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Mckenzie versus William's Exercise for Non-Specific Low Back Pain in Adolescents: A Comparative Study

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ABSTRACT
Background: Non-specific low back pain (NSLBP) in adolescence is common and crucial problem that affects a child's ability to function in daily life, their relationships with others, their happiness, and their mental health. Also, it may become compounded into adulthood. Williams and McKenzie exercises are the most commonly used to treat patient's back pain. **Objective:** This study aimed to compare between Mckenzie and William exercises regarding their affection pain, spinal flexibility and balance for adolescents with NSLBP. **Patients and methods**: A total of 34 adolescent males with NSLBP participated in this study. Those who met the criteria for inclusion, were divided randomly into two groups; *Group A* received Mckenzie extension exercises; and *Group B* received William flexion exercises. Data was collected from groups pre-treatment, 2 and 4 weeks post-treatment (Post I and II) regarding visual analogue scale, flexibility score, vestibular balance and balance board scores. **Results**: Comparative analysis showed that both groups were similar at baselines. Patients in both study groups showed significant reduction of pain and improvement in spinal flexibility and balance. No significant differences were observed between the effectiveness of McKenzie and William exercises on pain, flexibility and balance for treating NSLBP in adolescents. **Conclusions**: Both McKenzie extension exercises and William flexion exercises are effective in treating adolescents with NSLBP. The effectiveness of both exercises regarding pain, spinal flexibility and balance were comparable.
Keywords: Adolescents, Balance, Low Back Pain, McKenzie Exercises, William's Exercises.

INTRODUCTION

Pain felt in the lumbar spine (lumbosacral region) below the twelfth rib and above the gluteal crease that cannot be attributed to a specific etiology (as cauda equina, radicular syndrome, fracture, infection, osteoporosis, tumor, structural deformity, as well as inflammatory disorder)is referred to as "non-specific low back pain" (NSLBP). It is mostly benign, but it can become chronic low back pain (LBP) if not treated properly [(1,2)]. In young people, NSLBP is the major cause of disability [(3)].

As a rule, adolescence is characterized by rapid maturation of the body. Musculoskeletal conditions, like NSLBP, are known to be brought on by changes in the spine's physical morphology [(4)]. Late activation, weakness, and decreased resistance in the deep muscles of the trunk were observed in patients with LBP. Conditions associated with LBP have also been linked to alterations in the hip extensor activation pattern and dysfunction of the gluteus maximus. Collectively, these alterations appear to increase susceptibility to falling and lessen the capacity to maintain balance. Indeed, people with NSLBP exhibited greater center of pressure displacement and velocity, especially with eyes closed and on unstable surfaces, as compared to healthy persons [(3)].

Reduced lumbar range of motion is associated with LBP patients, who have less spinal mobility as a result of their condition. The range of motion in the spine is evaluated with the modified Schober's test [(5,6)]. First-line treatment for NSLBP according to the European Guidelines includes supervised exercise therapy. The significance of exercise in the management of LBP has been recommended by previous systematic reviews, and there is a lack of evidence to support any particular form of exercise (like, abdominal strengthening, flexion/extension, or William's exercises, stretching, McKenzie) [(7)].

Inexpensive and simple back exercises have been shown to be an effective treatment option for NSLBP, the most well-known types of back exercises are that of McKenzie and the William [(8)]. Physical therapists frequently use McKenzie method as a means of treating LBP [(9)]. It's a helpful treatment for reducing back pain and enhancing spinal mobility [(5)]. Studies have shown that individuals with mechanical chronic LBP who performed William's exercises saw a decrease in pain intensity and an increase in daily activities.

The purpose of this study was to evaluate the effectiveness of Mckenzie extension exercises against William flexion exercises in reducing pain and improving spinal flexibility and balance in adolescents with non-specific low back pain.

PATIENTS AND METHODS

Study Design and Setting

Prospective quasi-experimental comparative trial of pre-post study design was used. Patients were recruited from the Outpatient Clinic of Zagazig General Hospital, Egypt.

PATIENTS

A total of 34 four adolescent males were recruited according to the following inclusion criteria: aged from 14 to 18 years, diagnosed as NSLBP, medically and clinically stable and within normal range weight and height. Adolescents have one or more of the followings

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were excluded: any spinal deformities, history of spinal or pelvic surgery, specific spinal pathologies as cauda equina syndrome, cord compression, infection, fracture, neoplasm, inflammatory disease and vertebro-basilar insufficiency, any visual or auditory problems that interfere with the rehabilitation program, and children with significant mental or psychological problems that interfere with understanding instructions. Also, guardians of adolescents who refused to participate in the study or missed any session were excluded.

