Beyond pain: the influence of psychological factors on functional status in fibromyalgia

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Abstract

Objective

Fibromyalgia (FM) is characterised by chronic widespread pain, often associated with fatigue, sleep disturbance, cognitive and mood impairment. Pain is a complex and multidimensional experience that significantly impacts personal, social, and professional functioning. Psychological factors related to chronic pain include catastrophising and self-efficacy in managing the painful condition. Therefore, this study explores the influence of chronic pain and related psychological factors on functional outcomes in FM patients.

Methods

In this study, 91 Italian patients with FM were assessed using an online questionnaire. The questionnaire included instruments to assess pain, such as the Numerical Rating Scale (NRS) and the Brief Pain Inventory (BPI), psychological characteristics, such as the Pain Self-Efficacy Questionnaire (PSEQ) and the Pain Catastrophizing Scale (PCS), and health-related quality of life with the 12-item Short Form Survey (SF-12). Multiple regression models were run, using the Interference subscale of the BPI and the physical and mental components of the SF-12 as outcomes, and the NRS, PCS and PSEQ scales as predictors.

Results

Our analysis revealed that in our model, both PCS and PSEQ were significant predictors of BPI-Interference (PCS: $\beta=0.29$; $p=0.001$; PSEQ: $\beta=-0.36$; $p<0.001$); NRS and PSEQ significantly predicted SF-12-Physical score (NRS: $\beta=-0.32$; $p=<0.001$; PSEQ: $\beta=0.50$; $p<0.001$); PCS was found to be the only significant predictor of SF-12-Mental scores ($\beta=-0.53$; $p<0.001$).

Conclusion

Our results suggested that psychological variables such as catastrophic thinking and self-efficacy play a significant role in determining daily functioning and physical and mental health status in FM patients, showing greater influence than pain intensity.

Key words

fibromyalgia, chronic pain, catastrophisation, self-efficacy, functional status

Clinical and Experimental Rheumatology 2024; **42**: 1224-1229.

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Received on May 3, 2024; accepted in revised form on June 10, 2024.

Funding: this work was supported by an "Unmet medical needs" grant from the Fondazione Regionale per la Ricerca Biomedica ("TechNoPain" Grant ID: 3440110). R. Ferrucci was supported by the "Aldo Ravelli" Research Center.

Competing interests: E.N. Aiello serves as an Editorial Board member for BMC Neurology.
B. Poletti received fees for consulting services and/or speaking activities from Liquidweb S.r.l., and is Associate Editor for Frontier in Neuroscience.
The other authors have declared no competing interests.

Introduction

Fibromyalgia (FM) is a condition characterised by chronic widespread pain, hyperalgesia and/or allodynia, and the presence of several tender pain points (1). The diffuse nature of pain is the main clinical feature of the disease. In addition, comorbid symptoms such as fatigue, sleep disturbances, mood disorders, cognitive impairment, and somatic symptoms are common (2). It is a pain processing disorder and a form of central sensitisation syndrome, but its aetiology remains unknown and its pathophysiology is not yet fully understood (3-5).

According to the definition of the International Association for the Study of Pains (IASP), the sensation of pain is inherently subjective and difficult to objectify because it is influenced by several factors, including previous experiences, beliefs, and biological, psychological and social factors (6). Pain is therefore a complex and multidimensional experience, resulting from the interaction of cognitive, motivational, affective and sensory components (7). It often incapacitates patients both physically and emotionally, to the extent that it alters their behaviour, life and habits, contributing significantly to negative personal, professional, and social consequences and leading to a high degree of mental illness and disability (8, 9). There is substantial evidence highlighting the importance of pain-specific psychosocial variables in shaping the experience of chronic pain (10, 11). These factors play a pivotal role in the development, maintenance, and treatment of chronic pain conditions, along with biomedical factors (12). Individuals with FM often exhibit heightened levels of psychological alterations such as anxiety, depression, pain catastrophising, and stress which correlate with increased sensitivity to painful stimuli and challenges in coping with their condition (13). Consequently, they experience greater impairment in functioning, autonomy, and quality of life (14). Catastrophising and self-efficacy emerged as crucial factors influencing pain experience and individual vulnerability to pain-related outcomes among patients with FM (15-17). Pain catastrophising is the tendency to exaggerate the threat value or severity of the pain experienced, often manifested through magnifying the perceived threat of pain, rumination about pain episodes and their possible consequences, and feelings of helplessness (17). Catastrophising is recognised as a critical factor in amplifying pain and leading to its chronicisation, acting as a mediator between pain intensity and related emotions (18). However, there are also psychological protective factors that can enhance quality of life despite the presence of pain. These include stable interpersonal relationships, strong therapeutic alliance with the psychotherapist, effective coping skills, self-awareness, self-efficacy and disposition to accept pain (19). Self-efficacy refers to confidence in personal ability to perform specific tasks and achieve desired outcomes (20). Given the importance of psychological factors and their profound influence on chronic pain experience (21), this study aims to explore the influence of chronic pain and related psychological factors on functional outcomes in FM patients.

