National Sports Academy

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DEPARTMENT OF THEORY AND METHODS OF THE PHYSIOTHERAPY

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EFFECT OF STABILIZZATION EXERCISES ON BACK PAIN AMONG ADOLESCENTS AGED 19-23

ABSTRACT

OF DISSERTATION FOR AWARDING THE EDUCATIONAL AND SCIENTIFIC DOCTOR’s DEGREE

for the Degree of Doctor of Philosophy in the Field of higher education 7.Healthcare and Sport, Professional field: 7.4. Public Health/Health care Scientific specialty: Kinesitherapy/Physiotherapy

SUPERVISOR:

Scientific Supervisor: prof. Evgeniya Dimitrova, PT, PhD, DSc

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The dissertation contains 108 pages of standard type-written pages. It is presented through 21 figures, 25 tables and 9 graphics. There are 8 appendixes. In those we show the study's surveys (8), indicators for completing the questionnaires. The ethical approval of the study and the informed consent form, the information will be held in strict confidence and only used for the purpose of the study. The bibliography includes 147 literary sources.

The dissertation was selected, discussed, and directed for official defense at a meeting of the Department of Theory and Methods of the Physiotherapy "Vasil Levski".

The public defense of the dissertation will take place on…. , 2022, of NSA "Vasil Levski"

I. INTRODUCTION

The idea of the thesis came to me as a consequence of working with people who were affected by chronic low back pain symptoms. Serving as e sport medicine doctor in many teams of different sport disciplines such as volleyball, basketball and football and also my experience in physical activity rehabilitation clinics, made me face this rapidly- growing problematic issue. Complaints related to the back problems were the main cause of adolescent and young adult patients seeking for medical advice, with the chronic low back pain being at the top list. The major part of the patients was not satisfied with the traditional-based treatment, mostly focused on invasive and pharmacological methods. Given the relatively young age of the patients, I had to find a more comprehensive, non-invasive and cost-effective method of treatment for these patients, and it seemed to me that stabilization exercises of the spine would be appropriate choice.

The main objective of the thesis was to focus on a better understanding of the contemporary high-quality studies regarding the spine stabilization exercises programs, given the fact that no such studies were carried out in my country. The findings of this thesis could give a significant contribute to the clinical management of the adolescent LBP population.

The principal aim of the thesis was to conduct a prospective cohort clinical trial in order to confirm the beneficiary impact of the trunk stabilization exercise on reestablishing the proper function of the core muscles (strength, endurance, motor control, etc.) on low back pain patients.

More specific **objectives of the study** include:

- To investigate to what extent the pain and pain related disability are affected by the duration of the stabilization exercise treatment (assessed by using VAS and ODI self-report questionnaire).

- To evaluate the relationship between pain intensity and disability scores in order to make adequate predictions for the outcomes of the stabilization exercise program.

- To evaluate the effects of pain intensity and pain functional incapacities in the fear avoidance beliefs of the patients with low back pain (assessed using FABQ questionnaires).

- To test the hypothesis that stabilization exercise program contributes to the improvement of the overall quality of life of the LBP adolescent and young adult patients.

In conclusion, these findings serve to further explain the physical activity in the patient with chronic back pain and expands into the existing literature by real-time physical activity assessment. Identifying some mechanisms that seem to affect engagement in the activity, the results of this study can ultimately also serve as a guide development of physical activity interventions in patients with chronic back pain.

Moreover, the physical changes of patient’s activities were related, either consistently positively or consistently negatively, to changes in pain and predicted pain.

Chapter II

SUMMARY OF LITERATURE REWIEW

Pain is the most universal physical and emotional stress that human beings experience. The pain perception is now accepted as complex neural interactions where impulses generated by tissue damage are modified by ascending systems activated by stimuli and also by descending pain suppressing systems activated by environmental and psychological factors (Melzac &Wall, 1965). The gate control theory provided the fuel for the radical change of thinking about pain. Referring to the International Association for the Study of Pain (IASP), *pain* is defined as 'An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage' (Merskey, 1994).