Adolescents who met the inclusion criteria were divided evenly between two groups (17 adolescents for each group); *Group A (Mckenzie group):* received Mckenzie extension exercises [10], *Group B (William's group):* received William's flexion exercises [10]. Each group had four weeks program.

PROCEDURES

A. Procedures for Evaluation:

All assessments were done before the treatment (pre-test) and 2 follow-ups (post-test); after 2weeks then after 4 weeks of intervention.

1. Height and weight Evaluation:

The person's height and weight were measured. Both of the child's feet were on the platform of the scale, and he or she was looking forward while their arms hung loosely at their sides. Value of the weight was written down. Legs were straight, arms were at sides, and shoulders were measured for children. The mid axillary line was used to measure the child's height.

2. Pain Assessment:

The visual analogue scale (VAS) [11] was used. The child put a mark on the line right where he was feeling to show where he thinks things are at the moment. When calculating the VAS score, the distance in millimeters between the left end of the line (the zero point) and the patient's marking was used.

3. Lumbar Flexion ROM Assessment:

The modified Schober's test (MST) [12] was used**.** The subject was tested by standing in a shoeless, neutral erect position. In an upright position, the therapist placed a marker 5 cm below the lumbosacral junction and 10 cm above it. The patient was then instructed to bend forward as far as possible twice; the first attempt served as a practice run, and the distance between the markings on the second try was measured by the therapist. Maximum range of motion in lumbar flexion was determined by measuring the size of the gap between the markers. The number needs to go up by at least 6 centimeters, to 21 centimeters. Reduced lumbar spinal mobility is indicated by an increment of less than 6 centimeters.

4. Balance Assessment:

Vestibular and board balance tests were selected to be used from YMED TEST Balance Test Application [13] as the following:

- **Vestibular balance test:** Smartphone device was fixed on the patient's back by strap and he was asked firstly to keep standing with open eyes for 10 seconds and therapist click start button then to keep standing with closed eyes for 10 seconds and wait for test reporting.
- **Balance board test:** Patient was asked to stand on a balance board steady as much as he can for 10 seconds while the smart phone was fixed on the board then the reports were printed.

B. Procedure for Treatment

- Treatment program included 3 sessions/week for 4 successive weeks. Each exercise included Ten seconds of holding each exercise position for three sets per workout. (30 repetitions/session).

Mckenzie Exercise Program [10]:

Patients of ***Group A*** (17 adolescents) received Mckenzie exercise program that included the following exercises:

- Prone exercise: Position on their stomach, arms at your sides, and your head to one side. Keep this up for 5 to 10 minutes.

- Prone on elbows: Hips should be on the floor or mat, and they should be lying on your stomach with your weight distributed evenly between your elbows and forearms. Let your lower back relax. Do not move from this position for 5-10 minutes. If you have any pain, go back to the first exercise and try again.

- Prone press-up: Get on their stomach and bring their hands to their shoulders. Keeping the hips on the ground and the back and stomach sagging, slowly push the shoulders up. Lower their shoulders slowly. Ten times more**.**

- Progressive extension with pillows: Put a pillow beneath their chests and lie on their stomach. Then, after a while (maybe a few minutes), they can add a second pillow. After a few minutes, if this is still comfortable, they can try using a third pillow. Ten minutes is the maximum time allowed for this position. Get rid of the pillows one by one over the course of many minutes.

- Standing extension: Stand with their hands at their waist and lean back slightly. Repetition: 20 second hold, then rest. If they have been lifting, leaning over, or sitting all day, try this routine to relax your back muscles.

William's Exercises Program [10]:

Patients in ***Group B*** (17 adolescents) received William's exercise program that included the following exercises:

- Pelvic tilt: Lie on your back with your knees bent and your feet flat on the floor. Press the small of your back up flat against the floor without using your legs. Maintain for 5-10 seconds.

- Single knee to chest: Lay supine with flexed knees. Inhale as they slowly bring the right knee to shoulder, and hold for 5-10 seconds. Then repeat with the other knee.

