Relationship between Pain Intensity, Activity Limitation, Static and Dynamic Back Muscles Endurance in Patients with Non-specific Long-term Low-back Pain

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ABSTRACT

Research on the correlation of trunk muscles' endurance with other outcome measures in patients with long-term low-back pain (LBP) is scarce. This study assessed the relationship between pain intensity, activity limitation, and static and dynamic back extensors endurance in patients with non-specific long-term LBP. Sixty-seven patients screened using the McKenzie Institute's Lumbar Spine Assessment Format participated in this study. Quadruple visual analog scale and the Roland-Morris disability questionnaire were used to assess pain and activity limitation respectively. Modified Biering-Sørensen test of muscular endurance and repetitive arch-up test were used to assess static endurance (SE) and dynamic endurance (SE) respectively. Data were analyzed using mean, standard deviation, range, Pearson's product moment correlation and stepwise regression at 0.05 Alpha level.

Mean present pain, Roland-Morris score (RMS), SE and DE were 6.55 ± 1.75, 9.22 ± 0.75, 37.64 ± 14.0 secs and 11.43 ± 3.03 repetitions respectively. Significant correlation was found between present pain and each of SE (r=-0.306; p=0.012) and RMS (r--0.862; p=0.001). SE and DE showed a direct moderate significant correlation with each other (r=0.519; p=0.001). Regression analysis showed that age (p=0.012) and sex (p=0.051) were significantly related to SE, age was significantly related to DE (p=0.003) while pain intensity was significantly related to RMS (p=0.001).

It is concluded that increase in pain intensity is associated with decreased static back extensors endurance and activity limitation. Static and dynamic back endurance was significantly positively correlated while age was a significant predictor of static and dynamic endurance. It is recommended that management focus of non-specific long-term LBP should address deficit in static and dynamic back muscles endurance beside pain and activity limitations.

Key words: *Activity limitation, back muscles endurance, low-back pain, participation restriction*

INTRODUCTION

Low back pain (LBP) is regarded as a symptom of pain, muscle tension, or stiffness localized below the costal margin and above the inferior gluteal folds, with or without leg pain (sciatica)[1] resulting from impairments in the structures in the low back that originate from, for example, muscles, ligaments and disc etc.[2] LBP is typically classified as being specific or non-specific.[3] Based on duration, LBP is often classified as acute (short term), sub acute (intermediate) and chronic (long term).[4] The non-specific LBP is described as a 'mechanical' back pain of musculoskeletal origin in which symptoms vary with physical activity[5] and it is not attributed to recognizable known specific pathology (e.g. infection, tumour, osteoporosis, ankylosing spondylitis, fracture, inflammatory process, Radicular syndrome or cauda equina syndrome).[6]

Long-term non-specific LBP results in both physical and psychological deconditioning that trap the patient in a vicious circle characterized by decreased physical performance, exacerbated nociceptive sensations, depression, impaired social functioning, and work disability.[7] There is some evidence that decreased muscular endurance could be both a cause and a consequence of LBP.[8] This stresses that weak muscles and/or trunk extensor-to-flexor muscles imbalance are major contributors to the aetiology of back pain.[9] It is believed that failure of muscles to protect passive structures from excessive loading may result in damage to these pain-sensitive structures and produce pain.[10] Nonetheless, the principal conditions that may give rise to disabling pain in the lower part of the back are numerous.[11,12] There have been analyses trying to relate development of LBP to other clinical, radiological, physiological, and psychological factors.[13] Chan and Chiu [14] noted that research on the correlation of lumbar muscle endurance in patients with long-term LBP with other outcome measures is very scarce. The objective of this study was to determine the relationship between pain intensity, activity limitation, static and dynamic back muscles endurance in patients with non-specific long-term LBP.

MATERIALS AND METHODS

Ethical approval for this study was obtained from the ethical review committee of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Nigeria. The participants for this study included 67 consenting patients referred for physiotherapy on account of non-specific LBP of not less than three months at the physiotherapy out-patient department of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC); and the Medical Rehabilitation Department, Obafemi Awolowo University, Ile-Ife, Osun state, Nigeria. All the participants were screened for their eligibility to take part in the study through the use of the McKenzie Institute's Lumbar Spine Assessment Format. Exclusion criteria for this study were: red flags indicative of serious spinal pathology with signs and symptoms of nerve root compromise (with at least two of these signs: dermatomal sensory loss, myotomal muscle weakness, reduced lower limb reflexes);[15] any obvious spinal deformity or neurological disease; pregnancy; previous spinal surgery; previous experience of static and dynamic endurance assessments; and a Roland-Morris disability score of less than four or greater than 20.

