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Escola Superior de Saúde de Aveiro

Sara Filipa Martins Alves

Educação em Neurociência da Dor e Exposição Gradual em utentes com Dor Lombar Crónica Idiopática em saúde ocupacional

Pain Neuroscience Education and Graded Exposure in Patients with Non-Specific Low Back Pain in an occupational setting

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Fisioterapia, realizada sob a orientação científica da Profª Doutora Anabela Gonçalves da Silva, Professora Adjunta da Escola Superior de Saúde da Universidade de Aveiro.

À minha Avó.

O júri

Presidente	Prof.ª Doutora Alda Marques Professora Adjunta da Escola Superior de Saúde da Universidade de Aveiro
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Resumo

Enquadramento: A Dor Lombar Crónica (DLC) tem uma elevada prevalência e impacto económico, e acredita-se que os fatores psicossociais desempenhem um papel importante na sua manutenção a longo prazo. A Educação em Neurociência da Dor (END) e a exposição gradual são abordagens cognitivo-comportamentais, enquanto que o Pilates, uma modalidade de exercício comumente utilizada, foca-se essencialmente num modelo biomédico para explicar a presença e persistência da dor. **Objetivo:** O principal objetivo é o de comparar a eficácia da END e exposição gradual contra o Pilates e educação postural na incapacidade de trabalhadores de uma fábrica de papel com DLC. O objetivo secundário é o de comparar as duas intervenções na intensidade da dor, catastrofização, crenças de medo-evitamento, sono, resistência dos músculos extensores da lombar, conhecimento em neurofisiologia da dor e perceção de mudança. **Métodos:** Um total de 26 participantes foi randomizado de forma aleatória num dos dois grupos de intervenção: END e exposição gradual ou Pilates e educação postural. Os dois grupos receberam 1 sessão por semana durante 8 semanas. **Resultados:** As duas intervenções apresentaram um impacto semelhante e positivo na incapacidade ($p<0,001$), intensidade da dor, crenças de medo-evitamento no trabalho, e no Índice do Sono II ($p<0,05$), no pós-intervenção. Contudo, o grupo de END e exposição gradual foi superior ao de Pilates e educação postural na catastrofização, medo-evitamento na atividade física, teste de Biering-Sørensen e conhecimento em neurofisiologia da dor ($p<0,05$). As melhorias no pós-intervenção mantiveram-se ao fim de 3 meses ($p<0,05$). No grupo de END, 72,7% dos participantes no pós-intervenção e 62,5% no acompanhamento dos 3 meses tiveram uma perceção de melhoria de moderadamente melhor a muito melhor, em contraste com 33,3% e 38,5% no grupo de Pilates. **Conclusão:** Este estudo fornece evidência preliminar que a END e exposição gradual em pessoas com DLC é superior ao Pilates e educação postural num contexto de saúde ocupacional na catastrofização, crenças de medo-evitamento e na perceção de mudança.

Palavras-chave

Educação em Neurociência da Dor; Exposição Gradual; Dor Lombar Crónica; Saúde Ocupacional.

Abstract

Background: Chronic Low Back Pain (CLBP) has a high prevalence and economic impact, and psychosocial factors are believed to play an important role on its long-term maintenance. Pain Neuroscience Education (PNE) and graded exposure are cognitive-behavioral intervention approaches while Pilates, a very popular modality, focuses more on a biomedical model to explain the presence and persistence of pain. **Objective:** The main objective is to compare the effectiveness of PNE and graded exposure against Pilates and postural education on disability in paper industry workers with CLBP. The secondary aim is to compare both interventions for pain intensity, catastrophizing, fear-avoidance beliefs, sleep, endurance of back extensor muscles, knowledge of pain neuroscience and patients' perceived impression of change. **Methods:** A total of 26 workers were randomly assigned to one of the two intervention groups: PNE and graded exposure or Pilates and postural education. Both groups received 1 session per week for 8 weeks. **Results:** Both interventions had a positive and similar impact on disability (p<0,001), pain intensity, fear-avoidance at work, and on the Sleep Index II (p<0,05), at post-intervention. However, PNE and graded exposure were superior to Pilates and postural education for catastrophizing, fear-avoidance of physical activity, the Biering-Sørensen and knowledge of pain neuroscience (p<0,05). Post-intervention improvements were maintained at 3 months follow-up (p<0,05). In the PNE group, 72,7% participants at post-intervention and 62,5% at 3 months-follow-up perceived themselves as moderately to a great deal better: contrasting to 33,3% and 38,5% in the Pilates group. **Conclusion:** This study provides preliminary evidence that PNE and graded exposure for CLBP is superior to Pilates and postural education in an occupational context for catastrophizing, fear-avoidance beliefs and patients' perceived impression of change.

Keywords Pain Neuroscience Education; Graded Exposure; Chronic Low Back Pain; Occupational Health.

List of abbreviations

CLBP – Chronic Low Back Pain

FABQ – Fear Avoidance Beliefs Questionnaire

FABQ-PA – Fear Avoidance Beliefs Questionnaire, Physical Activity Subscale

FABQ-W – Fear Avoidance Beliefs Questionnaire, Work Subscale

ICC – Intraclass Correlation Coefficient

MCIC – Minimal Clinically Important Change

MOS – Medical Outcomes Study

NPQ – Neurophysiology of Pain Questionnaire

NPRS – Numeric Pain Rating Scale

ODI – Oswestry Disability Index

PDQ – Pain Detect Questionnaire

PGIC – Patient's Global Impression of Change

PCS – Pain Catastrophizing Scale

PNE – Pain Neuroscience Education

SD – Standard Deviation

SLR – Straight Leg Raise

SPSS – Statistical Package for the Social Sciences

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1. INTRODUCTION

1.1. LOW BACK PAIN DEFINITION AND ITS ASSOCIATED DISABILITY

Low back pain (LBP) is defined as pain and discomfort, localised below the costal margin and above the inferior gluteal folds, with or without referred leg pain (Airaksinen et al., 2006). Chronic LBP (CLBP) is pain that persists for at least 12 weeks or that lasts beyond the expected period of healing (Allegri et al., 2016; Dagenais, Tricco, & Haldeman, 2010). LBP is the most frequent musculoskeletal condition affecting the general population, with a lifetime prevalence reported to be as high as 84% (Airaksinen et al., 2006; Hoy, Brooks, Blyth, & Buchbinder, 2010; Hoy, March, et al., 2010; Maher, Underwood, & Buchbinder, 2017). In the Portuguese population, 26,4% of individuals report LBP complaints in the previous 4 weeks (Branco et al., 2016). In terms of age, CLBP may peak at 45 to 59 years old (Meucci, Fassa, & Faria, 2015; Scaia, Baxter, & Cook, 2012), and overall prevalence increases with age until 60 to 65 years (Hoy, Brooks, et al., 2010).

CLBP is well established as the main cause of years lived with disability (Hoy et al., 2014; Hoy, March, et al., 2010), and it is one of the conditions in the ranking of the ten clinical conditions with the higher economic burden (Gouveia et al., 2016). Its economic impact includes direct medical care, indemnity payment, productivity loss, employee retraining, administrative expenses, and litigation (Hoy, March, et al., 2010). CLBP accounts for one-third of all worker compensation claims (Hwang, Kwon, Jung, Ahn, & Kim, 2019). Nonetheless, pain affects everyone in varying degrees. It becomes a burden for individuals and affects their quality of life, but it also impacts other family members, as adjustments need to be made to adapt to the chronic problem (Phillips, 2009). CLBP negatively impacts the ability to perform domestic chores, recreational and leisure activities; leads to feelings of isolation associated with social activities, family difficulties, issues surrounding sexual relations, fear of spoiling events for others and the inability to predict the onset of pain leads to anticipation of pain that compromises the ability to plan (Froud et al., 2014). CLPB also has consequences on children, as they may not understand their parents' pain experience, and need to assume the responsibility for some chores, displaying some resentment at having to take over household responsibilities (De Souza & Oliver Frank, 2011; Strunin & Boden, 2004). Also, parents with CLBP show less disposition to play with kids (Strunin & Boden, 2004). Ultimately, the individual burden of CLBP becomes a burden for family and society (Buchbinder et al., 2011).

CLBP is considered nonspecific in about 80 – 90% of cases. Only a minority of cases can be attributed to specific pain-generators such as nerve roots, facet joints, intervertebral discs, tumors, infections or spinal stenosis (Airaksinen et al., 2006; Allegri et al., 2016; Hoy, Brooks, et al., 2010; Maher et al., 2017). Despite all data concerning CLBP, it has a complex etiology, that may originally be a consequence of biomechanical factors, but resists by various psychosocial and occupational factors (Hwang et al., 2019).

1.2. Factors associated with CLBP

Lifestyle, sociodemographic factors, physical and psychosocial characteristics have an important role in the development and maintenance of CLBP (Hwang et al., 2019; Mazloum, Sahebozamani, Barati, Nakhaee, & Rabiei, 2018). It is more likely to affect older individuals, women, people with low educational status, and those with overweight, with low physical activity levels and who smoke (Hoy, Brooks, et al., 2010). In addition to personal and lifestyle factors, the remaining factors associated with CLBP may be grouped into psychosocial and occupational factors (Hoy, Brooks, et al., 2010).

Psychosocial factors, also described as yellow flags, include stress, anxiety, and depression. There is moderate evidence (level B) that psychosocial distress, depressive mood, the severity of pain and functional impact, patient expectations, and prior episodes are predictors of chronicity (Airaksinen et al., 2006). Yellow flags may also refer to maladaptive beliefs and attitudes about pain (ex.: pain is a sign of tissue damage and passive treatments are the most adequate), inappropriate pain behaviors (fear of movement and reduced activity levels), poor coping strategies, functional disability and poor general health (Maher et al., 2017). Psychosocial workplace factors associated with the transition from acute to CLBP, include poor work relationships, job dissatisfaction, perceived ability, and disputed compensation claims (Hoy, Brooks, et al., 2010).

It is believed that knowledge of psychological factors associated with pain, in parallel with the understanding of fear-avoidance, catastrophizing, expectations, cognitions, and individual beliefs are key to the success of rehabilitation (Louw, Puentedura, Zimney, & Schmidt, 2016). Pain catastrophizing is a negative and exaggerated response to a painful experience and a well-known stress factor associated to CLBP (Simon et al., 2016), such as fear of movement (kinesiophobia), fear of re-injury and perception of injustice (Bodes Pardo et al., 2018; Miller, MacDermid, Walton, & Richardson, 2015). When someone responds to pain with catastrophic interpretations concerning the origin and consequences of pain, fear of pain will most likely develop. Protective behaviors such as avoidance and hypervigilance contribute to increased levels of fear, pain, and disability in the long term (Leeuw et al., 2008). All of these psychosocial and emotional risk factors related to pain perception and cognitions seem to contribute to the chronification of pain (Watson et al., 2019).

Occupational factors, also described as blue flags, include heavy physical demands, heavy or frequent manual operations, repeated rotation of the trunk, pushing and pulling activities, whole-body vibration, static postures while working, monotonous work, poor social support by colleagues and supervisors, low job autonomy, undesirable work hours, fear of re-injury and beliefs that pain and activity/work are harmful (Costa-Black, Loisel, & Anema, 2010; Fanavoll, Nilsen, Holtermann, & Mork, 2016; Ghaffari et al., 2008). There is strong evidence (level A) that low workplace support is a predictor of chronicity in patients with LBP; moderate evidence (level B) that shorter job tenure, heavier tasks with no modified duty are also good predictors of CLBP (Airaksinen et al., 2006). It should be noted that contextual factors such as compensation, legal issues, and the culture of the workplace also play a role in the development of chronic symptoms and return to work (Staal et al., 2004).

For most workers that seek medical care, their main goal is not only pain relief, but the restoration of function and work participation, fundamental parameters to achieve mental health benefits and well-being, promoting self-confidence and self-control in this important life dimension that is the work participation (Costa-Black et al., 2010). Hence, in occupational health, one of the main challenges is to promote self-management of workers with CLBP, with a special need to find effective interventions to those at risk of persistent disability and absenteeism due to pain (Hlobil et al., 2005; Staal et al., 2008). On the other hand, absenteeism and presenteeism are considerably higher in those with negative beliefs concerning CLBP, comparing to those who have more positive attitudes (Dagenais et al., 2010; Maher et al., 2017).

It is speculated that CLBP affects the control and coordination of trunk muscles and affects movement stability. It is also assumed that isolated and voluntary contraction of stabilizer muscles can correct the poor motor control associated with CLBP and reduce disability (Nabavi, Mohseni Bandpei, Mosallanezhad, Rahgozar, & Jaberzadeh, 2018; Shamsi, Sarrafzadeh, Jamshidi, Arjmand, & Ghezelbash, 2017). Although a model that focuses on biomechanical dysfunctions may help explain and alleviate some of the musculoskeletal complaints, it is not enough to explain more complex status such as CLBP and its associated disability (Jay et al., 2014). Approaches exclusively anatomic and biomechanical can contribute to increasing levels of fear, anxiety, and stress (Louw, Diener, Butler, & Puentedura, 2011).

The multifactorial etiology of CLBP highlights the need of adopting a biopsychosocial model for both the assessment and interventions of individuals with CLBP (Macedo, Smeets, Maher, Latimer, & Mcauley, 2010; Watson et al., 2019).

1.3. INTERVENTION IN CLBP

Patients with CLBP are advised to stay active and perform normal activities, and multi-modal treatment options that combine self-management principles and cognitive-behavioral approaches are recommended across guidelines (Barbari, Storari, Ciuro, & Testa, 2020; O'Connell, Cook, Wand, & Ward, 2016). A common approach is Pain Neuroscience Education (PNE), which is defined as education on neurobiology and neurophysiology of pain and its processing by the central nervous system. Instead of a traditional model that links tissue damage with nociception and pain, PNE aims to describe the neural changes associated with chronic pain (e.g. peripheral sensitization, central sensitization, synaptic activity, and modulating mechanisms) and how these contribute to the pain experience (Louw et al., 2011; Moseley, 2002, 2003a; Moseley, Nicholas, & Hodges, 2004). Patients are taught that central processing and several psychosocial aspects determine their pain experience and that pain does not always correlate with the real state of tissues. PNE helps patients reconceptualize pain perceiving it as the interpretation that the brain makes of danger, making them more prone to move, practice physical activity and exercise (Louw et al., 2011; Watson et al., 2019). Thus, with decreased pain perception and a better knowledge of non-mechanical factors that influence nerve sensitivity (failed treatments, fear, emotions and different explanations to their problems), patients become more confident in increasing their activity levels (Louw et al., 2011; Louw, Zimney, Puentedura, & Diener, 2016; Zimney, Louw, & Puentedura, 2014). Studies show that PNE is capable of decreasing fear (Moseley, 2003b), has an immediate and positive effect on patients' attitudes about pain (Moseley, 2003a), pain intensity, disability, catastrophic thoughts and kinesiophobia (Louw, Zimney, et al., 2016; Moseley, 2007; Moseley et al., 2004; Nijs, Paul van Wilgen, Van Oosterwijck, van Ittersum, & Meeus, 2011; Tegner, Frederiksen, Esbensen, & Juhl, 2018; Wood & Hendrick, 2019). Furthermore, one study showed PNE positive effects are maintained at 1-year follow-up (Moseley, 2002).

Another recommended intervention is therapeutic exercise (Shamsi et al., 2017; van Middelkoop et al., 2010). There are several different types of exercises and the superiority of one type over the other is yet to be proved (Shipton, 2018). There are exercise-based interventions that make use of a cognitive-behavioral therapy approach that promotes exercise tolerance, such as graded exposure (Mun, Gil-martı, & Mun, 2016). Graded exposure tries to ameliorate functional ability by reducing the perceived harmfulness of activities (Leeuw et al., 2008). Treatment begins with the establishment of a graded hierarchy of fear-induced activities, where patients are systematically exposed to activities similar to the feared ones (Macedo et al., 2010; Mun et al., 2016; Vlaeyen, 2001). This way, each individual is capable of understanding the consequences that any activity has, and build new beliefs towards that activity (George & Giorgio Zeppieri, 2009; Leeuw et al., 2008). The graded increase approach to activity is believed to lead to a reduction in pain and movement-related fear (Staal et al., 2008). It has been suggested that this approach may be superior to aerobic or resistance exercise for patients showing fear-avoidance beliefs, and passive self-efficacy strategies (Booth et al., 2017).

