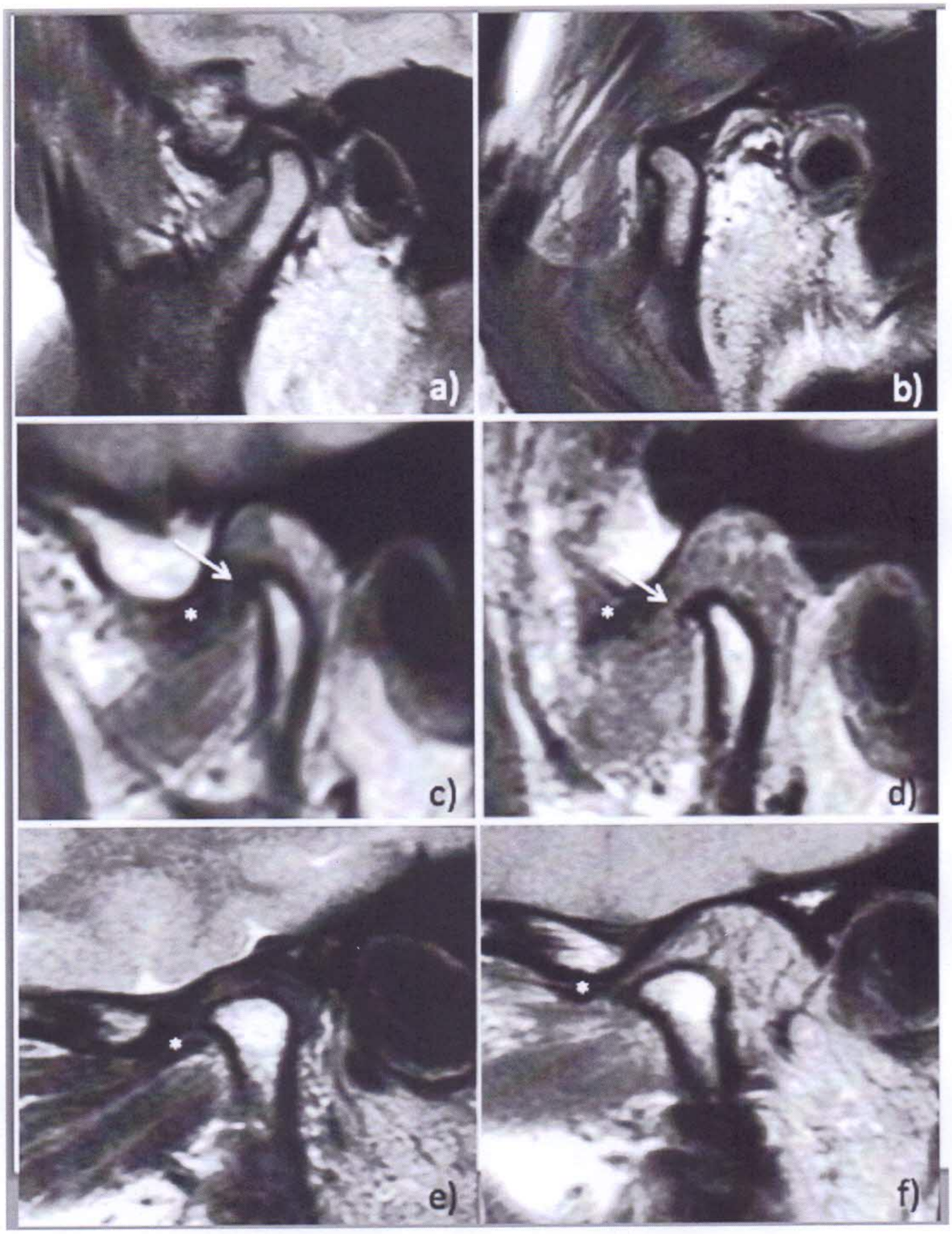

Figure 1. Oblique sagittal view of the TMJ. Normal articular disc morphology and TMJ with closed mouth (a) and open mouth (b). In the closed mouth position (c) and (e) and open mouth position (d) and (f), it is possible to see that the articular disc (asterisk) is displaced anteriorly to the condyle, characterizing DDWOR. Presence of osteophyte (c) and (d) (arrows). Morphological changes of the condyle can be noticed in (e) and (f).

