

# 1 Improved Respiratory Characteristics in Non-specific Low Back Pain: Comparison of 2 Feldenkrais Method versus Routine Physiotherapy

## 3 Abstract

4 **Purpose:** Abnormal breathing patterns, decrease in respiratory muscle strength and  
5 endurance are some of the alterations, which are observed in non-specific low back pain (NS-  
6 LBP). The purpose of this study was to determine the efficacy of the Feldenkrais method  
7 (FM) on respiratory muscle strength, Maximum Voluntary Ventilation (MVV), Total Faulty  
8 Breathing Scale (TFBS), Cloth Tape Measure (CTM) and core stability among NS-LBP  
9 participants. **Methods:** Participants were recruited from a rehabilitation clinic and  
10 randomized either to experimental group (EG) or the control group (CG). For the EG (FM  
11 and routine physiotherapy), and for the CG routine physiotherapy alone were carried out  
12 three days per week over a period of 8 weeks. Outcome measures including Respiratory  
13 Muscle Strength, MVV, TFBS, Numeric Rating Scale (NRS), CTM, and Pressure  
14 biofeedback device (PBU) were evaluated at baseline and 8 weeks. **Results:** Forty  
15 participants were assigned to an EG (n=20) and CG (n=20) based on the study criteria. There  
16 was a significant increase in inspiratory muscle strength (MIP) ( $p=0.004$ ) for the EG, but no  
17 significant change in the CG ( $p=0.455$ ). There was also a significant increase in the  
18 expiratory muscle strength (MEP) for the EG ( $p=0.001$ ), but no changes in the CG ( $p=0.574$ ).  
19 In addition, decrease in pain, increase in xiphoid process chest expansion and improvement in  
20 core stability were observed in EG and improvement in MVV was observed in CG.  
21 **Conclusions:** FM is a potential training program that can improve respiratory variables  
22 among NS-LBP.

## 23 1. Introduction

24 Feldenkrais is an educational approach whereby people correct their faulty movement  
25 patterns through self-exploration of their own bodily movement [1]. The Feldenkrais method  
26 (FM) is recommended as an alternate therapy in the field of musculoskeletal practice and is  
27 increasingly being used in current practice [2,3]. The FM approach is directed through two  
28 methods which are Awareness Through Movement (ATM) and Functional Integrations (FI).  
29 The fundamental principles related to efficient use of the neuro-musculoskeletal system in  
30 FM are reduction of effort, attending body' parts, speed of movement, coordinated well-  
31 learnt action, co-contraction of muscles and respiratory mechanic principles [1]. A key aspect  
32 of FM is to pay attention to and develop awareness of breathing to maximize movement  
33 patterns, which eases the aggravating symptoms [4]. The FM breathing mechanic principles  
34 focus mainly on movement of the diaphragm and movement of the rib cage [1].

35 Recently, there has been renewed interest regarding the involvement of respiratory  
36 characteristics in NS-LBP [5,6,7]. A case-control study of 18 participants with Chronic LBP  
37 and 29 healthy subjects examined the function of the diaphragm during postural limb  
38 activities in performing isometric flexion of upper and lower limbs. The study concluded that  
39 participants with chronic LBP had an abnormal diaphragm position and the steeper slope of  
40 diaphragm using Magnetic Resonance Imaging [5]. An earlier study hypothesized that the  
41 increased respiratory demand compromises spinal control, especially in individuals with LBP

42 [6]. The study was carried out comparing healthy controls to participants with LBP using  
43 trans diaphragmatic pressure; findings suggested that the individuals with LBP exhibit greater  
44 diaphragm fatiguability compared to healthy controls [6]. Additionally, a recently published  
45 study suggested that eight weeks of IMT showed an increased reliance on back  
46 proprioceptive signals during postural control, increased in inspiratory muscle strength, and  
47 reported a deficit associated with LBP severity [7]. **In addition, it was projected that the**  
48 **models such as multifactorial model, a model of movement dysfunction, and ‘Puzzle’ model**  
49 **theorized that there existed a relationship between LBP and respiratory variables [8,9,10].**  
50 These studies suggest a relationship between LBP and respiratory characteristics. Therefore,  
51 the exercises that are related to the respiratory component of FM will be advantageous to  
52 LBP population, and there is a clear need to explore this area of research.