Pilates is another therapeutic exercise commonly used in CLBP patients (Shipton, 2018). Pilates is a low-impact exercise that aims to correct faulty postures and restore physical vitality and was found to be an effective rehabilitation tool with positive outcomes in reducing pain and disability in people with CLBP (Byrnes, Wu, & Whillier, 2018). However, it is focused on a biomedical model to explain the presence and persistence of pain: the stabilizing muscles of the trunk and lower back are inhibited, and the support of the lower back is compromised, conducting to pain (Wells, Kolt, & Bialocerkowski, 2012).

Nonetheless, a combination of PNE and exercise shows better results than any of these two interventions alone (Bodes Pardo et al., 2018; Louw et al., 2011; Louw, Zimney, et al., 2016; Moseley, 2002; Wood & Hendrick, 2019). PNE prepares the patient for cognition targeted exercise therapy, aiming at desensitizing the nervous system. Through graded exposure of fearful activities, it is possible to replace the maladaptive movement-related pain memories (Nijs, Lluch Girbés, Lundberg, Malfliet, & Sterling, 2015; Nijs et al., 2014). In short, performing PNE before therapeutic exercise interventions enhance deep learning and reconceptualization of pain, decreasing the belief of the threatening nature of pain and improving exercise outcomes, including the acceptance of possible acute pain following exercise (Nijs et al., 2017). Even though patients still experience pain, they think differently about it (Louw, Zimney, et al., 2016).

1.4. Study aim

In summary, CLBP is one of the main musculoskeletal problems that lead people to seek physiotherapy care. CLBP is a complex problem that requires a multimodal and biopsychosocial approach. In occupational settings, the rationale of pain is centered on a biomedical point of view (ergonomics and postural awareness, for instance) to explain the etiology, persistence, and management of pain, conversely to what is now known about the multifactorial etiology of CLPB

(Barbari et al., 2020). Based on neuroscience of pain and on how pain influences and is influenced by several factors (physical, emotional, professional, social), it seems conceivable that a biopsychosocial intervention should be the preferred approach in occupational settings. However, we were unable to find studies reporting on PNE, alone or combined with exercises such as graded exposure or other forms of exercise, in occupational settings. Therefore, this study aimed to compare the effectiveness of PNE and graded exposure against a more biomedical education (focused on postural education, ergonomic counseling and modification to the workstation) and Pilates on disability in paper industry workers. The secondary aims of this study were to assess how these two different approaches impact on pain (intensity and frequency), catastrophizing, fear-avoidance beliefs, sleep, the endurance of back extensor muscles, knowledge of pain neuroscience, and patient's perceived impression of change in the same sample.

2. Methods

This chapter presents a detailed description of the study objectives, type of study, and methodological procedures (sample, participant recruitment, outcome measures, and intervention).

2.1. Ethical Considerations

The present study was approved by the Ethics and Deontology Council of Aveiro University and by the coordinator of Security and Health of *The Navigator Company*. All workers who participated in the present study and who met the inclusion criteria completed a written consent form, after receiving oral and written information concerning the study objectives and procedures (Annex I, Appendixes I and II).

2.2. Study Design

This was a pilot randomized controlled and experimental study. There were two groups, one group received an intervention based on Pilates and postural education, and the other group received PNE and graded exposure. Both interventions were delivered in the physiotherapy office of a paper industry company. Participants were randomly allocated to one of the two intervention arms based on the work team they belonged to: there were five teams that performed continuous shift work, and three teams were randomly allocated to an intervention arm and the other two teams to the other intervention arm. The randomization was performed at the level of the work team to minimize the transfer and sharing of contents between intervention arms, i.e., to decrease the risk of cross-contamination (Keogh-Brown et al., 2007). The randomization was performed using the Research Randomizer software (https://www.randomizer.org/) after the baseline assessment and by an investigator not involved in the recruitment or evaluation of participants.

2.3. Methodology

2.3.1. Participants and Recruitment

The present study took place in a factory at Aveiro district, Portugal, with 376 employees, 223 of which perform manual labor and were the target for the present study. The remaining perform administrative, laboratory, support and management functions. The inclusion criteria to participate in the study was: to have nonspecific low back pain lasting longer than three months, felt in the anatomic region below the costal margin and above the inferior gluteal folds and not related to any specific pathology such as lumbar fracture, ankylosing spondylitis, *cauda equina* syndrome, infection or tumor (Balagué, Mannion, Pellisé, & Cedraschi, 2012; Overaas et al., 2017) and not receiving treatment for their pain. Participants were excluded if during the physical examination they showed i) altered sensorial signs indicative of radiculopathy, ii) any red flag such as weight loss without a particular cause, iii) cancer diagnosis, iv) sustained use of corticoids, or the v) presence of any rheumatic, neurologic or cardiorespiratory disease that prevent the practice of physical exercise (Allegri et al., 2016).

2.3.2. ASSESSMENT PROCEDURES

The initial identification of potential participants for this study was performed by asking workers (n=223 workers who performed manual labor) to fill in the Nordic Musculoskeletal Questionnaire (NMQ), which was adapted and validated to European Portuguese (Mesquita, Ribeiro, & Moreira, 2010). The NMQ allowed the identification of workers with low back pain who were invited for further assessment and verification of the inclusion criteria. A physical assessment was conducted to warrant eligibility against inclusion and exclusion criteria. This included a careful subjective examination as well as an objective examination including both the Straight Leg Raise (SLR) and the crossed SLR. In a framework of radiculopathy, it is usual to find altered sensorial signs, such as numbness along with the dermatome distribution of the nerve root, muscle weakness along the myotome, and decreased reflexes. Radiculopathy may be associated with radicular pain and in those cases, the dermatomal distribution of numbness indicates the segment of origin rather than the distribution of pain. The most common clinical diagnostic tests to predict possible disc herniation or nerve root compression are the SLR and the crossed SLR (Maher et al., 2017). These tests are performed on a patient lying horizontally in supine on an examiner's table, with the knee fully extended, while the examiner raises the patient's leg slowly off the table. The examiner continues to raise the leg until the maximum flexion of the hip is reached or until the patient reports the onset of leg pain. The test must be performed bilaterally to compare differences in the angle of hip flexion reached and on the onset of symptomatology (Dagenais et al., 2010; Scaia et al., 2012). The SLR exhibits high sensitivity (91%) and low specificity (26%) to diagnose a herniated disc. On the other hand, crossed SLR has high specificity (88%), but low sensitivity (29%) (van der Windt et al., 2010). For these reasons, the SLR results alone are not indicative of radiculopathy, which makes it even more important to take a careful clinical assessment and attention to history findings. Along with the SLR, a sensory analysis was also performed (Allegri et al., 2016; Balagué et al., 2012; Iversen et al., 2013). The final decision was made based on all the findings of the assessment.

Once inclusion criteria have been ascertained, participants were assessed for sociodemographic and anthropometric data, disability, pain, presence of a neuropathic component, pain catastrophizing, fear-avoidance beliefs, sleep quality, the endurance of back extensor muscles, knowledge of pain neuroscience and global impression of change related to the intervention. Sociodemographic data and pain phenotype were only assessed at baseline, all of the remaining were re-evaluated at post-intervention and 3 months after the intervention, except for the endurance test which was not performed at the 3 months follow-up due to the SARS-CoV-2 Pandemic.

A detailed description of the instruments that were used in the present study is given below (see Appendix III for the complete evaluation form).

Sociodemographic and anthropometric data

Sociodemographic data were collected through a brief questionnaire and included sex, age, dominance, academic qualifications, and work position. Anthropometric data concerning weight and height were collected with a weighting scale and a stadiometer, respectively.

Low back pain associated disability

Disability was measured using the Oswestry Disability Index (ODI) published in 1980 and one of the most recommended outcome measures used to evaluate disability in LBP patients (Fairbank, Davies, Couper, & O'Brien, 1980). This questionnaire was validated and adapted to European Portuguese, has high internal consistency (Cronbach's alpha of 0,95) and test-retest reliability (r= 0,90) (Martins, 2002). It has good convergent validity with the Roland Morris Disability Questionnaire, Visual Analogue Scale, Waddell Disability Index, and good sensitivity to change (Cruz, Matos, & Branco, 2003). The questionnaire has 10 self-report questions (related to the situation of today) and takes 3 to 5 minutes to complete (Fairbank & Pynsent, 2000). Each question has 6 answer options that depict LBP repercussion on activities of daily life: pain intensity, personal cares (washing, dressing, etc.), lifting activities, walking, seating, standing, sleep, sexual activity, social and recreational activities (Cruz et al., 2003). The final score may vary from 0 to 100 (zero – no complaints and 100 – severe disability) (Ostelo & de Vet, 2005). Disability percentages between 0-20% reveal minimum disability, 21%-40% moderate, 41%-60% severe, 61%-80% very severe, and 81%-100% symptom exaggeration (Fairbank & Pynsent, 2000). The Minimal Clinically Important Change (MCIC) for this measure in LBP patients is 10 points (Ostelo & de Vet, 2005).

Pain

Pain intensity at the moment was assessed by the Numeric Pain Rating Scale (NPRS). This 11-point scale is a measure of pain in which patients rate their pain ranging from 0 (no pain) to 10 (worst imaginable pain) and it has been shown to have concurrent and predictive validity as a measure of pain intensity (Childs, Piva, & Fritz, 2005; Ferreira-Valente, Pais-Ribeiro, & Jensen, 2011; Von Korff, Jensen, & Karoly, 2000). A cut-off of 2 points in this measure is considered the MCIC, distinguishing those who got better from those whose complaints remained unchanged.

Pain frequency during last week was assessed with a closed question with the following response options: (1) never, (2) rarely (once a week), (3) sometimes (2-3 times a week), (4) frequently (more than 3 times a week), (5) always.

CLBP duration had the following answer possibilities: (1) between 3 and 6 months, (2) more than 6 months and less than a year, (3) more than a year and less than 2, (4) more than 2 years and less than 5, (5) more than 5 years.

Pain phenotype

It was assessed using the Portuguese version of the Pain Detect Questionnaire (PDQ) (Santos, Pimentel Santos, & Cruz, 2017), which showed high internal consistency (Cronbach's alpha of 0,84), an excellent test-retest reliability (Intraclass Correlation Coefficient (ICC) of 0,97), and high construct validity when compared against the Douler Neuropathique 4 (r=0,739). The PDQ is a self – report questionnaire that aims to identify the main pain phenotype (Freynhagen, Baron, Gockel, & Tölle, 2006). The total score varies from -1 to 38 points. Scores below 12 indicate little probability of a neuropathic component (85% chance of not having); scores between 12 – 19 reveal a mixed phenotype, whereas a score above 19 reveals a high probability of neuropathic pain (90% chance). This instrument is superior to others that evaluate the same components, thanks to its high capability to identify neuropathic symptoms reported by the patient himself without the need for a physical assessment (Santos et al., 2017).

Pain catastrophizing

It was assessed using the Pain Catastrophizing Scale (PCS). This is a 13-item self-report measure designed to assess the extent to which one experiences catastrophic thoughts and feelings when in pain, and is divided into 3 dimensions: Rumination (4 items), Magnification (3 items), and Helplessness (6 items). Items are responded on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely), with a possible total of 52 points. The higher the score, the more likely the catastrophic thoughts (Parkerson et al., 2013). The European Portuguese version showed high internal consistency (Cronbach's alpha of 0,91) (Jácome & Cruz, 2004; Rodrigues, Mamede, & Cruz, 2010). The MCIC for this outcome measure is 6,71 (Suzuki et al., 2020).

Fear – Avoidance

Fear-avoidance beliefs were assessed using the Fear-Avoidance Beliefs Questionnaire (FABQ) (Waddell, Newton, Henderson, Somerville, & Main, 1993). This is a self-report questionnaire that comprises 16 statements that are divided into two subscales: "fear-avoidance and physical activity" (FABQ-PA) (5 items) and "fear-avoidance and work" (FABQ-W) (11 items). Each item score varies from zero (totally disagree) to 6 (totally agree). The score from the FABQ-PA subscale is calculated through 4 items (2, 3, 4 and 5) and has a maximum score of 24. The score from the FABQ-W subscale is calculated using items 6, 7, 8, 9, 10, 11 and 14, with a maximum score of 42 (Waddell et al., 1993). A score higher than 15 in the FABQ-PA subscale is indicative of high beliefs of fear-avoidance (Burton, Waddell, Tillotson, & Summerton, 1999). Concerning the FABQ-W subscale, scores over 34 are related to an increased risk of not returning to work, and scores under 29 are related to a decreased risk (Fritz & Steven Z, 2002). FABQ was translated and validated to European Portuguese with high reliability (r=0,92) and internal consistency (Cronbach's alpha of 0,96), also ensuring construct validity with its original form (Gonçalves & Cruz, 2007). A study performed in Italian subjects defined the MCIC for the FABQ-PA to be 4 points, and for the FABQ-W to be 7 points (Marco et al., 2020).

Sleep Quality

Evaluation of sleep was carried out with the Medical Outcome Study Sleep Scale (MOS-Sleep). This scale is a 12-item measure that contains 7 subscales and 2 overall index scores (a 6-item and a 9-item) (Hays & Stewart, 1992). This scale has positive psychometric properties in a broad range of patients with chronic pain conditions and impaired sleep, revealing a specificity of 81% and a sensitivity of 76% (Hays & Stewart, 1992). To score this scale, first, original numeric values from the survey are recoded and all items are scored so that a high score reflects more of the attribute implied by the scale name, i.e., more problems related to snoring, short of breath and headache, somnolence and general sleep adequacy and disturbances. Each item is then converted to a 0-100 scale (Spritzer & Hays, 2003). The Portuguese version showed acceptable values for internal consistency (above 0,70 for Cronbach's alpha for all domains), good intra-observer reliability with ICC of 0,80, and standard error of measurement of 9,10 (Mesquita et al., 2014). The MCIC considered for this scale was 10% of the total possible score of each subscale (Arvin et al., 2016).

Endurance of back extensor muscles

Evaluation of back extensor' muscle endurance was assessed with the Biering-Sørensen test. This test measures how many seconds the participant can keep the unsupported upper part of the body in a horizontal position with a load that is equal to the weight of the upper part of the body. The lower extremities are stabilized with three belts at the level of the hips, just below the knees and at the ankle site. Iliac crests are positioned at the edge of a table with the trunk extended beyond the table and initially hanging flexed at 90°. The trunk then is raised to the horizontal position with hands crossed over the chest. The test only stops when the participant can no longer sustain the horizontal position or when reaching the limit of fatigue (Gruther et al., 2009). This test revealed an ICC of 0,88 in patients with current CLBP (Latimer, Maher, Refshauge, & Colaco, 1999).

Knowledge of pain neuroscience

The revised version of the Neurophysiology of Pain Questionnaire (NPQ-12) was used to assess the patients' understanding of pain neurophysiology. This questionnaire has 12 statements to which there are three answer possibilities: "true", "false" and "undecided" (Catley, O'Connell, & Moseley, 2013; Nogueira et al., 2018). The score varies from zero to 12, each correct answer counts 1 point. Catley et al., (2013) showed that the NPQ-12 is sensitive enough to distinguish between high and low performances (Person Separation Index=0,82). The MCIC considered for this scale was 10% of the total possible score of the NPQ-12 (Arvin et al., 2016).

Impression of change

Participants rated their perception of improvement using the Patient Global Impression of Change (PGIC) scale. This is a unidimensional measure widely used in chronic pain studies, in which the patients classify their improvements using a 7-point scale, varying from "1- no change" to "7 – a great deal better and a considerable improvement that has made all the difference" (Cruz & Domingues, 2012; Dworkin et al., 2008). PGIC gives clinical important data regarding a change in health status perceived by the patient as meaningful. The PGIC scale was validated and adapted to European Portuguese, and revealed a high construct validity with pain intensity (r=-0,822) (Cruz & Domingues, 2012).

2.3.3. INTERVENTION

The intervention lasted for 8 weeks, during which participants had 1 face-to-face session per week with a duration of approximately 60 minutes each (Louw et al., 2011). One group (Pilates plus postural education group) received an intervention based on Pilates and postural education. The other group had theoretical sessions of PNE and graded exposure (PNE plus graded exposure group). A more detailed description of the sessions can be consulted in Appendixes IV and V.