Statistical analysis

In order to try to establish a correlation among the number of MRI findings with age and gender, a multinomial regression model (Wald test) was applied to the data, in which the groups with the highest number of patients (Group 1 and female gender) were considered as the reference categories for comparison. Tests were performed at a level of significance set at 5% with SAS, version 9.3.

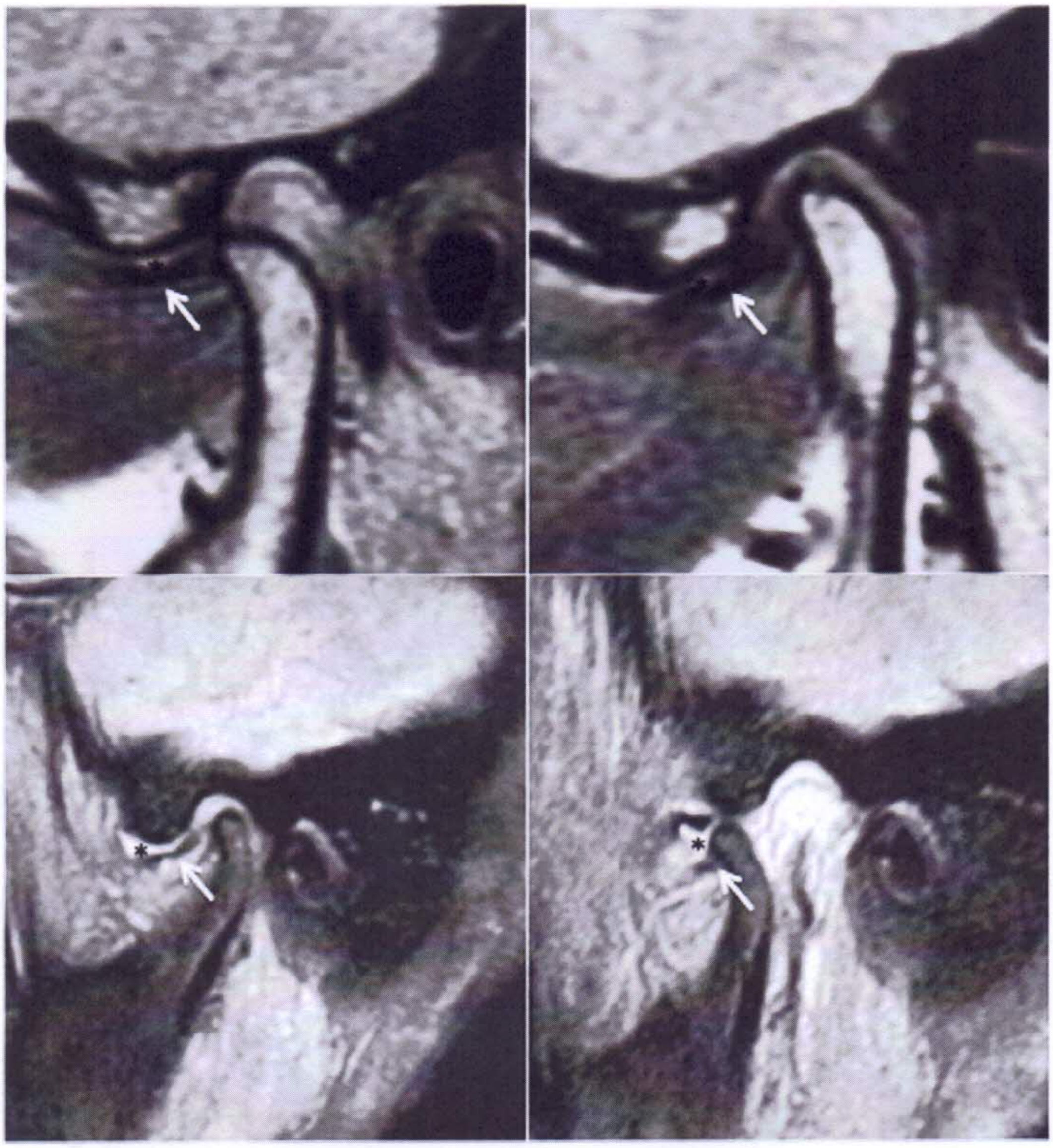

Figure 2. Oblique sagittal view of the TMJ (a) and (b), and T2 images of the TMJ (c) and (d). In closed mouth position in (b) and (c), the articular disc can be seen anteriorly to the condyle (arrows). In closed mouth and open mouth positions (c) and (d), the presence of joint effusion in the upper compartment (asterisk) can be seen, and the articular disc is positioned anteriorly to the condyle, characterizing DDWOR.