53 The existing body of research on FM suggests that FM helps to manage pain for people with  
54 LBP following a single session of ATM which was implemented through pre-recorded tape  
55 for visualization and breathing sequences [11]. Recently, investigators have examined the  
56 efficacy of FM for relieving pain in people with LBP and investigated the improvement of  
57 interoceptive awareness, which is the ability to detect internally generated bodily signals  
58 involved in maintaining the homeostasis [12]. The intervention used in the study was based  
59 on ATM lessons for a period of five weeks. It has been observed that FM was more effective  
60 in improving visual analogue scale (VAS) and McGill Pain Questionnaire, Present Pain  
61 Intensity scores. [12]. In light of recent evidence in FM, it is becoming extremely difficult to  
62 ignore the potential impact of FM on LBP, as it is known that no single intervention is  
63 superior to the other for management of LBP. The main challenge faced by these two  
64 experiments is the implementation of ATM. However, research has consistently shown that  
65 there is improvement following FM irrespective of different ATM approaches. Although,  
66 research has been carried out regarding FM and LBP and musculoskeletal disorders, no single  
67 study explored the potential impact of respiratory characteristics on NS-LBP [13,14,15].  
68 The present study looked at the potential of ATM sessions to influence respiratory  
69 characteristics among participants with NS-LBP as FM has a respiratory mechanism as one  
70 of the principles related to efficient use of the neuromusculoskeletal system. Hence, the study  
71 hypothesized that inclusion of FM would be advantageous to the LBP participants in  
72 ameliorating respiratory parameters.

73

## 74 **2. Materials and methods**

### 75 2.1 Design

76 The trial was a prospective design with pre-test and post-test evaluation and followed the  
77 Consolidated Standards of Reporting Trial statement for Non-pharmacologic treatment [16].  
78 This study received ethics approval from local Research Ethics Committee [600-IRMI  
79 (5/1/6)/ REC/256/16], and all participants provided informed consent before entering the  
80 study.

81

### 82 2.2 Participants

83 Eligible participants were male or female aged between 18-55 years, diagnosed by the  
84 physicians with chronic LBP [17,18] with the pain intensity of LBP in the range of a minimal

85 pain intensity (2/10 – 5/10) by the numeric rating scale (NRS). Participants were excluded if  
86 they had any respiratory disease, pregnancy or a history of surgeries to the lumbar spine [7].  
87 The study criteria were based on a recent study used by Mohan et al. (2018) [19]. The study  
88 was conducted in a Centre of Physiotherapy at a public university. **Initially, leaflets were**  
89 **displayed in the rehabilitation clinic of the university hospital. Potential patients who**  
90 **approached the researcher were recruited and allocated consequently.**

91

### 92 2.3 Randomization-sequence generation

93 Two research assistants **that were final year Physiotherapy students who are trained in the**  
94 **protocol** were randomly assigned and delivered the protocol; either for the experimental  
95 group (EG) or for the control group (CG). Participants were randomly assigned to EG or CG  
96 by block randomization using computer randomization method and drawing lots from the  
97 concealed envelopes. The assessors remained blinded to the treatment conditions throughout  
98 the study.

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### 100 2.4 Interventions

101 **The CG received routine physiotherapy using modalities such as infrared rays or**  
102 **interferential therapy or shortwave diathermy, spinal flexion or extension exercises whereas**  
103 **the EG received a predesigned exercise protocol along with routine physiotherapy (Appendix**  
104 **1).**

105 **Both groups received treatment for a period of 8 weeks. The participants in both groups were**  
106 **instructed to carry out the exercises 3 days per week. Once a week, the training was**  
107 **supervised by a research assistant, and the exercises were progressed based on the patient's**  
108 **level of pain. If the level of pain remained the same or reduced, then the exercise was**  
109 **progressed. If the patient was unable to maintain the lumbar stability with a pressure of +/- 10**  
110 **mmHg using a pressure biofeedback device (PBU), the exercise was not progressed.**

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### 112 2.5 Outcomes

113 The primary outcomes were the respiratory muscle strength variables: maximal inspiratory  
114 pressure (MIP) and maximal expiratory pressure (MEP), maximum voluntary ventilation  
115 (MVV) for measuring respiratory muscle endurance [19]. Secondary outcome measures were  
116 **Total Faulty Breathing Scale (TFBS) for assessing faulty breathing pattern [20], Cloth Tape**  
117 **Measure (CTM) for measuring chest expansion at the level of axilla, 4<sup>th</sup> Intercostal space and**  
118 **xiphoid [21], NRS for measuring pain level and PBU for core stability [19,22]. The stability**  
119 **was tested using 7 levels (level 1 – level 7) with the participant in supine lying with knees**  
120 **bent and feet flat on the floor, and the levels of testing were described in previous literature**  
121 **[22]. The measurement procedures for all the outcome measures were based on the**  
122 **procedures used by Mohan et al. 2018 [19]. The reliability measures of TFBS and CTM were**  
123 **established in earlier studies [20,21]. All the outcome measures were evaluated at baseline**  
124 **and after 8 weeks of treatment by a blinded assessor.**