Methods

Participants

We examined 91 patients with FM using a digital questionnaire (22). Responses were recorded between May 2023 and October 2023 and participants came from all over Italy. Patients of both sexes, older than 18 years, were included. The research was approved by the appropriate ethics committee of Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico (Ethics Committee Milan Area 2) and informed consent was obtained from all participants.

Materials

After consenting to the processing of personal data, participants received a link directly on their devices that enabled them to access an online questionnaire. The structure of the questionnaire had two sections: the first consisted of a series of closed and open questions to collect pain-related, clinical and socio-demographic data; the second consisted of five structured psychometric instruments to assess specific chronic pain-related measures and psychological characteristics. There were single-choice, multi-option, open-ended, graded, or Likert scale responses throughout the questionnaire.

Patients were administered various pain- and health-related instruments, illustrated below:

Numerical Rating Scale (NRS) (23) was used to measure pain severity and mood. The subjects graphically indicated on a predetermined line 10 cm long the number that corresponds to the degree of pain experienced or mood felt from 0 to 10, with higher scores indicating greater pain intensity perception for pain and better mood for mood ratings.

Pain Self-Efficacy Questionnaire (PSEQ) (24, 25). The PSEQ is a self-administered questionnaire that measures perceived self-efficacy in performing daily life activities despite the presence of pain. The patients responded to 10 statements using a 7-point Likert scale from 0 to 6. The total score ranges from 0 to 60: the higher the score, the greater self-efficacy, whereas a lower score indicates a person focused on pain. People with high self-efficacy scores are more prone to feel confident in their ability to manage chronic pain in functions such as work, social activities, household chores and pain management without medication.

Pain Catastrophizing Scale (PCS) (26). This self-administered questionnaire measures catastrophic thinking related to chronic pain. The patients rated how often they have 13 different thoughts and feelings while experiencing pain from 0 to 4. The total sum of the scores ranges between 0 and 52, with higher total scores indicating more catastrophic thinking.

Brief Pain Inventory (BPI) (27, 28). This self-administered questionnaire assesses pain severity and its impact on quality of life through 15 questions. The patients responded using a 10-point Likert scale, with higher scores indicating greater pain severity and greater interference with that aspect of life.

Short Form Survey (SF-12) (29) is a health-related quality of life assessment tool used to measure the physical and mental health of patients. Synthetising the 12 items' scores two indices of health status are obtained: physical state (Physical Component Summary, PCS) and mental health (Mental Component Summary, MCS). The lower the score on each index, the more impaired physical and mental health.

Table I. Patients background and clinical characteristics.

n.	91
Age (years)	37.4±11.8 (18-62)
Sex	
Male	1.1%
Female	98.9%
Education	
Middle school	6.6%
High school	56%
Bachelor's degree	18.7%
Master's degree	13.2%
Post-lauream	5.5%
Civil status	
Single/married/cohabiting/widowed	36.2%/23.1%/38.5%/2.2%
Smoking status	
Yes/no	26.4%/73.6%
Comorbidities	
Yes/no	76.9%/23.1%
Prophylactic pharmacotherapy	
Yes/no	82.4%/17.6%
Acute pharmacotherapy	
Yes/no	93.3%/7.7%
Familiarity with chronic pain	
Yes/no	72.5%/27.5%
Frequency of pain attacks experienced in the past 12 months	
Monthly/weekly/daily	16.5%/34.1%/49.5%
NRS	
Pain	7.2±1.9 (2-10)
Mood	4.3±2.7 (0-10)
BPI	
Severity	5.6±1.9 (1.5-10)
Interference	6.2±2.1 (0.7-10)
SF-12	
Physical	30.8±6.5 (15.6-49)
Mental	33.9±8.3 (15.6-62.5)
PSEQ	21.9±31.1 (0-60)
PCS	33.1±9.5 (11-52)

NRS: Numeric Pain Rating Scale; PCS: Pain Catastrophising Scale; PSEQ: Pain Self-Efficacy Questionnaire; BPI: Brief Pain Inventory; SF-12: Short Form Survey.