Results

Of the 228 participating patients (mean age 42.8 ± 16.15 years), 158 (69.3%) were female (mean age 44.45 ± 16.28 years), and 70 (30.7%) male (mean age 39.09 ± years).

DDWR was the most frequently detected condition both in isolation (90 patients) and in association with other findings (194 patients), followed by morphological changes (83 patients) and effusion (74 patients). DDWR and DDWOR were observed either alone or in association with one or more findings. Morphological alterations, bone edema, effusion, and avascular necrosis, on the other hand, were always observed in association with one or more findings, but never alone. Proportionally, DDWR, effusion, edema, and avascular necrosis were more commonly found in men, while morphological alterations and DDWOR were more common in women (Table 1).

The absolute and relative frequency distribution of MRI findings of the TMJ among the patients analyzed is shown in Table 2. One male patient presented no MRI findings, while three female patients presented five findings. Overall, one finding presented the highest frequency (93

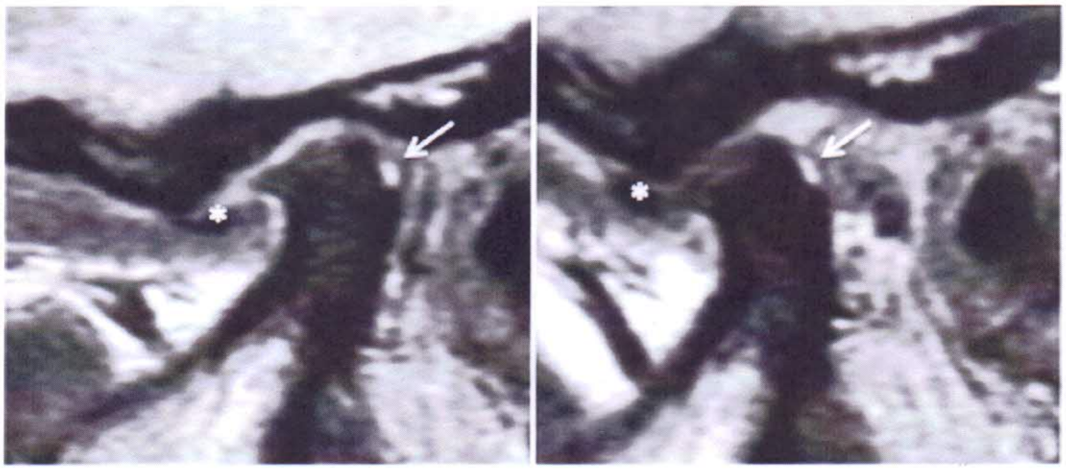

Figure 3. Oblique sagittal view of the TMJ. In both closed mouth position (a) and open mouth position (b), the articular disc is displaced anteriorly to the condyle, characterizing DDWOR (asterisk). Presence of morphological changes of the condyle, with characteristics of avascular necrosis (arrows) can also be seen.

