

# Effects of auriculotherapy with mustard seeds on chronic low back pain of nursing professionals

*Efeitos da auriculoterapia com sementes de mostarda na dor lombar crônica de profissionais de enfermagem*

*Efectos de la auriculoterapia con semillas de mostaza en el dolor lumbar crónico de los profesionales de enfermería*

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**ABSTRACT** | More than 60% of nursing workers have an episode of low back pain for one year, causing a negative socioeconomic impact, as this is one of the major causes of absence from work. Auriculotherapy is a low-cost, non-invasive acupuncture technique that uses the auricular pavilion as a microsystem of the human organism mapped by points that when stimulated can treat several ailments. Thus, this study aims to verify the efficacy of mustard seed (*Brassica juncea*) auriculotherapy in alleviating pain, improving functionality and lumbar mobility of female technical professionals and nursing assistants with chronic low back pain. A blind randomized clinical trial was conducted with two groups: one group used mustard seeds for acupressure in the ear points “Shen-Men,” “Kidney,” “Sympathetic,” and “Lumbar Spine”; the placebo group used low density polyurethane foam in place of seeds. Each group performed four auriculotherapy sessions, one per week. The groups were analyzed using infrared thermograms and pressure algometry for pain, finger-floor measurement for mobility and Roland-Morris Questionnaire for spine functionality, with a 95% confidence interval. Mustard seed auriculotherapy reduced the average temperature in the thermograms analyzed by 0.8 °C, as well as increased the pain threshold to lumbar spine pressure of the volunteers by 0.4 Kgf, which shows a significant improvement of low back pain. Therefore, mustard seed auriculotherapy was effective in alleviating low back pain.

**Keywords** | Low Back Pain; Auriculotherapy; Nursing Professionals.

**RESUMO** | Mais de 60% dos trabalhadores de enfermagem apresentam episódio de lombalgia durante um ano, provocando um impacto socioeconômico negativo, uma vez que é uma das maiores causas de faltas e afastamentos do trabalho. A auriculoterapia é uma técnica de acupuntura de baixo custo e não invasiva, que utiliza o pavilhão auricular como um microsistema do organismo humano mapeado por pontos que, estimulados, podem tratar diversas enfermidades. Sendo assim, o objetivo deste estudo foi verificar a eficácia da auriculoterapia com sementes de mostarda (*Brassica juncea*) na melhora da dor, na funcionalidade e na mobilidade lombar de profissionais técnicos e auxiliares de enfermagem do sexo feminino com dor lombar crônica. Foi realizado um ensaio clínico randomizado cego, dividido em dois grupos: um utilizou sementes de mostarda para acupressão nos pontos auriculares “Shen-Men”, “Rim”, “Simpático” e “Coluna Lombar” e o grupo placebo utilizou espuma de poliuretano de baixa densidade no lugar das sementes. Cada grupo realizou quatro sessões de auriculoterapia, uma vez por semana. Os grupos foram analisados por meio de termogramas infravermelhos e algometria por pressão para a dor, a medida dedo-chão para mobilidade e Questionário Roland-Morris para funcionalidade da coluna, com intervalo de confiança de 95%. A auriculoterapia com sementes de mostarda reduziu a temperatura média nos termogramas analisados em 0,8°C, bem como, aumentou o limiar de dor à pressão na coluna lombar das voluntárias em 0,4 Kgf, o que demonstra uma melhora significativa

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da dor lombar. Portanto, a auriculoterapia com sementes de mostarda mostrou-se eficaz na melhora da dor lombar.