- Double knee to chest: From supine position, First bring the right knee to the chest, then the left, and hold for 5-10 seconds. Slowly bring legs down one at a time.
- Partial sit-up: From crook lying slowly curl head and shoulders off the plinth. Hold and slowly return back to the beginning.
- Hamstring stretch: Take long sitting position and bend forward from the waist, maintain their knees and arms extended and their eyes focused ahead.
- Hip Flexor stretch: In this position, the feet should be hip-width apart, their left knee bent and their right knee held straight. Kneel on the floor with their left foot and flex their body forward until their left knee touches their left armpit. Replace the left leg with the right one and do it again.

Ethical Considerations:
The research protocol was approved by the Faculty of Physical Therapy at Cairo University in Egypt with the following ethical committee number: (No: P.T.REC/012/003327). The guardians of all children in this study signed a consent form before they could participate. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis:
Measurements were taken pre-intervention, after 2 weeks (after I), and again after 4 weeks (post II). The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 25 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Some examples of parametric statistics (both descriptive and inferential) are: The average and variance of each variable; paired t-tests to determine whether or not there were statistically significant differences between groups before and after treatment. When comparing VAS, flexibility, vestibular balance, and balance board scores before and after treatment in each group, we used an analysis of variance (ANOVA) with repeated measures, and when comparing these measures between groups, we used an unpaired t-test. P value < 0.05 was considered significant.

RESULTS
There was no statistically significant difference in the mean age, weight, or height of the subjects when we compared the two groups (p >0.05) (Table 1).

Table (1): Comparison of the mean age, weight and height between group A and B

General Characteristics	Group A	Group B	t- value	P-value	Sig.
	$\bar{X}$ ± SD	$\bar{X}$ ± SD			
Age (years)	15.17 ± 1.23	15.53 ± 1.54	-0.73	0.46	**NS**
Weight (kg)	62.88 ± 8.85	60.26 ± 8.55	0.87	0.38	**NS**
Height (cm)	166.82 ± 7.14	165.37 ± 9.71	0.49	0.62	**NS**

Statistical analysis showed that both groups were similar at baselines (Pre-test) regarding VAS score, flexibility score, vestibular balance score and balance board score as showed in table (2).

Table (2): Comparison of pre-treatment mean values of VAS, flexibility and balance scores (vestibular and balance board scores) between groups A and B.

Pre-treatment scores	Group A	Group B	t- value	P-value	Sig.
	$\bar{X}$ ± SD	$\bar{X}$ ± SD			
VAS score	6.21 ± 1.55	6.76 ± 1.67	-1.01	0.32	**NS**
Flexibility score	19.64 ± 1.37	20.21 ± 1.21	-1.25	0.22	**NS**
Vestibular balance score (opened eyes)	833.86 ±139.11	856.34 ± 132.36	-0.48	0.63	**NS**
Vestibular balance score (closed eyes)	851.72 ± 78.53	856.85 ± 94.31	-0.17	0.86	**NS**
Balance board score	778.78 ± 167.25	815.38 ± 166.82	-0.63	0.52	**NS**

Within group analysis revealed significant differences when comparing pre-test, post I (after 2 weeks) and post II (after 4 weeks) regarding VAS score, flexibility score, vestibular balance score and balance board score for each study group as showed in tables (3 & 4).

Table (3): Comparison of mean values between pre-treatment, post I and post II of group A:

Group A	$\overline{X}$ ± SD			F- value	P-value	Sig.
	Pre treatment	Post I	Post II			
VAS score	6.21 ± 1.55	3.71 ± 1.09	1.44 ± 1.52	159.51	0.0001	**S**
Flexibility score	19.64 ± 1.37	21.29 ± 1.07	22.67 ± 0.98	67.78	0.0001	**S**
Vestibular balance score (eyes opened)	833.86 ± 139.11	904.69 ± 87.68	988.01 ± 19.23	19.12	0.001	**S**
Vestibular balance score (eyes closed)	851.72 ± 78.53	954.74 ± 43.59	960.9 ± 48.34	20.27	0.0001	**S**
Balance board	778.78 ± 167.25	910.25 ± 86.71	974.59 ±34.16	24.24	0.0001	**S**

Table (4): Comparison of mean values between pre-treatment, post I and post II of group B:

Group B	$\overline{X}$ ± SD			F- value	P-value	Sig
	Pre-treatment	Post I	Post II			
VAS score	6.76 ± 1.67	4.29 ± 2.54	2.17 ± 2.35	40.59	0.0001	**S**
Flexibility score	20.21 ± 1.21	21.64 ± 0.99	22.32 ± 1.27	34.6	0.0001	**S**
Vestibular balance score (eyes opened)	856.34 ± 132.36	926.53±109.18	984.62 ± 20.21	10.37	0.001	**S**
Vestibular balance score (eyes closed)	856.85 ± 94.31	935.01 ± 62.59	948.25 ± 50.14	12.31	0.0001	**S**
Balance board	815.38 ± 166.82	925.65 ± 63.11	977.15 ± 37.85	12.78	0.001	**S**

Between groups analysis revealed non-significant differences between the effectiveness of McKenzie and William exercises regarding VAS score, flexibility score, vestibular balance score and balance board score as presented in tables 5, 6 and 7.