Measurements and Instruments

Anthropometric measurements included height, weight, body mass index (BMI). A height metre calibrated from 0-200cm was used to measure the height of each participant to the nearest 0.1cm while a bathroom weighing scale calibrated from 0 to 120kg was used to measure the body weight of participants in kilograms to the nearest 1.0 kg. A 24-item Roland - Morris Back Pain and Disability Questionnaire (RMDQ) was used to assess activity limitation among the participants. The questionnaire assessed activities of daily living including housework, moving around, self-care, walking, self-care, walking, sleeping, sitting, irritability and appetite. There was a single check-box for each item on the questionnaire. One point was awarded for each selected item. The total score was the sum of the selected items. Total possible score ranges from 0-24 with higher score representing high activity limitation. A Yoruba-translated version of the RMDQ was used for participants who preferred Yoruba. The translation was carried out at the Department of Linguistics and African Languages of Obafemi Awolowo University, Ile-Ife. A Pearson product moment correlation coefficient (r) of 0.86 was obtained for reliability of the back translation of the Yoruba version.

A Quadruple Visual Analogue Scale (QVAS) was used to assess pain intensity experienced by the participants at the time of assessment (present pain), typical or average pain, pain at its best and pain at its worst respectively.[16] The summation of the scores of present pain, average pain and pain at its worst was divided by three to obtained the total QVAS score. A Yoruba-translated version of the QVAS was used for participants who preferred the Yoruba version. The translation was carried out at the Department of Linguistics and African Languages of Obafemi Awolowo University, Ile-Ife. A Pearson product moment correlation coefficient (*r*) of 0.88 was obtained for reliability of the back translation of the Yoruba version.

PROCEDURES

Physical performance tests used in this study included the modified Biering-Sørensen test of muscular endurance for static (BSME) and repetitive arch-up test (RAUT) for dynamic endurance respectively. Prior to the endurance tests, participants were instructed in detail on the study procedures. The tests were preceded by a low-intensity warm-up phase of five minutes that comprised stretches and strolling at a self-determined pace around the research venue. The modified BSME and RAUT were performed in random order among the participants with a 15-minute interval provided between both tests. The tests ended with a cool-down phase, comprising the same low-intensity stretches and strolling around the research venue for about five minutes. A special plinth that could be inclined at angles 30°, 45° and 60° respectively was used for the purpose of conducting the modified BSME and repetitive arch-up test (RAUT).

Assessment of Static Back Endurance

The modified BSME was used to assess the static back endurance. During the test the participant laid on the plinth in the prone position with the upper edge of the iliac crests aligned with the edge of the plinth with their hands held by their sides. The lower body was fixed to the plinth by two non-elastic straps located around the pelvis and ankles. A towel was positioned beneath the ankle straps to reduce the strain on the distal aspect of the tendo calcaneus (Achilles tendon) and thereby ensure comfort of the participants during the tests. Once a loss of contact for more than 10 seconds was noticed, the participant was encouraged once to immediately maintain contact again. Once the participant could not immediately correct or hold the position or claimed to be fatigued the test was terminated.[17, 18] A Quartz stop watch (Quartz USA) was used to determine the endurance time (i.e. from the onset of the BSME to volitional fatigue). This was recorded in seconds (s).

Assessment of Dynamic Back Endurance

Repetitive arch-up test (RAUT) was used to assess the static back endurance. During the test, the participant lay in a prone position on the plinth with the arms positioned along the sides. The iliac crest was positioned at the edge of the plinth. The lower limb was fixed to the plinth by two non-elastic straps located around the pelvis and ankles. With the arms held along the sides touching the body, the subject was asked to flex the upper trunk downward to 45^0 as indicated by a board. The participant then raised the upper trunk upwards to the horizontal position followed by returning back downward to 45 degrees to complete a cycle. The repetition rate was one repetition per three seconds. The movement was repeated as many times as possible at a constant pace synchronous to a metronome count. Once the movement became jerky or non-synchronous, or did not reach the horizontal level, the subject was encouraged once to immediately correct the motion again. The test was terminated once the participant could not continue with the tempo of the motion or reported fatigue or exhaustion.[17] A metronome (Wittner Metronome System Maelzel, made in Germany) was used to set the tempo for the RAUT.

Data Analysis

Descriptive statistics of mean and standard deviation were used to summarize data. Inferential statistics involving Pearson's product moment correlation were also used. Alpha level was set at 0.05. The data analyses were carried out using SPSS 13.0 version software (SPSS Inc., Chicago, Illinois, USA).

RESULTS

The ages of the participants ranged between 38 and 62 years, with a mean age of 51.8 ± 7.35 years. The physical characteristics, static and dynamic endurance, pain intensity and activity limitation scores of all the participants are presented in table 1. The mean static and dynamic back extensor muscle endurance level of the participants were 37.64 ± 14.0 seconds (secs) and 11.43 ± 3.03 repetitions respectively. The VAS scores for present pain and cumulative QVAS were 6.55 ± 1.75 and 69.7 ± 10.2 respectively. The mean Roland-Morris score of all the participants was 9.22 ± 0.75.