**Descritores** | Dor Lombar; Auriculoterapia; Auxiliares de Enfermagem.

**RESUMEN** | Más del 60% de los trabajadores de enfermería tienen un episodio de dolor lumbar durante un año, causando un impacto socioeconómico negativo, ya que es una de las mayores causas de ausencias y despidos del trabajo. La auriculoterapia es una técnica de acupuntura de bajo costo y no invasiva que utiliza el pabellón auricular como un microsistema del organismo humano mapeado por puntos que, estimulados, pueden tratar diversas enfermedades. Así, el objetivo de este estudio fue verificar la eficacia de la auriculoterapia con semillas de mostaza (*Brassica juncea*) en la mejora del dolor, la funcionalidad y la movilidad lumbar de mujeres profesionales técnicas y auxiliares de enfermería con dolor lumbar crónico. Se realizó un ensayo clínico aleatorizado ciego, dividido en

dos grupos: uno utilizó semillas de mostaza para acupresión en los puntos auriculares “Shen-Men”, “Riñón”, “Simpático” y “Columna Lumbar” y el grupo placebo utilizó espuma de poliuretano de baja densidad en lugar de las semillas. Cada grupo realizó cuatro sesiones de auriculoterapia una vez por semana. Los grupos se analizaron mediante termogramas infrarrojos y algometría de presión para el dolor, prueba de distancia dedos-suelo para la movilidad y Cuestionario Roland-Morris para la funcionalidad de la columna vertebral, con un intervalo de confianza del 95%. La auriculoterapia con semillas de mostaza redujo la temperatura promedio en los termogramas analizados en 0,8°C, así como aumentó el umbral de dolor a presión en la columna lumbar de las voluntarias en 0,4 Kgf, lo que demuestra una mejora significativa en el dolor lumbar. Por lo tanto, la auriculoterapia con semillas de mostaza ha demostrado ser eficaz para mejorar el dolor lumbar.

**Palabras clave** | Dolor de la Región Lumbar; Auriculoterapia; Auxiliares de Enfermería.

## INTRODUCTION

Considered a musculoskeletal disorder, low back pain directly interferes with the quality of life at work, overloading the health system due to high rates of leaves of absence and missed work days<sup>1</sup>, a common problem in nursing professionals due to their work activities. There are several non-drug approaches for the low back pain management, namely: physical exercises of muscular strengthening and stretching, manual therapy, low-power laser therapy, patient education about the problem, programs of multidisciplinary biopsychosocial rehabilitation, cognitive-behavioral therapy. Besides all these methods, we have auriculotherapy, an acupuncture technique that uses the auricular pavilion to treat several diseases, working points located in the ear that comprise a microsystem of the human organism, that is, the representation of the whole body is contained in the auricular pavilion<sup>2</sup>.

The most used materials in auriculotherapy are semi-permanent needles and mustard seeds, which are fixed to the ear by adhesives, usually for a minimum period of four days or for up to one week<sup>3</sup>.

Pain relief by auriculotherapy is also explained by the release of neurotransmitters during the stimulus on these points. The stimulus performed at an acupuncture point promotes the body's neurohumoral response, that stimulates the secretion of opioid substances such as

endorphin, serotonin, and enkephalin, which are natural analgesics that provides pain relief and a sensation of well-being<sup>4</sup>.

This study aimed to investigate auriculotherapy with mustard seeds (*Brassica juncea*) as a possible therapeutic resource for the relief of pain at pressure, functionality and increase in lumbar spine mobility and its possible thermographic changes in technical and auxiliary nursing professionals with chronic low back pain.

## METHODOLOGY

This is a randomized clinical trial study for intent-to-treat with simple blinded-sample, following the checklist of the Consolidated Standards of Reporting Trials, 2010 (CONSORT), in its non-pharmacological extension.

The volunteers were duly informed about the procedures used and they agreed to participate by signing the informed consent form.

The nursing technicians and auxiliaries of the Hospital das Clínicas of the Universidade Federal de Pernambuco (HC-UFPE) and the Hospital Getúlio Vargas (HGV), both located in Recife, state of Pernambuco, Brazil, were analyzed at the *Laboratório de Cinesioterapia e Recursos Terapêuticos Manuais* (LACIRTEM) of the Physical Therapy Department of the Universidade Federal de Pernambuco.