PNE plus graded exposure group

The first session was exclusive of PNE, since it promotes compliance with the rehabilitation and exercise (Watson et al., 2019). In subsequent sessions, PNE was progressively decreased according to the patient's understanding and needs while the graded exposure component was increased.

PNE is a cognitive-behavioral intervention that attempts to increase patient's understanding of their pain, explaining the neurophysiological processes that lead to chronic pain, to change maladaptive belief towards disease, reconceptualizing them and desensitizing the central nervous system (Bodes Pardo et al., 2018; Moseley et al., 2004; Tegner et al., 2018; Wood & Hendrick, 2019). During PNE, these concepts are presented to patients using simple pictures and metaphors to explain complex pain neuroscience. There is a particular focus on the brain and its role in thoughts and attitudes (Clarke, Ryan, & Martin, 2011).

PNE content was based on work from previous authors (Louw et al., 2011; Louw, Puentedura, & Mintken, 2012; Moseley, 2004). The specific content of the educational sessions was: nociception and nociceptive pathways, neurons, synapses, action potential, spinal inhibition and facilitation, peripheral sensitization, central sensitization, and plasticity of the nervous system. No reference to anatomic or pathoanatomic models nor discussion of emotional or behavioral aspects of pain was made (Louw et al., 2011; Nijs et al., 2014, 2011). Specific contents from our occupational context involved job-related perceptions of injustice, lack of social support, poor relationships with colleagues and supervisors and how that made participants feel, assessing how participants saw their work demands and how they correlated with their pain, perceptions on whether the job was dangerous for their backs and how participants dealt with the complaints daily, and what made them feel better. All this information, alongside with the therapist's knowledge of the workstations, allowed the elaboration of metaphors and analogies specific for each participant, for instance: comparing the nervous system with the operational command room or with the different alert systems in the industry that go on when something does not work. In all sessions the therapist resorted to examples given by each participant on how the workday went, and if there were any technical concerns that they had to surpass or any other real examples to approximate the concepts used to convey neuroscience concepts to their daily and work experience so that these concepts are more meaningful to them (see Appendix

VI for all the metaphors and analogies used). Also, patients were encouraged to perform pauses with movement during labor to desensitize the nervous system. Sleep hygiene was also approached so that they understand how poor sleep reflects on chronic pain. Participants were given a leaflet with the PNE contents addressed in each session and a written activity for them to complete.

Graded exposure

Along with PNE, there was a component of graded exposure. These strategies aimed to show to the patient how to engage in their valued life goals and exercise, avoiding the pain-inactivity cycle. Once patients begin to master the skills of graded exposure, their engagement in life goals may increase, with associated decreases in disability (Staal et al., 2008; Watson et al., 2019). This technique increases the patient's activity and exercise tolerance, and promotes a return to function and a higher quality of life (Louw, Puentedura, et al., 2016), although type and dose are not yet described (Mun et al., 2016). The primary goal of this type of approach is not to improve aerobic endurance, muscle strength, or any other aspect of physical fitness but to make the patient aware that it is safe to move and to be physically active despite pain (Staal et al., 2004).

In the first session of graded exposure, the patients were challenged to create a hierarchical list with the functional activities they experience fear, and exposure beginning with the one they were less fearful of. This assessment was performed with the help of the Fear of Daily Activities Questionnaire (FDAQ) (George & Giorgio Zeppieri, 2009). This questionnaire is moderately correlated with pain-related fear, catastrophizing and pain intensity (r=0,24-0,52), and has stronger correlations with disability (r=0,49 and 0,70) (George, Giorgio Zeppieri, Robinson, & Valencia, 2009; George, Valencia, Giorgio Zeppieri, & Robinson, 2009). Afterward, both the therapist and the participant determined a specific group of exercises that were similar to the activities described by the participants and which they believed to lead to pain, and that were defined as goals to achieve. Exercise "dose" was determined with each participant by directly questioning each participant on how many repetitions he or she thought to able to perform (Hlobil et al., 2005). The therapist helped the patient evaluate exposure and its consequences so that they could address counterproductive and maladaptive beliefs, to help decrease activity-associated anxiety (Leeuw et al., 2008). Once the negative associations were extinguished, activities associated with higher levels of anxiety and fear were addressed in the same way (Macedo et al., 2010). All of the defined goals were gradually increased according to a time contingent principle instead of a pain contingent (Hlobil et al., 2005; Staal et al., 2004). Progressions and regressions were done by modifications on load, velocity or range of movement (Jay et al., 2014). Some of the most executed exercises involved anterior and lateral flexions and torsions of the trunk, while seating or standing, with or without a load, and some specific activities from the workplace that combined a lot of upper and lower limb combinations of movements. When participants performed the exercises in the physiotherapy office without increasing maladaptive beliefs, therapist addressed exercises that were the most approximate with the job tasks. In the last two sessions, the graded exposure was done in the worksite so that the fearful activity was properly confronted.

Pilates and postural education group

The educational approach in this group followed a more biomechanical strategy, focusing on Pilates' principles and postural care at home and work. Accordingly, there were addressed themes such as injury and causative factors, necessary precautions to take throughout the day concerning techniques to manual handling loads (perform a squat when there is a need to lift something from a below position, among others), learning how to properly breathe, engage the center whenever performing effort tasks for the low back and properly place the ribcage, shoulder blade, head and neck when executing upper limp repetitive tasks. Ergonomic counseling included education on computer and chair height, arm support, lumbar position (use of a pillow to keep a neutral spine), and knees and hips on 90° degrees. Other given advice was whenever possible to get up and do some stretches to alleviate muscular tension.

Pilates is a mental and physical conditioning technique that emphasizes position and movement control (Kamioka et al., 2016; Wells et al., 2012). Exercises are done in a mat, and are based in some principles such as: centering, concentration, control, precision, breath, and flow, promoting activation of trunk stabilizers, such as the transversus abdominis (TrA), multifidus and internal obliques, once it is suggested that weakness of these muscles is associated with low back and pain (Cruz-Díaz, Bergamin, Gobbo, Martínez-Amat, & Hita-Contreras, 2017; Yamato et al., 2016). It is believed that Pilates acts through re-activation of these muscular groups, increasing spine support, and contributing to reductions in pain and disability (Mazloum et al., 2018).

In the first session, basic Pilates principles were taught and reinforced at the beginning of the follow-up sessions, including: postural alignment (neutral spine position, shoulder blade and neck position) and core recruitment along with controlled breathing. Each session had a warm-up, mobility, stability and strengthening exercises and a cool-down period. Warm-up (10 minutes) aims at raising awareness of the activation of the center through acquiring a neutral pelvis position with TrA activation during breath out and mobility exercises. The second phase

(20 – 30 minutes) includes strength, flexibility and coordination exercises with progressive load according to individual skills. The cool-down period (5-10 minutes) included exercises to alleviate muscular tension, such as active stretching, along with deep and slow breathing. TrA isolated contraction may be performed in prone, supine and quadruped, by asking the patient to gently contract the TrA and instructing them in muscle palpation two centimeters inside the anterior superior iliac spine. Patients who experienced difficulties in TrA activation with verbal and tactile cues were encouraged to feel the TrA activation by active contraction of the pelvic floor muscles (Cruz-Díaz et al., 2017).

Participants were given a booklet with the Pilates exercises taught in each session, and a written form for them to complete with the activities they did during the week.

The exercise in the Pilates group was performed at moderate intensity and monitored using the Rated Perceived Exertion (RPE) Borg scale. This scale varies from 6 to 20, is one of the best instruments to evaluate the perceived effort, and is directly correlated with heart rate and oxygen uptake (Cabral, Lopes, Wolf, Stefanello, & Pereira, 2017).

Both groups were instructed to perform aerobic training at home, such as walking, running, cycling or any other activity participants enjoyed at least 3 times per week, during 30 minutes or depending on previously stipulated duration (PNE group). Alongside the aerobic training, they were given instructions to complete 3 exercises daily, which were taught in the presential sessions, and received an educational leaflet with the respective exercises. Some of the exercises in the PNE group could be executed at the workplace, as exercises were based in the formerly reported fearful activities.

2.3.4. Assessment of between-group contamination

At the end of the intervention, participants were asked to complete a contamination questionnaire to evaluate instances of shared information between both intervention groups. This questionnaire was based on the work of Sharma, Jensen, Moseley, & Abbott, (2019), and included 5 rapid questions that assessed if participants have talked to each other about the intervention, if they were aware of the intervention other participants were receiving, and if they read information given to the other group.

2.4. Data Analysis

All data analysis was performed using IBM Statistical Package for Social Sciences (SPSS), version 23.0. Descriptive statistics were used to describe continuous (mean and standard deviations (SD)), ordinal, and categorical variables (count and proportion).

The *Shapiro-Wilk* test was used to determine if the data had a normal distribution. Between-group differences at baseline were explored using a Student's t-test or the non-parametric equivalent for continuous variables and using a Chi-square for nominal variables. Two repeated-measures ANOVA of two factors were used to identify between-group differences, one comparing values from the baseline and the post-intervention (2x2: factor 1 – moment of evaluation: before and post-intervention; factor 2 – group: PNE versus Pilates) and another that included the 3 moments of assessment (3x2: factor 1 – moment of evaluation: before, post-intervention and 3 months follow-up; factor 2 – group: PNE versus Pilates). We repeated the ANOVA as 5 participants did not complete the post-intervention to 3-months follow up. The significance level was set at $p<0,05$ for all measurements. ANOVA requirements were assessed, namely the residuals tests of normality, homogeneity tests, and sphericity. Variance's homogeneity was always verified, but sphericity not. Nevertheless, ANOVA is robust for small normality deviations, whereby it was used in all variables in the study (Kirkwood & Sterne, 2003).

Also, individual scores for the outcome variables were compared against the MCIC values and the number of participants per group that had a clinically important change in pain, disability, catastrophizing, fear-avoidance beliefs, sleep, and knowledge of pain neuroscience was counted.

3. RESULTS

This section presents the results of this study.

3.1. SAMPLE DEMOGRAPHIC AND ANTHROPOMETRIC CHARACTERISTICS

A total of 26 participants entered the study out of 223 workers initially screened. All of these 26 completed the post-intervention assessment, but 5 did not complete the 3 months follow-up assessment. These 26 participants were distributed into two groups: the PNE group (n=11) and the Pilates group (n=15) as shown in Figure 1. In the PNE group, one participant was a female (9,1%), while in the Pilates group all participants were male. The mean age (± SD) in the PNE group was 40,0 ± 9,83 years old, and in the Pilates group was 36,13 ±7,08 years old. No significant differences (p>0,05) were found between groups for sociodemographic data (Table 1).

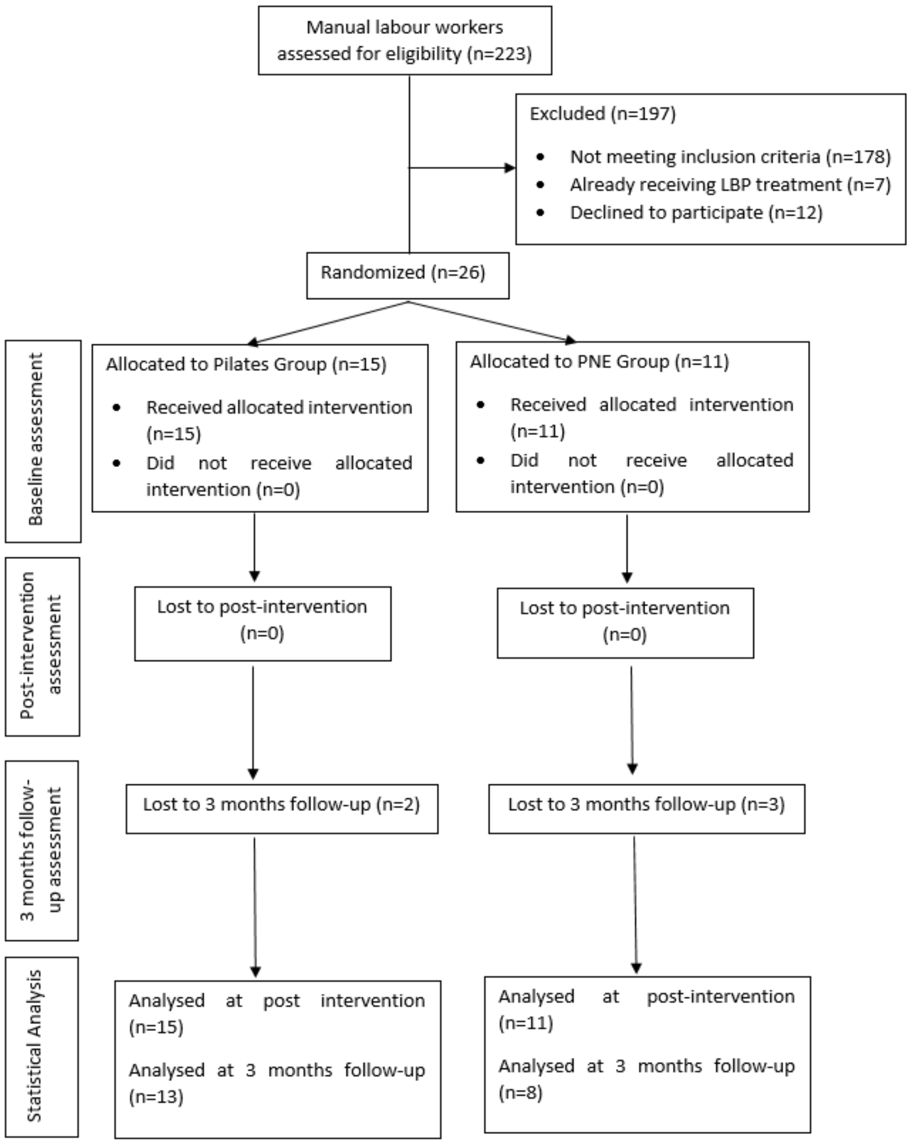

Figure 1: Study flow-chart.

Table 1: Sample Demographic and Anthropometric Characteristics.

Variables		**Pilates Group** (n=15)	**PNE Group** (n=11)	***p***
Gender	Male n (%) Female n (%)	15 (100%) 0 (0%)	10 (90,9%) 1 (9,1%)	0,234
Age (years)	Mean (± SD)	36,13 (±7,08)	40,0 (±9,83)	0,254
Weight (kg)	Mean (± SD)	81,60 (±12,77)	82,09 (±13,75)	0,926
Height (cm)	Mean (± SD)	172,47 (±4,16)	173,45 (±4,20)	0,557

Legend: kg- kilograms; cm – centimeters; SD – Standard Deviation.

3.2. Low Back Pain Characteristics

Table 2 presents the characteristics of low back pain for each group. At baseline, mean (± SD) low back pain intensity in the PNE group was 5,55 (±1,64) and in the Pilates group was 5,33 (±2,32). No between-group significant differences were found (p>0,05) for pain characteristics.

Table 2: Low Back Pain Characteristics at Baseline.

Pain Characteristics		**Pilates Group** (n=15)	**PNE Group** (n=11)	***p***
Pain Last Week n (%)	Yes No	13 (86,7%) 2 (13,3%)	11 (100%) 0 (0%)	0,207
Frequency n (%)	Rarely Sometimes Frequently Always	1 (6,7%) 7 (46,7%) 5 (33,3%) 2 (13,3%)	2 (18,2%) 2 (18,2%) 5 (45,5%) 2 (18,2%)	0,465
Duration n (%)	More than 6 months and less than 1 year More than 1 year and less than 2 years More than 2 years and less than 5 years More than 5 years	2 (13,3%) 3 (20,0%) 2 (13,3%) 8 (53,3%)	1 (9,1%) 5 (45,5%) 2 (18,2%) 3 (27,3%)	0,466
PDQ (<12 neuropathic absence; 12-19 undefined; >19 neuropathic)	Mean (± SD)	8,13 (±6,31)	8,64 (±5,78)	0,837
NPRS (0-10)	Mean (± SD)	5,33 (±2,32)	5,55 (±1,64)	0,798

Legend: PDQ – Pain Detect Questionnaire; NPRS – Numeric Pain Rating Scale; SD – Standard Deviation.