Table (5): Comparison of post-treatment mean values of VAS score between group A and B.

VAS score	Group A	Group B	t-value	P-value	Sig.
	$\overline{X}$ ± SD	$\overline{X}$ ± SD			
Post I (2 weeks)	3.71 ± 1.09	4.29 ± 2.54	-0.87	0.38	**NS**
Post II (4 weeks)	1.44 ± 1.52	2.17 ± 2.35	-1.08	0.28	**NS**

Table (6): Comparing of post-treatment mean values of flexibility scores between the study groups (A and B).

Flexibility score	Group A	Group B	t-value	P-value	Sig.
	$\overline{X}$ ± SD	$\overline{X}$ ± SD			
Post I (2 weeks)	21.29 ± 1.07	21.64 ± 0.99	-0.99	0.32	**NS**
Post II (4 weeks)	22.67 ± 0.98	22.32 ± 1.27	0.9	0.37	**NS**

Table (7): Comparing of post-treatment mean values of balance scores (vestibular and balance board scores) between the study groups (A and B).

Balance scores		Group A	Group B	t- value	P-value	Sig.
		$\overline{X}$ ± SD	$\overline{X}$ ± SD			
Vestibular balance score (eyes opened)	**Post I**	926.53 ± 109.18	904.69 ± 87.68	-0.64	0.52	**NS**
	Post II	984.62 ± 20.21	988.01 ± 19.23	0.5	0.62	**NS**
Vestibular balance score (eyes closed)	**Post I**	935.01 ± 62.59	954.74 ± 43.59	1.07	0.29	**NS**
	Post II	948.25 ± 50.14	960.9 ± 48.34	0.74	0.46	**NS**
Balance board score	**Post I**	925.65 ± 63.11	910.25 ± 86.71	-0.59	0.55	**NS**
	Post II	977.15 ± 37.85	974.59 ± 34.16	-0.21	0.83	**NS**

DISCUSSION

The purpose of this study was to compare between the effect of Mckenzie and William exercises on pain, balance and spinal flexibility in adolescents with NSLBP; in order to find which exercise method can be more effective. Findings of this study detected no significant differences between both methods, both found to be effective in decreasing pain and improving spinal flexibility and balance in adolescents with NSLBP.

Individuals who experienced episodes of back pain as teens were more likely to experience back pain as adults, suggesting that efforts to study, prevent, and treat this condition should be directed toward this age group [(14)]**.** Adolescent back pain is crucial to diagnose and treat, so learning more about this condition is essential. If back pain is treated and managed properly during adolescence, it is less likely to persist into adulthood [(15).]

The VAS was used for assessment of LBP in participated adolescents, it is a reliable, valid, responsive, and frequently used pain outcome measure [(17)]**.**To account for the complexity of pain, most pediatric clinical trials rely on participants' own reports of their level of pain in most cases, children old enough to understand and use self-report scales can be employed for self-report measures., do not have severe emotional disturbances and do not have significant difficulties communicating, who have not been shown to have overstated or understated assessments based on their own thoughts, feelings, or circumstances [(16)]**.** There was no statistically significant difference between the two groups in terms of VAS scores after therapy. However, there is a reduction in pain on both groups.

In this study, MST was used to evaluate flexibly of the spine in the flexion direction. A radiographically validated tape measure method, it is widely used by medical professionals to assess lumbar flexibility during maximal trunk flexion. As part of the diagnostic process for LBP, a patient's spinal range of motion is measured, most frequently assessing flexion [(18)]**.** Patients with NSLBP demonstrated markedly diminished abdominal muscle function. Prophylactic protection against NSLBP in adults has been linked to high levels of trunk muscle endurance. Adult studies have revealed that significant quantities of co-contraction in trunk flexor muscles are necessary for dynamic motion of the lumbar spine, providing strong scientific support for a relationship between trunk muscular endurance and LBP [(19)]**.**

Flexibility scores of adolescents participated in both groups of this study showed significant improvement when comparing pre-post results within each group. No program was found to be significantly effective than the other. Adolescents (those aged 14-18) were found to have significantly tighter hamstrings than younger children (those aged 6-13), and there was an association between back pain and decreased flexibility of the posterior muscles of the thigh in adolescent boys (those aged 14-18), but not in girls or younger children (those aged 6-13) [(20)].

