Archives of Psychiatry and Psychotherapy, 2019; 1: 45–58

DOI: 10.12740/APP/100435

Oral health-related quality of life and cognitive functioning in myofascial temporomandibular disorders pain

Joanna Marta Biegańska-Banaś, Józef Krzysztof Gierowski, Małgorzata Pihut, Ewa Ferendiuk

Summary

Aim: The aims of the study were to assess whether the Oral Health Related Quality of Life (OHRQoL) is decreased in patients with temporomandibular disorders –myalgic type, to evaluate to what extent myofascial pain intensity affects OHRQoL and to investigate the relationships between cognitive function and OHRQoL.

Subject or material and methods: The study included 45 patients diagnosed with the muscle-related temporomandibular disorders. The study group consisted of twenty three people with painful form of disorder. The control consisted of twenty two people without pain experience. The study was a part of a larger research project. The data to be analyzed for this article was obtained in the course of a single questionnaire survey conducted prior to the start of the treatment process.

Results: The results show that the study group suffering from myofascial pain experiences related to temporomandibular disorders of myalgic type consistently reported higher quality of life levels than the patient group who reported lack of pain experiences. In principle the better OHRQoL, the poorer cognitive functioning in most neurocognitive domains investigated in the study.

Discussion: The results, however surprising, may indicate specific relationships between factors analyzed in the study. These need to be confirmed with larger sample, taking into account general quality of patients life and psychoemotional factors.

Conclusions: OHRQoL of patients with temporomandibular disorders shows a co-variation with certain aspects of cognitive functioning. The results should be considered with a caution that is resulting from the limitations of the research sample.

cognitive functions, chronic pain, temporomandibular disorders, myofascial pain, Oral Health Related Quality of Life

[1]**Joanna Marta Biegańska-Banaś**, [2]**Józef Krzysztof Gierowski**, [3]**Małgorzata Pihut**, [3]**Ewa Ferendiuk**: [1] Jagiellonian University Medical College, Department of Psychiatry, Medical Psychology Unit SWPS University of Social Sciences and Humanities, Faculty in Poznan; [2] SWPS University of Social Sciences and Humanities, Faculty in Katowice; [3] Jagiellonian University Medical College, Department of Dental Prosthetics, Consulting Room of Functional Disorders of Masticatory Organ
Correspondence address: bieganskajm@gmail.com

INTRODUCTION

Health-related quality of life in dental practice

According to the World Health Organization (WHO), the concept of 'quality of life' (QoL) encompasses almost all aspects of human life and can be understood as an 'individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations and standards determined by features of their environment' [1, p. 1405]. Tobiasz-Adamczyk defines QoL as an 'individual's comprehensive evaluation of their physical health, psychological state, social relationships, level of autonomy and independence from other people, personal beliefs and convictions' [2, p. 36]. Analyses of quality of life in terms of state of health, disease occurrence and the natural aging process commonly employ the multidimensional concept of health-related quality of life (HRQoL), in which 'good' HRQoL means good state of health or fewer limitations in psychophysical and social functioning [3-4]. Any health-related conceptualisation of QoL should encompass three main areas: feelings (subjective sense of well-being in all areas of life); functioning (physical, cognitive and interpersonal activity) and future (anticipated changes in the other two areas) [5].

It seems especially important to include all three of these areas when considering diseases where recovery is temporary or incomplete, as in the case of temporomandibular disorders [6]. However, oral health is often defined in a narrower way; for example, Yewe-Dyer [7] describes it as a condition of the oral cavity and associated structures in which illness is currently under control, occlusion is sufficient to enable chewing, teeth are of socially acceptable appearance and future illness is inhibited. Although this definition takes account of functional and social aspects, it considers health as mere absence of illness, concentrating on the oral cavity rather than the whole patient. The literature offers varying definitions of oral health; for example, according to Dolan [8], oral health is the state of comfortable and functional dentition enabling fulfilment of desired social roles. On this view, the key elements relate to perceived comfort, placing the patient at the centre beyond consideration of their oral cavity alone. While investigations of the oral cavity may extend from the teeth to associated tissues and structures, its condition may be assessed in terms of its effects on physical, social and psychological well-being, as for example in the Canadian Dental Association's definition [9].

In general, definitions facilitate analysis of diseases of the stomatognathic system at two levels: 1) *body level* (i.e. two-way relationships between diseases in the oral cavity or facial area and those located in other places) and 2) *unit level*, where such diseases are related to overall health and well-being. As Locker [10] noted, these levels are inseparable, and oral health-related quality of life (OHRQoL) can therefore be understood as a multi-dimensional and dynamic notion. Inglehart and Bagramian [11] argued that OHRQoL (including experiences of pain) should not be described only in terms of physical condition but should also take account of relevant psychological and social factors. Sischo and Broder [12] went further in specifying the elements that must be considered when analyzing OHRQoL [12]. The widely cited theoretical model of OHRQoL proposed by David Locker [13] is perhaps also the most wide-ranging. According to Locker, the construct can be described on three levels: level of damage, average level (i.e. perceived pain, discomfort, limitations on functioning and dissatisfaction with appearance) and final impact level (i.e. disability or handicap). Locker emphasises that the third level encompasses the other two; as such, it describes individual functioning in three areas: physical, psychological (i.e. mood and emotions such as sadness and fear associated with physical limitations) and social (as in the quality of social, vocational and other interpersonal functioning). Based on this model, Patrick and Bergner [14] differentiated seven QoL dimensions: possibilities; perception of health; functional status (social, psychological and physical); dysfunction and death; and length of life.

Ongoing research on temporomandibular disorders indicates the significant effects of recurring chronic pain on social functioning, and no other aspect of OHRQoL seems to undergo such dynamic changes in the course of treatment. Interestingly, there is some evidence that objective improvement in a patient's stomatognathic system does not necessarily lead to changes in physical and functional aspects of perceived quality of life [15]. Nevertheless, improved general OHRQoL seems to depend on changes in the scope of width of mouth opening and reduction of pain [16], and it seems that pain can permanently diminish estimated quality of life, especially social aspects.