Statistical analysis

Each dependent variable (*i.e.* BPI-Interference, SF-12-Physical and -Mental scores) was normally distributed, as indexed by skewness and kurtosis values $<|1|$ and $|3|$, respectively (30).

Hence, in order to explore the simultaneous effect of chronic pain and psychological features on functional outcomes, multiple regression models were run by addressing, as the outcomes, BPI-Interference, SF-12-Physical and -Mental scores, and, as predictors, the NRS, the PCS and the PSEQ. Within these models, background demographic and disease-related features (*i.e.* age, comorbidities, prophylactic pharmacotherapy, acute pharmacotherapy and frequencies of pain attacks), were entered as covariates.

Within all the models, collinearity was diagnosed in the presence of both a Variance Inflation Factor (VIF) >10 and a Tolerance Index (TI) <0.10 (31).

A Bonferroni-adjusted significance threshold was addressed when selecting significant predictors within each of the models above, *i.e.* $\alpha_{adjusted}$=0.05/ numbers of target predictors (*i.e.* excluding covariates).

Analyses were run *via* jamovi 2.3 (the jamovi project, 2022).

Table II. Effects of NRS pain, PCS total and PSEQ total scores on BPI interference, SF-12 physical and mental scores as yielded by the multiple linear regression models.

	BPI Interference			SF-12 Physical			SF-12 Mental		
	β	t	p	β	t	p	β	t	p
NRS	0.18	1.93	0.056	**-0.32**	-3.43	<0.001	-0.02	-0.13	0.890
PCS	**0.29**	3.34	0.001	0.14	1.51	0.135	**-0.53**	-5.17	<0.001
PSEQ	**-0.36**	-3.97	<0.001	**0.50**	5.36	<0.001	0.10	0.91	0.365

Significant coefficient at $\alpha_{adjusted}$=0.017 are reported in bold.
NRS: Numeric Rating Scale; PCS: Pain Catastrophising Scale; PSEQ: Pain Self-Efficacy Questionnaire; BPI: Brief Pain Inventory; SF-12: Short Form Survey.

Table III. Pearson's correlations between each item of the BPI-Interference and PCS and PSEQ scores.

	9B Mood		9C Walking		9D Job skills		9E Social activities		9F Sleep		9G Pleasure of life	
	r	p	r	p	r	p	r	p	r	p	r	p
PCS	**0.42**	<0.001	**0.29**	0.005	**0.33**	0.001	**0.52**	<0.001	0.19	0.060	**0.62**	<0.001
PSEQ	**-0.44**	<0.001	**-0.44**	<0.001	**-0.56**	<0.001	**-0.45**	<0.001	**-0.31**	0.003	**-0.44**	<0.001

Significant coefficients at $\alpha_{adjusted}$=0.01 are reported in bold.
PCS: Pain Catastrophising Scale; PSEQ: Pain Self-Efficacy Questionnaire; BPI: Brief Pain Inventory.

Results

A total of 91 participants [(mean±SD) age 37.4±11.8 years, women, 98.9%] were included in the study. The patients' background, clinical and psychological characteristics are summarised in Table I.

Table II displays the results of the three separate multiple linear regression models addressing BPI-Interference, SF-12-Physical and -Mental scores as the outcomes. Within both these sets, no collinearity was diagnosed (VIF ≤1.45; TI ≥0.69). As to the model addressing BPI-Interference scores, the PCS and the PSEQ proved to be significant predictors at $\alpha_{adjusted}$=0.017 (PCS: β=0.29; t=3.34; p=0.001; β = -0.36; t = -3.97; p<.001). In the light of the fact that the BPI-Interference covers several functional domains, *i.e.* mood (item 9B), walking (item 9C), job skills (item 9D), social activities (item 9E), sleep (item 9F) and overall pleasure of life (item 9G), an off-label, data-driven set of Bonferroni-corrected, Pearson's correlations was run to test which of these domains were associated the most with PCS and PSEQ scores. The results of such analyses are reported in Table III.