In total, 23 female nursing professionals who had been feeling low back pain for at least three months and working in adult wards, providing direct nursing care to hospitalized patients, were analyzed.

Sample calculation was performed with the G\*Power 3.1.9.2 software, considering the Wilcoxon test, also known as the Mann-Whitney test, to compare the results of the evaluations between the “auriculotherapy” and “placebo” groups, considering a 0.05 significance level ( $\alpha$ ).

The effect size was calculated considering a difference in the mean between the groups of 0.6kg/cm<sup>2</sup> and standard deviation of 0.5kg/cm<sup>2</sup> for algometry; a difference in the mean between the groups of 0.6°C and standard deviation of 0.5 °C for thermography; and a difference in the mean between the six points groups and standard deviation of five points for the Roland Morris questionnaire, all values were based on the results of the studies by Hakgüder et al.<sup>5</sup> and Imamura et al.<sup>6</sup>.

Thus, the required sample size was estimated in 20 patients (power=0.80;  $\alpha$ =0.05; effect size=1.20), 10 for the intervention group and 10 for the placebo group. The comparison between the groups was conducted with the improvement “variation,” being calculated as: Value\_post-tto – Value\_pre-tto=value of improvement (or  $\Delta$ tto), where “tto” means “treatment” in the formula used, indicating how much the patient improved or worsened in each group and comparing this value between the groups.

The inclusion criteria were licensed technicians and auxiliaries nursing professionals from the adult wards of HC-UFPE and HGV who provide direct care to hospitalized patients with BMI ranging from 18.5 and 29.9, aged between 20 and 60 years, with nonspecific chronic low back pain ( $\geq$ 03 months) without a previous diagnosis of self-reported herniated disc, malignant tumor of any type, any degenerative disease, infectious or rheumatic disease (rheumatoid arthritis, ankylosing spondylitis, and osteoarthritis), or previous surgery on the lumbar spine. Exclusion criteria were pregnant and lactating women, people allergic to micropore adhesive, professionals who perform only bureaucratic activities other than direct care to hospitalized patients.

Participants were divided into two groups by simple computerized randomization (<http://randomization.com>): Group 1 – Auriculotherapy, receiving treatment with mustard seeds stimulating the therapeutic points of the protocol, and Group 2 – Placebo, receiving treatment with conventional polyurethane foam of 26kg/m<sup>3</sup> density instead of mustard seeds at the points of the protocol for low back pain. Since the foam is flexible and has

low density, it did not make mechanical stimulation of the ear points.

Blinding was possible due to the unnoticeable difference between seed and foam; only the researcher was aware of the difference. None participant had previous treatment with auriculotherapy and the groups had no contact with each other.

Firstly, information on the sample characteristics were collected, as well as the signature of the informed consent form, then the Roland-Morris Disability Questionnaire for low back pain validated for Brazil<sup>7</sup> was applied to participants who did not present any exclusion criteria.

In the next week, the participants went to the Laboratório de Cinesioterapia e Recursos Terapêuticos Manuais (LACIRTEM) of the Physical therapy Department of the UFPE, where the thermographic examination with thermographic camera (FLIR Systems – E40, Sweden) was performed, with sensitivity of 0.05°C, and infrared resolution of 320 x 240 pixels, programmed with emissivity of 0.98, reflected temperature of 20°C, image fusion, and rainbow palette.

During the measurement, the participants stood with the trunk upright, on an insulating rubberized surface. The region analyzed was kept free of clothes. The image was captured at a distance of 100cm from the region, in order to allow proper framing, with a black radiation shield to avoid reflection of infrared radiation.

The region examined was delimited according to the Glamorgan<sup>8</sup> protocol for the lumbar, where the minimum, average, and maximum temperatures of the region of interest were calculated with FLIR Quick Report software (version 1.2). The volunteers remained in the position requested for 10 minutes for acclimatization of the camera, with room temperature (22°C to 24°C) controlled by air conditioners and illuminated with cold fluorescent lights, without the presence of electric equipment that generates heat or the direct incidence of sunlight.

