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Published in:
Complementary Therapies in Clinical Practice

DOI:
[10.1016/j.ctcp.2018.03.008](https://doi.org/10.1016/j.ctcp.2018.03.008)

E-pub ahead of print: 15/03/2018

Document Version
Peer reviewed version

[Link to publication on the UWS Academic Portal](#)

Citation for published version (APA):
Kuvacic, G., Fratini, P., Padulo, J., Dello Iacono, A., & De Giorgio, A. (2018). Effectiveness of yoga and educational intervention on disability, anxiety, depression, and pain in people with CLBP: a randomized controlled trial. *Complementary Therapies in Clinical Practice*, 31, 262-267.
<https://doi.org/10.1016/j.ctcp.2018.03.008>

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Original article

Effectiveness of Yoga and educational intervention on disability, anxiety, depression, and pain in people with CLBP: A randomized controlled trial

ABSTRACT

Objective: The current study investigates the effects of an 8-week yoga program with educational intervention compared with an informational pamphlet on disability, anxiety, depression, and pain, in people affected by chronic low back pain (CLBP).

Methods: Thirty individuals (age 34.2 ± 4.52 yrs) with CLBP were randomly assigned into a Yoga Group (YG, n=15) and a Pamphlet Group (PG, n=15). The YG participated in an 8-week (2 days per week) yoga program which included education on spine anatomy/biomechanics and the management of CLBP.

Main outcome measures: Monitoring response to intervention, the Oswestry Low Back Pain Disability Questionnaire (ODI-I), Zung self-Rating Depression Scale (SDS), Zung Self-Rating Anxiety Scale (SAS) and Numeric Rating Scale for Pain (NRS 0-10) were used to collect data.

Results: After intervention, the YG showed a significant decrease ($p<0.05$) in the mean score in all assessed variables when compared with baseline data. In addition, statistically significant ($p<0.05$) differences were observed among groups at the end of intervention in depression, anxiety, and pain, but not in disability.

Conclusions: The yoga program and education together appear to be effective in reducing depression and anxiety, which can affect perception of pain.

Keywords: psychological factors; emotions; patient-centered; pamphlet.

1. Introduction

Low Back Pain is a pain syndrome in the lower back region and may be classified by duration as acute (pain lasting less than 6 weeks), sub-chronic (6 to 12 weeks), or chronic (more than 12 weeks; CLBP) [1,2]. CLBP is a common health problem, and is also considered to be one of the most expensive medical conditions [3–6]. In 85% of cases of low back pain, diagnosis may be sought in non-specific vertebral-mechanical disorders [7–9]. The complexity of the origin of CLBP appears to be due to two main factors: a) mechanical-degenerative origin [10], evidenced by a clinical instrumental examination [11] as well as functional impairments [12,13]; b) non-mechanical origin, including neuroplastic changes in the central nervous system at the supraspinal level [14,15]. Growing evidence in the literature suggests that the symptomatology of CLBP can be exacerbated by psychological and psychosocial factors [16,17,18]. Among these psychological and psychosocial factors are the quality of life and personal emotions, which can influence posture and body signal awareness [18–20] which can increase perception of pain [21,22].

Feuerstein and colleagues [23] studied the interaction between psychological factors (i.e. general stress, perceived social climate, family and work environments, anxiety, depression, and perceived pain) in individuals affected by CLBP compared with healthy individuals. The authors observed that the CLBP group was characterized by a higher anxiety level and by depression, with an unstable social environment (family conflict/control). The authors reported that family and work environment data were more related to perceived pain than the general stress index, as well as that good family organization and independence were associated with less depression and anxiety. Hence, it appears that CLBP cannot be completely understood and managed without taking into account psychological and psychosocial factors at the same time [24]

Boutevillain and colleagues [25] reported three main factors that influence the overall health status of CLBP individuals: physical, psychological and socio-environmental. The authors observed that physical activity was difficult for them to include in everyday life due to several aspects, including psychological variables (i.e. motivation), socio-environmental variables (i.e. lack of time), and, mainly, the existing pain. Interestingly, the authors found that supervision/monitoring during physical activity had a great influence on patients' adherence to intervention.

In this context, interesting interventions, such as yoga, have proved to play a major role in reducing depression [26–28], anxiety [29,30], and stress [31] in adult individuals. Buttner and colleagues [32] found that yoga intervention reduced stress and depression levels in postpartum women affected by depression. Similarly, Streeter and colleagues [33] found that yoga intervention improved mood and decreased anxiety in the experimental group compared to their control counterparts, who only did walking exercise. In his longitudinal study, Brems [31] demonstrated

that a 10-week yoga program (breathing, meditation, posture, for ≈ 90 minutes each session) significantly reduced the stress level in both university staff and students.

Emerging evidence suggests that reduction of stress, anxiety, and depression can help individuals with CLBP control and manage pain [34–36], and yoga intervention has been shown to be one of the most effective in reducing pain [37–39]. However, the mechanisms that lie behind these results are still unclear, and further research is needed. Chang and colleagues [40] suggested that yoga exercises can affect the individual's physical status and may stimulate the release of several hormones responsible for body wellbeing and energy, such as serotonin, cortisol, dehydroepiandrosterone, and the brain-derived neurotrophic factor [41,42]. As such, a possible decrease in pain level may appear in response to this type of exercise [43].