According to the American Society of Interventional Pain Physicians (ASIPP), *chronic pain* is a pain that persist 6 month after an injury and beyond the usual course of an acute disease or a reasonable time for a comparable injury to heal, that is associated with chronic pathologic processes that cause continuous or intermittent pain for months or years, that may continue in the presence or absence of demonstrable pathologies; may not me amenable to routine pain control methods; and healing may never occur (Manchikanti et al, 2009). *Musculoskeletal pain* is defined as pain deriving from the musculo-skeletal apparatus.

Although there are a lot of articles concerning *the incidence and prevalence of chronic low back pain,* this information is very difficult to interpret because of the different definitions used to outline the symptoms and their duration (Andersson, 1999). Most human beings are expected to experience at least one episode of LBP during their lifetime because of its lifetime prevalence between 49% - 70% (Koes et al, 2006).

Based on possible *etiological factors* LBP can be classified into three categories:

a) Non-specific low back pain
b) Serious Spinal pathologies
c) Nerve root compromise (Waddell, 2004)

Practically every anatomical structure of the spine such as the muscle around the vertebrae, vertebral bone, intervertebral discs, ligaments, facet joint, nerve roots, can cause low back pain. Serious spinal pathologies causing LBP are of various forms such as tumors, infections, inflammatory diseases such as ankylosing spondylitis, spondylolisthesis, etc. Nerve root compression can arise from a herniated disc, sciatica, spinal stenosis or surgical scarring.

Finally, most of the cases are classified as non-specific low back pain (NSLBP). Less than 1% of LPB cases are from serious spinal pathologies, less than 5% are from nerve root compression and the majority nearly 96% remain of non-specific origin (Waddell, 2004). Non-specific low back pain is described in a recent review of national guidelines as a diagnosis of exclusion, where pain caused by a suspected or confirmed serious spinal pathology or a radicular syndrome have been excluded (Orrock & Myers, 2013).

Based on the *duration of symptoms*, LBP is classified in three stages:

a) Acute low back pain, when the episode of pain lasts less than 6 weeks.
b) Sub-acute low back pain, with the pain persisting between 6 to 12 weeks
c) Chronic low back pain, as the pain continues for more than 12 weeks (Airaksinen et al, 2006).

The *treatment-based classification* of low back pain.

The most notable classifications were those of McKenzie and Dellito and colleagues (Billis et al,2007).

a) The McKenzie methods is based on Robin McKenzie's clinical observation of patients with low back pain. This classification consists of anamnestic and screening examination for serious spinal pathology followed by a detailed clinical examination consisting of an analysis of the posture, range of movements and assessment of symptom response to different loading strategies. The combination of anamnesis with clinical assessment permits the therapist to classify the patient in one of the three syndromes: derangement, dysfunction and postural. The treatment is then designed for each specific syndrome (McKenzie, 2003).

b) The classification developed by Delitto and colleagues is based on the patient's history, clinical presentation, and physical examination. It identifies and places then the patients into one of the four treatment-based categories: direction-specific exercise, manipulation, stabilization and traction (Delitto et al, 1995).

By the 20th century, back pain as an injury and mechanical problem was seen as a problem that could be treated by orthopedic principles (Waddell, 2004). The role of surgery was established for the treatment of back pain but in the recent years is more evident *the role of physiotherapy in managing the LBP problem.*

Chapter III

Methodology

3.1 Working hypothesis

Treatment of adolescent low back pain (LBP) is an up-to-date and socially significant problem. Based on the literary sources studied and our experience in this field, we formulated the following ***working hypothesis*****:** The creation of a *spine stabilization exercises program* and its implementation as part of the overall treatment plan would lead to reestablishing the proper function of the core muscles on adolescent low back pain patients.

3.2 Thesis outline and objective

Purpose of the dissertation work

The purpose of the dissertation work is to develop, implement and study the effect of the application of spine stabilization exercises program in adolescent low back pain patients.