3.3. Low Back Pain Disability, Catastrophizing, Fear-Avoidance Beliefs, Sleep, Biering-Sørensen Test and Knowledge of Pain Neuroscience

Table 3 shows mean values for each of the two groups for disability, catastrophizing, fear-avoidance beliefs, sleep, knowledge of pain neuroscience and the score for the Biering-Sørensen test. A statistically significant between-group difference was found at baseline for disability (PNE (mean±SD)= 26,18 ±13,04; Pilates (mean±SD) = 17,60 ±7,26; p=0,042) and catastrophizing (PNE (mean±SD)= 22,82 ±7,52; Pilates (mean±SD)= 15,33 ±7,11; p=0,014). No between-group statistically significant differences were found for the remaining variables (p>0,05).

Table 3: Baseline values for all variables in study.

Variables			Pilates Group (n=15)	PNE Group (n=11)	*p*
ODI (0-100)		Mean (± SD)	17,60 (±7,26)	26,18 (±13,04)	0,042
PCS (0-52)		Mean (± SD)	15,33 (±7,11)	22,82 (±7,52)	0,014
FABQ	Activity (0-24)	Mean (± SD)	12,80 (±5,0)	13,73 (±6,51)	0,685
	Work (0-42)		24,53 (±9,47)	21,18 (±9,70)	0,386
MOS Sleep	Minutes to fall asleep	0-15	2 (13,3%)	2 (18,2%)	0,252
		16-30	6 (40,0%)	1 (9,1%)	
		31-45	3 (20,0%)	1 (9,1%)	
		46-60	2 (13,3%)	2 (18,2%)	
		>60	2 (13,3%)	5 (45,5%)	
	Index I (0-100)	Mean (± SD)	33,3 (±15,73)	40,91 (±22,27)	0,319
	Index II (0-100)		33,11 (±15,68)	43,69 (±23,83)	0,184
Biering-Sørensen (seconds)		Mean (± SD)	49,23 (±15,07)	44,85 (±20,93)	0,659
NPQ-12 (0-12)		Mean (± SD)	4,20 (±1,90)	4,82 (±2,18)	0,449

Legend: ODI – Oswestry Disability Index; PCS – Pain Catastrophizing Scale; FABQ – Fear-avoidance Beliefs Questionnaire; MOS – Medical Outcomes Study; NPQ-12 – Revised Neurophysiology of Pain Questionnaire; SD – Standard Deviation.

3.4. Post-Intervention Assessment

3.4.1. Low Back Pain Characteristics

There was no interaction between time of assessment and the group of intervention for pain intensity ($F(1,24)=1,90$; $p=0,181$; $\eta^2p=0,07$), but there was a significant effect of time ($F(1,24)=11,66$; $p=0,002$; $\eta^2p=0,32$).

No between-group differences were found for pain presence and frequency (p>0,05) (Table 4).

Table 4: Pain Characteristics at post-intervention.

Pain Characteristics		**Pilates Group** (n=15)			**PNE Group** (n=11)		
		Before	After	Diff.	Before	After	Diff.
Pain Last Week n (%)	Yes	13 (86,7%)	13 (86,7%)	0	11 (100%)	8 (72,7%)	-3
Frequency n (%)	Never	0	0	0	0	2 (18,2%)	+2
	Rarely	1 (6,7%)	2 (13,3%)	+1	2 (18,2%)	3 (27,3%)	+1
	Sometimes	7 (46,7%)	8 (53,3%)	+1	2 (18,2%)	5 (45,5%)	+3
	Frequently	5 (33,3%)	4 (26,7%)	-1	5 (45,5%)	0	-5
	Always	2 (13,3%)	1 (6,7%)	-1	2 (18,2%)	1 (9,1%)	-1
NPRS (0-10)	Mean (± SD)	5,33 (±2,32)	4,60 (±2,32)	-0,73	5,55 (±1,64)	3,82 (±2,56)	-1,73

Legend: NPRS – Numeric Pain Rating Scale; SD – Standard Deviation.

3.4.2. Low Back Pain Disability, Catastrophizing, Fear-Avoidance Beliefs, Sleep, Biering-Sørensen Test and Knowledge of Pain Neuroscience

For low back pain disability no significant interaction between time and group was found ($F(1,24)=2,84$; $p=0,105$; $\eta^2p=0,11$), but there was a significant main effect of time ($F(1,24)=20,06$; $p<0,001$; $\eta^2p=0,46$).

Catastrophizing showed a statistically significant interaction between time of evaluation and group ($F(1,24)=16,76$; $p<0,001$; $\eta^2p=0,41$).

For the FABQ-PA subscale, there was a statistically significant interaction between time and group ($F(1,24)=14,53$; $p=0,001$; $\eta^2p=0,38$). On the contrary, for the FABQ-W subscale, there was only a significant main effect of time ($F(1,24)=26,93$; $p<0,001$; $\eta^2p=0,53$).

For the Sleep Index I no significant interaction was found between time and group ($F(1,24)=0,20$; $p=0,660$; $\eta^2p=0,008$) neither there was an effect of time ($F(1,24)=1,41$; $p=0,247$; $\eta^2p=0,06$). For the Sleep Index II there was no significant interaction between time and group ($F(1,24)=0,79$; $p=0,383$; $\eta^2p=0,03$), but there was a significant main effect of time ($F(1,24)=8,08$; $p=0,009$; $\eta^2p=0,25$).

For the NPQ-12, there was a significant interaction between time and group ($F(1,24)=59,15$; $p<0,001$; $\eta^2p=0,71$).

Similarly, for the Biering-Sørensen test there was a significant interaction between time and group ($F(1,24)=8,02$; $p=0,009$, $\eta^2p=0,25$).

Table 5 shows between-group differences for the PNE and the Pilates group, and the means (± SD) of all variables described above.

Table 5: Mean and standard deviation (SD) for both the Pilates and the PNE group at baseline and at post-intervention.

Variables			Pilates Group (n=15)			PNE Group (n=11)		
			Baseline	Post	Diff.	Baseline	Post	Diff.
ODI (0-100)		Mean (± SD)	17,60 (±7,26)	13,07 (±9,29)	-4,53	26,18 (±13,04)	16,18 (±10,29)	-10
PCS (0-52)		Mean (± SD)	15,33 (±7,11)	12,93 (±7,50)	-2,4	22,82 (±7,52)	11,73 (±7,44)	-11,09
FABQ	Activity (0-24)	Mean (± SD)	12,80 (±5,0)	11,80 (±5,10)	-1,0	13,73 (±6,51)	6,27 (±3,88)	-7,46
	Work (0-42)		24,53 (±9,47)	21,33 (±9,79)	-3,2	21,18 (±9,70)	14,64 (±7,17)	-6,54
MOS Sleep	Minutes to fall asleep	0-15	2 (13,3%)	4 (26,7%)	+2	2 (18,2%)	2 (18,2%)	0
		16-30	6 (40,0%)	8 (53,3%)	+2	1 (9,1%)	4 (36,4%)	+3
		31-45	3 (20,0%)	0 (0,0%)	-3	1 (9,1%)	1 (9,1%)	0
		46-60	2 (13,3%)	2 (13,3%)	0	2 (18,2%)	1 (9,1%)	-1
		>60	2 (13,3%)	1 (6,7%)	-1	5 (45,5%)	3 (27,3%)	-2
	Index I (0-100)	Mean (± SD)	33,3 (±15,73)	30,0 (±13,97)	-3,3	40,91 (±22,27)	39,39 (±23,80)	-1,52
	Index II (0-100)		33,11 (±15,68)	30,15 (±13,30)	-2,96	43,69 (±23,83)	38,03 (±22,53)	-5,66
Biering-Sørensen (seconds)		Mean (± SD)	49,23 (±15,07)	60,69 (±22,54)	+11,46	44,85 (±20,93)	77,95 (±21,97)	+33,1
NPQ-12 (0-12)		Mean (± SD)	4,20 (±1,90)	4,60 (±1,50)	+0,4	4,82 (±2,18)	9,27 (±1,42)	+4,45

Legend: ODI – Oswestry Disability Index; PCS – Pain Catastrophizing Scale; FABQ – Fear-avoidance Beliefs Questionnaire; MOS – Medical Outcomes Study; NPQ-12 – Revised Neurophysiology of Pain Questionnaire; Post – Post-intervention; Diff – mean differences between baseline and post-intervention.

3.4.3. Patient's Global Impression of Change

More than half of the participants from the PNE group (72,72%) reported being, at least, moderately better and a slight but noticeable change, against 33,3% participants from the Pilates group (Table 6).

Table 6: Results from the PGIC scale at post-intervention.

PGIC	Pilates Group (n=15)	PNE Group (n=11)
1. No change (or condition got worse)	1 (6,67%)	0
2. Almost the same, hardly any change at all	5 (33,3%)	1 (9,09%)
3. A little better, but no noticeable change	3 (20%)	0
4. Somewhat better, but the change has not made any real difference	1 (6,67%)	2 (18,18%)
5. Moderately better, and a slight but noticeable change	2 (13,3%)	3 (27,27%)
6. Better, and a definite improvement that has made a real and worthwhile difference	3 (20%)	3 (27,27%)
7. A great deal better, and a considerable improvement that has made all the difference	0	2 (18,18%)

Legend: PGIC- Patient's Global Impression of Change.

3.4.4. Possible contamination

The answers of participants to the contamination questionnaire, suggest no between-group contamination (Table 7).

Table 7: Results for the contamination questionnaire.

Possible Contamination	Pilates group (n=15)	PNE Group (n=11)
1. Have you talked to other participants about the intervention?	3 (20%)	2 (18%)
2. If yes, was your attitude/ intervention changed?	0 (0%)	0 (0%)
3. Are you aware of the intervention that participants in the other group are receiving?	0 (0%)	0 (0%)
4. Are participants in the other group aware of the type of intervention you are receiving?	0 (0%)	0 (0%)
5. For the Pilates group: did you read the pain education booklet provided to the experimental group?	0 (0%)	----

3.5. Three months Follow-up Assessment

Of the 26 total participants, only 21 answered the 3 months follow-up assessment. Data assessment at 3 months follow-up was conducted online due to the *SARS-CoV-2* Pandemic. For the same reason, we were unable to conduct the Biering-Sørensen test at the 3 months follow-up.

3.5.1. Low Back Pain Characteristics

For pain intensity, there was no significant interaction between time and group (F(2,38)=0,52; p=0,597; η^2p=0,03), but there was a significant main effect of time (F(2,38)=6,88; p=0,003; η^2p=0,27). Pairwise comparisons revealed a decrease in pain intensity from T0 to T1, T0 to T2 (p<0,05) but not from T1 to T2 (p>0,05). No between-group differences were found for pain presence and pain frequency (p>0,05) (Table 8).

3.5.2. Low Back Pain Disability, Catastrophizing, Fear-Avoidance Beliefs, Sleep, and Knowledge of Pain Neuroscience

For disability levels, there was no interaction between time and group (F1,14;21,59)=2,13; p=0,157; η^2p=0,10), but there was a significant main effect of time (F(1,14;21,59)=17,74; p<0,001; η^2p=0,48). Pairwise comparisons detected a statistically significant effect from T0-T1 and T0-T2 (p<0,05).

Regarding catastrophizing, there was a statistically significant interaction between time and group (F(1,16;22,11)=13,94; p=0,001; η^2p=0,42). Pairwise comparisons revealed a statistically significant difference from T0-T1 and T0-T2 (p<0,001).

On what regards the FABQ-PA subscale, results also showed a significant interaction between time and group (F(1,12;21,32)=11,10; p=0,002; η^2p=0,37). Pairwise comparisons showed statistical differences to be significant between T0-T1 (p=0,003) and T0-T2 (p=0,001). Similarly, concerning the FABQ-W subscale, there was a significant interaction between time and group (F(1,11;21,12)=4,21; p<0,05; η^2p=0,18). From the pairwise comparisons we could see changes from T0-T1 (p<0,001) and T0-T2 (p<0,001).

For the Sleep Index I results showed no significant interaction between moment and group (F(1,15;21,83)=0,65; p=0,451; η^2p=0,03) and no effect of time (F(1,15;21,83)=0,64; p=0,452; η^2p= 0,03). For the Sleep Index II, there was no significant interaction between time and group (F(1,17;22,25)=0,47; p=0,531; η^2p=0,02), but there was a significant main effect of time (F(1,17;22,25)=6,31; p=0,016; η^2p=0,25). However, pairwise comparisons failed to significantly distinguish between times of assessment ($p>0,05$ in all comparisons). Between T0-T1 the *p* was close to the level of significance ($p=0,052$).

For the NPQ-12, there was a significant interaction between time and group ($F(1,65;31,26)=39,33$; $p<0,001$; $\eta^2p=0,67$). Pairwise comparisons revealed significant differences between T0-T1 ($p<0,001$), T0-T2 ($p<0,001$) and T1-T2 ($p=0,029$).

Table 9 shows the mean differences between the PNE and the Pilates groups.

Table 8: Mean and standard deviation (SD) for both the Pilates and the PNE group at baseline, at post-intervention, and 3 months follow up, and mean differences for post-intervention to 3 months follow-up.

Pain Characteristics		**Pilates Group** (n=13)				**PNE Group** (n=8)			
		Baseline (n=15)	Post (n=15)	3 mo	Diff. Post – 3 mo	Baseline (n=15)	Post (n=15)	3 mo	Diff. Post – 3 mo
Pain Last Week n (%)	Yes	13 (86,7%)	13 (86,7%)	10 (76,9%)	-9,8%	11 (100%)	8 (72,7%)	5 (62,5%)	-10,2%
Frequency n (%)	Never	0	0	1 (7,7%)	+7,7%	0	2 (18,2%)	1 (12,5%)	-5,7%
	Rarely	1 (6,7%)	2 (13,3%)	4 (30,8%)	+17,5%	2 (18,2%)	3 (27,3%)	3 (37,5%)	+10,2%
	Sometimes	7 (46,7%)	8 (53,3%)	5 (38,5%)	-14,8%	2 (18,2%)	5 (45,5%)	2 (25,0%)	-20,5%
	Frequently	5 (33,3%)	4 (26,7%)	2 (15,4%)	-11,3%	5 (45,5%)	0	1 (12,5%)	+12,5%
	Always	2 (13,3%)	1 (6,7%)	1 (7,7%)	+1%	2 (18,2%)	1 (9,1%)	1 (12,5%)	+3,4%
NPRS (0-10)	Mean (± SD)	5,33 (±2,32)	4,60 (±2,32)	4,54 (±2,90)	-0,06	5,55 (±1,64)	3,82 (±2,56)	4,00 (±3,02)	+0.18

Legend: NPRS – Numeric Pain Rating Scale; Post – Post-intervention; 3 mo - 3 months follow-up; Diff - mean differences between post-intervention and 3 months follow-up.

Table 9: Mean and standard deviation (SD) for both the Pilates and the PNE group at baseline, at post-intervention and 3 months follow-up, and mean differences for post-intervention to 3 months follow-up.