Temperature and humidity were monitored by incoterm digital thermohygrometer model 7666.02.0.00, with temperature in degrees Celsius and relative humidity in percentage that oscillated between 60 and 65%. Participants were instructed to avoid alcohol ingestion, tobacco use, exercise, bathing, intake of stimulant substances such as caffeine for at least two hours before the examination.

To assess pain, the participants were positioned seated on a bench without backrest, bent knees at 90°, head in neutral position and relaxed shoulders. The volunteers were asked to indicate with their fingers the most painful

point and then palpation of the lumbar muscles was performed to determine and to verify the trigger points. For measurement, the area was marked with a ballpoint pen, and then photographed in a digital camera for reassessment after the auriculotherapy sessions.

To measure the pressure pain threshold, Kratos electronic model DDK pressure algometer (PA), with a metallic, flat and circular probe, measuring 1cm in diameter and pressure in kgf was used. The seated volunteers (position that facilitates the perpendicular application of the pressure with the apparatus at the trigger points) were instructed about the application of the PA at the marked trigger point and instructed to say “stop” immediately when they felt pain. Each measurement was performed twice and the mean between them was considered.

To evaluate lumbar mobility, Finger-Floor Distance (FFD) was performed, where the participants were instructed to perform an anterior flexion of the trunk to the first point of pain or resistance with both hands attached towards the ground. The distance from the tip of the third finger to the ground was measured in centimeters (cm) with an acrylic ruler. Two measurements were taken and the mean between them was considered. The treatment protocols used in the groups were performed in four sessions that occurred once a week, respecting the participants’ work scale.

The intervention used was auricular acupressure with mustard seeds due to their spherical format, rigidity, with about 2 mm in diameter, for having low cost, being organic, and producing mechanical action on the therapeutic points of the ear for low back pain. Polyurethane foam was used in place of seeds for the placebo group, not stimulating the protocol points due to its flexibility. Both seeds and foams were attached to the participants’ ears by micropore adhesive.

The seeds and foams were placed on the points with the assistance of a dissection tweezer, after cleaning the entire auricular region with 70% gel alcohol. The participants had no contact with each other or between the groups and had not undergone any previous auriculotherapy treatment.

The points chosen were directed according to those described in Traditional Chinese Medicine (TCM): “Shen Men,” “Kidney,” “Sympathetic,” and “Lumbar Spine.” The last point was stimulated with two seeds, following the lumbar spine shape in the ear. The choice of points was based on auriculotherapy studies such as those of

Santos<sup>9</sup> and Souza<sup>10</sup>, which mention the same cartography for the mitigation of low back pain.

The participants were instructed to gently stimulate the seeds, on the points on average three times a day (when getting up, in the middle of the afternoon and before bed), lasting one minute at each point. The seeds remained in the ear until the next session.

Each session was initiated by the ear of the dominant side of the participant (right-handed or left-handed). There was an alternation between right and left ears at each weekly session in order to avoid saturation of the points until the end of the treatment cycle.

All participants were oriented by cell phone messages to reinforce the guidelines for auriculotherapy and lumbar evaluations. Only three participants reported a fall in seeds/foam and were replaced by the researcher in less than 12 hours.

One week after the end of the sessions, a reassessment of the lumbar region of the volunteers who did not present any exclusion criteria for the analysis of the study objectives was performed. During the study period, the participants were instructed not to use any medication (analgesic, anti-inflammatory and/or muscle relaxant), as well as not to undergo another type of treatment. All sessions were conducted in the volunteers’ workplaces, except for two of them, who needed to be held in their households, due to the change of shift and start of vacation. The researcher paid the costs of travel.