At $\alpha_{adjusted}$=0.01, all the above-mentioned BPI-Interference items showed moderate-to-strong associations – based on Cohen's (32) effect size benchmarks, with PCS and PSEQ scores, except for the association between item 9F, assessing sleep and the PCS (r(91)=0.19; p=0.06).

As to the model addressing SF-12-Physical scores, the NRS and the PSEQ proved to be significant predictors at $\alpha_{adjusted}$=0.017 (NRS: β = -0.32; t= -3.43; p=<0.001; PSEQ: β=0.50; t=5.36; p<0.001), whilst the PCS was found to be the only significant predictor of SF-12-Mental scores (β=-0.53; t=-5.17; p<0.001).

Discussion

Given the significant associations between psychosocial factors and chronic pain syndromes such as FM, the present study aimed to explore the influence of chronic pain and related psychological factors on functional outcomes in FM patients. Our results showed that 72.5% of participants reported a family history of chronic pain, consistent with existing research indicating a familial component in the development of FM (33), and that half of participants experienced pain every day. Furthermore, the predominance of women in our sample supports the well-documented higher prevalence of FM in females (3).

Among the psychological determinants affecting functional outcomes associated with chronic pain, there appears to be a significant predictive pattern involving both catastrophising and self-efficacy, which influence the pain interference with daily activities, regardless of the perceived intensity of pain.

The analysis showed that an increase in the total score on the pain catastrophising (PCS) predicted an increase in the BPI-Interference scores. Therefore, a higher tendency to catastrophise in dealing with pain is associated with a greater impact on daily activities, and this is consistent with other studies that have reported pain catastrophising as a significant variable in reduced functioning in women with FM (34). Moreover, the PCS showed associations with all domains covered by the scale except sleep. This finding means that the more negative patients interpret the pain experienced and think about the possible consequences, the more impaired their mood, walking, professional skills, social activities and enjoyment of life. Interestingly, the persistent catastrophising tendency was not associated with sleep disturbances in our sample. Although sleep disturbances were initially viewed as a result of pain, recent research has shown that sleep plays an important role in the development and persistence of pain (35). Thus, our results may highlight the complex and bidirectional relationship between sleep and pain and confirm the notion that poor sleep is a risk factor in chronic pain conditions. Future research could focus on further examining the association between pain catastrophising and sleep, also assessing sleep quality and sleep disturbances in FM patients, and conducting longitudinal studies to better characterise this issue.

In addition, the PSEQ showed a moderate to strong association with all domains included in the BPI questionnaire. Furthermore, a predictive relationship was found between self-efficacy and pain interference. In fact, a decrease in pain self-efficacy scores (PSEQ) predicted an increase in pain interference scores (BPI-Interference). In other words, as self-efficacy in coping with pain decreases, self-reported interference with daily activities due to pain increases.

Conversely, an increase in confidence in one's ability to cope with pain is associated with a lower likelihood of limitation in activity and functional independence. As patients perceive themselves to be less effective, their willingness and functionality decline accordingly. This finding is supported by other studies that have found similar predictive patterns for self-efficacy and physical functioning (15, 36).

Furthermore, our analysis provided interesting insights into the impact of pain and psychological dimensions on health-related quality of life of FM patients and particularly on their physical health and mental well-being. Specifically, the results showed that the SF-12 physical score was significantly predicted by the perceived pain intensity (NRS) and the pain self-efficacy (PSEQ). Regarding the predictive role of pain intensity, the negative coefficient suggests that pain intensity has an inverse effect on perceptions of physical health, thus as the pain increases, a reduction in the perception of physical health occurs. Regarding self-efficacy, a predictive effect on the SF-12-Physical score was observed. In other words, the levels of self confidence in dealing with painful situations in daily life, managing emotional problems, or other symptoms associated with chronic pain has a significant influence on physical performance (SF-12-Physical scores), but not on mental domain of quality of life (SF-12-Mental scores). This predictive pattern indicates that the lower the confidence in managing pain in daily situations, the higher the physical disability experienced by the patients. These results suggest that there is an interplay between psychological factors and pain intensity in predicting health status (37).

Notably, the only significant predictor of SF-12-Mental scores was pain catastrophising, therefore the catastrophic thinking significantly affects the outcome of the perception of mental health. The negative sign of the coefficient indicates that as catastrophising increases, mental health scores tend to decrease. This suggests that an increase in the tendency to reflect persistently and negatively about pain is associated with a worsening in perceived mental health (38). The literature consistently supports these findings (21), as demonstrated in a recent meta-analysis (39) showing the negative effects of pain catastrophising, a key element of the fear avoidance model, and how it contributes to increased psychological distress, greater pain-related disability and higher pain intensity in individuals living with chronic pain.