Variables			**Pilates Group** (n=13)				**PNE Group** (n=8)			
			Baseline (n=15)	Post (n=15)	3 mo	Diff. Post-3 mo	Baseline (n=11)	Post (n=11)	3 mo	Diff. Post-3 mo
ODI (0-100)		Mean (± SD)	17,60 (±7,26)	13,07 (±9,29)	12,46 (±7,54)	+0,61	26,18 (±13,04)	16,18 (±10,29)	15,25 (±10,53)	-0,93
PCS (0-52)		Mean (± SD)	15,33 (±7,11)	12,93 (±7,50)	12,00 (±7,74)	-0,93	22,82 (±7,52)	11,73 (±7,44)	11,00 (±7,41)	-0,73
FABQ	Activity (0-24)	Mean (± SD)	12,80 (±5,0)	11,80 (±5,10)	10,92 (±5,19)	-0,88	13,73 (±6,51)	6,27 (±3,88)	5,75 (±4,20)	-0,52
	Work (0-42)		24,53 (±9,47)	21,33 (±9,79)	21,23 (±9,36)	-0,1	21,18 (±9,70)	14,64 (±7,17)	15,75 (±8,29)	+1,11
MOS Sleep	Minutes to fall asleep	0-15	2 (13,3%)	4 (26,7%)	4 (30,8%)	0	2 (18,2%)	2 (18,2%)	1 (12,5%)	-1
		16-30	6 (40,0%)	8 (53,3%)	6 (46,2%)	-2	1 (9,1%)	4 (36,4%)	3 (37,5%)	-1
		31-45	3 (20,0%)	0 (0,0%)	0 (0,0%)	0	1 (9,1%)	1 (9,1%)	0 (0,0%)	-1
		46-60	2 (13,3%)	2 (13,3%)	2 (15,4%)	0	2 (18,2%)	1 (9,1%)	1 (12,5%)	0
		>60	2 (13,3%)	1 (6,7%)	1 (7,7%)	0	5 (45,5%)	3 (27,3%)	3 (37,5%)	0
	Index I (0-100)	Mean (± SD)	33,3 (±15,73)	30,0 (±13,97)	31,28 (±16,81)	+1,28	40,91 (±22,27)	39,39 (±23,80)	47,50 (±22,52)	+8,11
	Index II (0-100)		33,11 (±15,68)	30,15 (±13,30)	31,28 (±15,40)	+1,13	43,69 (±23,83)	38,03 (±22,53)	44,86 (±22,82)	+6,83
NPQ-12 (0-12)		Mean (± SD)	4,20 (±1,90)	4,60 (±1,50)	4,92 (±1,12)	+0,32	4,82 (±2,18)	9,27 (±1,42)	10,13 (±1,36)	+0,86

Legend: ODI – Oswestry Disability Index; PCS – Pain Catastrophizing Scale; FABQ – Fear-avoidance Beliefs Questionnaire; MOS – Medical Outcomes Study; NPQ-12 – Revised Neurophysiology of Pain Questionnaire; Post – Post-intervention; 3 mo – 3 months follow-up; Diff - mean differences between post-intervention and 3 months follow-up.

3.5.3. Patient's Global Impression of Change

More than a half of the participants from the PNE group (62,5%) reported to be, at least, moderately better and a slight but noticeable change, against 38,5% participants from the Pilates group (Table 10). Furthermore, two participants (15,4%) in the Pilates Group reported no change or worsening of their condition.

Table 10: Results from the PGIC scale at 3 months follow-up.

PGIC	**Pilates Group** (n=13)	**PNE Group** (n=8)
1. No change (or condition got worse)	2 (15,4%)	0
2. Almost the same, hardly any change at all	4 (30,8%)	1 (12,5%)
3. A little better, but no noticeable change	1 (7,7%)	1 (12,5%)
4. Somewhat better, but the change has not made any real difference	1 (7,7%)	1 (12,5%)
5. Moderately better, and a slight but noticeable change	2 (15,4%)	2 (25%)
6. Better, and a definite improvement that has made a real and worthwhile difference	3 (23,1%)	1 (12,5%)
7. A great deal better, and a considerable improvement that has made all the difference	0	2 (25%)

Legend: PGIC- Patient's Global Impression of Change

3.6. Minimal Clinically Important Changes

Table 11 presents the number (and percentage) of participants that showed potential clinically important changes for pain intensity, disability, catastrophizing, fear-avoidance beliefs, sleep, and knowledge of pain neuroscience detected at post-intervention and at 3 months follow-up, for each intervention group.

Pain intensity and disability at post-intervention and at 3 months follow-up, showed a similar percentage of participants reporting clinically important changes, in what concerns improvements. Regarding clinically important changes that revealed worsening of condition in pain intensity ratings, the Pilates group showed the worst results at post-intervention.

Catastrophizing revealed the biggest changes, favourable to the PNE group, with 75% of participants at 3 months follow-up reporting decreases clinically important against 7,7% in the Pilates group. Similarly, the percentage of participants that reported clinically important changes for the FABQ (72,7% and 45,5%) and for the NPQ (100%) was also higher in the PNE group. The percentage of participants reporting clinically important changes in the MOS Sleep Index I was higher in the Pilates group (20% to 30,8%), but similar in both groups for the MOS Sleep Index II.

Table 11: Number and percentage of participants in each group that showed potential clinically important changes for pain intensity, disability, catastrophizing, fear-avoidance beliefs, sleep quality and knowledge of pain neuroscience.

Outcome Measures	MCIC	Pilates Group		PNE Group	
		T0-T1 (n=15)	T0-T2 (n=13)	T0-T1 (n=11)	T0-T2 (n=8)
NPRS (0-10)	2	5↓ (33,3%)	6↓ (46,1%)	5↓ (45,5%)	4↓ (50%)
		3↑ (20%)	1↑ (7,7%)	1↑ (9,1%)	1↑ (12,5%)
ODI (0-100)	10	5↓ (33,3%)	4↓ (30,8%)	4↓ (36,4%)	3↓ (37,5%)
PCS (0-52)	6,71	2↓ (13,3%)	1↓ (7,7%)	8↓ (72,7%)	6↓ (75%)
FABQ - PA (0-24)	4	2↓ (13,3%)	3↓ (23,1%)	8↓ (72,7%)	4↓ (50%)
FABQ - W (0-42)	7	4↓ (26,7%)	4↓ (30,8%)	5↓ (45,5%)	5↓ (62,5%)
MOS SLEEP I (0-100)	10	3↓ (20%)	4↓ (30,8%)	0↓	0↓
MOS SLEEP II (0-100)	10	2↓ (13,3%)	3↓ (23,1%)	2↓ (18,2%)	2↓ (25%)
NPQ-12 (0-12)	1,2	3↑ (20%)	3↑ (23,1%)	11↑ (100%)	8↑ (100%)

Legend: MCIC – Minimal Clinically Important Change; NPRS- Numeric Pain Rating Scale; ODI- Oswestry Disability Index; PCS- Pain Catastrophizing Scale; FABQ – Fear-Avoidance Beliefs Questionnaire; PA – Physical Activity Subscale; W- Work Subscale; MOS – Medical Outcomes Study; NPQ-12 – Revised Neurophysiology of Pain Questionnaire.

Note: For the NPRS, it is also shown the number and percentage of participants that increased their pain ratings a value similar to the MCIC.

4. DISCUSSION

This study aimed to compare the effects of PNE and graded exposure versus Pilates and postural education, on disability, pain intensity, catastrophizing, fear-avoidance beliefs, sleep, the endurance of back extensor muscles, pain neuroscience knowledge, and perceived impression of change on adults with CLBP in an occupational setting at post-intervention and 3 months follow-up. Both interventions had positive and similar effects on pain intensity, disability, and on one of the subscales of sleep, but PNE and graded exposure were superior to Pilates and postural education for catastrophizing, fear-avoidance beliefs, back extensor muscles endurance and perceived impression of change. Furthermore, positive effects at post-intervention were maintained at 3 months follow-up.

Both interventions had positive and similar effects on disability. A study that used graded activity on occupational healthcare facilities showed that both graded activity and usual care presented the same results on functional status (Graded activity mean improvement (±SD)= 6,3 (±6,7); Usual Care mean improvement (±SD)= 4,9 (±6,2)) (Staal et al., 2004). In our study, 4 (36,4%) participants from the PNE group at post-intervention and 3 (37,5%) participants at 3 months follow-up achieved the MCIC for the ODI, which is in line with the findings in the previous study. Still, this comparison must be interpreted with caution, because even though graded activity and graded exposure have the same base principle of the fear-avoidance model, they are not the same intervention. Despite our results, it has been suggested that graded exposure is more effective than graded activity (De Jong et al., 2005; Leeuw et al., 2008; Woods & Asmundson, 2008). Regarding Pilates interventions, the literature suggests it can be effective in daily functioning and disability thanks to a better knowledge of own body and movement, together with the deep trunk muscles activation and coordination, but the methodological quality of the studies was low (Aladro-Gonzalvo, Araya-Vargas, Machado-Díaz, & Salazar-Rojas, 2013; Albert Anand, Mariet Caroline, Arun, & Lakshmi Gomathi, 2014; Byrnes et al., 2018; Cruz-Díaz et al., 2017; Natour, Cazotti, Ribeiro, Baptista, & Jones, 2015; Silva, Silva, Oliveira, & Oliveira, 2018; Yamato et al., 2016). Howsoever, this is a biomechanical and reductionist view of CLBP (Mostagi et al., 2015). Comparisons with previous studies are limited as we were unable to find any study comparing PNE and graded exposure to Pilates and postural education.

Similarly to disability, both interventions significantly decreased pain, and despite a slightly higher decrease in the PNE group at post-intervention, no between-group significant differences were found. This was probably a consequence of the small sample size. Furthermore, considering the MCIC for the NPRS (Childs et al., 2005), 3 participants in the Pilates group increased their pain ratings in 2 points or more at post-intervention. At 3 months follow-up, in the Pilates group, 6 participants (46,1%), and 4 participants (50%) in the PNE group had a clinically important decrease. These results at 3 months follow-up are in agreement with the evidence that states exercise programs to be effective in reducing pain and reoccurrence rates for CLBP for up to 6 months after the end of treatment (Byrnes et al., 2018; Smith & Grimmer-Somers, 2010). Also, the fact that a few participants in the Pilates group reported increased pain intensity is in line with results from the PGIC scale, which showed that more participants in the PNE group have reported relevant clinical improvements in the PNE group at post-intervention and 3 months follow-up when compared to the Pilates group. These findings are associated with those of Farrar, Young, LaMoreaux, Werth, & Poole (2001), that found that a 2 point reduction in the NPRS represented a clinically important change correlated with "much improved" and "very much improved" categories of the PGIC. Hurst & Bolton (2004) stated that a PGIC score above 5 depicts a significant clinical improvement. Decreased pain intensity after the PNE program is in line with the results of previous studies that combined exercise and PNE in the treatment of CLBP (Airaksinen et al., 2006; Bodes Pardo et al., 2018; Malfliet et al., 2017; Miller et al., 2015; Nijs et al., 2015; Ryan, Gray, Newton, & Granat, 2010; van Middelkoop et al., 2011, 2010).

Results of clinical trials and systematic reviews suggest no agreement on the most appropriate exercise type for CLBP (Hayden et al., 2019; Mazloum et al., 2018; Mun et al., 2016; Shipton, 2018; van Middelkoop et al., 2010). This might be related to generalised exercise-induced hypoalgesia, despite its type or dose (Ellingson & Cook, 2011; Koltyn, 2002; Lemley, Hunter, & Bement, 2015; Mazloum et al., 2018; Naugle, Fillingim, & Riley, 2012; Nijs, Kosek, Van Oosterwijck, & Meeus, 2012; Rice et al., 2019). Previous studies suggest an absence of definite conclusions on the benefits of Pilates in the management of CLBP, when compared with general exercises (Aladro-Gonzalvo et al., 2013; Mostagi et al., 2015; Posadzki, Lizis, & Hagner-Derengowska, 2011). In our study, workers in both groups were also encouraged to perform aerobic exercise such as walking, bicycling or running at home, 3 times per week at least, so exercise induced-hypoalgesia may be related to aerobic training as well (Byrnes et al., 2018; Jones, Booth, Taylor, & Barry, 2014).

Fear of pain, fear of work-related activities and fear of movement have been described as often occurring in patients suffering from pain (Jay et al., 2014). Woods & Asmundson (2008) performed a randomized controlled trial where they randomly assigned patients into 3 possible groups: graded exposure, graded activity, and waiting-list, and demonstrated a significantly greater improvement in fear of movement and fear-avoidance beliefs in the graded exposure group, and these improvements were maintained at a one-month follow-up. Literature suggests that decreasing the threat value of pain and movement may be an effective way of helping people with chronic pain (Louw, Zimney, et al., 2016; Moseley & Butler, 2015; Wideman et al., 2013). Thus, applying PNE and graded exposure within the context of physical activity to specifically help people with chronic pain reappraise the threat value that they associate with pain and movement is advantageous (Malfliet et al., 2017; Nijs et al., 2015; Rice et al., 2019). Similarly, people with impaired exercise-induced hypoalgesia are expected to decrease their catastrophic thinking about potential symptom flares with the graded exposure, through dissipation of negative reactions with time (Rice et al., 2019). In our study, the PNE and graded exposure group was superior to the Pilates and postural education group for pain catastrophizing. When looking at individual improvements, rather than group responses, there were 8 out of 11 (72,7%) participants and 6 out of 8 (75%) participants at post-intervention and 3 months follow-up, respectively, that reported a clinically important change, contrasting to only 2 out of 15 (13,3%) and 1 out of 13 (7,7%) in the Pilates group. However, the PNE group reported significantly higher values at baseline than the Pilates group, increasing the possibility for improvement. Nevertheless, evidence suggests that PNE has a positive impact on catastrophizing (Louw, Zimney, et al., 2016; Moseley et al., 2004; Tegner et al., 2018; Watson et al., 2019).

Avoidance behaviours have an impact on daily life tasks as selective attention to pain-related stimuli may contribute to disability (Leeuw et al., 2007). Fear and beliefs are more disabling than pain itself and drive escape and avoidance (Dagenais et al., 2010; Leeuw et al., 2007). Results show a tendency of major improvements in the PNE group, compared to the Pilates group. Supporting these findings are the results obtained through analysis of the MCIC values for FABQ-PA and FABQ-W subscales (Marco et al., 2020). In the PNE group, 8 (72,2%) participants at post-intervention had decreased their fear-avoidance beliefs in physical activity at least the MCIC, and 4 (50%) had the same result at 3 months follow-up, contrasting to only 2 (13,3%) and 3 (23,1%) in the Pilates group, respectively. Regarding fear-avoidance beliefs at work, results considering the MCIC are still positive to the PNE group, which had 5 (62,5%) participants reporting improvements above the MCIC at 3 months follow-up, contrasting to 4 (30,8%) in the Pilates group. One plausible justification for this between-groups discrepancy may be related to Pilates strategy being based exclusively on biomedical assumptions, and that biomedical model may induce fear and anxiety, which may further fuel fear-avoidance and pain catastrophizing (Louw et al., 2011). Pain neuroscience, on the other hand, teaching patients more about their pain from a biological and psychosocial viewpoint, creates a change in the participants' behavior and decreases the threatening nature of pain (Louw, Puentedura, et al., 2016; Nijs et al., 2017; Wood & Hendrick, 2019). Graded exposure to fearful movements and goal setting also contribute to generating new memories of safety in the brain, increase the patient's activity, and capacitate him to safely move with less focus on pain as the ultimate goal, enhancing the patient's ability to cope with their condition (George & Giorgio Zeppieri, 2009; Nijs et al., 2017, 2015, 2014; Watson et al., 2019).

Results of the Biering-Sørensen test showed improvements in both groups, but these were higher in the PNE group. These findings may suggest that decreases in pain, fear, and catastrophizing may have interfered with the performance in the endurance test as endurance was not specifically targeted in the PNE group.

Results of the NPQ-12 were in line with what was expected considering that only one group received PNE. Furthermore, results suggest that the knowledge of pain neurophysiology remains until 3 months after the intervention, which means participants didn't forget what they were taught about their pain experience. PNE provided an insight into how the participant understood his pain, and was a helpful strategy to reduce the threat value of pain, assisting pain reconceptualization, and increasing security in physical activity. The acquired knowledge helped to reduce fear and catastrophic thinking, breaking the cycle of fear-avoidance. Our findings are in line with those of Louw, Zimney, et al. (2016).

Sleep deprivation is one possible trigger for generalised hyperalgesia and anxiety (Nijs et al., 2017). In our study, improvements in sleep were poorer and similar for both interventions. These results may be justified by the shift work participants perform, and their influence on sleep quality, and also by all the several factors that impact sleep, such as physical function, pain, cognitive or emotional aspects (Gerhart et al., 2017).

There is a dearth of studies performed in an occupational setting, and none used PNE and graded exposure. Nonetheless, considering anterior studies on PNE and graded exposure or exercise interventions, our results are consistent with the literature, demonstrating improvements in pain, disability, catastrophizing and fear-avoidance beliefs (Bodes Pardo et al., 2018; Clarke et al., 2011; Louw et al., 2011; Louw, Zimney, et al., 2016; Moseley, 2002; Ryan et al., 2010). A systematic review by Watson et al. (2019) showed high-quality evidence for pain relief after PNE versus control in the short-term; moderate-quality evidence for decreases in disability at short-term and moderate-quality evidence for reductions in pain catastrophizing and kinesiophobia at short-term. Miller, MacDermid, Walton, & Richardson (2015) showed that PNE and individualized goal-oriented exercises improve function, which is also in line with our findings in the same outcome measure.