## Statistical analysis

For data distribution analysis, the Shapiro-Wilk normality test was performed, using the Student’s t-test or Mann-Whitney test to compare the means between the placebo and auriculotherapy groups. For categorical variables, the Chi-square test or the Fisher’s exact test was used. The continuous variables were expressed in mean and standard deviation, mean difference and 95% confidence interval, or median and quartile interval. Categorical variables were expressed in number of cases and frequency.

Statistical analysis was performed with Graph Pad Prism 4.0 (GraphPad Software Inc., USA) and Sigma Plot 12.0 (Systat Software, Inc., Germany). Values of  $p \leq 0.05$  were considered statistical significance. For the losses, values equal to those of the pre-auriculotherapy evaluation were imputed, considering it as the worst outcome, without any alleviation of pain, since the analysis was intended to treat it.

**RESULTS**

Figure 1 shows that among the 54 eligible participants, 31 were excluded by BMI or because they did not perform pre-intervention tests, and 23 were randomized

into two groups, 11 of which were allocated into the Placebo group and 12 into the Auriculotherapy group. Three participants were lost because they did not perform the four sessions of auriculotherapy, one for illness and two for withdrawal.

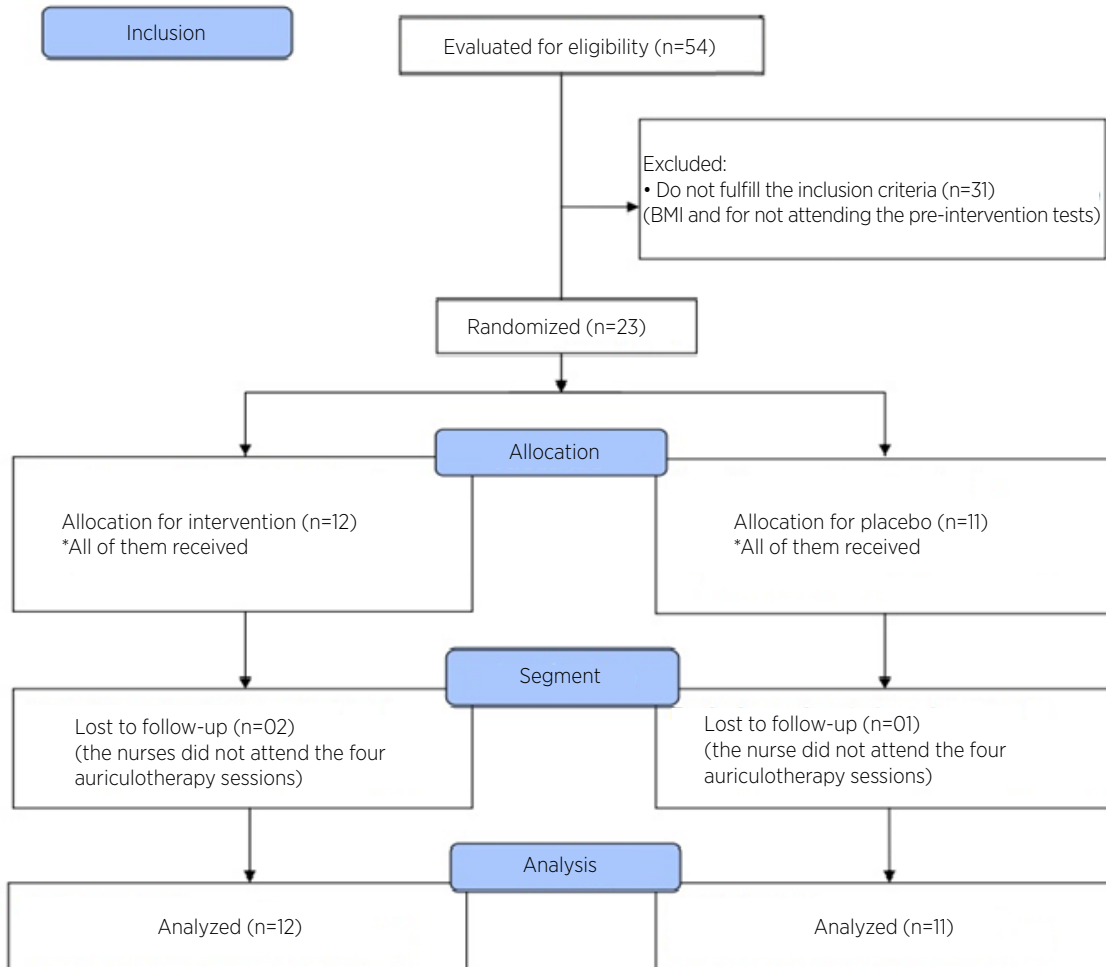


Figure 1: Flowchart CONSORT

Table 1 shows the results of the groups before and after the auriculotherapy sessions for temperature, pressure pain threshold, Roland-Morris score, and Finger-Floor Distance.

The placebo group started with an average of 9.9±4.6 points of the Roland-Morris score, while the intervention