It is interesting how adverse mental health outcomes are predicted by a negative affective-cognitive response to pain, such as pain catastrophising, whereas favourable physical health outcomes are predicted by a positive psychological feature, such as self-efficacy. These findings seem to suggest that the examined psychological variables exhibit a distinct impact on the two components of health-related quality of life.

The present study has some limitations. First, the size is limited and there is a lack of homogeneity, particularly regarding age and gender, which limits the generalisability of the results. The lack of representativeness of these variables may hinder extending the results to a broader and more diverse population. Furthermore, it should be noted that the questionnaire and scales used did not comprehensively consider all relevant psychosocial factors, potentially limiting the deep understanding of the phenomenon under study. Further limitations relate to the non-response bias in the questionnaire, which may have led to a distortion of the collected data. In addition, the risk of memory and self-reporting bias should be considered, as participants' answers may be influenced by the subjective interpretation of the questions. Finally, because the study design is cross-sectional, the lack of follow-up evaluations prevents the analysis and comparison of results over time, limiting the understanding of long-term dynamics and the determination of causal relationships between the variables considered.

Conclusions

In conclusion, impairment of daily functioning and physical and mental health in patients with FM appears to be more influenced by psychological variables such as catastrophic thinking and self-efficacy than by pain intensity. Pain intensity only predicts physical health status. Therefore, our results support the idea that, despite the pervasive and persistent nature of the pain condition, it is the activation of specific psychological processes that influences pain-related functional outcome.

Our results highlight the importance of a biopsychosocial approach to pain management that integrates psychosocial and behavioural interventions alongside traditional medical treatments. This approach can lead to more comprehensive care and better overall outcomes for patients with chronic pain conditions (11, 40) such as FM. Promoting interventions to increase self-efficacy and reduce pain catastrophising levels may help mitigate the impact of pain on daily functioning and autonomy. Future research could examine tailored therapeutic interventions that target maladaptive, pain-catastrophising thoughts and increase self-efficacy through skill-building exercises and goal-setting strategies (41). Targeting treatment toward improving overall functioning, in addition to pain management, can increase its overall effectiveness and improve patients' quality of life.

References

1. WOLFE F, SMYTHE HA, YUNUS MB *et al.*: The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. *Arthritis Rheum* 1990; 33(2): 160-72. https://doi.org/10.1002/art.1780330203
2. BHARGAVA J, HURLEY JA: Fibromyalgia. In: *StatPearls*. Treasure Island (FL), StatPearls Publishing, 2023.
3. CLAUW DJ: Fibromyalgia: a clinical review. *JAMA* 2014; 311(15): 1547-55. https://doi.org/10.1001/jama.2014.3266
4. GIORGI V, SIROTTI S, ROMANO ME *et al.*: Fibromyalgia: one year in review 2022. *Clin Exp Rheumatol* 2022; 40(6): 1065-72. https://doi.org/10.55563/clinexprheumatol/if9gk2
5. DI CARLO M, BIANCHI B, SALAFFI F *et al.*: Fibromyalgia: one year in review 2024. *Clin Exp Rheumatol* 2024; 42(6): 1141-49. https://doi.org/10.55563/clinexprheumatol/mbyi1n
6. RAJA SN, CARR DB, COHEN M *et al.*: The revised International Association for the Study of Pain definition of pain: concepts, challenges, and compromises. *Pain* 2020; 161(9): 1976-82. https://doi.org/10.1097/j.pain.0000000000001939
7. CHEN ZS, WANG J: Pain, from perception to action: A computational perspective. *Science*