Muscle tension was more common in boys than in girls, and there was no correlation between incidental LBP (among 377 teenagers with no history of pain) and flexibility as determined by MST and sit and reach tests. Generalized estimating equations analysis found only a significant association between decreased quadriceps flexibility and future LBP. Tight hamstring muscles are associated with back pain [(21)].

People who suffer from LBP on a regular basis tend to have less control over their bodies in their posture than healthy people who serve as comparisons. It is possible that postural control impairments, which often emerge within the first three months after the onset of LBP and can persist even after pain has subsided, contribute to the elevated risk of low back re-injury [(3)]. The center of pressure, mean velocity, sway in the antero-posterior direction, and overall excursion are all higher in patients with NSLBP than in healthy people [(22)].

Decreased afferent feedback, insufficient motor control, or deficiencies in the strength and mechanical instability of the back, hip, knee, and ankle can all disrupt body balance. Long-term patients with NSLBP tend to favour the use of the ankles, with an increased feed forward preparation of ankle stiffness, and to employ fewer hip and back strategies during destabilizing perturbations aimed at achieving balance recovery, suggesting that the selection of postural control strategies is predetermined in these patients. Interestingly, NSLBP is more common in younger persons than in older ones [(3)]**.**

A variety of traumas can affect one's sense of balance, which can lead to a host of medical complications. Social and economic repercussions are enormous. Thus, early and accurate measurement of body balance can aid in injury prevention and improve clinical rehabilitation. The use of smartphone apps for assessing bodily balance is also on the rise as more and more devices are equipped with the necessary technology [(13)]**.**

Balance was measured for participated adolescents by YMED mobile application which included vestibular balance assessment with opened and closed eyes and also, balance board test. Balance Y-MED smart phone application uses a motion accelerometer sensor It has been proven to be accurate and useful as a portable method of measuring postural equilibrium [(23)]. While no statistically significant difference was seen between the two exercise regimens, this study did find that both the McKenzie and William's exercises improved vestibular and balance board balance in adolescents with NSLBP.

Clare *et al.* [(24)] performed a meta-analysis on the effectiveness of McKenzie treatment for back pain. Everyone from young children to elderly people and

both sexes were included. If NSLBP was the predominant complaint of the study participants, with or without radiation to the extremities, then the study qualified. Reviewers found that compared to other standard therapies, McKenzie therapy for LBP patients resulted in shorter periods of pain and disability.

William's flexion exercises were proven to alleviate functional symptoms in LBP patients regardless of patient's age. The more the exercise frequency, the better the Oswestry Disability Index (ODI) score outcome. The implementation of this exercise was recommended among the population in the primary health-care center could be considered [25].

Both William's flexion exercises and McKenzie extension exercises were found to be efficient in reducing mechanical LBP [10], but some study's conclusions were conflicting as to which was better.

A study comparing the effectiveness of the McKenzie and William's exercise protocols for treating LBP found that the McKenzie exercise protocol was more successful at reducing LBP and speeding the recovery of pain-free range of movement in the lumbar spine in a subset of people [25]. **Moldovan *et al.*** [27] early data indicated that the McKenzie exercise routine was superior than William's exercise in terms of pain reduction, pain incidence while sitting, pain-free lumbar movement, and recovery time [28].

On the other hand, a study by **Jeganathan *et al.*** [10] underlined that, in comparison to McKenzie extension exercises, William's flexion exercises are more effective in alleviating mechanical LBP.

Many points strengthen the current study; the used tests and assessment tools were reliable and valid. The trial was prospectively registered and its protocol was approved. The treatment programs and assessment were conducted by the same therapist who was properly trained, and there was an excellent treatment adherence. On the other hand, the procedures of this study lack true randomization and blinding. It was limited to 34 adolescent males; future studies may studied larger sample, female adolescents or other types of LBP.

CONCLUSION

In conclusion, both McKenzie extension exercises and William flexion exercises are effective in treating adolescents with NSLBP. The effectiveness of both exercises regarding pain, spinal flexibility and balance were comparable. Future blinded randomized trials with long-term follow-up may strengthen these findings.

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