group started with an average of 9 ± 4.5 points. The variation for the groups after the auriculotherapy sessions was -1.4±5.2 for the placebo group and -1.8±2.4 for the intervention group, which did not show a statistically significant difference.

Table 1. Pre- and post-intervention variables in the Placebo and Auriculotherapy groups.

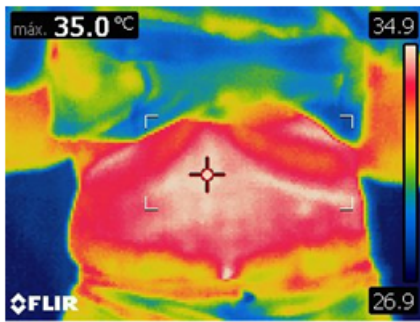
	Placebo			Auriculotherapy			Mean difference (CI) Δpre-post	p-value <sup>1</sup> Between groups
	Pre	Post	Δpre-post	Pre	Post	Δpre-post		
Q. Roland-Morris	9.9±4.6	8.5±5.0	-1.4±5.2	9.0±4.5	7.2±5.4	-1.8±2.4	-0.4 (-3.9 to 3.0)	0.778 <sup>#</sup>
Pressure pain threshold (Kgf)	1.6±0.5	1.4±0.5	-0.2±0.7	1.6±0.8	2.0±1.2	0.4±0.8	0.6 (0.1 to 1.4)	<b>0.038</b>
Finger-Floor Distance (cm)	12.5±6.4	10.2±5.8	-2.3±3.1	15.5±9.0	13.1±8.8	-2.4±3.5	0.1 (-2.8 to 2.9)	0.974
Temperature (°C)	32.7±1.0	32.9±0.6	0.2±1.1	33.2±0.5	32.4±0.7	-0.8±0.8	-1.0 (-0.5 to -2.1)	<b>0.003</b>



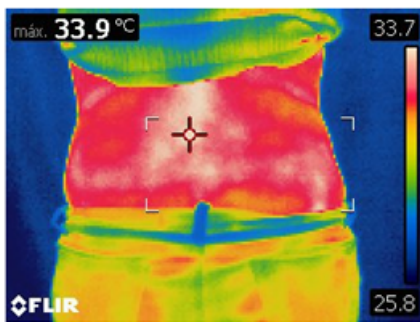
Initially, both groups presented low pressure thresholds to painful stimulus. The initial pain threshold in kilogram-strength for both groups was on average 1.6, with a standard deviation of  $\pm 0.5$  for the placebo group and  $\pm 0.8$  for the intervention group. After the auriculotherapy sessions, an increase in the pain threshold of the Auriculotherapy group was observed and a slight decrease in this threshold in the Placebo group. In both groups these changes were statistically significant.

The groups were not significantly different from each other for the Finger-Floor Distance, both pre- and post-intervention, and a decreased mobility in both groups was identified.