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### 126 2.6 Sample size

127 MIP which is considered as one of the primary outcomes in the study was used to calculate  
128 the sample size using the G\*power program 3.1.0 for two tails, paired test. The mean and

129 standard deviation (SD) of MIP were taken from an earlier study for sample size estimation  
130 [7]. The estimated sample to obtain a power of minimum 80% at a significant alpha level of  
131 95% required a total of 34 participants. Therefore, at least 17 participants with NS-LBP were  
132 in both EG and CG to identify a difference between the two interventions. However, to  
133 account for the possibility of drop-out during the therapeutic treatment program, 10% of the  
134 sample size was added, therefore at least 20 participants per group were included in this  
135 study.

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## 137 2.7 Statistical methods

138 The data was analysed using SPSS statistical software, version 20.0. The measurement  
139 variables were subjected to descriptive and inferential analysis. Description of demographic  
140 variables and study variables are presented as mean, standard deviation, frequency and  
141 percentage. Results were tested for normal distribution using the Shaapiro-wilk test.  
142 Demographic details between the groups were tested using Mann-Whitney U-test. Based on  
143 the assumption of normality, Wilcoxon signed rank test were used to compare **baseline** and  
144 post **intervention** of the EG and CG.

## 145 3. Results

146 **A total of 40 participants (n=40; 8 males, 32 females) were recruited and randomized. EG**  
147 **(n=20) aged with mean±SD 22.85±2.10 years and CG (n=20) aged with mean±SD**  
148 **24.00±2.57 years.** The demographic characteristics showed that there were no significant  
149 differences in participants details between EG and CG at baseline. This indicates that the  
150 participants in both groups had similar characteristics with regard to age, gender and body  
151 mass index (BMI) at the start of the study. The clinical background and the results of the  
152 baseline and post values were presented in **Table 1 - Table 4** for primary and secondary  
153 variables **‘Insert Table 1, 2, 3 & 4 here’**. **Three participants from each group dropped out**  
154 **during the training as they are unable to meet the required follow-ups (Figure 1).** MVV  
155 values were lower in both **baseline** and **post intervention** values in CG as compared to EG.

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### 157 3.1 Primary outcome variables

158 There was a significant increase in MIP values from **baseline to post intervention** (p=0.004)  
159 in the EG. Similarly, with regard to MEP values, there was significant increase in the values  
160 (p=0.001) for the EG. On the other hand, there were no significant changes for the MIP and  
161 MEP in the CG. There was no significant increase in MVV scores in the EG from **baseline** to  
162 post **intervention** (p=0.367). There was a significant increase in respiratory muscle endurance  
163 score in CG (p=0.005).

164

### 165 3.2 Secondary outcome variable

166 In relation to chest expansion the participants in the EG showed improvement at the level of  
167 xiphoid process (p=0.004) but did not show improvement at the **level** of the axilla and 4<sup>th</sup> ICS  
168 (p=0.582, and 0.084, respectively). With regard to the CG, the participants did not show  
169 improvement in chest expansion for axilla, 4<sup>th</sup> ICS and xiphoid (p=0.480, 0.679, 0.317,  
170 respectively).

171 In relation to NRS values, there was significant reduction in the pain ( $p=0.004$ ) for the EG,  
172 but there was no reduction in pain for the CG ( $p=0.746$ ). TFBS scores did not change for the  
173 either EG or the CG ( $p>0.05$ ). The scores for the core stability component for the EG  
174 ( $p=0.001$ ) and for the CG ( $p=0.414$ ) showed that there was improvement in lumbo-pelvic  
175 stability in the EG alone.

176

#### 177 **4. Discussion**

178 **This study achieved its aim by improving certain respiratory variables and reducing pain in**  
179 **people with NS-LBP following FM training in EG.** Similarly, there were effects on  
180 respiratory muscle endurance and on pain among CG exercise training protocols.  
181 Specifically, the FM was effective in respiratory muscle strength components, pain and in  
182 promoting breathing pattern components. **These results corroborate the findings of a great**  
183 **deal of the multifactorial model, a model of movement dysfunction and system-based**  
184 **classification of ‘Puzzle’ model proposed for the relationship between respiratory variables**  
185 **and LBP [8,9,10].** Therefore, the hypothesis of improving respiratory variables and reducing  
186 pain following a pre-designed FM was supported.