The findings related to pain catastrophizing and fear-avoidance beliefs were consistent with the fear-avoidance model and the importance of decreasing these measures in CLBP patients (Leeuw et al., 2007).

4.1. Clinical Implications

This study findings suggest that PNE and graded exposure are superior to Pilates and postural education on catastrophizing, fear-avoidance beliefs, endurance of back extensor muscles, perceived impression of change and knowledge of pain neuroscience both immediately after the intervention and at 3 months (except for back endurance, which was not measured). These results indicate the importance of a biopsychosocial intervention on chronic pain, emphasizing not only pain and physical fitness, but also fears and beliefs related to pain in an industrial setting. Results suggest that PNE and graded exposure can be implemented in an occupational context as specific and physically demanding as a paper industry with positive results. It is likely that making an effort for both PNE and graded exposure to relate directly to the workers activity and daily experiences made a positive difference. We believe Pilates is a good exercise intervention to achieve gains in musculoskeletal fitness, but its principles must be explained differently, not giving so much importance to segmental stabilization, and used alongside any other approach that allows the patient to better understand their pain (in a biopsychosocial model), and create coping strategies not based exclusively on biomedical and postural advice.

4.2. Limitations

Several limitations can be depicted in this study. First of all, and one of the most relevant limitation, is the small sample size, in the way that a reduced number of participants don’t allow the study to achieve the pre-calculated power, thus preventing the detection of differences in some variables, and may have caused a type II error (not detecting between-group changes when they exist). Second, the design of the study didn’t allow the blinding of the physiotherapist who registered the assessments and who delivered both interventions. Nonetheless, care was taken so that participants weren’t aware of the different intervention groups, by analyzing contamination at the end of the intervention. Third, PNE and Pilates group presented statistically significant differences at baseline for disability and catastrophizing, which may have interfered with the results.

Moreover, it is important noting that assessments were performed in different shifts, as well as interventions, so the disposition of participants and their physical and emotional status could vary depending on whether they were leaving a night shift, or yet to begin the workday.

4.3. FUTURE RESEARCH

Future randomized, controlled trials in this field across different occupational and organizational settings are needed to clarify both the mechanisms and the generalizability of our results. Further studies should include larger sample sizes and a long-term follow-up to assess the effects of PNE in this, particularly, challenging environment.

5. Conclusion

This study provides preliminary evidence for the use of PNE and graded exposure for CLBP on an occupational context, in the way it had a positive impact especially in catastrophizing and fear-avoidance beliefs related to work activities. Although effect sizes are small and no between-group statistically significant changes were found for disability and pain intensity, clinically important changes point to the benefits of this intervention compared to Pilates and postural education.

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ANNEX I – ETHICS COMMITTEE APPROVAL

Assunto: CED-UA - Parecer n.º 21-CED/2019

"Educação em neurociência da dor e exposição gradual ao exercício em contexto ocupacional em utentes com dor lombar crónica idiopática"

Levo ao conhecimento de V. Exª que, o Conselho de Ética e Deontologia (CED), com base no Parecer da Comissão Permanente para os Assuntos de Investigação do mesmo Conselho, relativamente ao trabalho de investigação em epígrafe deliberou que, uma vez assegurados em todos os procedimentos o respeito pela legislação nacional e europeia relacionada com a Proteção dos Dados Pessoais:

II - Deliberação

Submetido ao CED o respetivo parecer da sua Comissão Permanente, este Conselho, em sua reunião plenária de 13 novembro de 2019, por entender que ficam salvaguardadas as exigências éticas e os princípios da justiça e da autonomia e bem-estar dos participantes, concorda por unanimidade com o mesmo, em razão do que, o ratifica e dá **parecer favorável** à realização do projeto intitulado: *"Educação em neurociência da dor e exposição gradual ao exercício em contexto ocupacional em utentes com dor lombar crónica idiopática"*.

Cordiais saudações,

O Presidente em exercício do CED-UA

(Prof. Doutor Armando Pinho)

Appendix I – Informed Consent

EDUCAÇÃO EM NEUROCIÊNCIA DA DOR E EXPOSIÇÃO GRADUAL AO EXERCÍCIO EM CONTEXTO OCUPACIONAL EM UTENTES COM DOR LOMBAR CRÓNICA IDIOPÁTICA

B. Consentimento informado

Por favor preencha a seguinte secção, assinalando com uma cruz (x) a opção mais adequada:

	Sim	Não
1. Li o documento informativo sobre este estudo?		
2. Recebi informação suficiente e detalhada sobre este estudo?		
3. Percebi o que o estudo implica e o que me vai ser pedido?		
4. Foi-me permitido fazer as perguntas que quis e as minhas dúvidas foram todas esclarecidas?		
5. Compreendi que posso abandonar este estudo: • Em qualquer altura • Sem dar qualquer explicação • Sem que daí resulte qualquer penalização para mim		
6. Concordo em participar voluntariamente neste estudo que inclui a avaliação e participação nas sessões de Educação em Neurociência da Dor e exposição gradual a exercícios?		

Nome do Participante: ____ Assinatura do Participante: ____

Data: ____/____/______

Nome do Investigador: ____ Assinatura do Investigador: ____

Data: ____/____/______

APPENDIX II – PRE-PARTICIPATION FORM

EDUCAÇÃO EM NEUROCIÊNCIA DA DOR E EXPOSIÇÃO GRADUAL AO EXERCÍCIO EM CONTEXTO OCUPACIONAL EM UTENTES COM DOR LOMBAR CRÓNICA IDIOPÁTICA

C. FORMULÁRIO PRÉ-PARTICIPAÇÃO

A.1. Apresenta alguma das seguintes condições? (por favor confirme se algumas das condições se aplica a si):

- fratura
- patologia de origem maligna ou visceral que provoque dor lombar
- doença inflamatória sistémica (i.e. artrite reumatoide, espondilite anquilosante)
- infeção
- trauma envolvendo a lombar
- lesão severa
- osteoporose
- deformidade estrutural
- doença do sistema nervoso
- gravidez (mulheres)
- doença severa do foro psiquiátrico
- contraindicação para a prática de exercício

Se qualquer das hipóteses anteriores se aplica a si, o questionário termina por aqui.

Se **não** apresenta nenhuma das condições acima, continue para a questão seguinte.

A.2 Dor (assinale as opções aplicáveis):

	Não	Sim, apenas nos **últimos 7 dias**	Sim, recorrentemente ao longo dos **últimos 3 meses**
1.Teve dor ou desconforto na região da lombar			
2.A sua dor irradia para a perna?			
3.Alguma vez recebeu algum tipo de tratamento para a sua dor?			
4.Se respondeu sim, que tipo de tratamento? (responder na coluna adequada)			

APPENDIX III – ASSESSMENT FORM

EDUCAÇÃO EM NEUROCIÊNCIA DA DOR E EXPOSIÇÃO GRADUAL AO EXERCÍCIO EM CONTEXTO OCUPACIONAL EM UTENTES COM DOR LOMBAR CRÓNICA IDIOPÁTICA

PROTOCOLO DE RECOLHA DE DADOS

Este protocolo destina-se apenas aos participantes do estudo que **PREVIAMENTE:**

- Receberam o documento informativo, aceitaram participar no estudo e assinaram o formulário de consentimento;
- Cumpriram todos os critérios de inclusão.

A participação no estudo implica o preenchimento dos instrumentos em três momentos distintos nos quais deve:

1. **Garantir as mesmas condições de preenchimento nos momentos de recolha de dados;**
2. **Respeitar o intervalo de tempo definido entre os momentos de recolha de dados;**
3. **Respeitar a sequência de passagem dos instrumentos.**

AVALIAÇÃO – MOMENTO 1

Previamente ao início da frequência das sessões.

O tempo de preenchimento dos instrumentos neste primeiro momento será de cerca de 30 minutos. Por favor, solicite o preenchimento dos seguintes instrumentos, pela ordem indicada, procurando cumprir os tempos sugeridos:

Instrumento	Tempo preenchimento (minutos)
QUESTIONÁRIO DE CARACTERIZAÇÃO SOCIODEMOGRÁFICA (A) E CLÍNICA (B)	4
AVALIAÇÃO DA RESISTÊNCIA MUSCULAR – *Biering-Sørensen* (C)	4
ÍNDICE DE INCAPACIDADE DE OSWESTRY - versão portuguesa (D)	5
ESCALA DE CATASTROFIZAÇÃO DA DOR– versão portuguesa (E)	3
QUESTIONÁRIO DE CRENÇAS DE MEDO-EVITMENTO– versão portuguesa (F)	5
QUESTIONARIO DE DETEÇÃO DA DOR – versão portuguesa (G)	5

QUESTIONÁRIO DE NEUROFISIOLOGIA DA DOR – versão portuguesa (H)	10
ESCALA DE SONO PARA O RESULTADO MÉDICO – versão portuguesa (I)	3

AVALIAÇÃO – MOMENTOS 2 E 3

Até 7 dias depois e 3 meses após o MOMENTO 2, respetivamente.

Por favor, solicite o preenchimento dos seguintes instrumentos, na ordem indicada, procurando cumprir os tempos sugeridos:

Instrumento	Tempo preenchimento (minutos)
QUESTIONÁRIO DE CARACTERIZAÇÃO CLÍNICA (B)	2
AVALIAÇÃO DA RESISTÊNCIA MUSCULAR – *Biering-Sørensen* (C)	4
ÍNDICE DE INCAPACIDADE DE OSWESTRY - versão portuguesa (D)	5
ESCALA DE CATASTROFIZAÇÃO DA DOR – versão portuguesa (E)	3
QUESTIONÁRIO DE CRENÇAS DE MEDO-EVITMENTO – versão portuguesa (F)	5
QUESTIONARIO DE DETEÇÃO DA DOR – versão portuguesa (G)	5
QUESTIONÁRIO DE NEUROFISIOLOGIA DA DOR – versão portuguesa (H)	10
ESCALA DE SONO PARA O RESULTADO MÉDICO – versão Portuguesa (I)	3
QUESTIONÁRIO DE PERCEÇÃO GLOBAL DE MUDANÇA - versão portuguesa (J)	2

EDUCAÇÃO EM NEUROCIÊNCIA DA DOR E EXPOSIÇÃO GRADUAL AO EXERCÍCIO EM CONTEXTO OCUPACIONAL EM UTENTES COM DOR LOMBAR CRÓNICA IDIOPÁTICA

QUESTIONÁRIO DE CARACTERIZAÇÃO CLÍNICA

Por favor responda a cada uma das perguntas de forma apropriada, assinalando com um X a resposta adequada ou preenchendo com a informação solicitada.

B. Informação clínica

B.1. Na última semana, teve dor ou desconforto na lombar e sentiu essa dor ou desconforto pelo menos **UMA VEZ POR DIA**?

- ☐ Sim (P.f. indique na Figura 1 a localização)
- ☐ Não

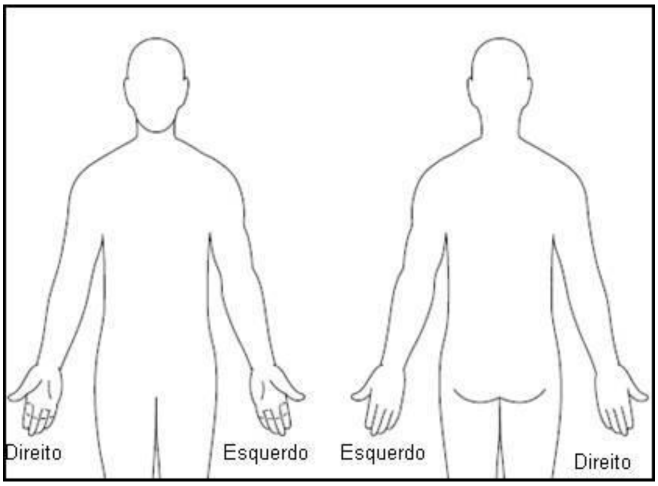


Figura 1. *Body-chart 1*

B.2. Quantas vezes, **NA ÚLTIMA SEMANA**, sentiu essa dor?

- ☐ Nunca
- ☐ Raramente (1 vez por semana)
- ☐ Ocasionalmente (2 a 3 vezes por semana)
- ☐ Muitas vezes (mais do que 3 vezes por semana)
- ☐ Sempre

B.3. Há quanto tempo sente dor na região da lombar?

- ☐ Entre 3 a 6 meses
- ☐ Entre 6 meses a 1 ano
- ☐ Entre 1 a 2 anos
- ☐ Entre 2 a 5 anos
- ☐ Mais de 5 anos

B.4. Escala Numérica da Dor

Na seguinte escala, na qual 0 corresponde à classificação “Sem Dor” e a 10 a classificação “Dor Máxima” (dor de intensidade máxima imaginável). Por favor selecione o número que melhor representa a intensidade da sua dor neste momento.

Sem Dor	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Dor Máxima**

Figura 2 – Escala Numérica da Dor (END).

B.5. Dor noutros locais

Na última semana, teve dor ou desconforto noutros locais e sentiu essa dor ou desconforto pelo menos UMA VEZ POR DIA?

- ☐ Sim (P.f. indique na Figura 3 a localização)
- ☐ Não

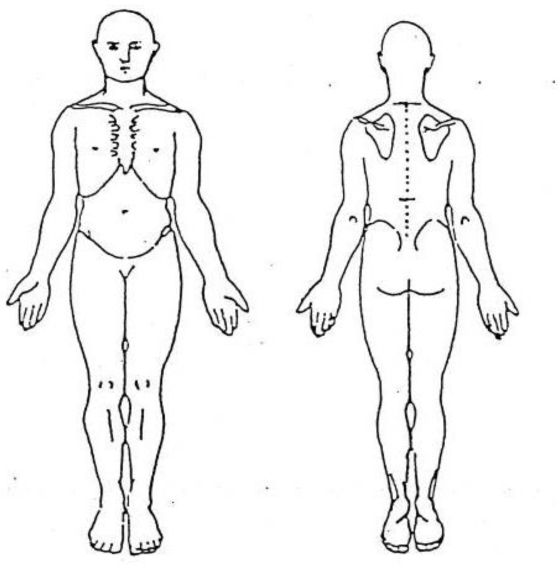


Figura 3. *Body-chart 2*

C. Avaliação da Resistência Muscular dos extensores da Coluna

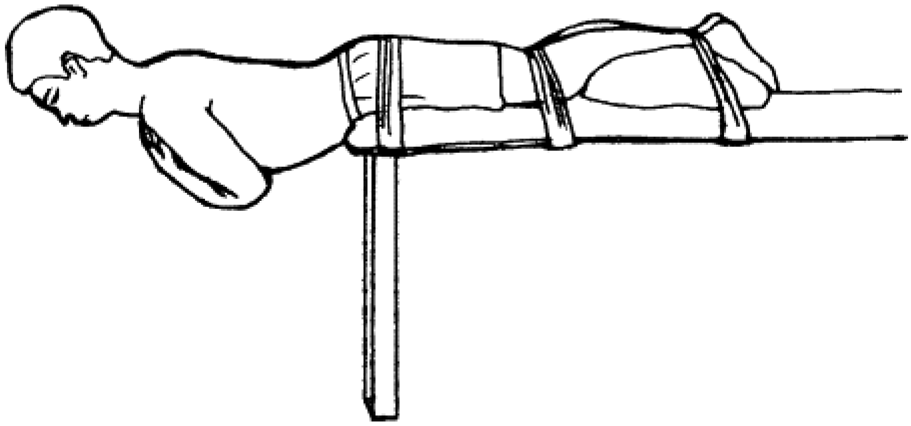


Figura 4: Imagem demonstrativa da posição de teste

	Teste 1	Teste 2	Teste 3
Tempo (s)			

D. Incapacidade associada à dor: Índice de Oswestry (V.2) – Versão Portuguesa

Índice de Oswestry sobre incapacidade (versão 2.0)

O questionário que se segue foi feito para nos dar informações de como o seu problema com as costas (ou perna) tem afectado a sua capacidade para viver o dia-a-dia .

Por favor responda a *todas as secções*.

Escolha *apenas o quadrado* em cada secção que melhor o descreve *hoje*.

