**Supplemental material**

**Supplemental file 1: Reasons for ineligibility for this study**

|  |  |
| --- | --- |
| Reasons for ineligibility | Number of patients |
| Low back pain less than 3 months | 2 |
| Patient could not understand English  | 1 |
| History of back surgery | 2 |
| Not residing in the study area | 2 |
| Pain in the location other than the lower back | 1 |
| History of trauma to the lower back | 2 |
| History of rheumatoid arthritis | 1 |
| Diagnosis of Spondylolisthesis | 1 |
| Total  | 12 |

**Supplemental material**

**Supplemental file 2: Instruments description**

|  |  |  |
| --- | --- | --- |
| Assessment | Description | Purpose |
| 1. Fear-Avoidance Belief Questionnaire (FABQ) | The FABQ helps to identify fear avoidance in individuals. It consists of 2 subscales; the Physical Activity (FABQPA) subscale and the Work (FABQW) subscale (items 6-16). All items were included when the reliability and validity of the scale. Each subscale is graded separately by summing the responses for each of the respective scale items (0 – 6 for each item); for scoring purposes, only 4 of the physical activity scale items are scored (24 possible points) and only 7 of the work items (42 possible points). Fear avoidance beliefs physical activity subscale is considered high if it is greater than 15 (FABQP > 15) while that of work subscale is considered high if it is greater than 34 (FABQW > 34). Fear-avoidance beliefs questionnaire has been shown to have good internal consistency, test-retest reliability and concurrent validity (14, 15).  | This instrument was used to assess the participants’ fear-avoidance beliefs (FABs) level at baseline and to ascertain who among the participants had high FABs and who has low FABs. This was used to classify the participants into high and Low FAB scores. |
| 2. Visual analogue scale (VAS) | This is a pain rating scale. It is a 10cm horizontal line with word descriptors at each end. Zero means no pain while 10 means very severe pain. Five means moderate pain. The participant marks on the line the point he feels represents his perception of his current pain state. The VAS score is determined by measuring in centimetres from the left end of the line to the point that the patient marks.It has good test-retest reliability but higher in literates (r= 0.94, P<0.001) than illiterate patients (r=0.71, P<0.001). For construct validity, it has an excellent correlation with a 5-point verbal descriptive scale (nil, mild, moderate, severe, very severe) 0.71-0.78 and a numeric rating scale of 0.62-0.91 (16, 17). | This instrument was used to rate the pain level of the participants at baseline, after 2 weeks of intervention and at the end of the intervention. |
| 3. Roland Morris Disability Questionnaire (RMDQ) | This is a list of 24 statements relating to activities (e.g. walking, dressing, getting up from sitting) and impairments of pain, appetite, mood, and sleep. Respondents select the statement that applies to them “today”. The selected items are summed to a total score ranging from 0 to 24 with a higher score indicating more severe disability.Its Test-retest reliability ranges from 0.42 – 0. For construct validity, RMDQ correlates with physical subscale of SF-36, physical subscale of Sickness Impact Profile, Quebec Low Back Scale, and Oswestry Disability Questionnaire (18). | This was used to assess the participants’ level of disability at baseline, after 2 weeks and at the end of intervention. The data of the participants who followed the study to the end and their last recorded values for the main outcome measures gotten were used in the analysis. |
| 4. Modified Schober’s test (MST) | The participant in standing position with his back towards the examiner, the examiner determines the location of the lumbosacral junction by precising the location of the Dimples of Venus (DOV). The intersection of the top of the DOV is marked by drawing a horizontal line. This line acts as a landmark. The second line is marked 10cm above the first and the third is marked 5cm below the first. The difference between the measurements in erect and flexed positions indicates the outcome of the lumbar flexion (34). The validity against radiographs is moderate (r = 0.59) while the interclass (r = 0.92) and intraclass (r = 0.96) reliability was found to be excellent (19, 20). | This was used to measure active range of motion (AROM) of lumbar flexion of the participants at baseline, after 2weeks of intervention and at the end of 4 weeks of intervention. |

Active Range of Motion (AROM),Visual Analogue Scale (VAS), Roland Morris Disability Questionnaire (RMDQ), Modified Schober’s Test (MST), Dimples of Venus (DOV), Fear-Avoidance Belief Questionnaire (FABQ), Fear Avoidance Beliefs, Physical Activity Subscale (FABQPA), Fear Avoidance Beliefs, Work Subscale (FABQW).