187

188 With regard to respiratory muscle strength, there was improvement in both MIP and MEP  
189 following FM exercise sessions as compared to CG exercise sessions. The results of the study  
190 cannot be compared with other studies related to FM **as this is the first study to use these**  
191 **outcome measures in this manner.** Most of the studies are qualitative in nature and the  
192 outcome measures used are mostly related to pain and interoceptive awareness [11,12]. There  
193 was also significant improvement in respiratory muscle endurance following CG, that might  
194 be due to the type of exercises which was interspersed from the initial exercise session  
195 onwards. It is known that the FM promotes respiratory mechanics rather than respiratory  
196 muscle endurance [1].

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198 Even though, the results of the study cannot be compared directly with earlier research, the  
199 results could be compared with relation to respiratory muscle strength. Firstly, trunk  
200 stabilizing functions of diaphragm which could have been achieved by promoting symmetry  
201 through FM sessions. Secondly, it is assumed that suboptimal position of diaphragm would  
202 have been improved because of FM. Potential future studies could explore if there is an  
203 association between diaphragm position and the development and recurrence of LBP.

204 The reason behind including pain and lumbo-pelvic instability as one of the outcome  
205 measures is, pain can alter an individual’s breathing pattern and lumbo-pelvic instability  
206 leading to low back pain. The EG reported a greater decrease in pain score compared to the  
207 CG. This indicates that the present study results with relation to pain score was supportive of  
208 the hypothesis that FM could alter pain through increased body awareness and symmetrical  
209 postural alignment [1]. Physiologically, FM is believed to stimulate the neuro-plastic  
210 properties of the nervous system. This could have reduced pain through exploration of normal  
211 movement, improving a person’s neuro-muscular self-image through sensory-motor  
212 awareness [1]. In addition, it could be argued, FM might have an impact on descending pain

213 control pathways, may utilise several neurotransmitters in their interaction with the dorsal  
214 horn cell pain transmission neurons contributing to a reduction in pain. Fear avoidance that  
215 could reduce movement because of an emotional component of pain would have been  
216 mitigated through mindful learning of FM [12]. These skills might have helped in organizing  
217 the body to transfer to other forms of mental activity there by reducing pain.

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219 There were changes in xiphoid level chest expansion following FM lessons, but there were no  
220 changes in any of the levels of chest expansion in the CG. There was also improvement in  
221 breathing pattern from moderate to mild following **EG interventions** as measured by the  
222 **TFBS**.

223

224 The changes in breathing pattern and chest expansion would have happened because of  
225 emphasis on the body through mindfulness, which is not being considered in their image of  
226 movement [12]. In addition, the respiratory mechanics, which are promoted through efficient  
227 use neuro-musculoskeletal system would have facilitated an appropriate breathing pattern and  
228 improved chest expansion [4]. The brain becomes aware of using a symmetrical breathing  
229 pattern through neuroplasticity as a result of mindfulness and body awareness following FM.

230 The significant changes in lumbo-pelvic core stability were observed in FM lesson group  
231 alone, and this was not observed in the routine physiotherapy exercise group. A total of three  
232 participants achieved level 5 which can be compared with the base line in which none of the  
233 participants achieved level 5 among EG. This signifies lumbo-pelvic stability improved  
234 through proper positioning and alignment following FM training sessions.

#### 235 **4.1 Limitations**

236 The findings of the study could be viewed in light of a few limitations. First, no **long-term**  
237 follow-up tests was conducted which could establish longer-terms effects of the intervention.  
238 Second, most of the participants were younger females which could limit external validity of  
239 the findings. Thirdly, the participants had mild-moderate pain intensity, and this data might  
240 not be applicable for those participants with severe pain. In addition, the study did not  
241 consider data imputation technique for the dropped-out participants, and there was a  
242 significant difference in baseline value between the group which need to be interpreted  
243 carefully while interpreting the study results.