Goals of the dissertation work

1. To make a critical analysis of the literature on applying the spine stabilization exercises programs in adolescent low back pain patients.
2. To specify the criteria for inclusion and exclusion from the

study and select an appropriate contingent for research.

3. To develop a methodology for functional examination in this contingent of patients.
4. To develop an author's methodology of spine stabilization exercises program.
5. To apply the methodology to a statistically reliable contingent of adolescent patients with low back pain.
6. To analyze the results obtained.
7. To formulate conclusions and recommendations on practice.

3.3 Study design

A prospective cohort clinical study was conducted. The protocol of the study was approved by the Ethics Committee of Sports University of Tirana (Appendix 1). A public announcement to recruit subjects was made at “Sports University of Tirana”, “Lady of Good Counsel Catholic University” and “Olympic Park Sport Venue”, in Tirana, Albania.

To diagnose Non-specific Chronic Low Back Pain (NCLBP) a primary interview was conducted by a rehabilitation specialist, followed by physical examination, and X-ray imaging. Then the eligible subjects were assessed with self-reported questionnaire. Pain, Disability, and FABQ questionnaires were assessed at T0 (baseline), T1 (four-weeks after the starting of the exercise program), and T2 (at the end of the twelve-weeks exercise program).

3.3Ethical considerations

Prior to proceeding with data collection, an information sheet detailing the research was provided to the participants and informed written consent was obtained from all the participants, for participation and publication of anonymous data, before starting the data collection (Appendix 2). Trials were conducted in accordance with guidelines of the Consolidated Standards of Reporting Trials (CONSORT).

3.5 Study population

Study participants were recruited by public announcements made in visible places and digital advertisement. Notifications were also sent to local physicians/physiotherapist and sport coaches requesting referrals. Diagnostic criteria developed by Koes et al, were used to diagnose NSLBP for these participant (Koes et al, 2010). Patients with chronic, nonspecific LBP, defined as pain localized below the costal margin and above the inferior gluteal fold, will be included if they meet the study inclusion criteria.

- Inclusion criteria of the study:

a. Age range between 19-23 years' old
b. Chronic/recurrent LBP for more than 12 weeks
c. Without associated leg pain
d. Pain reported as tolerated during exercise
e. No structural deformities such as scoliosis and/or kyphosis.

- Exclusion criteria of the study:
  a. Spinal pathologies (e.g. tumors, fractures, inflammatory diseases)
  b. Nerve root compression, presence of two or more of the following signs: weakness of lower extremity, reflex change, sensory loss associated with the same spinal nerve.
  c. Spinal surgery
  d. Pregnancy
  e. Illiteracy
  f. Cardiorespiratory disease
  g. Fibromyalgia or any musculoskeletal disease that may interfere with the movements during the exercise protocol.
- Criteria for drop out of the study:
  a. Deterioration of back pain

b. Severe physical/physiological damage
c. Patient refusal
d. Drastic compliance reduction.

3.6 Recruitment of patients

To all the potential eligible participants were made phone calls, explaining the trial procedure in detail and to check the selection criteria. If the patients fulfilled the initial requirements for eligibility, an appointment was scheduled at the physiotherapy clinic. A trained rehabilitation specialist made a screening assessment to check the eligibility criteria. The participant who met the eligibility criteria were then provided with verbal and written information about the purpose of the study. The respondent could ask any questions and resign from the study at any time. The interviewer gave relevant instruction before filling the questionnaires.

3.7 Examination procedures

3.7.1 Anamnesis

The examination procedure started with a standardized history-taking, which included questions on the mode of onset, the frequency of episodes, intensity, and duration of the current episode. They were also asked about the response to various interventions for the previous episodes. Furthermore, information about the distribution of the symptoms for the current episodes was taken, with questions about ranking sitting versus standing and walking and morning versus evening with respect to their symptoms.