We observed that the temperature values increased after the interventions in the Placebo group and decreased in the Auriculotherapy group. Both groups showed asymmetric thermograms of the lumbar spine; the blank areas over the large red area represent the highest surface temperatures of the skin, being respective to the points where pain was reported (Figure 2).



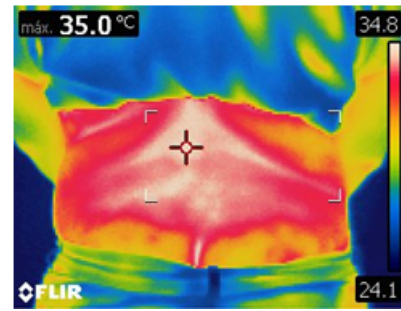
Participant of the Placebo group pre-intervention



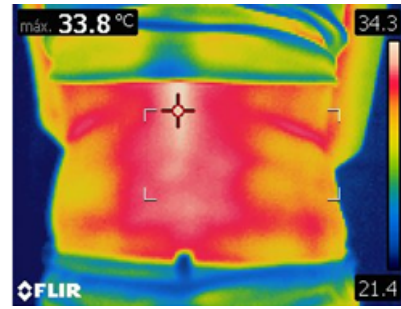
Participant of the Auriculotherapy group pre-intervention

Figure 2. Pre- and post-intervention Variables in the Placebo and Auriculotherapy groups.

Variations in the final thermograms were also visualized, showing a decrease in white area (Figure 3), when compared to the initial thermograms.



Participant of the Placebo group post-intervention



Participant of the Auriculotherapy group post-intervention

Figure 3. Post-intervention thermograms, Placebo and Auriculotherapy groups

## DISCUSSION AND CONCLUSIONS

Auriculotherapy with mustard seeds proves to be an interesting way to treat low back pain, increasing the pain threshold at the lumbar spine of the volunteers investigated in this study. The proportion of overweight or obese participants found (62%) is higher than that found in studies such as that of Malta et al.<sup>11</sup>, which obtained 43.1% of overweight and obesity in a female population between 2006 and 2013, and of Citko et al.<sup>12</sup>, 48.44% in Polish nurses. In this study, participants with obesity were excluded.

Regarding the effects promoted by auriculotherapy on lumbar functionality, measured by the Roland-Morris score, the results were similar between the groups, not presenting a significant decrease in this value concomitant with pain alleviation, similar to that observed in the studies by Ushinohama et al.<sup>13</sup> who used at least one of the same ear points used in this study.

In Ushinohama's et al. study was noted that the sample also did not have significant mean Roland-Morris score values for lumbar disability (mean of 4.2) as well as in this study, although pain was present and decreased with only one intervention session. Similarly, they tested postural balance and no improvement in balance was found as occurred with low back pain.

In the study by Moura et al.<sup>14</sup>, an improvement in the Roland-Morris disability score was observed, however, this study evaluated pain in the lumbar, thoracic and cervical spine in the same way, in addition to the population being mixed (men and women) and with osteoarthritis, applying five sessions of auriculotherapy instead of four sessions, according to the methodology of this study.

Kim et al.<sup>15</sup>, when applying the Roland-Morris questionnaire in patients with chronic low back pain and low back pain with radicular pain, showed that the group with radicular pain had higher scores. The researchers also applied questionnaires for psychological evaluation of the groups, which showed a strong risk of mental health impairment in the group with greater pain and lumbar disability, making the authors suggesting a psychological approach in the treatment of chronic low back pain, to improve the scores of functionality by the multifactorial characteristics of pain.

Although the results of the questionnaire are not statistically different between the groups, there is a tendency for clinical improvement that cannot be disregarded, corroborating the use of the therapy studied to influence lumbar functionality.