With regard to yoga training intervention, researchers demonstrated that seven days of a residential intensive yoga-based lifestyle program improved spinal flexibility in individuals with CLBP [44]. Some studies reported similar results in elderly women (50-79 years old) [45] and men [46]. Such intervention has also been demonstrated to reduce blood pressure and metabolic rate during rest, and to increase heart rate variability [47], with amelioration of the degree of motivation and psychological characteristics [48,49]. On the other hand, in order to improve the effectiveness of yoga interventions, it is important to include effective education about the illness itself and how to mentally manage it (i.e. patient education) [50–52].

Therefore, the purpose of this study was to investigate the role of a yoga program and education intervention in reducing disability, anxiety, depression, and pain in people with CLBP. We compared psychological outcomes with data from an informational pamphlet group based on the Zung questionnaires in participants suffering from anxiety and depression. We applied a particular yoga program, which included education on spine anatomy/biomechanics and the management of CLBP, based on contemporary yoga practices, suited to CLBP subjects, and including: a) static yoga posture to develop body awareness; b) short dynamic sequences to coordinate movement with breathing; c) meditation to train exploration of feelings and thoughts concerning the spine and basic anatomy/biomechanics.

2. Materials and methods

2.1. Participants

Thirty individuals (M=16; F=14) without previous experience in yoga/mindfulness/meditation practices participated in this study. They were randomly assigned to an experimental or yoga group (YG: M=9, F=6; mean age: 33.6 ± 4.30 yrs), or to a control group/pamphlet group (PG: M=7, F=8; mean age: 34.7 ± 4.83 yrs).

Inclusion criteria were: (1) pervasive CLBP, (2) adult age (≥ 18 years old), (3) depression and anxiety according to the Zung questionnaires. Exclusion criteria were: (1) acute low back pain (including recent thoracic-lumbar trauma), (2) specific causes of low back pain (lumbar stenosis, disc hernia, spinal deformity, fracture, spondylosis, osteoporosis of the spine), (3) current or preexisting neurologic, oncologic, or psychiatric conditions (e.g. dementia, Parkinson's disease, congenital central nervous system malformations, multiple sclerosis, tumors, schizophrenia, head trauma); (4) any previous experience in mindfulness, meditation, or yoga practice; (5) people with recent cerebrovascular accidents and myocardial infarctions; (6) obesity. Eligible participants were investigated for demographic and clinical characteristics (Table 1). Following intervention, yoga classes were offered to all the participants.

Statistical power analysis was carried out to calculate the sample size. Results showed that twelve subjects for each of two groups were required to achieve a statistical power of 80% (0.80), in order to detect a small effect ($d=0.30$) when assessed by two-way repeated-measure analysis of variance (ANOVA) with a significance level of 5% (0.05).

Table 1. Demographic and clinical data of all participants

Age: <i>Mean (min;max)</i>	34.2 (25; 42)
Gender: male; female	16; 14
Occupation	
<i>Employed</i>	20
<i>Self-employed</i>	4
<i>Domestic work</i>	4
<i>Non-employed</i>	2
Education	
<i>Elementary school</i>	0
<i>Middle school</i>	3
<i>High school</i>	8
<i>University education</i>	19
Pharmacological therapy for CLBP	
<i>Analgesic</i>	6; 7
<i>Muscle relaxant</i>	8; 3
<i>Both</i>	3; 2
Comorbidities	
Physical/ Physiotherapy therapy	10; 5
Sports	12; 7
Smoking	7; 9

2.2. Procedures

2.2.1. Yoga program and educational intervention

The YG participated in an 8-week yoga training program, two days per week. All sessions took place under the same conditions (room, light, and temperature $\approx 23^{\circ}\text{C}$) and with the same expert. During the intervention, an expert in yoga – a ‘yoga teacher’ with substantial professional experience in treating posture and back problems – monitored the training sessions.

Sessions included contemporary yoga practices suited to CLBP subjects, which included: a) static yoga posture to develop body awareness; b) short dynamic sequences to coordinate movement with breathing; c) non-yogic breathing exercises; d) education on spine anatomy/biomechanics and the management of CLBP.

The Yoga program was based on: *asanas* – selected postures for participants with CLBP, *pranayama* – a workout on the breathing experience and control, *Yoga Nidra* – a systematic method to consciously induce physical, mental, and emotional relaxation, and *Vipassana* – a mindfulness meditation from the Buddhist tradition. Each session lasted 75 minutes, and included:

- 10 minutes of education/instruction regarding the spine (biomechanical and breathing mechanisms).
- 20 minutes of sitting on a chair or on a mat, relaxing, with eyes closed; exploring feelings and aspects of the body contact and posture; focusing on breathing movement and sensations. This exercise enables preparation for controlling emotions, as well as for awareness and meditation.
- 30 minutes of performing a series of lying down, kneeling, and standing postures, including stronger postures, balance work, and forward bends, before returning to the floor for a series of supine postures.
- 10 minutes of lying-down posture, relaxing, and reducing breath frequency, in order to manage emotional surges and increase deep internal awareness.
- 5 minutes of a discussion and suggestions.