Oral health-related quality of life and cognitive functioning

Psychological functioning is a standard element in OHRQoL assessment of patients receiving prosthetic treatment, and ongoing test results suggest that psychological discomfort is a key determinant of low OHRQoL in such cases [17-18]. Similar results have been reported for patients with myofascial pain experienced in the course of temporomandibular disorders, where psychological factors generally have a more significant impact on experienced quality of life as a result of chronic pain [cf. 19-21].

As an integral part of general psychological functioning, cognitive elements are usually included in any assessment of HRQoL. A good example is Lewton's Good Life Model [22], which describes quality of life in terms of four dimensions: behavioural competence, objective environment, psychological well-being and perceived quality of life. Cognitive functioning is assessed in terms of behavioural competence, health, physical fitness, time management and social behaviour, based on physical and socio-normative criteria. Locker's theory adopts a similar approach to construct two widely used tools for assessing OHRQoL: Oral Health Impact Profile and Oral Impacts on Daily Performance [23]. This approach aligns with evidence that impaired cognitive functioning may negatively affect functional aspects of quality of life [24-25].

Cognitive functions can be defined as mental activities involved in recognising the characteristics and form of the external and internal environment and consolidating them into a coherent and relatively durable representation. Contributing to the individual's system of knowledge about the world, cognition facilitates adequate responses to changing internal and external conditions. Basic cognitive processes include perception, attention and memory while thinking (imagination), language functions, cognitive control and executive functions are more complex.

Lezak and colleagues [26] proposed a different four-dimensional typology of human cognitive performance that included an emotional dimension along with the following three cognitive domains:

- *cognitive functions*, encompassing both basic processes (perception, memory, thinking) and the so-called 'expressive' language functions (speaking, reading, writing), construction and praxis;
- *executive functions*, which are closely linked to action, including activity initiation, monitoring, modification and termination; and
- *global functions* related to behaviours that are characterised by high volatility, such as attention and psychomotor speed.

Lezak's typology has been adopted for the purposes of this study. An understanding of cognitive functions plays an important role in the subclinical presentation of changes in patients' general health, as poor executive performance affects complex task performance, including the above functions. By undermining perception and functional status accuracy, cognitive impairment affects OHRQoL. Conversely, there is evidence that improved cognitive functioning positively affects health related quality of life [27].

Cognitive functioning and quality of life in the context of chronic myofascial pain in temporomandibular disorders

Changes in cognitive functioning are often associated with the effects of pain, especially in its chronic form [28]. Reduced cognitive performance relates mainly to attention, psychomotor speed and memory [29]. Use of non-steroidal anti-inflammatory agents is known to affect cognitive functioning and appears to prevent cognitive disorders in moderate doses [30]. However, there is some evidence that up to 80% of patients suffering from chronic pain associated with temporomandibular disorders may abuse such agents [31], significantly modifying their positive effects.

Some studies have suggested that quality of life is associated with beliefs about pain rather than actual intensity, and that the content of those beliefs depends on cognitive functioning [32]. On that basis, understanding the links between pain, cognitive functioning and quality of life in patients reporting myofascial pain may be crucial for understanding their psychological state and, in turn, when planning treatment.

Although earlier research found correlations between cognitive impairment and emotional distress or emotional well-being, few studies have documented the relationship between these factors and quality of life [33-34]. There is evidence that while efficient cognitive functioning is associated with better OHRQoL, impaired cognitive functioning may be associated with dental problems of various kinds [35-38] (although this does not necessarily undermine perceived quality of life). Lame and colleagues [32] found that people with mild cognitive disorders (as measured by certain screening tools) assessed their OHRQOL as substantially better than those without cognitive disorders.

AIMS AND OBJECTIVES

In light of the above review, the purpose of the present study was to contribute to knowledge of OHRQoL among patients with muscle-related temporomandibular disorders, with particular emphasis on the characteristics of experienced pain. Analyses of pain were extended to encompass location and quality, as these characteristics have not yet been addressed in the published research on patients suffering from temporomandibular disorders. The study addressed two key research questions.

- Does the experience of myofascial pain differentiate the health-related quality of life profile of patients with temporomandibular disorders?
- How is cognitive functioning associated with health-related quality of life among patients with myofascial pain?

MATERIALS AND METHODS

Participants

The study was part of a long-term research project conducted between June 2014 and June 2016. In total, 65 subjects reporting myofascial pain syndrome were included in the project. Of these, 39 dropped out after the first phase—a retention rate of 40%. Dropout related to chance events rather than to the clinical context. The final analysis was based on data collected from 23 people aged 20–75 years (M = 35.63; SD = 12.19), including 14 women and 9 men; 2 participants were excluded because of unfinished neuropsychological assessment. The control group comprised 22 people aged 24–53 (M = 35.06; SD = 9.49), including 13 women and 9 men. Subjects were recruited from patients diagnosed with muscle-related temporomandibular disorders at the Masticatory System Functional Disorders Laboratory of the Dental Prosthetic Clinic at the Jagiellonian University Medical College. The inclusion criteria were: good general health; temporomandibular disorder with hypertension and/or pain in masticator muscles for at least 3 months; A1 Eichler classification with no previous orthodontic therapy; and provision of informed consent. The treatment group consisted of patients suffering from concomitant pain; those with no pain were assigned to the control group. Exclusion criteria were: joint component of temporomandibular disorders (pain in temporomandibular joints, acoustic symptoms); general conditions such as musculoskeletal diseases not associated with the stomatognathic system (frequent painful muscle contraction); tetanus or other conditions that would prevent participation in the study (e.g. fever); and any somatic diseases with a documented negative impact on cognitive functioning, especially neurological and mental diseases.

Study tools

The battery of tools used included the following questionnaires or scales and neuropsychological tests.

- Demographic survey—designed by the author to gather basic socio-demographic data, as well as information about some of the variables controlled for in the study, including duration of pain experience, previous treatment, pharmacological background (drugs used, doses etc.).
- Visual Analogue Scale (VAS)—a 100 mm straight line with a clearly marked beginning (no pain) and end (unbearable pain). Each participant was asked to

mark a point on the scale corresponding to the experienced severity of pain.