#### 244 **5. Conclusions**

245 FM technique is suggested to be a potential additional exercise for participants with LBP  
246 which could improve respiratory, pain and lumbo-pelvic stability components. **Further**  
247 **research is needed to compare FM with other forms of physiotherapy exercises in order to**  
248 **clarify their effects, and the potential of combination of exercises with FM in treating LBP.**

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252



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340 **Table 1**  
 341 Demographic Details of Participants between Experimental and Control Groups [mean +/-  
 342 SD; number (%)]

Characteristics	Experimental (n=20)	Control (n=20)
Age (Years)	22.85±2.10	24.00±2.57
BMI (Kg/m <sup>2</sup> )	23.99±4.20	25.25±5.64
Gender (%)	F- 16 (80%) M- 4 (20%)	F- 16 (70%) M- 4 (30%)

343 **Note:** No significant differences in participants' demographics between groups (p>0.05)

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 345  
 346 **Table 2**  
 347 Comparison of the Primary Outcome variables (MVV, MIP, MEP) between Experimental and Control  
 348 Groups [data represented as mean (95% CI)]

Parameters	Groups	Before [Experimental: n=17, Control :n=17]	After [Experimental: n=17, Control :n=17]
MVV (l/min)	Experimental Control	95.27 (86.18 to 104.36) 75.47 (63.60 to 87.33)	93.61 (85.13 to 102.09) 87.49 (76.28 to 98.71) <sup>a</sup>
MIP (cm H <sub>2</sub> O)	Experimental Control	61.47 (52.80 to 70.13) 76.64 (66.46 to 86.83)	70.88 (63.23 to 78.53) <sup>a</sup> 75.23 (66.61 to 83.85)
MEP (cm H <sub>2</sub> O)	Experimental Control	52.17 (46.56 to 57.78) 61.23 (53.63 to 68.83)	62.94 (56.92 to 68.95) <sup>a</sup> 62.05 (54.26 to 69.85)

349 **Note:** <sup>a</sup>Significant change within group (p<0.05) from pre- to post

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372 **Table 3**  
 373 Comparison of the Cloth Tape Measure (CTM) at different levels and Numerical Rating Scale (NRS)  
 374 between Experimental and Control Groups [data represented as mean (95% CI)]

Parameters	Groups	Pre- Values (Experimental: n=17, Control: n=17)	Post Values (Experimental: n=17, Control: n=17)
Axilla (cm)	Experimental	1.62 (1.39 to 1.84)	1.53 (1.12 to 1.94)
	Control	1.41 (1.15 to 1.67)	1.29 (1.05 to 1.53)
4 <sup>th</sup> ICS (cm)	Experimental	1.31 (1.08 to 1.55)	1.57 (1.26 to 1.89)
	Control	1.55 (1.32 to 1.79)	1.52 (1.22 to 1.93)
Xiphoid (cm)	Experimental	1.33 (1.06 to 1.60)	1.81 (1.44 to 2.17) <sup>a</sup>
	Control	2.11 (1.72 to 2.50)	2.17 (1.80 to 2.55)
Numerical Rating Scale (10)	Experimental	3.58 (2.51 to 4.66)	1.23 (.567 to 1.90) <sup>a</sup>
	Control	2.88 (2.34 to 3.42)	2.41 (1.86 to 2.95) <sup>a</sup>

375 **Note:** <sup>a</sup>Significant change within group (p<0.05) from pre- to post