2023; 26(1): 105707. https://doi.org/10.1016/j.isci.2022.105707

8. DUEÑAS M, OJEDA B, SALAZAR A, MICO JA, FAILDE I: A review of chronic pain impact on patients, their social environment and the health care system. *J Pain Res* 2016; 9: 457-67. https://doi.org/10.2147/jpr.s105892
9. ALCIATI A, ATZENI F, SALAFFI F, SARZI-PUTTINI P: Onset and temporal sequencing patterns of comorbidity between lifetime major depression, panic disorder and fibromyalgia. *Clin Exp Rheumatol* 2022; 40(6): 1194-201. https://doi.org/10.55563/clinexprheumatol/ryp027
10. BÖRSBO B, GERDLE B, PEOLSSON M: Impact of the interaction between self-efficacy, symptoms and catastrophising on disability, quality of life and health in with chronic pain patients. *Disabil Rehabil* 2010; 32(17): 1387-96. https://doi.org/10.3109/09638280903419269
11. MEINTS SM, EDWARDS RR: Evaluating psychosocial contributions to chronic pain outcomes. *Prog Neuropsychopharmacol Biol Psychiatry* 2018; 87(Pt B): 168-82. https://doi.org/10.1016/j.pnpbp.2018.01.017
12. BERNIK M, SAMPAIO TP, GANDARELA L: Fibromyalgia comorbid with anxiety disorders and depression: combined medical and psychological treatment. *Curr Pain Headache Rep* 2013; 17(9): 358. https://doi.org/10.1007/s11916-013-0358-3
13. GIESECKE T, WILLIAMS DA, HARRIS RE *et al*.: Subgrouping of fibromyalgia patients on the basis of pressure-pain thresholds and psychological factors. *Arthritis Rheum* 2003; 48(10): 2916-22. https://doi.org/10.1002/art.11272
14. DELL'OSSO L, BAZZICHI L, CONSOLI G *et al*.: Manic spectrum symptoms are correlated to the severity of pain and the health-related quality of life in patients with fibromyalgia. *Clin Exp Rheumatol* 2009; 27 (Suppl. 56): S57-61.
15. SAHAR K, THOMAS SA, CLARKE SP: Adjustment to fibromyalgia: The role of domain-specific self-efficacy and acceptance. *Aust J Psychol* 2016; 68(1): 29-37. https://doi.org/10.1111/ajpy.12089
16. THOMPSON DP, ANTCLIFF D, WOBY SR: The role of self-efficacy and catastrophizing in explaining improvements in disability, pain and fatigue among patients with chronic widespread pain treated with physiotherapy: An exploratory analysis. *Physiotherapy* 2022; 114: 96-102. https://doi.org/10.1016/j.physio.2021.03.009
17. VARALLO G, SUSO-RIBERA C, GHIGGIA A *et al*.: Catastrophizing, kinesiophobia, and acceptance as mediators of the relationship between perceived pain severity, self-reported and performance-based physical function in women with fibromyalgia and obesity. *J Pain Res* 2022; 15: 3017-29. https://doi.org/10.2147/jpr.s370718
18. EDWARDS RR, CAHALAN C, MENSING G, SMITH M, HAYTHORNTHWAITE JA: Pain, catastrophizing, and depression in the rheumatic diseases. *Nat Rev Rheumatol* 2011; 7(4): 216-24. https://doi.org/10.1038/nrrheum.2011.2
19. CLAUW DJ, ESSEX MN, PITMAN V, JONES KD: Reframing chronic pain as a disease, not a symptom: rationale and implications for pain management. *Postgrad Med* 2019; 131(3): 185-98. https://doi.org/10.1080/00325481.2019.1574403
20. BANDURA A, FREEMAN WH, LIGHTSEY R: Self-efficacy: the exercise of control. Springer, 1999.
21. NIMBI FM, RENZI A, LIMONCIN E, BONGIOVANNI SF, SARZI-PUTTINI P, GALLI F: Central sensitivity in fibromyalgia: testing a model to explain the role of psychological factors on functioning and quality of life. *Clin Exp Rheumatol* 2024; 42(6): 1187-97. https://doi.org/10.55563/clinexprheumatol/h8jgv3
22. CONTI L, MARZORATI C, GRASSO R *et al*.: Home-based treatment for chronic pain combining neuromodulation, computer-assisted training, and telemonitoring in patients with breast cancer: protocol for a rehabilitative study. *JMIR Res Protoc* 2023; 12(1): e49508. https://doi.org/10.2196/49508
23. JENSEN MP, MCFARLAND CA: Increasing the reliability and validity of pain intensity measurement in chronic pain patients. *Pain* 1993; 55(2): 195-203. https://doi.org/10.1016/0304-3959(93)90148-i