- Questionnaire Regarding Pain Sensations in the Masticatory Organ Dysfunctions (QRPSMOD)—an original 9-item self-report tool for collecting basic socio-demographic data, as well as information about the frequency, dynamics, location and changing intensity of pain and the use of painkillers.
- The Oral Health Impact Profile (OHIP)—a self-report tool for collecting information on dysfunctions, discomfort and disability associated with oral cavity disorders. Among the questionnaire's 49 questions, 3 concern dentures; according to the instructions, these are omitted in the case of patients who do not have this problem. As most of the participants did not wear dentures, these questions were omitted from subsequent analyses; the instructions indicated that all subsequent questions related only to experiences associated with temporomandibular disorders. The questionnaire consists of a list of potential consequences of oral disorders and their impact on everyday functioning, including functional limitations, physical pain, psychological discomfort, physical limitations, psychological limitations, interpersonal limitations and disability/impairment in relation to performing social roles (e.g. work). On a Likert-like 5-point scale, subjects were asked to indicate how often they experienced particular problems during the period indicated in the instruction (in this case, 1 month). Possible responses are: 1 (*very often/all the time*), 2 (*quite often*), 3 (*sometimes*), 4 (*hardly ever*) and 5 (*never*). The tool exhibits good reliability (Cronbach's α 0.70–0.96 for all subscales, although in one study (58), α was 0.37 for the disability subscale).

The following neuropsychological tests were also used.

- Trail Making Test (TMT)—comprising two parts (A and B), this test assesses immediate recognition of the symbolic meaning of numbers and letters, as well as the ability to repeatedly eye-search the entire worksheet to find consecutive numbers or letters under time pressure.
- Attention and Perception Test (APT)—requiring each subject to mark symbols among visually similar ones (e.g. 3s among 8s), within a time limit of 3 minutes. Each person was administered one of two equal versions of the task.
- Digit Span Test (DST)—a subscale of the Wechsler Intelligence Scale (WAIS-R(PL)), in which the subject is required to repeat 3–9 digits forward and then 2–9 digits backward. This subscale measures working memory, attention and concentration.
- Rey Auditory Verbal Learning Test (RAVLT)—the subject is required to memorise and repeat a list of 15 words. This procedure is repeated five times, and the researcher then reads out another list of 15 different words, which the subject is asked to repeat. The subject is then asked to attempt to repeat the words from the original list.
- Verbal Fluency Test (VFT)—each person is required to generate words beginning with an indicated letter for a period of 90 seconds; for the subsequent 90 seconds, they are asked to generate words belonging to a category indicated by the researcher
- Wisconsin Card Sorting Test (WCST) (computer version)—the subject is presented with 4 sample cards and must then organise up to 128 cards according to a given rule (colour, number or shape). This tool is frequently used to measure aspects of cognitive control.
- Go-No Go clinical trial (computer version)—the subject is asked to react by pushing a button when a specified letter (e.g. *p*) is presented on the screen and not to react if another letter (e.g. *r*) is presented. In the second part of the trial, the person is asked to react when they see *r* and not when they see *p*. This is a commonly used measure of cognitive control.

Procedure

Patients were invited to participate in the study by their attending physician, who obtained their consent to meet with a psychologist, who in turn briefed them on the study's purpose and procedures and asked whether they wished to participate in the study. Candidates were informed that the research goal was to study pain in temporomandibular disorders and its impact on everyday life. The study was anonymous, and participation was voluntary. Candidates were told that the results would not be used for any purpose by the medical staff. Although they were not offered any financial compensation, all participants were invited to attend five psychoeducational meetings to increase their awareness of the psychogenic factor in functional masticatory organ disorders and to improve their coping strategies. In a separate subsequent meeting, subjects were asked to complete paper-and-pencil questionnaires and to undergo a neuropsychological assessment as specified in the study procedure. Individual assessments were conducted by a trained psychologist. The full test procedure lasted about 45 minutes. The study was approved by the Bioethics Committee of the Jagiellonian University (KBET/172/B/2014).

Data analysis

The analyses performed included intergroup and intragroup comparisons. All analyses were conducted using IBM SPSS Statistic Version 22.0. Statistical significance for all tests was set at $p < 0.05$. The study (myofascial pain) group and the control (no pain) group were compared using independent (unpaired) samples t-testing. Intragroup (treatment group) comparisons were carried out using dependent (paired) samples t-testing.

RESULTS

Myofascial pain and OHRQoL

The mean VAS score in the treatment group was 4.76 with SD=2.66.

Table 1 shows the mean OHIP scores in the study and control groups. A two-sided independent samples *t*-test was added to the summary.

Table 1. Mean OHIP scores in treatment and control groups tested for statistical significance.

OHRQoL	Group				t	df	p
	study		control				
	M	SD	M	SD			
Functional symptoms (FI)	22.19	6.77	17.00	5.83	2.70*	41	0.010
Pain (P)	26.00	4.06	20.09	4.15	4.72***	41	0.000
Psychological discomfort (PD)	16.24	3.35	13.59	3.53	2.52*	41	0.016
Physical disability (PDi)	21.76	5.80	15.14	6.46	3.53**	41	0.001
Cognitive impairment (CI)	16.57	3.43	13.14	3.86	3.08**	41	0.004
Social impairment (SI)	14.38	3.93	8.64	2.95	5.44***	41	0.000
General impairment in role performance (GIRP)	18.05	5.28	11.05	4.93	4.50***	41	0.000
General indicator (GI)	135.19	27.34	98.64	20.53	4.97***	41	0.000

M: mean value; SD: standard deviation; t: t-test statistic; df: degrees of freedom; p: two-sided statistical significance; *p < 0.05; **p < 0.01; ***p < 0.001

Statistically significant intergroup differences were observed for all study variables. Mean values in the treatment group were higher than in the control group (cf. Figs.1 and 2).

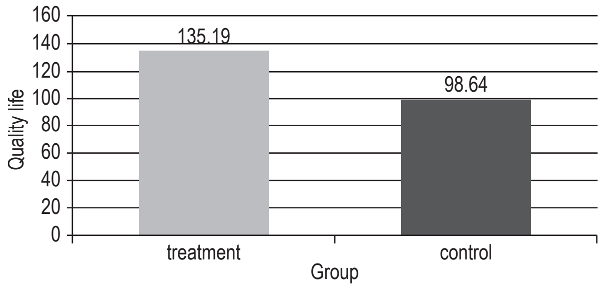

Fig. 1. Mean general OHIP scores: treatment group and control group.