Secção 1: Intensidade da dor

- ☐ Neste momento não tenho dores
- ☐ A dor é muito ligeira neste momento
- ☐ A dor é moderada neste momento
- ☐ A dor é um bocado forte neste momento
- ☐ A dor é muito forte neste momento
- ☐ A dor é o pior que se possa imaginar neste momento

Secção 2: Cuidados pessoais (lavar, vestir, etc.)

- ☐ Consigo arranjar-me como antes sem ter mais dores
- ☐ Consigo arranjar-me como antes mas tenho muitas dores
- ☐ Tenho muitas dores quando me estou a arranjar e sou muito lento(a) e cuidadoso(a)
- ☐ Preciso de alguma ajuda mas consigo arranjar-me quase todo(a) sozinho(a)
- ☐ Preciso de ajuda todos os dias na maior parte dos meus cuidados pessoais
- ☐ Não me visto, lavo-me com dificuldade, e fico na cama

Secção 3: Levantar pesos

- ☐ Consigo levantar grandes pesos sem ter mais dores
- ☐ Consigo levantar grandes pesos mas tenho mais dores
- ☐ As dores não me deixam levantar grandes pesos do chão mas já consigo fazê-lo se estiverem num sitio que dê jeito, por exemplo, em cima duma mesa
- ☐ As dores não me deixam levantar grandes pesos mas consigo levantar pesos leves ou médios se estiverem num sítio que dê jeito
- ☐ Só consigo levantar pesos muito leves
- ☐ Não consigo levantar ou carregar absolutamente nada

 1

Secção 4: Andar

- ❑ As dores não me impedem de andar qualquer distância
- ❑ As dores não me deixam andar mais de 1,5 km
- ❑ As dores não me deixam andar mais de 500 m
- ❑ As dores não me deixam andar mais de 100 m
- ❑ Só consigo andar com uma bengala ou com canadianas
- ❑ Estou na cama a maior parte do tempo e tenho que me arrastar para ir a casa de banho

Secção 5: Estar sentado/a

- ❑ Consigo estar sentado/a em qualquer cadeira o tempo que eu quiser
- ❑ Consigo estar sentado/a na minha cadeira preferida o tempo que eu quiser
- ❑ As dores não me deixam estar sentado/a mais de uma hora
- ❑ As dores não me deixam estar sentado/a mais de meia hora
- ❑ As dores não me deixam estar sentado/a mais de 10 minutos
- ❑ As dores não me deixam estar sentado/a

Secção 6: Estar de pé

- ❑ Consigo estar de pé o tempo que eu quiser sem ter mais dores
- ❑ Consigo estar de pé o tempo que eu quiser mas tenho mais dores
- ❑ As dores não me deixam estar de pé mais de uma hora
- ❑ As dores não me deixam estar de pé mais de meia hora
- ❑ As dores não me deixam estar de pé mais de 10 minutos
- ❑ As dores não me deixam estar de pé

Secção 7: Dormir

- ❑ O meu sono nunca é perturbado pelas dores
- ❑ O meu sono é ocasionalmente perturbado pelas dores
- ❑ Por causa das dores durmo menos de 6 horas
- ❑ Por causa das dores durmo menos de 4 horas
- ❑ Por causa das dores durmo menos de 2 horas
- ❑ As dores não me deixam dormir

 2

Secção 8: Vida sexual (se se aplicar)

- ❑ A minha vida sexual é normal e não me causa mais dores
- ❑ A minha vida sexual é normal mas causa-me mais dores
- ❑ A minha vida sexual é quase normal mas causa-me muitas dores
- ❑ A minha vida sexual é limitada pelas dores
- ❑ Quase não tenho vida sexual por causa das dores
- ❑ As dores não me deixam ter uma vida sexual

Secção 9: Vida social

- ❑ A minha vida social é normal e não me causa mais dores
- ❑ A minha vida social é normal mas aumenta a intensidade das dores
- ❑ As dores não têm grande influência na minha vida social para além de limitaram as minhas actividades mais exigentes, por exemplo, desporto, etc
- ❑ As dores limitaram a minha vida social e eu já não saio tanto
- ❑ As dores confinaram a minha vida social à minha casa
- ❑ Não tenho vida social por causa das dores

Secção 10: Viajar

- ❑ Consigo viajar para qualquer lado sem dores
- ❑ Consigo viajar para qualquer lado mas causa-me mais dores
- ❑ As dores incomodam-me mas consigo fazer viagens de mais de 2 horas
- ❑ As dores não me deixam fazer viagens de mais de 1 hora
- ❑ As dores restringem-me a viagens necessárias e curtas, de menos de 30 minutos
- ❑ As dores não me deixam viajar a não ser para fazer tratamento

AGRADECEMOS A SUA COLABORAÇÃO E O TEMPO QUE NOS CONCEDEU AO PREENCHER ESTE QUESTIONÁRIO

E. Catastrofização: Escala de Catastrofização da Dor (PCS) – Versão Portuguesa

Todas as pessoas experienciam situações dolorosas em alguma altura das suas vidas. Essas experiências dolorosas podem ser dores de cabeça, dores de dentes, dores musculares ou das articulações. As pessoas são frequentemente expostas a situações que podem causar dor como por exemplo, uma doença, uma lesão ou um procedimento cirúrgico.

Gostaríamos de saber os tipos de pensamento e sentimentos que tem sempre que experiencia dor. Em baixo encontram-se listadas treze afirmações descrevendo diferentes pensamentos e sentimentos que podem estar associados à dor. Utilizando a escala que se segue, indique por favor em que medida tem estes pensamentos e sentimentos quando sente dor.

0 – Nunca 1- Poucas Vezes 2 – Algumas vezes 3-Muitas vezes 4 - Sempre

Quando tenho dor …

1 ☐ Preocupo-me constantemente sobre quando terminará a dor.

2 ☐ Sinto que não sou capaz de continuar assim.

3 ☐ É terrível e penso que nunca irá melhorar nem um pouco.

4 ☐ É horrível e sinto que isso me domina.

5 ☐ Sinto que não consigo aguentar mais.

6 ☐ Fico com medo que a dor se torne pior.

7 ☐ Penso continuamente noutras situações dolorosas

8 ☐ Desejo ansiosamente que a dor desapareça.

9 ☐ Parece que não posso afastar a dor do meu pensamento.

10 ☐ Penso constantemente sobre o quanto me dói.

11 ☐ Penso constantemente sobre o quão desesperadamente quero que a dor acabe.

12 ☐ Não há nada que eu possa fazer que reduza a intensidade da minha dor.

13 ☐ Eu pergunto a mim mesmo se algo de grave poderá acontecer.

…Total

F. Medo do Movimento: Questionário de Crenças de Medo-Evitamento – Versão Portuguesa

Em seguida, estão algumas das coisas que outros doentes disseram a respeito da sua dor.
Para cada frase, por favor, assinale com um círculo num dos números de 0 a 6, de forma a indicar o quanto actividades físicas tais como, dobrar-se, levantar objectos, andar ou guiar, afectam ou podem vir a afectar a *sua* dor nas costas.

	DISCORDO COMPLETAMENTE			NÃO TENHO A CERTEZA			CONCORDO COMPLETAMENTE
1. A minha dor foi causada por actividade física	**0**	**1**	**2**	**3**	**4**	**5**	**6**
2. A actividade física faz piorar a minha dor	**0**	**1**	**2**	**3**	**4**	**5**	**6**
3. A actividade física poderá prejudicar as minhas costas	**0**	**1**	**2**	**3**	**4**	**5**	**6**
4. Eu não devo fazer actividades físicas que fazem (poderão fazer) piorar a minha dor	**0**	**1**	**2**	**3**	**4**	**5**	**6**
5. Eu não posso fazer actividades físicas que fazem (poderão fazer) piorar a minha dor	**0**	**1**	**2**	**3**	**4**	**5**	**6**

As frases seguintes referem-se ao modo como a sua actividade profissional/ trabalho afecta ou poderá afectar a sua dor nas costas.

	DISCORDO COMPLETAMENTE			NÃO TENHO A CERTEZA			CONCORDO COMPLETAMENTE
6. A minha dor foi causada pelo meu trabalho ou por um acidente de trabalho	**0**	**1**	**2**	**3**	**4**	**5**	**6**
7. O meu trabalho fez agravar a minha dor	**0**	**1**	**2**	**3**	**4**	**5**	**6**
8. O meu trabalho é muito pesado para mim	**0**	**1**	**2**	**3**	**4**	**5**	**6**
9. O meu trabalho faz ou poderá vir a fazer com que a minha dor piore	**0**	**1**	**2**	**3**	**4**	**5**	**6**
10. O meu trabalho poderá prejudicar as minhas costas	**0**	**1**	**2**	**3**	**4**	**5**	**6**
11. Actualmente, com esta dor, eu não deveria fazer o meu trabalho normal	**0**	**1**	**2**	**3**	**4**	**5**	**6**
12. Eu não consigo fazer o meu trabalho com a dor que tenho actualmente	**0**	**1**	**2**	**3**	**4**	**5**	**6**
13. Eu não posso continuar o meu trabalho normal até a minha dor estar tratada	**0**	**1**	**2**	**3**	**4**	**5**	**6**
14. Eu não acredito que vou voltar ao meu trabalho normal nos próximos 3 meses	**0**	**1**	**2**	**3**	**4**	**5**	**6**
15. Eu não acredito que seja alguma vez capaz de voltar ao meu trabalho normal	**0**	**1**	**2**	**3**	**4**	**5**	**6**

G. Componente de Dor: Questionário de Deteção da Dor (PD) – Versão Portuguesa

painDETECT — **QUESTIONÁRIO SOBRE DOR**

Data: .... **Paciente:** Apelido: .... Nome: ....

Como avalia a sua dor **agora**, neste momento?

0	1	2	3	4	5	6	7	8	9	10

ausente — máxima

Qual a intensidade da dor **mais forte** que sentiu nas últimas 4 semanas?

0	1	2	3	4	5	6	7	8	9	10

ausente — máxima

Em média, qual a intensidade da dor que sentiu nas últimas 4 semanas?

0	1	2	3	4	5	6	7	8	9	10

ausente — máxima

Assinale a imagem que melhor descreve a evolução da sua dor:


Dor constante com ligeiras variações ☐


Dor constante com crises de dor ☐


Crises de dor sem dor nos intervalos ☐


Crises frequentes de dor com dor nos intervalos ☐

Por favor indique **a principal zona de dor**

A sua dor espalha-se a outras regiões do corpo?
sim ☐ não ☐
Se sim, indique a direcção para onde a dor se espalha.

Sofre de sensação de queimadura ou ardor (p. ex., como se tocasse em urtigas) nas zonas indicadas?

nenhuma ☐ insignificante ☐ ligeira ☐ moderada ☐ forte ☐ muito forte ☐

Sente uma sensação de picada ou formigueiro na zona da dor (como formigas a caminhar ou uma vibração eléctrica)?

nenhuma ☐ insignificante ☐ ligeira ☐ moderada ☐ forte ☐ muito forte ☐

Um toque superficial (com roupa, cobertor) nesta zona provoca dor?

nenhuma ☐ insignificante ☐ ligeira ☐ moderada ☐ forte ☐ muito forte ☐

Tem crises repentinas de dor na zona afectada, como choques eléctricos?

nenhuma ☐ insignificante ☐ ligeira ☐ moderada ☐ forte ☐ muito forte ☐

O frio ou o calor (como a água do banho) provoca-lhe dor ocasional nesta zona?

nenhuma ☐ insignificante ☐ ligeira ☐ moderada ☐ forte ☐ muito forte ☐

Sofre de sensação de dormência nas zonas que indicou?

nenhuma ☐ insignificante ☐ ligeira ☐ moderada ☐ forte ☐ muito forte ☐

Uma leve pressão nessa zona, por ex., com um dedo, desperta dor?

nenhuma ☐ insignificante ☐ ligeira ☐ moderada ☐ forte ☐ muito forte ☐

(A preencher pelo médico)

nenhuma	insignificante	ligeira	moderada	forte	muito forte
☐ x 0 = 0	☐ x 1 = ☐	☐ x 2 = ☐☐	☐ x 3 = ☐☐	☐ x 4 = ☐☐	☐ x 5 = ☐☐

Pontuação total ☐☐ **de 35 no máximo**

(A preencher pelo médico)

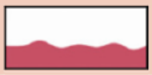
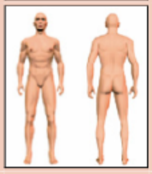
painDETECT — Pontuação do questionário sobre dor

Data: .... Paciente: Apelido: .... Nome: ....

Por favor introduza aqui a pontuação total obtida no questionário sobre dor:

Pontuação total [ ][ ]

Por favor, adicione os valores seguintes de acordo com o padrão de evolução da dor assinalado e a irradiação da dor. Em seguida calcule a pontuação final:

	Dor constante com ligeiras variações	0	
	Dor constante com crises de dor	-1	se assinalou esta opção ou
	Crises de dor sem dor nos intervalos	+1	se assinalou esta opção ou
	Crises frequentes de dor com dor nos intervalos	+1	se assinalou esta opção
	Irradiação da dor?	+2	se respondeu que sim

Pontuação final [ ][ ]

Resultado do despiste

da presença de uma componente de dor neuropática

negativo	indefinido	positivo
0 1 2 3 4 5 6 7 8 9 10 11 12	13 14 15 16 17 18	19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
Improvável (< 15%) a presença de uma componente de dor neuropática	O resultado é ambíguo, contudo poderá estar presente uma componente de dor neuropática	Provável (> 90%) a presença de uma componente de dor neuropática

Esta ficha não substitui o diagnóstico médico.
Destina-se ao despiste da presença de uma componente de dor neuropática.

DFNS

pain — Pfizer · Analgesic · Innovative · Network

H. Conhecimento da Dor Crónica: Questionário de Neurofisiologia da Dor (PNQ12) – Versão Portuguesa

Assinale com uma cruz a resposta correta para cada uma das questões. A resposta pode ser **Verdadeiro (V), Falso (F) ou Indeciso (I)** no caso de estar com dúvidas.

	V	F	I
1. É possível ter dor e não saber.			
2. Quando uma parte do seu corpo está lesionada, recetores especiais da dor transmitem a mensagem de dor para o seu cérebro.			
3. A dor só ocorre quando está lesionado ou em risco de se lesionar.			
4. Quando está lesionado, recetores especiais transmitem uma mensagem de perigo para a sua medula espinhal.			
5. Nervos especiais na sua medula espinhal transmitem mensagens de "perigo" para o seu cérebro.			
6. Os nervos adaptam-se, aumentando o seu nível de excitação em repouso.			
7. Dor crónica significa que uma lesão não curou corretamente.			
8. As piores lesões resultam sempre numa pior dor.			
9. Os neurónios descendentes são sempre inibitórios.			
10. Há dor sempre que está lesionado.			
11. Quando tem uma lesão, o ambiente em que está não influencia a quantidade de dor que sente, desde que a lesão seja exatamente a mesma.			
12. O cérebro decide quando vai sentir dor.			