2.2.2. Pamphlet program

The PG was not informed about the intervention group. Participants in the PG received a pamphlet in which the vertebral spine and its biomechanical aspects were explained. This pamphlet also contained images of the ergonomic use of the spine during daily life and sport/recreation, as well as information on the correct way of carrying weight, correct body posture during work, and

adequate movement and body shape that should be adapted during standard, daily activities (e.g. dressing, eating, and bathing). The breathing mechanism was also explained and it was recommended to perform it at home during the same experimental period. Finally, twice per week, the participants received a 2- or 3-page newsletter with a point-by-point summary of all the details from the beginning of the research.

2.3.Measurement

Before and after the intervention, a psychological assessment was performed on all of the participants. This assessment included a questionnaire related to anxiety and depression (Zung, SAS; SDS), and a second questionnaire to evaluate back pain disability (Oswestry Low Back Pain Disability). Participants from both the YG and PG received the second questionnaire at the same session (the first meeting), so that they could evaluate pain through the NRS 0-10 scale. The post-psychological assessment was performed one week after the end of the study through an online version of questionnaires.

Oswestry Low Back Pain Disability Questionnaire, ODI-I

ODI-I is a self-administered questionnaire to assess pain-related disability in persons with low back pain [53]. It contains ten items related to: intensity of pain, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and traveling. The reliability, construct, and criterion validity of the scores of Italian participants on the ODI-I have been well established in various samples of adults [54]. The participants were asked to complete the ODI-I and give their answers based on the statement they felt applied to them. Each question is scored on a scale of 0 (minimal disability) to 5 (severe disability). A maximum score of 50 was allowed. The score obtained by an individual subject can be multiplied by 2, and this will provide a percentage score. Scores' interpretation is as follows: 0–20 = Minimal Disability; 21–40 = Moderate Disability; 41–60 = Severe Disability; 61–80 = Crippling Back Pain; 81–100 = Participants who are either bed-bound or have an exaggeration of their symptoms.

Zung Self-Rating Depression Scale, SDS

SDS is a short self-administered survey to quantify the status of depression in an individual [55]. There are 30 items on the scale that qualify the affective, psychological, and somatic symptoms associated with depression. Each question is scored on a 4-point Likert scale: 1 (only a little of the time) to 4 (most of the time). The total raw scores range from 20 to 80. The scores fall into four

categories: 20–44 = Normal Range; 45–59 = Mildly Depressed; 60–69 = Moderately Depressed; 70 and above = Severely Depressed.

Zung Self-Rating Anxiety Scale, SAS

SAS is a short self-report scale to measure an individual's anxiety level [55]. Twenty items are based on scoring in 4 groups of manifestation: cognitive, autonomic, motor, and central nervous system symptoms. When answering the statements, the participants should indicate how much each statement had applied to them within a period of one or two weeks prior to testing. Each question is scored on a 4-point Likert scale: 1 (only a little of the time) to 4 (most of the time). The total raw scores range from 20 to 80. The raw score consequently needs to be converted to an "Anxiety Index". Here, the clinical interpretation of one's level of anxiety is as follows: 20–44 = Normal Range; 45–59 = Mild to Moderate Anxiety Level; 60–74 = Marked to Severe Anxiety Level; 75–80 = Extreme Anxiety Level.

Numeric Rating Scale for Pain, NRS 0-10

This scale is based on a scale of 11 degrees (0-10), and identifies "0" as a total absence of pain and "10" as the worst aspect of pain perceived [56]. The participant was asked to give a score of from 0 to 10 to describe his/her pain.

2.4. Ethical considerations

The participants reviewed and submitted their written consent on a form specifically approved by the local Ethical Committee of the Institution. The local Scientific Committee approved the entire study design which was conducted according to the principles expressed in the Declaration of Helsinki.

2.5. Statistical analysis

All questionnaires were analyzed according to the scoring system established by the guidelines. The changes in disability, depression, anxiety, and pain across the experiments were analyzed with a two-way repeated-measure ANOVA with time (pre- and post-intervention) and group (YG and PG) as factors, together with their interaction (time×group). Analysis of the data in pre- and post-intervention between and within groups was performed through the Scheffe post-hoc analysis of interaction effects when the ANOVA was significant. All data were reported as means

(± SD). Statistical significance was designated at $p < 0.05$ for all comparisons. Statistical analyses were carried out using Statistica software version 13.0 (Dell Inc., Round Rock, TX, USA).

3. Results

Results of the two-way repeated measures ANOVA with scores in regard to the questionnaires' values (mean± SD) for both groups are shown in Tables 2 and 3. The results showed that the groups were not statistically different ($p > 0.05$).

Large differences between groups were observed in Depression ($F_{1,28}=18.004$, $p < 0.001$; $\eta^2=0.391$), with significant ($p < 0.05$) time×group interaction ($F_{1,28}=6.008$, $P=0.021$; $\eta^2=0.177$). The post-hoc Scheffe test showed a statistically significant difference in the results between the participants in the post-testing (YG and PG; $p < 0.001$).