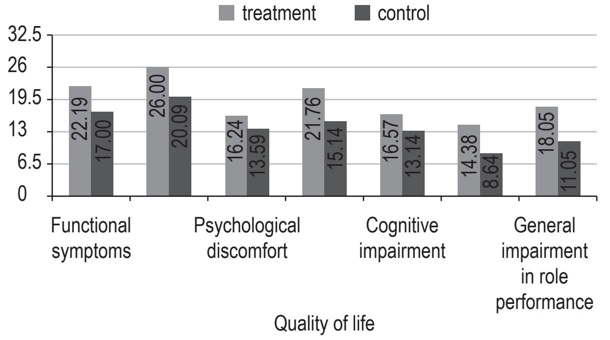

Fig. 2. Mean sub-areas OHIP scores: treatment group and control group.

Pearson's r correlation coefficients indicate positive, linear correlations between intensity of myofascial pain and functional symptoms, pain, psychological discomfort and cognitive impairment scales, as well as OHIP scores (see Table 2).

Table 2. Pearson's r correlation coefficients between the intensity of pain and the health-related quality of life with the test of statistical significance.

	Intensity of pain	
	r	p
Functional symptoms	0.487*	0.025
Pain	0.437*	0.048
Psychological discomfort	0.554**	0.009
Physical disability	0.383	0.087
Cognitive impairment	0.462*	0.035
Social impairment	0.359	0.110
General impairment in role performance	0.357	0.112
General indicator	0.513*	0.017

r: Pearson's r correlation coefficient; p: two-sided statistical significance; *$p < 0.05$; **$p < 0.01$

Statistically significant positive correlations were also observed between number of pain regions and results on OHIP scales of pain and psychological discomfort. Table 3 shows Pearson's r correlation coefficients for number of indicated pain regions and OHIP.

Table 3. Pearson's r for number of pain regions and OHIP with statistical significance test

	Number of pain regions	
	r	p
Functional symptoms	0.429	0.052
Pain	0.530*	0.013
Psychological discomfort	0.449*	0.041
Physical disability	0.275	0.227
Cognitive impairment	-0.031	0.896
Social impairment	-0.032	0.889
General impairment in role performance	0.101	0.663
General indicator	0.310	0.172

r – Pearson's r correlation coefficients; p – two-sided statistical significance; * – $p<0.05$

Cognitive functioning and OHRQoL

No statistically significant associations were found between TMT and OHIP scores, as shown in Table 4.

Table 4. Pearson's r correlation coefficients for TMT and OHIP scores with statistical significance test

Continuity of attention and alternating attention		FS	P	PD	PDi	CI	SI	GIRP	GI
Result part A	r	-0.026	0.154	0.151	0.085	0.254	0.267	0.221	0.176
	p	0.872	0.330	0.341	0.592	0.104	0.087	0.159	0.265
Result part B	r	-0.096	-0.127	-0.114	-0.164	-0.159	-0.152	-0.265	-0.193
	p	0.546	0.423	0.474	0.300	0.313	0.337	0.090	0.221

r: Pearson's r correlation coefficient; p: two-sided statistical significance

In contrast, there were some significant associations between OHIP and APT scores. Statistically significant negative correlations were observed between number of responses and psychological discomfort, physical disability, cognitive impairment, social impairment, general impairment of role performance and general health-related quality of life. Number of correct responses was negatively correlated with functional symptom score, physical disability, cognitive impairment, social impairment, general impairment of role performance and general health-related quality of life. Table 5 shows the values of Pearson's r correlation coefficients for APT and OHIP.

Table 5. Correlation coefficients for APT and OHIP with statistical significance test

Variable		FS	P	PD	PDi	CI	SI	GIRP	GI
Number of responses	r	-0.273	-0.148	-0.330*	-0.488**	-0.345*	-0.411**	-0.410**	-0.427**
	p	0.081	0.349	0.033	0.001	0.025	0.007	0.007	0.005
Number of correct responses	r	-0.366*	-0.145	-0.266	-0.421**	-0.332*	-0.471**	-0.497**	-0.449**
	p	0.017	0.359	0.089	0.005	0.032	0.002	0.001	0.003

r – Pearson's r correlation coefficients; p – two-sided statistical significance; * – p<0.05

Similarly, there were statistically significant negative correlations between working memory scores and physical disability, cognitive impairment, social impairment, general impairment of role performance and general health-related quality of life. Table 6 shows the values of Pearson's r correlation coefficients for DST and OHIP scores.

Table 6. Correlation coefficients for DST and OHIP scores with statistical significance test

Variable		FS	P	PD	PDi	CI	SI	GIRP	GI
Immediate memory	r	-0.075	-0.248	-0.145	-0.150	-0.135	-0.262	-0.228	-0.213
	p	0.649	0.127	0.377	0.363	0.412	0.107	0.162	0.193
Working memory	r	-0.274	-0.307	-0.299	-0.502**	-0.406**	-0.518**	-0.494**	-0.494**
	p	0.087	0.054	0.061	0.001	0.009	0.001	0.001	0.001

r: Pearson's r correlation coefficient; p: two-sided statistical significance; *p < 0.05

A statistically significant negative correlation between the pain scale and the number of words of the semantic category given by the end of 30 seconds was also observed. The following table shows the values of Pearson's r correlation coefficients between the VFT scores and OHRQoL (see Table 7).