I. Escala de Sono para o Resultado Médico (MOS) – Versão Portuguesa

1. Quanto tempo levou geralmente a adormecer após o início do turno atual?
(*Assinale uma*):

0-15 minutos................................ 1
16-30 minutos 2
31-45 minutos.............................. 3
46-60 minutos 4
Mais de 60 minutos........................ 5

2. Em média, quantas horas dormiu por noite após o início do turno atual?
(*Escreva o nº de horas por noite*):_______________

Com que frequência após o início do turno atual lhe aconteceu?
(*Assinale um número em cada linha*):

		Sempre	Quase sempre	Muitas vezes	Algumas vezes	Poucas vezes	Nunca
3.	Sentiu que o seu sono não era sossegado (agitou-se, sentiu-se tenso, falou durante o sono, etc.).	1	2	3	4	5	6
4.	Dormiu o suficiente para se sentir descansado ao acordar na manhã seguinte.	1	2	3	4	5	6
5.	Acordou com falta de ar ou com dores de cabeça.	1	2	3	4	5	6
6.	Sentiu-se sonolento ou dormiu durante o dia.	1	2	3	4	5	6
7.	Teve problemas em adormecer.	1	2	3	4	5	6
8.	Acordou durante a noite e teve problemas em adormecer.	1	2	3	4	5	6
9.	Teve dificuldades em ficar acordado durante o dia.	1	2	3	4	5	6
10.	Ressonou enquanto dormia.	1	2	3	4	5	6
11.	Fez sestas de 5 minutos ou mais durante o dia.	1	2	3	4	5	6
12.	Obteve o sono que precisa.	1	2	3	4	5	6

J. Escala de Perceção global de Mudança (PGIC) – Versão Portuguesa

Desde o início do tratamento nesta instituição, como é que descreve a mudança (se houve) nas LIMITAÇÕES DE ATIVIDADES, SINTOMAS, EMOÇÕES E QUALIDADE DE VIDA no seu global, em relação à sua dor (selecione UMA opção):

Sem alterações (ou a condição piorou)	☐	1
Quase na mesma, sem qualquer alteração visível	☐	2
Ligeiramente melhor, mas, sem mudanças consideráveis	☐	3
Com algumas melhorias, mas a mudança não representou qualquer diferença real	☐	4
Moderadamente melhor, com mudança ligeira mas significativa	☐	5
Melhor, e com melhorias que fizeram uma diferença real e útil	☐	6
Muito melhor, e com uma melhoria considerável que fez toda a diferença	☐	7

APPENDIX IV – PNE AND GRADED EXPOSURE CONTENTS

Week	Session	Topics	Duration	Strategies used (examples)
0	0	Presentation of the study and of the treatment rationale.	10 min	Oral presentation and delivery of written information concerning frequency and duration of the intervention plan, as well as the follow up period.
		Baseline assessment: anthropometric data, bodychart, numerical pain rating scale, Oswestry Disability Questionnaire, Pain Catastrophizing Scale, Fear-Avoidance Beliefs Questionnaire; MOS Sleep; NPQ-12; Biering-Sorensen	35-40 min	
1	Session 1	Assessment of patients' beliefs towards pain, exercise and work load as well as patients' motivation and barriers to overcome the pain (whether they be individual characteristics, or job related: perceptions of injustice, lack of social support at work, poor relashionship with colleagues and supervisors...)	15 min	A prompting question: What are your thoughts on your work demands and how do you correlate it with your pain? Do you think you can be physically active with your condition? Do you think your job is dangerous for your back pain? Why? Do you see pain as a sign of harm? Do you have any previous experiences with physiotherapy to adress this problem? How did they work for you? How do you deal with your complaints on a daily basis? Do you think it is useful to help you feel better? (answers to these questions will help customize education)
		Pain is not a sign of tissue damage. Normal pain processing: Pain pathways and intervenients from nociceptors to pain perception. Characteristics of acute versus chronic pain, the purpose of acute pain, and how it originates from the nervous system.	30 min	Verbal explanation by the therapist, and visually through images shown in paper/power-point; drawings; metaphors. Patients will be encouraged to ask questions throughout the sessions and their input will be used to individualise the information.
		Definition of an homework activity	5 min	Think about some personal goals the participant wants to achieve,
2	Session 2	Nociceptors, ion gates, neurons, action potential, nociception, peripheral sensitization, synapses, synaptic gap, inhibitory/excitatory chemicals, spinal cord, descending/ascending pain pathways, role of the brain, pain memory and pain perception. How pain become chronic (plasticity of the nervous system, modulation, modification, central sensitization, the pain neuromatrix theory) and potential sustaining factors of central sensitization like emotions, stress, ilness perceptions, pain cognitions and pain behaviour.	20 min	as previous
		Neurofisiology of Pain Questionnaire -NPQ	5 min	
		Define the activities that cause pain related fear, and kinesiophobia behaviours and establish an order from the one that causes the most fear and is strongly associated with fear of reinjury, to the simplest one.	5 min	
		Define the maximum capacity of the individual to perform the acivities and exercises established previously.	15 min	Perform the different movements and tasks that cause pain related fear to full capacity.
		Definition of homework activities with identification of 1 treatment goal by each patient.	5 min	Delivery of a booklet with written and illustrated information with the main aspects regarding PNE and advised to read it several times at home (the patient will be given a summary of the main topics each session).

3	Session 3	Discuss topics that require aditional explanation according to the results of NPQ and revision of main concepts from last session	15 min	Based on incorrect answers, the therapist will explain the topics once again and if necessary in more detail.
		Discuss with the patient how the information provided can be applied to everyday situations.		Give information towards the application of adaptative pain coping strategies, self-management skills and potentiate the compliance to a graded exposure program.
		Importance of exercise/the role of fear avoidance in pain neuromatrix	5 min	Verbal explanation of how the various treatment components are likely to contribute to decreasing the hyperensitivity of the CNS: exercises are not intended to adress local back problems, but aim at retraining the brain.
		Gradual exposure to exercise. Time contingent intensity instead of pain dependent. Intensity starts at 10-20% less than the maximum established in the previous session.	20 min	Start with the activity that has the lower grade of difficulty - focus on functionality instead of pain relief.
		Definition of homework activities.	5 min	Perform this exercise 10 times regardless of the pain, in spite of "stop when it hurts". Start to do some exercises during work and at home.
4	Session 4	Review homework activities.	10 min	
		Discussion of some PNE concepts and difficulties performing exercise at home.		Some questions like: I know that you have got a lot of new information. How are you processing this? Do you feel like this new knowledge is applicable to your situation?; Do you understand how pain, behaviour, thoughts and emotions are related and how they all influence and maintain each other?
		Pain and cognitions (fear, catastrophyzing, self-efficacy at work); pain and emotions (anger, depression, burnout…)	15 min	How to deal with the job demands, and the feelings of inaptitude and disability. Counseling on how to manage the symptons during labour, teaching the benefits of pauses with movement to desensitize the nervous system
		Topics on sleep quality		The bedroom is to sleep; avoid naps during the day; perform calm activities before going to bed; lie down and get up at the same time; if unable to fall asleep after 20 minutes you should get up; …
		Gradual exposure to exercise. Evolve to another activity in the hierarchy if possible.	20 min	as previous.
		Definition of homework activities.	5 min	as previous.
5	Session 5	Review homework activities.	10 min	
		Revision of main PNE concepts from previous sessions		Discuss any existing doubts concerning the leaflets that the participants are advised to read at home.
		Evaluate different behaviours towards work and if the participant has made any variation on how to manage their condition while at work.		Review main difficulties in performing exercises at work (lack of time? High work demands? Fear of retaliation by superiors?)
		Gradual exposure to exercise. Evolve to another activity in the hierarchy if possible.	30 min	as previous.
		Definition of homework activities.	5 min	as previous.

		Review homework activities.		
6	Session 6	Evaluation of important concepts regarding PNE and discussion of some difficulties with implementing PNE concepts throughout daily life activities.	15 min	Asking the patient to explain the treatment rationale of a specific treatment component. If the pain cognitions change towards maladaptative ones, the therapist need to re-educate the patient: re-read the written information on pain physiology and try to link that information with his current rehabilitation program. Have you been experiencing some lack of motivation during this intervention? Do you think that now you can manage your pain by yourself and not be worried if you are hurting yourself?
		Gradual exposure to exercise.	30 min	as previous
		Definition of homework activities	5 min	as previous or try to increase the number of repetitions.
		Review homework activities.		
7	Session 7	Review homework activities.	10 min	Ask in which exercises they experience better feelings and enjoy to perform. If hey were capable to complete the established set proposed.
		Gradual exposure to exercise - continuously evolving on the hierarchy, incrementing intensity of previous exercises.	30 min	as previous
		Definition of homework activities - Review concepts of PNE and continue to perform exercises at work and at home	10 min	Draw a diagram explaining principles of pain pathways and processing.
8	Session 8	Review homework activities.	5 min	
		Gradual exposure to exercise - continuously evolving on the hierarchy, incrementing intensity of previous exercises and reach the primary goal etablished during the previous sessions.	35 min	Final revisions.
		Identification of any kind of difficulties during some specific exercises.	20 min	
		Open discussion on how to manage chronic pain.		
		Post-intervention assessment, minus anthropometric and sociodemographic data	30 min	

APPENDIX V – PILATES AND POSTURAL EDUCATION CONTENTS

Week	Session	Topics	Duration	Strategies used (examples)
0		Presentation of the study and of the treatment rationale.	10 min	Oral presentation and delivery of written information concerning frequency and duration of the intervention plan, as well as the follow up period.
		Baseline assessment: anthropometric data, bodychart, numerical pain rating scale, Oswestry Disability Questionnaire, Pain Catastrophizing Scale, Fear-Avoidance Beliefs Questionnaire; MOS Sleep; NPQ-12; Biering-Sorensen	35-40 min	
1	Session 1	Introdution to Pilates - 5 key elements	40 min	Explain injury and causative factors, explain necessary precautions to take throughout the day. Learning how to properly breathe (breathe in and allow your ribs to expand widthways); engage the center (tilt the pelvis towards a neutral position); ribcage placement (think of softening your breast bone); shoulder blade placement (iimagine you are drawing the letter "V" with your shoulder blades); head and neck placement (lengthening the back of your spine to upright postures). Learn the imprinting technique.
		Definition of homework activities.	5 min	Try to perform isolated contraction of the TrA while driving, when having a coffee, while whatching tv, ...
2	Session 2	Revision of some concepts on Pilates' principles and difficulties at homework activity.	5 min	Dicussion of main difficulties on achieving neutral spine position or the correct shoulder blade position while activating the inferior trapezius, for instance.
		Pilates warm up	10 min	Intensity established using the Borg Perceived Exertion Scale: 8-10 - light intensity; 11-13 - moderate intensity. Challenge local stabilizers, improve endurance of postural muscles in sitting and other activities of daily living.
		Pilates exercises - closed kinetic chain, static stability - muscle activation	20 min	
		Pilates cool down	10 min	
		Definition of homework activities.	5 min	Delivery of a booklet with 3 different exercises to perform at home.
3	Session 3	Discussion of difficulties at homework activities. Counseling on ergonomic modifications to the worstation.	10 min	Computer and chair height, arm support, lumbar position (use of a pillow to keep a neutral spine), knees and hips on 90º degrees, perform a squat when there is a need to lift something frow a below position, among others.
		Pilates warm up	5 min	as previous
		Pilates exercises - closed kinetic chain, static stability	25 min	
		Pilates cool down	5 min	
		Definition of homework activities.	5 min	as previous.

4	Session 4	Revision of some ergonomic concepts.	5 min	Delivery of a booklet with some information regarding good posture at work and house tasks.
		Pilates warm up	10 min	
		Pilates exercises - open kinetic chain, dynamic stability	25 min	as previous plus strengthen gluteals and hamstrings.
		Pilates cool down	5 min	
		Definition of homework activities.	5 min	Include new exercises with different difficulty levels to perform at home and work.
5	Session 5	Revision of difficulties while performing exercises at home or during work.	5 min	
		Pilates warm up	7 min	
		Pilates exercises - open kinetic chain, dynamic stability	25 min	as previous.
		Pilates cool down	7 min	
		Definition of homework activities.	5 min	as previous.
6	Session 6	Revision of some ergonomic concepts and homework exercises.	5 min	
		Pilates warm up	10 min	
		Pilates exercises - open kinetic chain, rotatory stability and mobility	25 min	as previous plus improve spinal mobility.
		Pilates cool down	5 min	
		Definition of homework activities.	5 min	Delivery of a new booklet with different exercises.
7	Session 7	Revision of homework activities.	5 min	If the therapist notices patient is not performing the defined tasks, be a little more assertive on the importance of exercising at home, and the need to be active in their own rehabilitation process.
		Pilates warm up	10 min	
		Pilates exercises - open kinetic chain, rotatory stability and mobility	20 min	as previous.
		Pilates cool down	5 min	
		Definition of homework activities.	5 min	as previous.
8	Session 8	Revision of homework activities.	5 min	
		Pilates warm up	5 min	
		Pilates exercises - functional movements.	25 min	Summary of all the exercises and their biomechanical benefits to good posture.
		Pilates cool down	5 min	
		Concept revision on ergonomics and exercises.	10 min	Final exercise prescription to maintain physical capacity.
		Post-intervention assessment, minus anthropometric and sociodemographic data	30 min	

APPENDIX VI – PNE METAPHORS AND ANALOGIES

PNE Concept	Metaphors and analogies used
Acute Pain	• Imagine having a burnt by lye or whitewash, you immediately feel pain. That is acute pain and works as an alert sign. • Pain is an alert sign, such is the strong smell of chlorine you feel which makes you enter in a flight or fight mode to exit that area as soon as possible. • Your brain is like your command room, without it there would be no pain, emotions, concerns, …
Chronic Pain	• Chronic pain involves changes in pain processing that occur with the continuous passage of dangerous information in the nerves. Just like a crumpled sheet does and it does not go back to being a flat sheet, the nervous system changes to facilitate pain. • In chronic pain, your nervous system is like an unbalanced machine, there are alarms sounding, but they are false alarms, because they are unbalanced and sound with little variations. Sometimes when you see an alarm sounding you call an operator to check it and he reports that nothing wrong is occurring in that area, so you activated a response without a real threat.
Pain Perception	• Your brain can have a wrong perception of what is really happening with you, and produce a response not correlated with the real tissues' state. Just like you in your caterpillar machine, sometimes you think you are closer from some object when in fact you are not. Your brain is not always right about the true threat value of pain.
Peripheral sensitization	• After your burnt with lye or whitewash, you will feel more sensitive in that skin area, and it will be more difficult for you to perform certain activities with that hand than it was before.
Central sensitization	• Imagine an event that implied the fabric to be with no power for 5 hours straight, due to a maintenance problem in your area. In the following days and weeks, even though the problem is fixed, you will pay more attention to that area, to prevent it from breaking again. Now, if only one alert sign fires in the beginning of your shift, you immediately try to initiate a chain of response to see what's happening, this is the impact that memory has on your life. A similar thing happens when dealing with pain that you have for a long time: pain memory, your previous concerns, emotions, work situation, negative thoughts, all of these factors influence your central nervous system.
Synaptic Activity	• When an alarm sounds in the command room, you contact your supervisor, and he calls the Head of your area/service. This chain can activate the maintenance people, so they can perform the needed intervention to solve the problem. In our nervous system, dangerous information goes through several points to achieve the brain and produce a response (pain, withdrawal effect, …). • Our central nervous system acts just like electric wires to conduct the energy needed to turn on the light.

Facilitation and inhibition	• Sometimes the chain activated to conduct the information of danger leads to the director and administrator of the Industric being called, and your line of work needs to abruptly stop. Nonetheless, sometimes, and after better analysis, you realize the problem was nothing big, and the stop could have been avoided. So, there was an amplified response to a "small problem", just like your nervous system acts when you have chronic pain for so long, it perceives pain as if something really wrong is happening to you, and produces even more pain to protect you, even without a real cause. • When an alarm which belongs to an area that has given quite a concern in the previous week sounds, you immediately try to call the maintenance people to check what is wrong, and maybe you amplify the response comparing to any other alarm that could have sounded, because you know from previous experience that that area is particularly important and may cause the whole industry to stop. • In chronic pain the dangerous message passes faster from the periphery to the spinal cord and brain. In this course, the message may be amplified. You can compare this to talking to your colleague, or to your supervisor, or worst, to your major responsible. You will try to be quicker and more effective when you talk to your responsible, than when you are talking with your colleague. • Sometimes, you pass the message to your supervisor, and it stops there, he doesn't speak with your responsible because he thinks it is not needed.
Nociception ≠ Lesion	• Imagine suffering a cut while you execute an unlock, or due to a wood splinter. It is more likely that you don't feel it at the time because you were busy with your work. But it doesn't mean that you didn't have any lesion, despite no pain was felt. The same happens when you enter in flight or fight response because you need to exit same area with a leak of chloride, and are not limited by your low back pain to run or go up and down the stairs.
Pain neuromatrix	• There are several different areas involved in the resolution of a problem (supervisors, directors, maintenance, laboratory technicians, human resources…), such as in pain processing: areas in the brain responsible for emotions, memory, movement, concentration, sleep, stress are all in alert when there is chronic pain. • Every day you perform two patrols in your area. When you go on vacations and come back to work, you do not forget how they are done, you may take longer to complete them, but quickly you get the skills and rhythm again. In your brain there are cerebral maps that allow you to connect the physic and mental experiences, in the way you only need to practice something to get back in shape. If you don't practice something, these areas become more distorted and the difficult it will be for you to go back to "normal".