For Anxiety, the main effect for both the YG and PG was not significant ($F_{1,28}=1.091$, $p=0.178$; $\eta^2=0.064$), but for the time ($F_{1,28}=35.939$, $p < 0.001$; $\eta^2=0.562$) and time×group interaction ($F_{1,28}=17.225$, $p < 0.001$; $\eta^2=0.381$) we observed significant ($p < 0.05$) differences.

The results of the post-hoc Scheffe test showed that the differences between groups were significant ($p < 0.001$). In Disability there were statistically relevant main effects for time ($F_{1,28}=10.486$, $p=0.003$, $\eta^2=0.272$) and group ($F_{1,28}=4.237$, $p=0.049$), $\eta^2=0.131$), but not for their interaction ($F_{1,28}=2.203$, $p=0.149$, $\eta^2=0.073$). Also, there was no significant difference between the YG and PG in the post-testing. Finally, analysis of variance showed statistically significant differences in Pain between the groups ($F_{1,28}=16.940$, $p < 0.001$; $\eta^2=0.377$), and between the participants in the post-testing (YG and PG; $p < 0.001$).

Table 2. Questionnaires results were analyzed using two-way repeated measures ANOVA between participants regarding effects and interaction

	Main effects				Interaction	
	Time		Group		Time x Group	
	F (p)	η^2	F (p)	η^2	F (p)	η^2
Disability	10.486 (0.003)	0.272	4.237 (0.049)	0.131	2.203 (0.149)	0.073
Depression	13.751 (0.001)	0.329	18.004 (0.000)	0.391	6.008 (0.021)	0.177
Anxiety	35.939 (0.000)	0.562	1.901 (0.178)	0.064	17.225 (0.000)	0.381
Pain	47.047 (0.000)	0.627	16.940 (0.000)	0.377	7.977 (0.009)	0.222

Legend: F – f test; p – significance; η^2 – effect size

Table 3. Scheffe post-hoc test for comparing between and within the groups

	PG (n=15)			%	YG (n=15)			%
	pre-	post-			pre-	post-		
Disability	23.00 ± 2.83	22.13 ± 2.50	3.4	21.27 ± 4.77	18.93 ± 3.65	8.4 ^a		
Depression	47.80 ± 2.18	47.13 ± 1.60	1.2	46.73 ± 1.53	43.47 ± 2.85**	6.9 ^b		
Anxiety	46.40 ± 1.24	45.60 ± 1.76	1.7	47.53 ± 2.13	43.13 ± 1.85*	9.1 ^c		
Pain	3.60 ± 0.63	2.93 ± 0.59	16.7	3.33 ± 0.82	1.73 ± 0.59**	44.0 ^c		

Legend: data presented as Mean ± Standard Deviations; % relative changes for both groups; * p < 0.01, ** p < 0.001 for Pamphlet/YG differences. ^ap < 0.05; ^bp < 0.01; ^c p < 0.001 for pre- and post- study.

4. Discussion

In order to demonstrate the efficacy of yoga intervention versus an educational program based on pamphlets and a newsletter, we investigated two groups that were made up of individuals with CLBP who exhibited symptoms of mild to moderate anxiety and mild depression, according to the Zung questionnaires.

It has been well demonstrated that practicing yoga is an efficient intervention for decreasing both anxiety [57] and depression [58]. According to yoga experts, the mind and body are a unique entity and are considered to be an indivisible and interconnected unit [59]. This perspective is currently accepted by neuroscientists and psychologists, and it describes the so-called “psycho-neuro-endocrino-immunology” system interaction [20,60]. In fact, it has been claimed that everything that can affect the mind, body perception, posture, and sensation can also stimulate the body’s immune system [61,62].

To the best of scientific knowledge, the mind exists because the body exists, and a practice that takes into account the body’s health, such as yoga [63], mindfulness [64], and other integrative practices [19,20,65] have a deep effect not only on the mind and mood but on the emotions as well. In particular, emotions are linked to pain [66], and these two conditions can provoke the so-called “kinesiophobia” that, in turn, may induce a hypervigilance in individuals suffering from this phenomenon, increasing the perceived disability, anxiety, and even depression [67]. As such, any intervention that helps individuals take care of their body and control hypervigilance can be valuable for improving their well-being.

In addition, some studies have demonstrated that a strong relationship between the patient and health-care monitoring is important for their well-being. Therefore, each patient can start to be the protagonist of their own care pathway [68,69]. These patients would also have the opportunity to communicate their own experience with pain and the disease in general [70].

We are convinced that a simple care plan that includes yoga exercises can have a great potential effect on psychological characteristics. A strong relationship and an effective collaboration between a yoga expert and the patient can ameliorate mind-body health. Indeed, merely providing pamphlets, and asking a person to join a yoga plan without any weekly meetings with a yoga trainer, can lead to non-adherence and feelings of loneliness. The slight improvement in the average values of the questionnaires from the pre- to post- experimental period in the control group can be explained by the fact that the individuals in the control group felt that someone was taking care of them; however, the differences between the groups highlighted that an information plan provided only through pamphlets was sufficient to ameliorate both back pain and psychological symptoms.

5. Conclusion

In conclusion, yoga combined with education and instruction has a favorable effect, compared to an informational pamphlet only, on individuals with CLBP. In fact, it appears that yoga has the potential of improving many psychological characteristics in the experimental populations. However, further rigorous, high-quality randomized controlled trials and evaluation of the long-term effects are needed.