Table 7. Pearson's r correlation coefficients for VFT scores and OHRQoL with statistical significance test

Verbal fluency		FS	P	PD	PDi	CI	SI	GIRP	GI
Lexical category 30 sec	r	-0.072	-0.272	-0.082	-0.106	-0.190	-0.239	-0.143	-0.186
	p	0.667	0.098	0.625	0.526	0.254	0.148	0.393	0.263
Lexical category 60 sec	r	0.022	-0.305	0.047	-0.130	-0.084	-0.216	-0.129	-0.140
	p	0.897	0.062	0.780	0.438	0.617	0.192	0.440	0.401
Lexical category 90 sec	r	0.040	-0.129	0.051	-0.246	-0.071	-0.283	-0.164	-0.149
	p	0.813	0.439	0.760	0.136	0.672	0.085	0.325	0.371
Semantic category 30 sec	r	-0.065	-0.331*	-0.117	-0.103	-0.159	-0.271	-0.232	-0.217
	p	0.699	0.042	0.483	0.538	0.339	0.100	0.161	0.190

Semantic category 60 sec	r	0.180	-0.075	0.145	0.067	0.014	-0.082	0.078	0.066
	p	0.280	0.657	0.386	0.689	0.931	0.626	0.641	0.696
Semantic category 90 sec	r	0.030	-0.120	-0.009	-0.135	-0.072	-0.222	-0.061	-0.101
	p	0.858	0.473	0.957	0.418	0.667	0.181	0.716	0.546

r: Pearson's r correlation coefficient; p: two-sided statistical significance; *p < 0.05

Some significant effects were also observed for the learning measure. To analyse the results obtained in the 1st and 2nd trials of the RAVLT, Pearson's r correlation coefficients were used. For the 3rd, 4th and 5th trials, Spearman's rank correlation coefficients were used because of a statistically significant deviation from the normal distribution. The analysis indicated a statistically significant negative correlation between cognitive impairment scores and the results obtained in the 4th RAVLT trial; other results proved insignificant (see Table 8).

Table 8. Correlation coefficients for RAVLT and OHIP scores with statistical significance test

Learning		FS	P	PD	PDi	CI	SI	GIRP	GI
1st trial	r	-0.170	-0.124	-0.109	-0.162	-0.207	-0.115	-0.198	-0.195
	p	0.289	0.439	0.498	0.312	0.195	0.472	0.214	0.223
2nd trial	r	-0.084	0.027	-0.089	-0.008	-0.179	-0.070	-0.114	-0.085
	p	0.600	0.868	0.580	0.962	0.264	0.662	0.478	0.598
3rd trial	ρ	0.062	-0.043	-0.182	0.054	-0.193	-0.122	-0.104	-0.039
	p	0.697	0.789	0.249	0.735	0.220	0.442	0.511	0.805
4th trial	ρ	0.098	-0.138	-0.049	0.024	-0.310*	-0.286	-0.246	-0.136
	p	0.538	0.384	0.758	0.881	0.046	0.066	0.116	0.390
5th trial	ρ	0.134	-0.024	-0.031	-0.010	-0.063	-0.119	-0.149	-0.053
	p	0.404	0.881	0.849	0.952	0.697	0.457	0.353	0.740

r: Pearson's r correlation coefficients; ρ: Spearman's rank correlation coefficients; p: two-sided statistical significance; *p < 0.05

Differences in Go-No Go trials and quality of life were also statistically insignificant. Table 9 shows the values of Pearson's r correlation coefficients for Go-No Go Test and OHIP scores.

Table 9. Correlation coefficients for Go-No Go Test and OHIP with statistical significance test

Variable		FS	Pain	PD	PDi	CI	SI	GIRP	GI
Correct responses	r	-0.041	0.115	-0.106	-0.100	-0.021	0.009	-0.124	-0.053
	p	0.798	0.470	0.504	0.529	0.893	0.953	0.432	0.737
Number of errors	r	-0.108	-0.263	0.066	0.052	-0.015	-0.038	0.070	-0.041
	p	0.496	0.093	0.677	0.742	0.923	0.812	0.662	0.798

r: Pearson's r correlation coefficients; p: two-sided statistical significance

However, some significant effects were observed for quality of life and WCST scores (another measure of executive function). Pain, social impairment, general impairment of role performance and general health-related quality of life scores were negatively correlated with number of perseverative responses and positively correlated with non-perseverative errors and number of trials to complete the first category. Psychological discomfort scores were negatively correlated with number of perseverative responses and perseverative errors. Results on the cognitive impairment scale were positively correlated with non-perseverative errors and number of trials to complete the first category, and negatively correlated with learning to learn (see Table 10).

Table 10. Correlation coefficients for WCST and OHIP scores with statistical significance test

Variable		Functional symptoms	Pain	Psychological discomfort	Physical disability	Cognitive impairment	Social impairment	General impairment in role performance	General indicator
Categories achieved	ρ	-0.243	-0.213	-0.017	0.003	-0.307	-0.189	-0.008	-0.131
	p	0.125	0.180	0.915	0.986	0.051	0.236	0.960	0.416
Number of trials	ρ	0.204	0.126	0.034	0.102	0.194	0.209	0.197	0.214
	p	0.201	0.432	0.832	0.527	0.224	0.190	0.217	0.180
Total number correct	ρ	-0.239	-0.171	0.058	-0.010	-0.282	-0.121	0.069	-0.083
	p	0.132	0.285	0.719	0.948	0.074	0.451	0.668	0.607
Total errors	ρ	0.257	0.150	-0.100	-0.022	0.255	0.043	-0.105	0.050
	p	0.105	0.349	0.535	0.891	0.108	0.788	0.513	0.757
Perseverative responses	ρ	0.020	-0.321*	-0.408**	-0.276	-0.287	-0.449**	-0.471**	-0.399**
	p	0.899	0.041	0.008	0.081	0.069	0.003	0.002	0.010
Perseverative errors	ρ	0.153	-0.166	-0.319*	-0.168	-0.050	-0.279	-0.405**	-0.215
	p	0.339	0.300	0.042	0.295	0.755	0.077	0.009	0.177
Nonperseverative errors	r	0.285	0.468**	0.258	0.232	0.338*	0.417**	0.360*	0.412**
	p	0.071	0.002	0.103	0.145	0.031	0.007	0.021	0.007
Trials to complete first category	ρ	0.262	0.477**	0.273	0.255	0.337*	0.401**	0.354*	0.415**
	p	0.098	0.002	0.084	0.107	0.031	0.009	0.023	0.007
Failure to maintain set	ρ	0.026	0.267	0.176	0.120	0.129	0.334*	0.317*	0.262
	p	0.870	0.091	0.271	0.456	0.423	0.033	0.043	0.097
Learning to learn	ρ	0.060	-0.115	0.059	-0.093	-0.478*	-0.335	-0.300	-0.226
	p	0.812	0.649	0.816	0.714	0.045	0.174	0.226	0.367
Conceptual level responses	r	-0.073	0.058	0.170	0.157	-0.184	0.017	0.208	0.071
	p	0.649	0.721	0.287	0.327	0.250	0.914	0.191	0.658

r: Pearson's r correlation coefficients; ρ: Spearman's rank correlation coefficients; p: two-sided statistical significance; *p < 0.05

DISCUSSION

These results show that the treatment group suffering from myofascial pain related to myalgic-type temporomandibular disorders consistently reported significantly higher quality of life than those with no pain experiences. These surprising results suggest that, in terms of oral health-related quality of life, level of experienced chronic pain may not be the most dominant symptom of such disorders, and that other variables may affect OHRQoL to a much greater degree. It may also be the case that patients within these two clinical groups perceive their OHRQoL in slightly different ways.