24. NICHOLAS M (Ed.): Self-efficacy and chronic pain. Annual Conference of British Psychological Society, St Andrews, 1989.
25. CHIAROTTO A, DEYO RA, TERWEE CB *et al*.: Core outcome domains for clinical trials in non-specific low back pain. *Eur Spine J* 2015; 24: 1127-42. https://doi.org/10.1007/s00586-015-3892-3
26. SULLIVAN MJ, BISHOP SR, PIVIK J: The pain catastrophizing scale: development and validation. *Psychol Assess* 1995; 7(4): 524. https://doi.org/10.1037//1040-3590.7.4.524
27. CLEELAND CS, RYAN KM: Pain assessment: global use of the Brief Pain Inventory. *Ann Acad Med Singap* 1994; 23(2): 129-38.
28. CARACENI A, MENDOZA TR, MENCAGLIA E *et al*.: A validation study of an Italian version of the Brief Pain Inventory (Breve Questionario per la Valutazione del Dolore). *Pain* 1996; 65(1): 87-92. https://doi.org/10.1016/0304-3959(95)00156-5
29. GANDEK B, WARE JE, AARONSON NK *et al*.: Cross-validation of item selection and scoring for the SF-12 Health Survey in nine countries: results from the IQOLA Project. International Quality of Life Assessment. *J Clin Epidemiol* 1998; 51(11): 1171-8. https://doi.org/10.1016/s0895-4356(98)00109-7
30. KIM H-Y: Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. *Restor Dent Endod* 2013; 38(1): 52. https://doi.org/10.5395/rde.2013.38.1.52
31. MIDI H, SARKAR SK, RANA S: Collinearity diagnostics of binary logistic regression model. *J Interdiscip Math* 2010; 13(3): 253-67. https://doi.org/10.1080/09720502.2010.10700699
32. COHEN J: Statistical power analysis for the behavioral sciences. Academic press, 2013. https://doi.org/10.4324/9780203771587
33. CLAUW DJ, CHROUSOS GP: Chronic pain and fatigue syndromes: overlapping clinical and neuroendocrine features and potential pathogenic mechanisms. *Neuroimmunomodulation* 1997; 4(3): 134-53. https://doi.org/10.1159/000097332
34. PASCHALI M, LAZARIDOU A, PASCHALIS T, NAPADOW V, EDWARDS RR: Modifiable psychological factors affecting functioning in fibromyalgia. *J Clin Med* 2021; 10(4): 803. https://doi.org/10.3390/jcm10040803
35. BILTERYS T, NIJS J, TANG N: Pain and Sleep: underlying mechanisms of the sleep-pain relationship. *In* JACKSON ML, DRUMMOND SPA (Eds): Advances in the Psychobiology of Sleep and Circadian Rhythms. Routledge, 2024; 141-57.
36. VAN LIEW C, BROWN KC, CRONAN TA, BIGATTI SM, KOTHARI DJ: Predictors of pain and functioning over time in fibromyalgia syndrome: an autoregressive path analysis. *Arthritis Care Res* 2013; 65(2): 251-6. https://doi.org/10.1002/acr.21792
37. SUSO-RIBERA C, GARCÍA-PALACIOS A, BOTELLA C, RIBERA-CANUDAS MV: Pain catastrophizing and its relationship with health outcomes: does pain intensity matter? *Pain Res Manag* 2017; 2017: 9762864. https://doi.org/10.1155/2017/9762864
38. WERTLI MM, BURGSTALLER JM, WEISER S, STEURER J, KOFMEHL R, HELD U: Influence of catastrophizing on treatment outcome in patients with nonspecific low back pain: a systematic review. *Spine* (Phila Pa 1976) 2014; 39(3): 263-73. https://doi.org/10.1097/brs.0000000000000110
39. ROGERS AH, FARRIS SG: A meta-analysis of the associations of elements of the fear-avoidance model of chronic pain with negative affect, depression, anxiety, pain-related disability and pain intensity. *Eur J Pain* 2022; 26(8): 1611-35. https://doi.org/10.1002/ejp.1994
40. CAPETTI B, CONTI L, MARZORATI C, GRASSO R, FERRUCCI R, PRAVETTONI G: The application of tDCS to treat pain and psychocognitive symptoms in cancer patients: a scoping review. *Neural Plast* 2024; 2024. https://doi.org/10.1155/2024/6344925
41. STUIFBERGEN AK, BLOZIS SA, BECKER H *et al*.: A randomized controlled trial of a wellness intervention for women with fibromyalgia syndrome. *Clin Rehabil* 2010; 24(4): 305-18. https://doi.org/10.1177/0269215509343247