Author's Contribution

GK and ADG each contributed to the study's design and supervised data collection. GK, JP, and ADG analyzed the data. GK and ADG contributed to the interpretation of the results. GK, PF, ADI and ADG each contributed to the drafting and writing of the manuscript. PF, JP, ADI reviewed the manuscript. PF, JP, ADI revised and provided feedback on the paper and approved the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of listing the authors.

Conflict of interest statement

The authors have no competing interests to declare.

Acknowledgments

We would like to extend our gratitude to the gym staff and yoga teacher. Most importantly, we would like to express our sincere gratitude to all the participants for their involvement in this study. The authors wish to thank Ms. Dinah Olswang for English editing.

References

- [1] A. Indahl, Low back pain: Diagnosis, treatment and prognosis, *Scand. J. Rheumatol.* 33 (2004) 199–209. doi:10.1080/03009740410006916.
- [2] J. Van Zundert, K. Van Boxem, P. Vanelderen, M. Puylaert, P. De Vooght, R. Mestrum, R. Heylen, K. Vissers, M. van Kleef, Establishing the diagnosis of low back pain: patient selection for interventional pain medicine, *Pain Manag.* 3 (2013) 129–136. doi:10.2217/pmt.13.3.
- [3] B.K. Cypress, Characteristics of physician visits for back symptoms: A national perspective, *Am. J. Public Health.* 73 (1983) 389–395. doi:10.2105/AJPH.73.4.389.
- [4] T.S. Carey, A. Evans, N. Hadler, W. Kalsbeek, C. McLaughlin, J. Fryer, Care-seeking among individuals with chronic low back pain, *Spine (Phila. Pa. 1976).* 20 (1995) 312–317.
- [5] L.G. Hart, R.A. Deyo, D.C. Cherkin, Physician office visits for low back pain. Frequency, clinical evaluation, and treatment patterns from a U.S. national survey, *Spine (Phila Pa 1976).* 20 (1995) 11–19.
- [6] D.P. Ritzwoller, L. Crouse, S. Shetterly, D. Rublee, The association of comorbidities, utilization and costs for patients identified with low back pain, *BMC Musculoskelet. Disord.* 7 (2006) 72. doi:10.1186/1471-2474-7-72.
- [7] S. Genevay, F. Balague, Diagnosis and prognosis of low back pain: contribution and limitations of the clinical approach, *Rev. Med. Suisse.* 13 (2017) 1283–1288.
- [8] R.S. Perera, P.H. Dissanayake, U. Senarath, L.S. Wijayaratne, A.L. Karunanayake, V.H.W. Dissanayake, Associations between disc space narrowing, anterior osteophytes and disability in chronic mechanical low back pain: a cross sectional study, *BMC Musculoskelet. Disord.* 18 (2017) 193. doi:10.1186/s12891-017-1562-9.
- [9] C. Ledford, Spine conditions: Mechanical and inflammatory low back pain., *FP Essent.* 461 (2017) 15–20.
- [10] H. Furunes, K. Storheim, J.I. Brox, L.G. Johnsen, J.S. Skouen, E. Franssen, T.K. Solberg, L. Sandvik, C. Hellum, Total disc replacement versus multidisciplinary rehabilitation in patients

with chronic low back pain and degenerative discs: 8-year follow-up of a randomized controlled multicenter trial, *Spine J.* 17 (2017) 1480–1488.

doi:10.1016/j.spinee.2017.05.011.

- [11] A.B. Sabnis, U. Chamoli, A.D. Diwan, Is L5-S1 motion segment different from the rest? A radiographic kinematic assessment of 72 patients with chronic low back pain, *Eur. Spine J.* (2017). doi:10.1007/s00586-017-5400-4.
- [12] J. Robinson, V. Apkarian, Low back pain, in: E. Mayer, M. Bushnell (Eds.), *Functional Pain Syndromes: Presentation and Pathophysiology*, IASP Press, Seattle, 2009: pp. 23–53.
- [13] R. D’hooge, P. Hodges, H. Tsao, L. Hall, D. Macdonald, L. Danneels, Altered trunk muscle coordination during rapid trunk flexion in people in remission of recurrent low back pain, *J. Electromyogr. Kinesiol.* 23 (2013) 173–81. doi:10.1016/j.jelekin.2012.09.003.
- [14] H. Flor, C. Braun, T. Elbert, N. Birbaumer, Extensive reorganization of primary somatosensory cortex in chronic back pain patients, *Neurosci. Lett.* 224 (1997) 5–8.
- [15] B.M. Wand, L. Parkitny, N.E. O’Connell, H. Luomajoki, J.H. McAuley, M. Thacker, G.L. Moseley, Cortical changes in chronic low back pain: current state of the art and implications for clinical practice, *Man. Ther.* 16 (2011) 15–20. doi:10.1016/j.math.2010.06.008.
- [16] T. Tsuji, K. Matsudaira, H. Sato, J. Vietri, The impact of depression among chronic low back pain patients in Japan, *BMC Musculoskelet. Disord.* 17 (2016) 447. doi:10.1186/s12891-016-1304-4.
- [17] M.B. Pinheiro, M.L. Ferreira, K. Refshauge, J.R. Ordoñana, G.C. Machado, L.R. Prado, C.G. Maher, P.H. Ferreira, Symptoms of depression and risk of new episodes of low back pain: A systematic review and meta-analysis, *Arthritis Care Res. (Hoboken)*. 67 (2015) 1591–603. doi:10.1002/acr.22619.
- [18] N. Dael, M. Mortillaro, K.R. Scherer, Emotion expression in body action and posture., *Emotion.* 12 (2012) 1085–1101. doi:10.1037/a0025737.
- [19] A. De Giorgio, R.M. Loscalzo, M. Ponte, A.M. Padovan, G. Graceffa, F. Gulotta, An innovative mindfulness and educational care approach in an adult patient affected by gastroesophageal reflux: the IARA model, *J. Complement. Integr. Med.* 0 (2017). doi:10.1515/jcim-2016-0154.
- [20] A. De Giorgio, A. Dante, V. Cavioni, A.M. Padovan, D. Rigonat, F. Iseppi, G. Graceffa, F. Gulotta, The IARA model as an integrative approach to promote autonomy in COPD patients through improvement of self-efficacy beliefs and illness perception: A mixed-method pilot study, *Front. Psychol.* 8 (2017) 1682. doi:10.3389/fpsyg.2017.01682.
- [21] A. Walters, Emotion and low back pain, *Appl Ther.* 10 (1966) 868–871.