The study results also suggest that the more severe the myofascial pain reported by patients and the more widespread their pain experiences, the higher their rating of OHRQoL is likely to be—both globally and in terms of particular domains (pain experiences, psychological discomfort, functional symptoms, cognitive impairment). These relationships invite further investigation with a bigger study sample. In particular, it would be interesting to determine whether pain intensity itself is important in this case or whether qualities such as beliefs about pain experiences are the central issue.

One noteworthy finding is that patients who reported the lowest *quality of life dependent on oral* *health in relation to experienced pain* exhibited relatively good cognitive function—that is, they made the fewest executive mistakes and demonstrated good semantic fluency (i.e. most efficiency in generating words to fit specified semantic categories), as well as being faster at problem conceptualisation. It would be interesting to investigate the internal structure of concepts recalled by these patients during verbal fluency trials, which might provide additional insights into how they perceive and understand illness-related experiences.

Oral health-related quality of life in relation to functional symptoms of masticatory organ dysfunction (i.e. restrictions in body functions such as chewing) was rated lowest by those exhibiting most working memory and perceptual capacity—that is, cognitive functions in which speed of information processing plays a significant role. One possible explanation relates to the importance assigned to certain QoL domains by this particular group of patients. Another possible explanation relates to the cognitive frugality typical of such people—that is, those who generally display high perceptual acuity and are able to execute mental operations efficiently are equally vulnerable to the use of schemas and heuristics [39]. When asked about health-related quality of life in a medical context, they may recall the most available events (based on intuitiveness or recall of these events during multiple previous medical interviews) in reaching conclusions that may not be entirely accurate.

Similar observed relationships between OHRQoL and specific cognitive functions, and between functional symptoms and *physical dysfunctions*, may point to similar association mechanisms. Future research with a larger sample could provide additional information in this regard. Paradoxically, the present results suggest that more efficient functioning in some cognitive areas may be associated with lower ratings of *quality of life in terms of cognitive functioning*. Higher quality of life in terms of cognitive functioning was reported by people exhibiting poorer learning abilities and less efficiency in subsequent conceptualisation, who made more frequent mistakes during task completion (i.e. poorer executive performance), with less efficient working memory and less quick and thorough information processing. Although intuitively surprising, this finding can be explained by the fact that, generally speaking, people with more efficient cognitive functioning are also more aware of their own limitations in this area; this does not seem to be the case for those with actual cognitive limitations, who more frequently tend to overestimate the quality of their execution of cognitive tasks [e.g. 40]. In light of the above, it can be assumed that limitations related to experienced dysfunctions mean that people who differ in cognitive performance will also differ in how they rate their quality of life in relation to their health condition.

These differences may be grounded in differing processes of self-regulation and self-control, which play an important role in knowledge formation, awareness and recognition of one's own limitations. It is important to emphasise that all study participants exhibited relatively high baseline cognitive functioning, and many had a professional career that required a certain level of cognitive capability. Self-esteem defence mechanisms related to quality of life (especially cognitive functioning) allow those with cognitive efficiency significantly below the baseline to mask failures and maintain motivation. Similarly, lower ratings of quality of life in terms of cognitive functioning among those who are relatively capable in this regard may reflect higher levels of self-criticism and self-expectations (including those related to functioning during illness).

Clearly, we cannot rule out the influence of other intervening variables that were not controlled for here, such as experienced stress or anxiety, which may affect self-perception of cognitive efficiency in those suffering from a somatic illness [e.g. 41]. Caorne et al. [42] explained similar findings in the development of dysphoria as a result of confrontation with one's own cognitive limitations. Corwin [43] emphasised the role of negative affect (related to the disorder itself), which is already present at baseline and is linked to a decline in cognitive function. It should be noted that the patients who experience greater pain related to this type of masticatory organ dysfunction are mostly those with temporomandibular disorders and poorer cognitive test performance (including learning, executive functions, working memory and information processing) [44-46]. It is important to bear in mind that pain may not help when recalling events, including those used to rate health-related quality of life [e.g. 47-48]. There is extensive evidence that pain is one of the key determinants of HRQol, including ratings in terms of cognitive functioning [e.g. 49-50].

Quality of life depending on health condition in relation to psychological discomfort was reported as lower with higher perseveration as expressed by perseverative answers and perseverative errors, where perseveration can be understood as a tendency to repeat certain reactions, thoughts, words or behaviours. Patients who demonstrated greater perseveration perceived their quality of life as lower; similar dependencies were observed in relation to quality of life dependent on general health, as well as other aspects such as cognitive functioning, pain, interpersonal and social role performance. These findings align with results for patients with somatic diseases, who exhibit perseverance tendencies [51-52] that result in negative ratings of quality of life. This also leads to reflection and rumination on their own health, accompanied by symptoms of anxiety and mood disorders.

Aside from greater perseverance, lower *quality of life estimated in relation to social aspects* was associated with certain executive deficits, including poorer conceptual ability, higher fallibility and difficulty in maintaining consistency in task performance. It may be that these aspects of cognitive functioning contribute in particular to the disorganised social functioning of patients with masticatory system dysfunction. Interestingly, patients with poorer visual perception and auditory operational memory tend to report higher quality of life. As these dependencies align with those for quality of life estimated by disruption of social role performance, these two aspects of OHRQoL seem related. It can be assumed that quality of visual perception and auditory operational memory are especially important in subjective ratings of interpersonal and social role performance in one's own quality of life. It would be of interest to explore possible mechanisms underlying the observed dependencies.