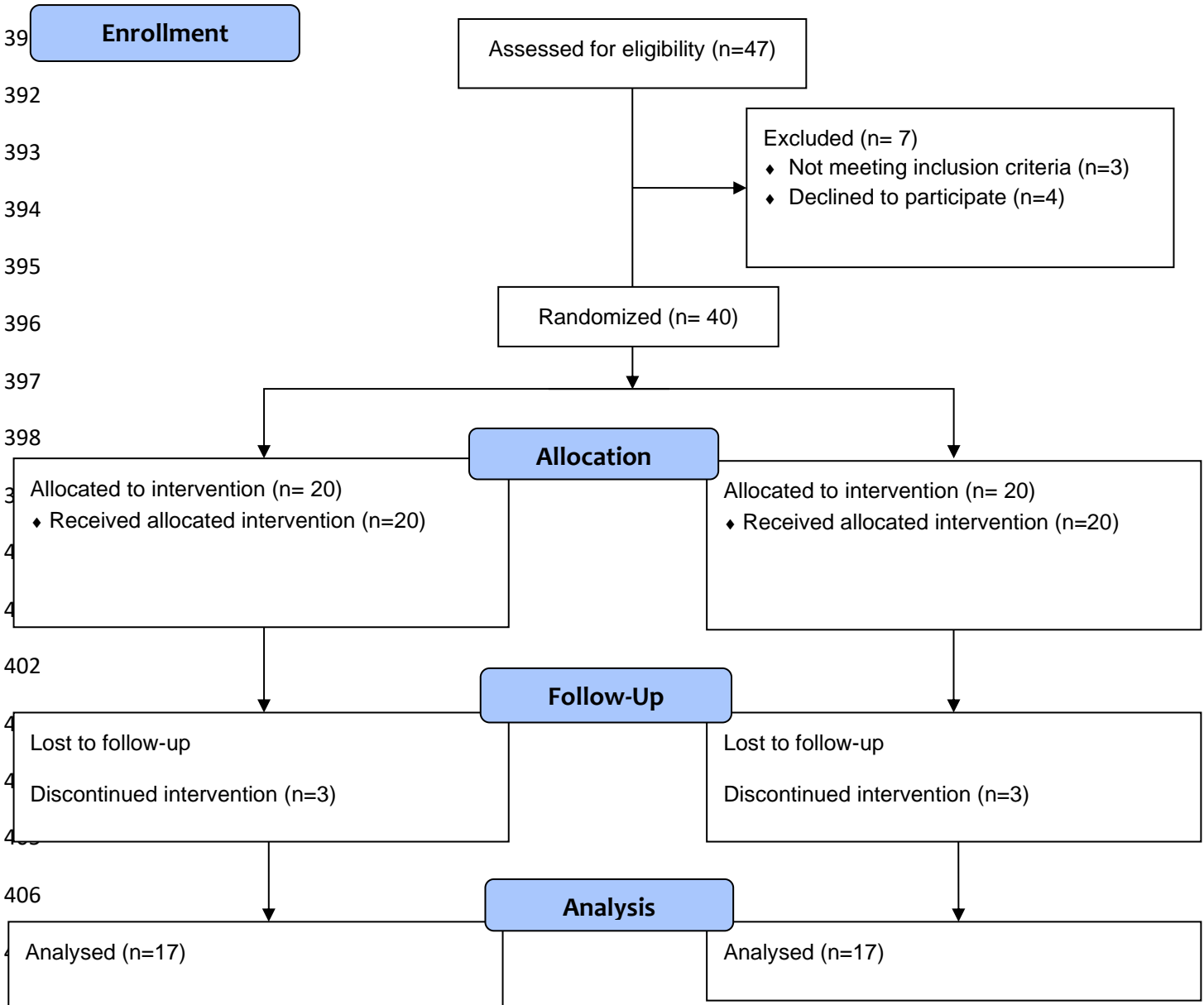
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 377 **Table 4**  
 378 Comparison of Total Faulty Breathing Scale (TFBS) and lumbo-pelvic core stability using pressure  
 379 biofeedback device between Experimental and Control Groups [represented as number (%)]

Parameters	Groups	Pre-Values (Experimental: n=17, Control: n=17)	Post Values (Experimental: n=17, Control: n=17)
Total Faulty Breathing Scale (TFBS)	Experimental	Mild- 16(94%) Moderate – 1(6%)	Mild- 17(100%)
	Control	Mild- 17(100%)	Mild- 17(100%)
Pressure biofeedback device (mmHg)	Experimental	Level 0- 2(12%)	Level 0- 1(6%) <sup>a</sup>
		Level 1- 8(47%)	Level 1- 1(6%)
	Level 2- 2(12%)	Level 2 - 5(29%)	
	Level 3- 4(23%)	Level 3 - 4(23%)	
Control	Level 4- 1(6%)	Level 4 - 3(18%)	
	Level 5- 1(6%)	Level 5 - 3(18%)	
	Level 1- 2(12%)	Level 1- 2(12%)	
	Level 2- 2(12%)	Level 2- 1(6%)	
Level 3- 8(47%)	Level 3- 9(53%)		
Level 4- 5(29%)	Level 4- 4(23%)		
Level 5- 1 (6%)	Level 5- 1 (6%)		

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388 **Figure 1- Flow of participants**

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## Appendix 1 - Feldenkrais Method Training Protocols

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### 416 **Week 1**

#### 417 **1. Tilting legs:**

418 **Patient position:** Initially, the participant were asked to lie on their back, with the knees bent  
419 and the soles of the feet in contact with the floor.

420 **Instruction for Movements:** Then gently, they were asked to let the knees tilt a little bit to  
421 the left, and then smoothly move to tilt them to the right. Make each repetition a little bit  
422 different – smoother, softer, easier, more comfortable. Try slowing down the breath so that  
423 when inhaling tilt the knees and while exhaling bring them back to the middle.

424 **Variation 1:** Movements are tried in knees close together and knees apart to know which  
425 position is comfortable.

426 **Variation 2:** Cross the right knee over the left. Reposition the knees on the floor if the  
427 subjects are fully comfortable

428 **Duration:** 1 hour **Rest period:** 3 minutes between each set of educational program

### 429 **Week 2**

#### 430 **2. Pelvic tilt:**

431 **Patient position:** Lie on the back, with knees bent and soles of the feet in contact with the  
432 floor.