- [22] T.I. Nava-Bringas, S.I. Macías-Hernández, J.R. Vásquez-Ríos, R. Coronado-Zarco, A. Miranda-Duarte, E. Cruz-Medina, A. Arellano-Hernández, Fear-avoidance beliefs increase perception of pain and disability in Mexicans with chronic low back pain, *Rev. Bras. Reumatol. (English Ed.* 57 (2017) 306–310. doi:10.1016/j.rbre.2016.11.003.
- [23] M. Feuerstein, S. Sult, M. Houle, Environmental stressors and chronic low back pain: life events, family and work environment, *Pain.* 22 (1985) 295–307. doi:10.1016/0304-3959(85)90030-2.
- [24] J.E. Moore, Chronic low back pain and psychosocial issues, *Phys. Med. Rehabil. Clin. N. Am.* 21 (2010) 801–815. doi:10.1016/j.pmr.2010.06.005.
- [25] L. Boutevillain, A. Dupeyron, C. Rouch, E. Richard, E. Coudeyre, Facilitators and barriers to physical activity in people with chronic low back pain: A qualitative study, *PLoS One.* 12 (2017) e0179826. doi:10.1371/journal.pone.0179826.
- [26] D. Shapiro, I.A. Cook, D.M. Davydov, C. Ottaviani, A.F. Leuchter, M. Abrams, Yoga as a complementary treatment of depression: Effects of traits and moods on treatment outcome, evidence-based complement, *Altern. Med.* 4 (2007) 493–502. doi:10.1093/ecam/nel114.
- [27] A. Woolery, H. Myers, B. Sternlieb, L. Zeltzer, A yoga intervention for young adults with elevated symptoms of depression, *Altern. Ther. Health Med.* 10 (2004) 60–3.
- [28] T. Field, M. Diego, J. Delgado, L. Medina, Tai chi/yoga reduces prenatal depression, anxiety and sleep disturbances, *Complement. Ther. Clin. Pract.* 19 (2013) 6–10. doi:10.1016/j.ctcp.2012.10.001.
- [29] K. Davis, S.H. Goodman, J. Leiferman, M. Taylor, S. Dimidjian, A randomized controlled trial of yoga for pregnant women with symptoms of depression and anxiety, *Complement. Ther. Clin. Pract.* 21 (2015) 166–172. doi:10.1016/J.CTCP.2015.06.005.
- [30] S. Ahmadizad, A. Moradi, S. Nikookheslat, H. Ebrahimi, A. Rahbaran, P. Connes, Effects of age on hemorheological responses to acute endurance exercise, *Clin. Hemorheol. Microcirc.* 49 (2011) 165–74. doi:10.3233/CH-2011-1466.
- [31] C. Brems, A yoga stress reduction intervention for university faculty, staff, and graduate students, *Int. J. Yoga Therap.* 25 (2015) 61–77. doi:10.17761/1531-2054-25.1.61.
- [32] M.M. Buttner, R.L. Brock, M.W. O’Hara, S. Stuart, Efficacy of yoga for depressed postpartum women: A randomized controlled trial, *Complement. Ther. Clin. Pract.* 21 (2015) 94–100. doi:10.1016/j.ctcp.2015.03.003.
- [33] C.C. Streeter, T.H. Whitfield, L. Owen, T. Rein, S.K. Karri, A. Yakhkind, R. Perlmutter, A. Prescott, P.F. Renshaw, D.A. Ciraulo, J.E. Jensen, Effects of yoga versus walking on mood, anxiety, and brain GABA levels: A randomized controlled MRS study, *J. Altern.*

Complement. Med. 16 (2010) 1145–1152. doi:10.1089/acm.2010.0007.