Global ratings of quality of life dependent on oral health were characterised by a similar interdependence. Our results suggest that better auditory-verbal operational memory, efficiency of perception, and ability to conceptualise correlate with lower perceived OHRQoL. This conflicts with earlier results for patients suffering from chronic diseases [53-54] but aligns with results for patients with somatic diseases in older age [see 55-56]. This is all the more interesting because the mean age of the studied population was 35 years, making it difficult to explain in terms of age characteristics. Another relevant factor in this context, both for older patients and those experiencing chewing dysfunctions, is a preoccupation with their own health and somatic symptoms that Manfredini et al. [57] identified as a personality trait typical of the latter group. There was no interdependence between quality of oral health considered globally and continuity and metastasis of visual attention, auditory-verbal learning, direct auditory memory, lexical verbal fluency or most aspects of problem functioning and conflict management. To verify these results, it will be necessary to replicate the study with a larger number of respondents. It may also be worth considering the use of more appropriate assessment tools, especially in light of the high baseline level of cognitive functioning in the treatment group.

CONCLUSION

The experience of myofascial pain differentiates patients suffering from masticatory dysfunctions in terms of perceived health-related quality of life, which co-varies with certain aspects of cognitive functioning among patients with myofascial pain. Areas associated with perceived quality of chewing differ according to the aspect of health-related quality of life being analysed. For OHRQoL, auditory-verbal operating memory and efficiency of perception were significant factors, along with problem-solving abilities involving conceptualisation and perseveration. It seems that cognitive functions related to speed and agility of material processing and quality-related characteristics of the material processed both play a role in subjective estimates of quality of life. Given the limited sample size, these results should be interpreted with caution, and further research should focus on possible underlying mechanisms.

Conflict of interest
None declared.

REFERENCES

1. WHOQOL Group. The World Health Organization quality of life assessment (WHOQOL): Position paper from the world health organization. Soc. Sci. Med. 1995; 41: 1403–1409.
2. Tobiasz-Adamczyk B. Jakość życia w naukach społecznych i medycynie. Sztuka leczenia. 1996; 2: 33-40.
3. Schipper H, Clinch JJ, Olweny CLM. Quality of life studies: definitions and conceptual issues. in Quality of Life and Pharmacoeconomics in Clinical Trials Ed B. Spilker. Lippincott-Raven Publishers 1996; 11-23.
4. Till JE, Sutherland HJ, Meslin EM. Is there a role for preference assessments in research on quality-of-life in oncology? Qual Life Res. 1992; 1: 31-40.
5. Dziurowicz-Kozłowska A. Wokół pojęcia jakości życia. Psychologia Jakości Życia 2002, 1: 77-99.
6. Tobiasz-Adamczyk B. Geneza zdrowia, koncepcji i ewolucja pojęcia jakości życia. in: Jakość życia w chorobach układu sercowo-naczyniowego. Metody pomiaru i znaczenie kliniczne Ed. K. Kawecka-Jaszcz K., M. Klocek, B. Tobiasz-Adamczyk. Termedia, 2006; 9–42.
7. Yewe-Dyer M. The definition of oral health. Br Dent J. 1993; 174: 224-225.
8. Dolan T. Identification of appropriate outcomes for an aging population. Special Care in Dentistry 1993;13: 35–39.
9. https://www.cda-adc.ca/en/about/position_statements/
10. Locker D. Concepts of oral health, disease and the quality of life. in: Measuring oral health and quality of life Ed. G.D. Slade. Dental Ecolog ,1997; 11–24.
11. Inglehart MR, Bagramian RA. Oral health-related quality of life: an introduction. in: Oral health related quality of life Ed. M.R. Inglehart, R.A. Bagramian. Quintessence 2002; 1-6.
12. Sischo L, Broder HL. Oral Health-related Quality of Life: What, Why, How, and Future Implications. J Dent Res. 2011; 90: 1264–1270.
13. Locker D. Measuring oral health: A conceptual framework. Community Dent Health. 1988; 5: 3-18
14. Patrick DL, Bergner M. Measurement of health status in the 1990s. Ann Rev Pub Health 1990; 11:165-183.
15. Murray H, Locker D, Mock D, Tenenbaum HC. Pain and the quality of life in patients referred to a craniofacial pain unit. J Orofac Pain 1996, 10: 316-323
16. Su N, Liu Y, Yang X, Shen J, Wang H. Correlation between oral health-related quality of life and clinical dysfunction index in patients with temporomandibular joint osteoarthritis. J Oral Sci., 2016; 58: 483-490.
17. Zheng J, Wong MCM, Lam CLK. Key factors associated with oral health-related quality of life (OHRQOL) in Hong Kong Chinese adults with orofacial pain. J Dent. 2011; 39: 564–571
18. Nikolovska J, Kenig N. Oral Health Related Quality of Life (OHRQoL) in Patients Wearing Fixed Partial Dentures. Coll. Antropol. 2014; 38: 987-992.
19. Xavier SR et al. Evaluation of depressive symptoms and quality of life in individuals with tinnitus and temporomandibular disorders. Saúde e Pesquisa. 2-17; 9: 415-423.
20. Kuzmanovic Pficer J et al. Occlusal stabilization splint for patients with temporomandibular disorders: Meta-analysis of short and long term effects. PLoS ONE 2017; 12, e0171296.
21. Reissmann DR, John MT, Schierz O, Wassell RW. Functional and psychosocial impact related to specific temporomandibular disorder diagnoses. Journal of Dentistry 2007; 35: 643–650.
22. Lawton M.P. A multidimensional view of quality of life in frail elders. in The concept of measurement of quality of life in frail elders Ed. J. Birren, J. Lubben, J. Rowe, D. Deutchman. Academic Press 1991: 3-27.
23. Slade GD, Spencer AJ. Development and evaluation of the oral health impact profile. Community Dental Health 1994; 11: 3-11.
24. de Melo Ferreira AP. et al. Quality of life in women with vulvar cancer submitted to surgical treatment: a comparative study. Eur J Obstet Gyn R B 2012; 165: 91-95.
25. de STIVAL MM. et al. Fatores associados à qualidade de vida de idosos que frequentam uma unidade de saúde do Distrito Federal. Rev. Bras. Geriatr. Gerontol. 2014; 17: 395-405, 2014.
26. Lezak M. Neuropsychological Assessment. Oxford University Press 2004.
27. Verleden S, Audenaert K, Noens L. Health-related cognitive and quality of life outcomes in acute leukemia patients during chemotherapy. Blood 2011; 118: 2063.
28. Moriarty O et al. The effect of pain on cognitive function: a review of clinical and preclinical research. Prog Neurobiol 2011; 93: 385-404.
29. Hart RP. Chronic pain and neuropsychological functioning. Neuropsychol Rev. 2000; 10: 131-149.
30. Cunningham C, Skelly DT. Non-Steroidal Anti-Inflammatory Drugs and Cognitive Function: Are Prostaglandins at the Heart of Cognitive Impairment in Dementia and Delirium ? JNIP 2012, 7: 60–73.
31. Nitecka-Buchta A, Baron S. Analiza dysfunkcji układu ruchowego narządu żucia u pacjentów z klinicznie rozpoznaną migreną. Protet Stomatol. 2010; 60: 17–21.
32. Lame I.E. et al. Quality of life in chronic pain is more associated with beliefs about pain, than with pain intensity. Eur J Pain 2005; 9: 15-24.
33. Reid-Arndt SA, Hsieh C, Perry MC. Neuropsychological Functioning and Quality of Life During the First Year after Completing Chemotherapy for Breast Cancer. Psycho-Oncology 19: 535–544.