433 **Instruction for movements:** The participants are instructed to feel the flat, low back or  
434 slowly they are asked to flatten the back to feel the roll on the back of the pelvis. This  
435 reminded the spine that it can change the shape.

436 **Duration:** 1 hour **Rest period:** 3 minutes between each set of educational program.

### 437 **Week 3**

#### 438 **3. Spine like a chain:**

439 **Patient position:** Same position as above.

440 **Instruction for movements:** Same as above exercises the participant should feel the lower  
441 back to flatten into the floor. Then they are instructed to go little farther in that direction and  
442 feel the tailbone peak out into the room. Roll back down, take an easy breath and then roll  
443 again, but a bit farther this movement in order to feel the sacrum.

444 **Duration:** 1 hour **Rest period:** 3 minutes between each set of educational program

### 445 **Week 4**

#### 446 **4. Prone kneeling:**

447 **Patient position:** The arms need to be at right angle to the torso and the knees can be directly  
448 below your hip joints.

449 **Instruction for movements:** Instruction was given such that belly is relaxed and hand down  
450 toward the floor. Then, gently pull the belly in. keep the movement small enough and gentle  
451 enough so that entirely the participants felt comfortable.

452 **Duration:** 1 hour **Rest period:** 3 minutes between each set of educational program

#### 453 **Week 5**

#### 454 **5. Prone lying:**

455 **Patient position:** Lie on the front and rest the arms on the floor on either side of the head.  
456 Let the legs be long and extended, comfortably apart, with the feet resting so that toenails are  
457 on the floor.

458 **Instruction for movements:** Comments were given such that to turn the heels to the left and  
459 then to the right. At the same time, the pupils should notice turning the heels rolls the pelvis,  
460 as rolling across the tummy from one hip-bone to the other. Then, keep rolling across the  
461 tummy to roll the pelvis and see how the heel follows.

462 When the heels are pointing to the left and the right leg needs to roll onto its inner edge, and  
463 draw up the knee towards the abdomen. Then let it straighten again. Do the exercise for  
464 several times and then rest.

465 For each and every exercise the participants are supposed to stand up easily, walk around a  
466 bit, and feel comfortable.

467 **Duration:** 1 hour **Rest period:** 3 minutes between each set of educational program

#### 468 **Week 6 -8**

469 All the above mastered techniques were carried out together for a period of 1 hour with rest  
470 periods in between the exercise program.

471 There was one session per week, which were supervised for 1 hour for 8 consecutive weeks  
472 and the subjects were instructed to perform the exercises 3 days in a week. Each exercise was  
473 progressed until 5 weeks and for the last three weeks the whole set of exercises was given.

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3<sup>rd</sup> revision - Answers to Reviewers Comments

Specific Comments	Answers to Reviewers Comments
Can insert information here on where participants were recruited from. E.g. participants were recruited from xxxxx and randomised to either the experimetna group (EG) or the control group (CG)	We have included the sentence as recommended as <b>‘Participants were recruited from a rehabilitation clinic and randomized either to experimental group (EG) or the control group (CG)’</b>
This is a result move to the results section.	We have moved this to the results section as <b>‘Forty participants were assigned to an EG (n=20) and CG (n=20) based on the study criteria’</b>
How often? Daily?	We have rephrased this sentence as <b>‘For the EG (FM and routine physiotherapy), and for the CG routine physiotherapy alone were carried out three days per week over a period of 8 weeks’</b>
Than what?	Thanks for asking this. We would like to inform that FM was effective in improving musculoskeletal parameters and no single study explored the potential impact of respiratory characteristics on NS-LBP. We have mentioned this part in the last line of the paragraph.
Was this not a randomised controlled trial?	This is not a randomised controlled trial
You could provide more information here, were their adverts circulated? Were they patients? How were the participants identified?	We have modified the sentence as <b>‘Initially, leaflets were displayed in the rehabilitation clinic of the university hospital. Potential patients who approached the researchers were recruited and allocated consequently’</b> .
What qualifications/training did they have?	We have refrained the contents as <b>‘Two research assistants that were final year Physiotherapy students who are trained in the protocol were randomly assigned and delivered the protocol;’</b>
It might be helpful to explain both the intervention and the control group separately as it is confusing here when you report both groups and then later on go on to distinguish the control group saying they received spinal flexion or extension exercises was this in addition to the other exercises.	We have revised the whole contents to make it clear. First, we presented both the groups and then presented the level of progression of exercises.