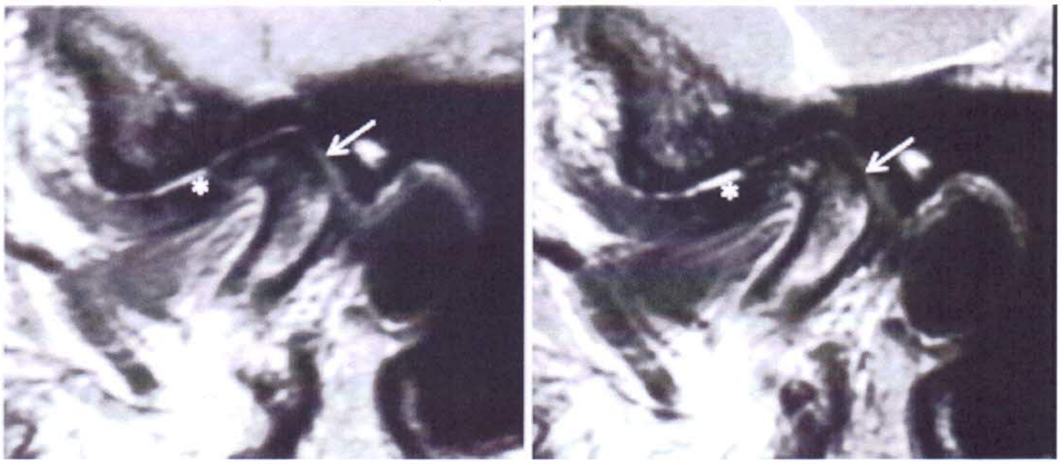

Figure 4. Oblique sagittal view of the TMJ. Closed mouth position (a) and open mouth position (b) with an important limitation of the articular disc-condyle complex. In both positions, the articular disc is displaced anteriorly to the condyle, characterizing DDWOR (asterisk). Morphological changes of the condyle with the presence of bone edema (arrows) are also present.

Table 1. MRI findings of the TMJ and their association to other pathologies.

Findings	Alone	1	2	3	4	Female *N* (%)	Male *N* (%)	Total *N* (%)
DDWR	90	51	32	18	3	135 (69.58)	59 (30.41)	194 (85.08)
MA	0	25	37	18	3	61 (73.49)	22 (26.50)	83 (36.40)
Effusion	0	29	28	14	3	50 (67.56)	24 (32.43)	74 (32.45)
DDWOR	3	24	36	18	3	65 (77.38)	19 (22.61)	84 (36.84)
Edema	0	4	1	4	2	9 (81.81)	2 (18.18)	11 (4.82)
AN	0	1	1	4	1	5 (3.16)	2 (4.88)	7 (3.07)

MRI: magnetic resonance imaging; TMJ: temporomandibular joint; DDWR: disc displacement with reduction; MA: morphological alterations; DDWOR: disc displacement without reduction; AN: avascular necrosis.

patients, 40.78%), followed by two findings (67 patients, 29.38%), and three findings (45 patients, 19.73%). A greater proportion of men presented one and two findings, while a greater proportion of women presented between three and five findings.

Due to the low prevalence of individuals with zero, four and five findings, patients were grouped together into three categories: Group 1 (≤1 finding); Group 2 (2 findings); and Group 3 (≥3 findings) for the application of the multinomial regression analysis (Table 3).

Table 2. Absolute (*N*) and relative (%) frequency distribution of MRI findings of the TMJ among patients.

Findings	Patients *N* (%)	Female *N* (%)	Mean age	Male *N* (%)	Mean age
0	1 (0.5)	–	–	1 (2.44)	61
1	93 (40.78)	58 (36.71)	43.33	35 (50)	39.31
2	67 (29.38)	50 (31.64)	44.14	17 (24.28)	42.24
3	45 (19,73)	36 (22.78)	43.69	9 (12,85)	34.22
4	19 (8,33)	11 (6.96)	52.55	8 (11,42)	34.12
5	3 (1.31)	03 (1.90)	50.66	–	–
Total	228 (100)	158 (100)	44.45	70 (100)	39.09

MRI: magnetic resonance imaging; TMJ: temporomandibular joint.

Table 3. Grouping of patients for the multinomial regression analysis.

Findings	Mean age	Standard deviation
≤1	42.02	15.82
2	43.66	14.82
≥3	43.04	17.98

The estimated coefficients obtained with the logistic multinomial model (Wald test), standard errors and *p*-values are shown in Table 4. The negative coefficient seen for the variable gender indicated that when compared to women, men were less likely to belong to Groups 2 and 3. On the other hand, the positive coefficients found for the variable age indicated that older patients were slightly more likely to fall in Groups 2 and 3 than in Group 1. However, no statistically significant differences were observed among groups.

Table 5 contains the estimated relative risk (RR) ratios, which indicate the probability or risk of a given category compared to other categories. RR values below 1 for the variable gender indicated that the risk of men falling into Groups 2 and 3 was smaller when compared to women. In Group 3, particularly, the risk of men falling into this category was moderated (RR = 0.5517). RR values just above 1 found for the variable age indicated that the risk of older patients falling in Groups 2 and 3 was slightly higher when compared to Group 1.