- [34] R. Shankarapillai, R. George, M. Nair, The effect of yoga in stress reduction for dental students performing their first periodontal surgery: A randomized controlled study, *Int. J. Yoga*. 5 (2012) 48. doi:10.4103/0973-6131.91714.
- [35] J.R. Morgan, M. Sullivan, A. Masuda, E. Tully, L.L. Cohen, P.L. Anderson, A case series on the effects of Kripalu yoga for generalized anxiety disorder, *Int. J. Yoga Therap.* 26 (2016) 1531–2054.0.0.000. doi:10.17761/1531-2054.0.0.000.
- [36] S. Prathikanti, R. Rivera, A. Cochran, J.G. Tungol, N. Fayazmanesh, E. Weinmann, Treating major depression with yoga: A prospective, randomized, controlled pilot trial, *PLoS One*. 12 (2017) e0173869. doi:10.1371/journal.pone.0173869.
- [37] H. Cramer, R. Lauche, C. Hohmann, J. Langhorst, G. Dobos, Yoga for chronic neck pain: A 12-month follow-up, *Pain Med.* 14 (2013) 541–548. doi:10.1111/pme.12053.
- [38] H.E. Tilbrook, H. Cox, C.E. Hewitt, A.R. Kang'ombe, L.-H. Chuang, S. Jayakody, J.D. Aplin, A. Semlyen, A. Trehwela, I. Watt, D.J. Torgerson, Yoga for chronic low back pain, *Ann. Intern. Med.* 155 (2011) 569. doi:10.7326/0003-4819-155-9-201111010-00003.
- [39] F. Jahdi, F. Sheikhan, H. Haghani, B. Sharifi, A. Ghaseminejad, M. Khodarahmian, N. Rouhana, Yoga during pregnancy: The effects on labor pain and delivery outcomes (A randomized controlled trial), *Complement. Ther. Clin. Pract.* 27 (2017) 1–4. doi:10.1016/J.CTCP.2016.12.002.
- [40] D.G. Chang, J.A. Holt, M. Sklar, E.J. Groessl, Yoga as a treatment for chronic low back pain: A systematic review of the literature, *J. Orthop. Rheumatol.* 3 (2016) 1–8.
- [41] K.J. Sherman, R.D. Wellman, A.J. Cook, D.C. Cherkin, R.M. Ceballos, Mediators of yoga and stretching for chronic low back pain, *Evidence-Based Complement. Altern. Med.* 2013 (2013) 1–11. doi:10.1155/2013/130818.
- [42] M. Lee, W. Moon, J. Kim, Effect of yoga on pain, brain-derived neurotrophic factor, and serotonin in premenopausal women with chronic low back pain., *Evid. Based. Complement. Alternat. Med.* 2014 (2014) 203173. doi:10.1155/2014/203173.
- [43] P. Posadzki, E. Ernst, Yoga for low back pain: a systematic review of randomized clinical trials, *Clin. Rheumatol.* 30 (2011) 1257–1262. doi:10.1007/s10067-011-1764-8.
- [44] P. Tekur, C. Singphow, H.R. Nagendra, N. Raghuram, Effect of short-term intensive yoga program on pain, functional disability and spinal flexibility in chronic low back pain: a randomized control study, *J. Altern. Complement. Med.* 14 (2008) 637–44. doi:10.1089/acm.2007.0815.
- [45] M. Grabara, J. Szopa, Effects of hatha yoga exercises on spine flexibility in women over 50

- years old, *J. Phys. Ther. Sci.* 27 (2015) 361–5. doi:10.1589/jpts.27.361.
- [46] L.C. Gonçalves, R.G. de S. Vale, N.J.F. Barata, R.V. Varejão, E.H.M. Dantas, Flexibility, functional autonomy and quality of life (QoL) in elderly yoga practitioners, *Arch. Gerontol. Geriatr.* 53 (2011) 158–62. doi:10.1016/j.archger.2010.10.028.
- [47] J.A. Raub, Psychophysiologic effects of Hatha Yoga on musculoskeletal and cardiopulmonary function: a literature review, *J. Altern. Complement. Med.* 8 (2002) 797–812. doi:10.1089/10755530260511810.
- [48] T.M. Kozik, M.M. Pelter, S.S. Al-Zaiti, M.G. Carey, Sudden shortness of breath and anxiety, *Am. J. Crit. Care.* 21 (2012) 453–454. doi:10.4037/ajcc2012340.
- [49] S.K. Bhat, L.J. Beilin, M. Robinson, S. Burrows, T.A. Mori, Relationships between depression and anxiety symptoms scores and blood pressure in young adults, *J. Hypertens.* 35 (2017) 1983–1991. doi:10.1097/HJH.0000000000001410.
- [50] G. Mansell, K. Storheim, I. Løchting, E.L. Werner, M. Grotle, Identification of indirect effects in a cognitive patient education (COPE) intervention for low back pain, *Phys. Ther.* 97 (2017) 1138–1146. doi:10.1093/ptj/pzx091.
- [51] R.B. Saper, C. Lemaster, A. Delitto, K.J. Sherman, P.M. Herman, E. Sadikova, J. Stevans, J.E. Keosaian, C.J. Cerrada, A.L. Femia, E.J. Roseen, P. Gardiner, K. Gergen Barnett, C. Faulkner, J. Weinberg, Yoga, physical therapy, or education for chronic low back pain, *Ann. Intern. Med.* 167 (2017) 85. doi:10.7326/M16-2579.
- [52] N. Patrick, E. Emanski, M.A. Knaub, Acute and chronic low back pain, *Med. Clin. North Am.* 98 (2014) 777–789. doi:10.1016/j.mcna.2014.03.005.
- [53] M. Yates, N. Shastri-Hurst, The Oswestry disability index, *Occup. Med. (Chic. Ill).* 67 (2017) 241–242. doi:10.1093/occmed/kqw051.
- [54] M. Monticone, P. Baiardi, S. Ferrari, C. Foti, R. Mugnai, P. Pillastrini, C. Vanti, G. Zanoli, Development of the Italian version of the Oswestry Disability Index (ODI-I): A cross-cultural adaptation, reliability, and validity study, *Spine (Phila. Pa. 1976)*. 34 (2009) 2090–5. doi:10.1097/BRS.0b013e3181aa1e6b.
- [55] W.W.K. Zung, Zung Self-Rating Depression Scale and Depression Status Inventory, in: *Assessment of Depression*, Springer Berlin Heidelberg, Berlin, Heidelberg, 1986: pp. 221–231. doi:10.1007/978-3-642-70486-4_21.
- [56] K. Eriksson, L. Wikström, K. Årestedt, B. Fridlund, A. Broström, Numeric rating scale: patients' perceptions of its use in postoperative pain assessments, *Appl. Nurs. Res.* 27 (2014) 41–46. doi:10.1016/j.apnr.2013.10.006.
- [57] S.G. Hofmann, G. Andreoli, J.K. Carpenter, J. Curtiss, Effect of Hatha yoga on anxiety: a