Table 1. Physical characteristics, static and dynamic endurance pain intensity and activity limitation of all the participants (n=67)

Variables	Mean ± S.D	Range	
		Minimum	Maximum
Age (years)	51.8 ± 7.35	38	62
Height (m)	1.66 ± 0.04	1.6	1.8
Weight (Kg)	76.2±11.2	55	99
BMI (Kg/m^2)	27.2 ±4.43	21.45	36.51
SBEME	37.64 ± 14.0	10	76
QVAS scores			
Present pain	6.55 ± 1.75	4	8
Average pain	6.19 ± 0.97	5	8
Best pain	4.19 ± 1.16	3	6
Worst pain	8.16 ± 0.99	7	9
Total pain score	69.7 ± 10.2	56.7	83.3
RMDQ score	9.22 ± 0.76	8	10

Key: BMI = Body mass index; SBEME = Static back extensor muscles endurance; DBEME = Dynamic back extensor muscles endurance; QVAS = Quadruple visual analog scale; RMDQ = Roland-Morris disability questionnaire

Pearson product moment correlation analysis was used to assess the relationships between present pain intensity, static and dynamic back muscle endurance and activity limitation. The correlation matrix of the relationship between pain intensity, static and dynamic back muscles endurance and activity limitation in patients with non-specific long-term low-back pain is presented in table 2. There was a significant but weak inverse correlation between present pain and static back extensor muscle endurance (r=-0.306; p=0.012). Similarly, a significantly strong correlation was found between present pain and Roland-Morris scores (p=0.001). Static and dynamic endurance of the back extensor muscles were found to be significantly correlated with each other positively (p=0.001) while dynamic endurance of the back extensor muscles was not significantly correlated with each of pain intensity and Roland-Morris scores (p>0.05).

Table 2. Correlation matrix of the relationship between pain intensity, static and dynamic back muscles endurance and activity limitation in patients with non-specific long-term low-back pain

	PP	SBEME	DBEME	RMDQ
PP	1	-0.306* (0.012)	-0.180 (0.145)	-0.862** (0.001)
SBEME		1	0.519** (0.001)	-0.226 (0.066)
DBEME			1	-0.149 (0.229)
RMDQ				1

Key: *p<0.05, ** p<0.01
PP = Present pain
SBEME = Static back muscles endurance
DBEME = Dynamic back muscles endurance
RMDQ = Roland-Morris disability questionnaire

Stepwise regression analyses were carried out to determine the influence of socio-demographic (i.e. age, gender), anthropometric (i.e. height, weight and BMI) variables and present pain intensity on static and dynamic endurance and activity limitation respectively. Summary of regression analysis of static and dynamic back extensor muscles endurance and activity limitation as outcomes and socio-demographic, anthropometric variables and present pain intensity as predictor is presented in table 3. The results indicated that pain intensity and sex significantly influenced static and dynamic back extensor muscles endurance. Age was a significant predictor of dynamic endurance while only pain intensity was significantly related to Roland-Morris scores (p<0.05).

Table 3. Summary of regression analysis of static and dynamic back extensor muscles endurance and activity limitation as outcomes and socio-demographic, anthropometric variables and present pain intensity as predictors

Outcome measures	Predictors	R	R^2	p-value
SBEME	Pain intensity	0.306	0.094	0.012*
	Age	0.21	0.044	0.088
	Sex	0.239	0.057	0.051*
	HT	0.079	0.006	0.526
	WT	0 .078	0.006	0.53
	BMI	0.099	0.006	0.428
DBEME	Pain intensity	0.18	0.017	0.145
	Age	0.355	0.112	0.003*
	Sex	0 .180	0.018	0.144
	HT	0 .061	0.012	0.626
	WT	0 .050	0.013	0.688
	BMI	0 .065	0.011	0.601
RMLDQ	Pain intensity	0 .970	0.941	0.001*
	Age	0 .054	0.003	0.664
	Sex	0 .166	0.028	0.179
	HT	0 .035	0.001	0 .776
	WT	0 .134	0 .018	0.279
	BMI	0 .101	0.01	0.416

*p < 0.05, ** p < 0.01

DISCUSSION

This study assessed the relationship between pain intensity, activity limitation, and static and dynamic back muscle endurance in patients with non-specific long-term LBP. The average present pain intensity observed in this study was high, while activity limitation was 9. The mean static and dynamic back extensor muscles endurance levels of the participants were 37.64 ± 14.0 secs and 11.43 ± 3.03 repetitions respectively.