From the results of the logistic regression, the predicted probability of men and women falling into the different categories studied (Groups 1, 2 and 3), according to age, was calculated (Figure 5). It can be noted that the probability of men falling into Group 1 (≤1 findings) and Group 2 (2 findings) was higher than that for women, and that for both genders it decreased with age. However, for group 3 (≥3 findings), the opposite occurred, with women presenting a higher probability than men. Moreover, contrary to Groups 1 and 2, the probability of both women and men falling into Group 3 increased with age.

Discussion

When it comes to the diagnosis of TMD, magnetic resonance imaging (MRI) is the tool of choice [10,19]. TMDs are a heterogenous group of conditions of non-dental origin, which can affect the TMJ and/or muscles of mastication [24]. The authors believe this is the first study to evaluate the correlation among gender, age, and number of TMD findings identified with MRI. The results found demonstrated that the number of findings tended to increase with age, in accordance with the initial hypothesis (I). However, the results also demonstrated that proportionally more men presented one or two findings than women, supporting the rejection of hypothesis (II).

Due to the low number of individuals with zero, four and five findings, these were included in the nearest category. As a result, Group 1 had 41.22% of the participants, Group 2 29.38%, and Group 3 29.38%, creating relatively homogenous groups. By organizing the number of findings in such a way, tendencies concerning gender, age, and the number of findings could be observed.

Mean age of the participants in the present study was 42.8 years, with a female/male ratio of 2.21:1. These data do not differ significantly from previous studies, which have found TMD prevalence among patients to be between 35 and 45 years [3,4] with a female/male ratio around 3:1 [3,4,10,12,18]. Several reasons have been considered in order to explain the higher number of women seeking TMD treatment than men. The threshold of pain, which tends to be lower in women than in men [25], could be one of the main reasons behind this demand. Moreover, the presence of increased intraarticular pressure in the functioning of temporomandibular joints in women, particularly concerning the presence of disc displacement, may also explain the higher frequency of TMDs in the gender [26].

Mechanical disturbances caused by morphological changes or disc displacements have been considered a major factor for the development of secondary

Table 4. Estimated coefficients, standard errors (SE) and *p* values of the multinomial regression analysis (Wald test) found for Group 2 (2 findings) and Group 3 (≥3 findings) in relation to the reference categories (Group 1 and women).

	Gender			Age		
Group	Coefficient	SE	*p*-value*	Coefficient	SE	*p*-value*
2	−0.5820561	0.3559036	0.10195852	0.003752029	0.01008771	0.7099370
3	−0.5947052	0.3558692	0.09469512	0.001367908	0.01012181	0.8924976

*p-value < 0.05 (Wald test).

Table 5. Estimated relative risk (RR) ratios and confidence intervals for Group 2 (2 findings) and Group 3 (≥3 findings) in relation to the reference categories (Group 1 and women).

	RR	RR
Group	Gender	Age
2	0.5587483 (0.2781446, 1.122437)	1.003759 (0.9841081, 1.023802)
3	0.5517252 (0.2746670, 1.108254)	1.001369 (0.9816991, 1.021433)

inflammatory and progressive degradation of the articular cartilage [27]. The fact that DDWR and DDWOR were the only conditions to be found in isolation seems to indicate that their presence may act as a trigger for other degenerative changes of TMJ components [28,29]. Disc displacement conditions have been closely and significantly related to degenerative changes of the condyle and the presence of joint effusion in patients with TMD [28]. However, such a relationship needs to be established, requiring prospective studies with long follow-up periods and the use of controls without TMDs.

The statistical analysis performed in this study demonstrated a correlation between the number of MRI findings and gender, with women being significantly more likely to have ≥3 findings than men. This might be explained by the presence of female reproductive hormones, especially estrogen [11,18]. Significantly higher serum estrogen levels have been found in patients affected by TMD when compared to healthy controls [30]. Considering the hypothesis that some joint tissues (bone, cartilage, collagen, proteins) could be a target for sexual hormones, higher levels of serum estrogen might be implicated in the physiopathology of TMD [30].