<p>Two research assistants supervised the session is this clear?</p>	<p>We have made this clear by mentioning ‘Once a week, the training was supervised by a research assistant, and the exercises were progressed based on the patient’s level of pain. If the level of pain remained the same or reduced, then the exercise was progressed’.</p>
<p>Please insert the references beside the outcome measure they correspond to.</p>	<p>I have inserted the reference as suggested. Reference 19 corresponds to all outcome measures as these outcome measures are referred in the same literature. References 20 &amp; 21 are referenced beside the outcome measures as they correspond to.</p>
<p>Measured at both the level of the xiphoid and the axilla</p>	<p>We have rephrased the whole sentence as ‘Secondary outcome measures were <b>Total Faulty Breathing Scale (TFBS) for assessing faulty breathing pattern [20]</b>, Cloth Tape Measure (CTM) for measuring chest expansion <b>at the level of axilla, 4<sup>th</sup> Intercostal space and xiphoid [21]</b>, NRS for measuring pain level and PBU for core stability [19,22]’.</p>
<p>What position was the participant in for this? As described in level 2</p> <p>This is not explained very clearly. I wonder would it be more beneficial to explain each level clearly with a diagram in an appendices or simply reference where these can be found</p>	<p>The stability was tested using 7 levels (level 1 – level 7) <b>with the participant in supine lying with knees bent and feet flat on the floor, and the levels of testing were described in previous literature [22]</b>.</p> <p><b>We have revised the sentences and referenced as 22 as suggested for its clarity.</b></p>
<p>For which outcome measures?</p>	<p>We have rephrased the sentence as ‘The measurement procedures <b>for all the outcome measures</b> were based on the procedures used by Mohan et al. 2018’.</p>
<p>Introduce here N=40 participants were recruited and randomised. And some demographic details here: age/gender of the</p>	<p>We have detailed the required details are suggested.</p>

<p>two groups</p> <p>Do you have a <b>CONSORT flow diagram</b>?</p> <p>How many were ineligible and to details reasons for dropout?</p>	<p>‘A total of 40 participants (n=40; 8 males, 32 females) were recruited and randomized. EG (n=20) aged with mean±SD 22.85±2.10 years and CG (n=20) aged with mean±SD 24.00±2.57 years’</p> <p>Yes, we have attached along with the revised script as Figure 1.</p> <p>‘Three participants from each group dropped out during the training because as they are unable to meet the required follow-ups’</p>
<p>Be consistent in use of language i.e. baseline and post intervention</p>	<p>We have refrained the language as recommended</p>
<p>Think about what was your most important finding? This this study achieve its aim. This is all a repetition of the background, consider the This is the first time mentioning “the puzzle” model. I think that this should have been brought in in the background.</p>	<p>We have rephrased the whole contents of the discussion as ‘<b>This study achieved its aim by improving certain respiratory variables and reducing pain in people with NS-LBP following FM training in EG.</b> Similarly, there were effects on respiratory muscle endurance and on pain among CG exercise training protocols. Specifically, the FM was effective in respiratory muscle strength components, pain and in promoting breathing pattern components. <b>These results corroborate the findings of a great deal of the multifactorial model, a model of movement dysfunction and system-based classification of ‘Puzzle’ model proposed for the relationship between respiratory variables and LBP</b>’</p> <p>In addition, we have included those three models in the background.</p>
<p>This is important if this is the first study to use these outcome measures in this manner, then you need to highlight this.</p>	<p>We have rephrased the sentence as ‘The results of the study cannot be compared with other studies related to FM <b>as this is the first study to use these outcome measures in this manner</b>’.</p>
<p>Is it subjective? Qualitative insinuates that they conducted qualitative research....</p>	<p>Yes, most of the studies are qualitative in nature and they are subjective.</p>
<p>I don’t think these sub headings are necessary</p>	<p>We have removed all the sub-heading from the discussion as recommended</p>
<p>Recommend deleting this, it is a repeat of</p>	<p>We have deleted the repeat of results as</p>

the results.	suggested.
Is there any reference for this?	We do not have direct reference to FM. Its our inference.
I was not aware that any group did FM alone?	We have rephrased the sentence as ‘There was also improvement in breathing pattern from moderate to mild following EG interventions as measured by the TFBS’.
Is further research needed to explore this?	Yes, we have added a sentence to the conclusion as ‘Further research is needed to compare FM with other forms of physiotherapy exercises in order to clarify their effects, and the potential of combination of exercises with FM in treating LBP’.

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