**Supplemental material**

**Supplemental file 3: Protocol description**

|  |  |
| --- | --- |
| Stage | Intervention |
| Preliminary stage | Aim: Informing patient and relaxation and gradual inceptionTailored education and advice based on literature and related to this research were provided before any intervention. Aimed at improving self-efficacy, self-management, understanding of the anatomical basis of back problems, activities of daily living, and home exercises. The exercises were described to each of the participants with the aid of pictures illustrating the anatomy of the local stabilizing muscles (TrA), (LM), (PF). Next, participants had 10 minutes of infrared radiation to the lower back to relax the patient and ensure preparation for optimum participation in the exercise programme. |
| Stage 1  | Aim: Gain progressive sustained contraction of the deep abdominal muscles and LM, co-activation of PF muscle.Each participant was given instructions on how to isolate low load activation of the TrA and LM muscles using abdominal draw-in manoeuvre with no movement (isometrically) and in minimal loading position (supine crook lying, quadruped position, sitting, and standing). Participants were trained until they were able to perform these exercises with 10 seconds hold for 10 contraction repetitions. Progressively, co-contraction of TrA, LM and PF muscles was thought to the participants.In stage 1, deep abdominal muscles were preferentially activated with correct breathing and without substitution from large torque-producing muscles (e.g. rectus abdominis muscle), using the abdominal drawing in manoeuvre in supine crook lying, sitting, quadruped and standing positions. Adequate relaxation is important in isolating contraction of core muscles by first inhibiting tone of global muscles. It is established when a soft end feel is gotten on palpation of the abdomen. To better achieve this, verbal and tactile cues were given by telling the participant to relax and let the tummy flop out with the instructor providing feedback until relaxation is achieved. Breathing in and out was also incorporated to ensure adequate relaxation. Participants were then instructed to slowly and gently draw in the lower abdomen towards the spine. Tactile cue was given as the participant performed this manoeuvre. The clinical measure used to ensure correct activation of the TrA muscle was to observe a slight drawing-in manoeuvre of the lower part of the anterior abdominal wall below the umbilical level, which is consistent with the action of this muscle (21). Instructor palpated medial to anterior superior iliac spine with the aim of feeling the desired response which included a gradual change of the tone from soft (relaxed) tone to spongy (contraction) tone. If the manoeuvre is done incorrectly, there is usually substitution with the global muscles which is indicated by firm tone and jerky/fast contraction showing the excessive tone of external oblique, internal oblique and rectus abdominis muscles. This was discouraged by the instructor whenever noticed.For the LM, a bulging action of the muscle is felt under the instructor’s fingers placed on either side of the spinous processes of the L4 and L5 vertebral levels, directly over the belly of this muscle as the participant performs the abdominal draw in manoeuvre (21).Once the participants were able to control the contraction of the deep abdominal muscles and LM, co-activation of PF muscle was taught by telling them to imagine cutting off the flow of urine concurrently as they drew in the lower part of the anterior abdominal wall. The holding time and the number of contractions were initially 5 contractions for 5 seconds (5x5seconds) at onset of training and then gradually increased to the point where participants were able to perform 10 contractions with 10 seconds holds (10x10seconds). Stage 1 lasted for a week and took approximately 30 minutes in each session. |
| Stage 2 | Aim: To integrate controlled movements into the extremities and progress to heavier loading positions. Once the participants were able to perform contraction of TrA, LM and PF muscles, the exercises were progressed with integration of controlled movements into the movements of the extremities and in heavier loading positions. These included abdominal draw-in in: Supine position leg extension, Supine position bridging, Supine position bridging with leg extension, Prone position bridging, Prone position alternate hand and leg raises, Quadruped position with alternate hand and leg raises.Exercise positions were held for 10 seconds and 10 contractions repetitions per set and 5 sets of each exercise per session. Participants had 10 seconds rest between sets. Stage 2 exercises were done in the 2nd and 3rd weeks of intervention and took 45-60 minutes. |
| Stage 3 | Aim: To maintain local segmental control while the load is added through open kinetic chain movement of adjacent segments. This directed progression so that stabilizing muscles’ co-contraction was integrated into light functional movement tasks (activities that required spinal or limb movements) in a formal way. These activities were advised in the 4th week with the incorporation of the previous weeks’ exercises and they included walking, lifting, and cleaning at tolerable work intensities.Participants had their exercises re-assessed every session to determine whether they could successfully perform the previous exercises. They were trained in the previous exercises until they could perform them.Participants were asked to perform home exercises comprising a sequence of 10 contractions for 10 seconds repetitions, daily (total exercise time was approximately 45min/day).Again, the rationale behind the treatment concept was explained to increase motivation for the programme, participants were given illustrated information leaflet describing the anatomy and functions of the stabilizing muscles, the exercises, their purpose and how to perform them. Various tips and advice on how to integrate the exercises into their activities of daily living were also given. Participants’ success with the home exercises was enquired at every treatment session, problems were discussed and necessary support and advice were provided.  |
| Post-intervention Assessment | The outcome variables were measured three times, at baseline, at the end of 2nd week and 4 weeks of intervention. This included the assessment and recording of pain, disability and lumbar spine AROM using VAS, RMDQ and MST respectively. |

Protocol adapted from: Koumantakis et al (2005), Mannion et al (2009) and Areeudomwong et al (2012) (21-23).

Transversus Abdominis (TrA), Specific Stabilisation Exercises (SSE), Lumbar Multifidus (LM), Pelvic Floor (PF), Active Range of Motion (AROM),Visual Analogue Scale (VAS), Roland Morris Disability Questionnaire (RMDQ), Modified Schober’s Test (MST),