Imamura et al.<sup>6</sup> found that healthy people support on average 4.75kgf in the dermatomes of the lumbar region. In our study, which compared only individuals with low back pain, we found an average of 1.6kgf supported by the volunteers of both groups, showing that low back pain actually decreases the amount of pressure supported in the region.

The study by Ozdolap, Sarikaya and Kokturk<sup>16</sup>, showed similar findings in a sample composed of 132 patients, in which 70 reported chronic low back pain and 62 were healthy individuals, both groups with a mean age similar to that of our sample, which also demonstrated that the pain threshold at pressure was lower in the group with chronic low back pain, being even lower in women who composed the sample.

In our study, auriculotherapy intervention group showed higher pain thresholds compared to the placebo group, results comparable to those of Yeh et al.<sup>17</sup>, which obtained a 70% improvement in pain measured in an algometer, they also used mustard seeds as an intervention, in the same ear points. Also, most participants on their study were female.

In addition to low back pain, the studies of Santoro et al.<sup>18</sup> show the algometer as an instrument to gauge pain thresholds at post-treatment pressure for shoulder and toe pain, and once again the mustard seeds used

for acupressure auricular, with mitigation of pain of the individuals studied in both studies.

Although infrared thermography does not directly measure pain, but the vasomotor alterations of the analyzed region, in our study we established this relationship between pain and infrared imaging, as shown by the pre- and post-intervention changes between the groups, measured by the thermograms (Figures 2 and 3) and the variation of the pressure pain thresholds, measured by the algometer<sup>19</sup>. Thermography should not be used alone, but in conjunction with other clinical evaluations to seek diagnostic clarification and follow-up of patients with pain.

In the study by Chen and Hu<sup>20</sup>, thermographic alterations in individuals with low back pain were compatible with lumbar disc herniation, confirmed by magnetic resonance imaging and computed tomography in 66% of cases. In our study, no previous diagnosis of the cause of low back pain was found.

In reviewing the literature, Bardhan et al.<sup>21</sup> showed that thermography can perform this pain measurement in the future, when algorithms capable of quantifying the painful reaction uniformly in individuals with thermal alterations in various diseases are developed. Challenges include pain subjectivity, control of environmental factors during image capture, and infrared camera technology.

Lumbar mobility, measured by Finger-Floor Distance, is decreased in female nursing professionals with low back pain, as shown in the study by Takenaka et al.<sup>22</sup>, when they evaluated Japanese nurses who were not treated. We found the same result in this study.

The sedentary lifestyle recorded among the participants of our study may have contributed to the reduction of this mobility, as shown by Takenaka et al.<sup>22</sup>, who observed the improvement of lumbar mobility after a three-month exercise program.

Still in our study, no significant difference was observed before and after auriculotherapy between the groups studied in the measures of lumbar mobility, similar to the study by Helmhout et al.<sup>23</sup> that, in a sample of 141 participants with low back pain and treated with physical therapy, presented mitigation in low back pain, but did not present improvement in mobility, parameters that are not necessarily associated, although the improvement in mobility with exercise will be greater in individuals without pain.

Ekedahl, Jonsson and Frobell<sup>24</sup> showed a strong relationship between Finger-Floor Distance and lumbar functionality, as measured by the Roland-Morris

questionnaire, which was also observed in our study. Both functionality and lumbar mobility did not have significant changes after auriculotherapy, although pain decreased in the treated group.

Auriculotherapy has been increasingly studied, but studies with larger samples and better controlled parameters are still scarce. Zhao et al.<sup>25</sup> in a systematic review of the literature, seeking the efficacy of auriculotherapy for low back pain, found two studies, among 15 studies, that used mustard seeds. None of these studies evaluated, together with pain, functionality, mobility, or infrared thermograms.

Therefore, this study showed that auriculotherapy with mustard seeds for chronic low back pain in nursing professionals reduced the mean temperature in the analyzed thermograms and increased the pressure pain threshold in kilogram-force in the lumbar spine of the volunteers in a noninvasive and low-cost manner.

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