The static back endurance level observed in this study is within the range of 39.55 to 54.5 secs reported among mixed-sex groups, with LBP reported in a literature review of previous studies.[19] The observed static back endurance in this study was much lower than the normal Biering– Sørensen endurance times of 198 secs [20] and the reference norm value of 113 secs reported by Mbada and Ayanniyi [21] among healthy Nigerians. On the other hand, dynamic back endurance has been investigated less compared to static endurance among patients with LBP, whereas, dynamic endurance is believed to be more needed as some daily tasks involve dynamic movement more than static endurance.[22, 23] Unfortunately, there is a paucity of studies for comparison with the results of this study. Nonetheless, the finding of 11.43 ± 3.03 repetitions for dynamic back extensor muscles endurance from the present study is lower than the normative value of 29 repetitions reported by Alaranta et al.[8] among subjects aged between 35 and 54. However, apart from the influence of LBP, it is adduced that the age range difference between the participants in this study and that of Alaranta et al.[8] may account for wide disparity in dynamic back extensors endurance between them.

From the results of this study, significant inverse correlations were found between present pain intensity and each of static back extensor muscles endurance and activity limitation. These findings are consistent with those from some studies that reported that pain intensity was **inversely** correlated with lumbar muscle endurance performance.[24-26] Pain is reported to be a strong inhibiting factor in the attempt to quantify lumbar muscular performance.[24] The association between pain and decreased endurance in the back extensor muscles has been linked with increased muscular fatiguability [27, 28] precipitated by increased muscle metabolite from prolonged tension and spasm,[29] muscle ,deconditioning,[30] and inhibition of the paraspinal muscles, [30] which results in overloading of the soft tissue and the passive structures of the lumbar spine.[31, 32] However, this study's findings contrast with those from other studies that no correlation exists between lumbar muscle endurance and pain intensity.[14, 33]

The association of pain intensity and disability in patients with chronic LBP is referred to frequently in the literature and the association is consistently positive.[2, 34, 35] It is adduced that pain becomes more closely related with disability during the course of LBP.[14] It is implied that pain becomes more disabling with chronicity. Nonetheless, some studies have found weak or no correlation between pain and disability in patients with chronic LBP.[36, 37]

The literature on the correlation of lumbar muscle endurance with other outcomes such as activity limitation is sparse. This study used the Roland-Morris Disability Questionnaire to assess activity limitation, which is the difficulty an individual may have in carrying out a task. The Roland-Morris Disability Questionnaire appears to be suitable for use in clinical settings to evaluate change in physical functioning in subjects with LBP.[38] Unexpectedly, this present study found no significant correlation between activity limitation and each of static and dynamic back extensor muscle endurance. On the other hand, some previous investigators [39, 40] found moderate to high correlation between activity limitations and static back endurance among patients with lumbar disc herniation. The result of the correlation between activity limitation and back endurance obtained in this study cannot be directly compared with those other studies because of the differences in assessment tools and patient population. To our knowledge, there seems to be no previous study on the relationship between activity limitation and dynamic back extensor muscles' endurance. However, the findings of this present study are open to speculation and future research. From the results of this study, the stepwise regression model indicated that pain intensity and gender significantly influenced static and dynamic back extensor muscle endurance among patients with long-term LBP. The results also showed that age was a significant predictor of dynamic endurance. Furthermore, only pain intensity was significantly related to activity limitation.

The limitations of this study were minimized by ensuring the homogeneity of the sample using the McKenzie Assessment algorithm and by following standardized protocols in the assessment of back extensor muscle endurance. However, the outcome measure used to assess activity limitation is reported to have ceiling and flooring effects in some previous studies. The findings of this study may not correspond to other sub-groups of patients with different histories of back pain.

Clinical implications

LBP is a complex disorder where pain, anatomical, physiological, psychological and social factors are involved.[2,41] Decreased endurance of the back extensor muscles is one of the physical impairments resulting from LBP. It is believed that the actual performance of patients with non-specific long-term LBP during a physical performance test may depend on several factors.[42] Seen from the bio-psychosocial model, a patient's performance during a physical performance test may depend on biological, psychological and social factors.[42] The associations of present pain intensity, static back extensor muscle endurance and activity limitation suggest that long-term LBP may perpetuate a vicious cycle of pain predisposing to reduced muscular endurance or activity limitation or vice-versa. However, longitudinal studies are needed to verify this assertion.

CONCLUSION

It is concluded that increase in pain intensity is associated with decreased static back extensors endurance and activity limitation. Static and dynamic back endurance was significantly positively correlated while age was a significant predictor of static and dynamic endurance. Dynamic endurance of the back extensor muscles was not significantly correlated with each of pain intensity and activity limitation. It is recommended that management focus of non-specific long-term LBP should address deficit in static and dynamic back muscles endurance beside pain and activity limitations.

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