Although not statistically significant, the data also suggest that the number of alterations in the TMJ tends to increase with the patient's age. It has previously been shown that among 83 individuals who presented morphological changes of the mandibular condyle and/or articular tubercle in their MRI scans, 29 of them (39.72%) were aged over 56 years [19]. Previous studies have also suggested that bone edema is a precursor of avascular necrosis [22],

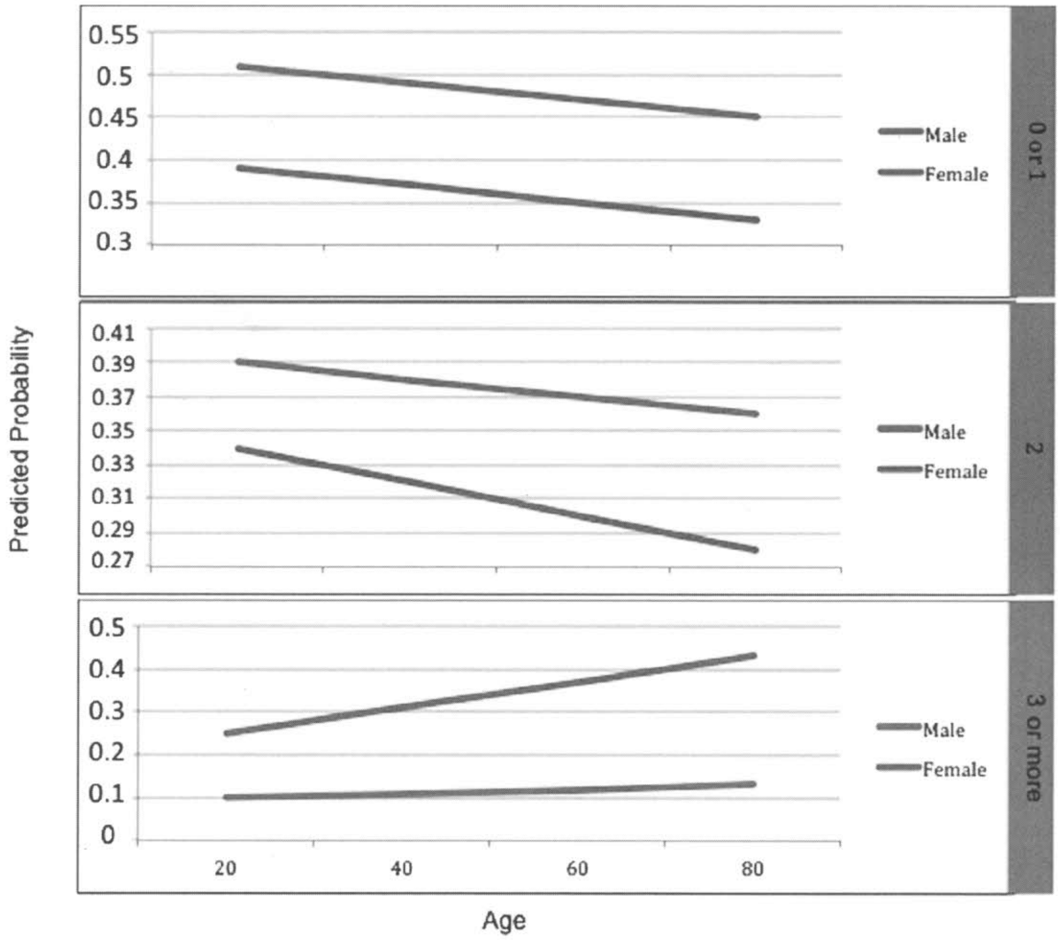

Figure 5. Predicted probabilities for women (red line) and men (blue line) according to age and for each category.

a condition that may be expected to primarily affect older individuals. Thus, considering that the majority of individuals in the analysis presented between zero and two findings (161 patients, 70.6%), it may be speculated that the increased number of findings observed with increasing age might be explained by gender-specific characteristics and the delay on patients' part to look for adequate treatment.

Conclusion

Clinically, the results of the present study seem to indicate that TMDs should receive proper attention as soon as the first signs and symptoms of the disease become apparent. Early intervention could prevent the development of further conditions correlated to disc displacement and morphological changes and avoid their evolution to more severe cases. It is also apparent that women should receive special attention, as the results seem to suggest that, due to their hormonal profile, they are more susceptible to developing a higher number of concomitant conditions. Nonetheless, further research is still required to better ascertain the relationship between the numbers of imaging findings and age in order to better understand the progression of TMD-related conditions.

Geolocation information

The present study was carried out in southern Brazil.

Disclosure statement

No potential conflict of interest was reported by the authors.

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