- meta-analysis, *J. Evid. Based. Med.* 9 (2016) 116–124. doi:10.1111/jebm.12204.
- [58] L. Bridges, M. Sharma, The efficacy of yoga as a form of treatment for depression, *J. Evid. Based. Complementary Altern. Med.* (2017) 215658721771592. doi:10.1177/2156587217715927.
- [59] M. Mehta, P. Taneja, Effect of short-term yoga practices on psychological general well being in medical students, *J. Evol. Med. Dent. Sci.* 2 (2013) 1812–1819. doi:10.14260/jemds/467.
- [60] R. Ader, *Psychoneuroimmunology*, 4th edition, Elsevier/Academic Press, 2007.
- [61] M. Faresjo, The link between psychological stress and autoimmune response in children, *Crit. Rev. Immunol.* 35 (2015) 117–134.
- [62] Z. Arefnasab, A. Babamahmoodi, F. Babamahmoodi, A.A. Noorbala, A. Alipour, Y. Panahi, J. Shams, F.R. Rad, V. Khaze, M. Ghanei, Mindfulness-based Stress Reduction (MBSfR) and its effects on psychoimmunological factors of chemically pulmonary injured veterans, *Iran. J. Allergy, Asthma Immunol.* 15 (2016) 476–486.
- [63] L. McCarthy, J. Fuller, G. Davidson, A. Crump, S. Positano, C. Alderman, Assessment of yoga as an adjuvant treatment for combat-related posttraumatic stress disorder, *Australas. Psychiatry.* 25 (2017) 354–357. doi:10.1177/1039856217695870.
- [64] L. Grazzi, E. Sansone, A. Raggi, D. D'Amico, A. De Giorgio, M. Leonardi, L. De Torres, F. Salgado-García, F. Andrasik, Mindfulness and pharmacological prophylaxis after withdrawal from medication overuse in patients with chronic migraine: an effectiveness trial with a one-year follow-up, *J. Headache Pain.* 18 (2017) 15. doi:10.1186/s10194-017-0728-z.
- [65] A. Dello Iacono, D. Martone, A. Alfieri, M. Ayalon, P. Buono, Core Stability Training Program (CSTP) effects on static and dynamic balance abilities, *Gazzetta Medica Italiana Archivio per le Scienze Mediche* 173 (2014) 197-206.
- [66] A.D. Ong, A.J. Zautra, M.C. Reid, Chronic pain and the adaptive significance of positive emotions, *Am. Psychol.* 70 (2015) 283–284. doi:10.1037/a0038816.
- [67] T.O. Trocoli, R. V. Botelho, Prevalence of anxiety, depression and kinesiophobia in patients with low back pain and their association with the symptoms of low back spinal pain, *Rev. Bras. Reumatol. (English Ed.)* 56 (2016) 330–336. doi:10.1016/j.rbre.2016.02.010.
- [68] R.M. Epstein, R.L. Street, The values and value of patient-centered care, *Ann. Fam. Med.* 9 (2011) 100–103. doi:10.1370/afm.1239.
- [69] H.K. Svensson, L.E. Olsson, T. Hansson, J. Karlsson, E. Hansson-Olofsson, The effects of person-centered or other supportive interventions in older women with osteoporotic vertebral compression fractures—a systematic review of the literature, *Osteoporos. Int.* 28 (2017) 2521–2540. doi:10.1007/s00198-017-4099-8.

- [70] L.R. Martin, S.L. Williams, K.B. Haskard, M.R. Dimatteo, The challenge of patient adherence, *Ther. Clin. Risk Manag.* 1 (2005) 189–99.