34. Plassman BL, Williams JW, Burke JR. et al. Systematic review: factors associated with risk for and possible prevention of cognitive decline in late life. Ann Intern Med. 2010; 153: 182-193.
35. Wu B, Plassman BL, Crout RJ et al. Cognitive function and oral health among community-dwelling older adults. J Gerontol A Bio Sci Med Sci. 2008; 63: 495-500.
36. Yu Y-H, Kuo H-K. Association between cognitive function and periodontal disease in older adults. J Am Geriatr Soc. 2008; 56: 1693-1697.
37. Jensen PM, Saunders RL, Thierer T et al. Factors associated with oral health-related quality of life in community-dwelling elderly persons with disabilities. J Am Geriatr Soc. 2008; 56: 711-717.
38. Silva CA, Grando LJ, Fabro SM, de Mello AL. Oral health related to quality of life patients with stomatological diseases. Stomatologija 2015; 17: 48-53.
39. Aronson E, Wilson TD, Akert RM. Psychologia społeczna. Serce i umysł. Zysk i S-ka 1997
40. Fragkiadaki S et al. Self-awareness of cognitive efficiency: Differences between healthy elderly and patients with mild cognitive impairment (MCI). J Clin Exp Neuropsych 2016; 38: 1-14.
41. Ojeda B et al. Factors influencing cognitive impairment in neuropathic and musculoskeletal pain and fibromyalgia. Pain Med 2018; 19: 499-510.
42. Carone DA, Benedict RHB, Munschauer III FE, Fishman I. Interpreting patient/informant discrepancies of reported cognitive symptoms in MS. Journal of the International Neuropsychological Society 2005; 11: 574-583.
43. Corwin J, Peselow E, Feenan K, Rotrosen J, Fieve R. Disorders of decision bias in affective disease: An effect of beta-adrenergic dysfunction? Biological Psychiatry 1990; 27: 813–833.
44. Biegańska-Banaś J, Gierowski JK, Ferendiuk E, Pihut M, Adamczyk K. In quest of the longest and most annoying pain for patients and for dentists. Quantitative and qualitative characteristics of temporomandibular myofascial pain dysfunction syndrome – questionnaire study. Health Psychology Report 2018; 6: 222-242.
45. Biegańska-Banaś J, Ferendiuk E, Gierowski JK, Pihut M. Funkcjonowanie poznawcze a ból mięśniowo-powięziowy w przebiegu zaburzeń czynnościowych narządu żucia. J Stom in press.
46. Biegańska-Banaś J, Pihut M, Gierowski JK, Ferendiuk E. Zmiany w funkcjonowaniu poznawczym jako efekt kompleksowego leczenia zaburzeń czynnościowych narządu żucia. J Stom in press.
47. Berger SE et al. Hippocampal morphology mediates biased memories of chronic pain. Neuro Image 2018; 166: 86-98.
48. Bąbel P, Pieniążek L, Zarotyński D. The effect of the type of pain on the accuracy of memory of pain and affect. European J Pain 2015; 19: 358-368.
49. Niv D, Kreitler S. Pain and quality of life. Pain Practice 2001; 1: 150–161.
50. McCarberg BH et al. The impact of pain on quality of life and the unmet needs of pain management results from pain sufferers and physicians participating in an Internet survey. Am J Ther 2008; 15: 312-320.
51. Proctor C, Maltby J, Linley PA. Strengths use as a predictor of well-being and health-related quality of life. J Happiness Stud. 2011; 12: 153-169.
52. Nolen-Hoeksema S. The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. J Abnorm Psych. 2000; 109: 504-511.
53. Solanki C, Sadana D, Arimappamagan A. et al. Impairments in quality of life and cognitive functions in long-term survivors of glioblastoma. J Neurosci Rural Pract 2017; 8: 228-235.
54. Ou R, Liu H, Hou Y. et al. Executive dysfunction, behavioral changes and quality of life in Chinese patients with progressive supranuclear palsy. J Neurol Scien 2017; 380: 182-186.
55. Zuluaga DJ, Montoya JA, Contreras CI, Herrera RR. Association between oral health, cognitive impairment, and oral health-related quality of life. Gerodontology 2012; 29: 667-673.
56. Padoani W et al. Cognitive performance and quality of life in a sample of 220 non-demented elderly people. Arch. Gerontol. Geriatr. 1998; 6: 373–380.
57. Manfredini D, Cerea S, Pavan C, Guarda-Nardini L. Personality traits are potentially associated with the presence of chronic temporomandibular joint pain in patients without effusion as determined by T-2 weighted magnetic resonance. Cranio 2018; 36: 91-97.