3.7.2 Physical examination

The physical examination procedures were adapted for adolescent ages following the recommendation of Houghton (2010). During the physical assessment the physician should try to reproduce the patient's pain through palpation and movement. Examination of posture, stance, core strength and hamstring flexibility is important in determining any potential predisposing or contributing factors. A complete neurological exam should include trunk and extremity strength, pain, proprioception and deep tendon reflexes. Examination of the hips, abdomen and pelvis is important to rule out referred pain (Houghton, 2010).

The following procedures were performed:

I. Observation

Standing

With the patient in standing position posture, pelvis heights, lower limb alignment, foot arch (cavus, planus), midline skin markings were observed. The standing posture of the spine is mild cervical lordosis, thoracic kyphosis and lumbar lordosis. Both anterior superior iliac spines (ASIS) and posterior superior iliac spines should be in the same horizontal plane; if they are not there may be pelvic obliquity. An exaggerated lumbar lordosis may be due to weak abdominal muscles or hip flexion contracture (Houghton, 2010).

Supine or sitting

Lower limb lengths and alignment can be assessed in supine or sitting position.

II. Range of motion

Active movements of the thoracolumbar spine were tested in standing position with the pelvis/iliac crest stabilized.

Flexion - patient bends as far forward as possible with knees straight (measure distance from fingertips to floor if patient can not touch the floor).

Extension - patient bends as far backward as possible with knees straight and lumbar spine supported by examiner (30 degrees).

Lateral flexion - patient bends to the side as far as possible (should be able to touch fibular head).

Rotation - in addition to stabilizing the pelvis with one hand on the iliac crest, the examiner may place a hand on the opposite shoulder. The patient rotates the trunk as far as possible (30 degrees).

III. Palpation

The posterior anatomic surface aspect of the spine is best appreciated with the patient standing. The point of maximal tenderness should be correlated with the underlying bone or soft tissue anatomy. Palpation was made over the spinous processes, facet joints, paraspinal muscles, sacroiliac joints, gluteal muscles, posterior superior iliac spines, posterior iliac crest, ischial tuberosity and greater trochanters. The anterior anatomic surface aspect of the spine is best appreciated with the patient supine with the knees bent to relax the abdominal muscles. The vertebral bodies of L4, L5 and S1 are palpable just below the umbilicus. The anterior abdominal muscles are best palpated with the patient performing a partial sit-up.

Patient standing was instructed to forward flex with the feet together and knees straight. The curve of structural scoliosis is more apparent when bending over and the examiner may observe an imbalanced rib cage, with one side being higher than the other.
Patient standing and measurements made 10 cm above and 5 cm below the lumbosacral junction. Repeat measurement with patient

in full forward flexion. In general, the measure should increase by at least 6 cm to 21 cm (Cassidy et al, 2005). An increase of less than 6 cm suggests decreased lumbar spinal mobility, which may be seen in spondylo-arthropathies.

I. Flexibility

The back and hips should be moved through active and passive range of motion.

Hamstring flexibility is determined by measuring the popliteal angle. The hips and knees are flexed to 90 degrees and then the examiner extends the knee until there is firm resistance. An angle greater than 45 degrees or asymmetry is common with tight hamstrings and low back pain.

II. Neurologic exam

If the patient history suggested potential neurological involvement the following tests were performed:

Deep tendon reflex tests [Patellar (L2, 3, 4), Achilles (S1)].

Superficial reflexes [Abdominal reflex (T7-T10 and T10 -L1 for upper and lower muscles)]; Upper motor neuron reflexes [Cremasteric reflex (T12), Anal wink (S 2, 3, 4)] Pathologic reflexes [Babinski test] Sensation of the lower leg in major dermatomes. Pain and proprioception.

III. Abdominal and pelvic exam

Different abdominal and pelvis pathology may refer pain to the back and deep palpation of the abdominal and pelvic regions was performed to exclude any possible pathology.

3.8 Baseline measurements

After finishing all the necessary examinations for selecting the appropriate subjects for the study, the evaluation protocol continued with the collection of demographic information and self-report measurements. According to recommendations and guidelines, translation, and adaptation of LBP-related self-report questionnaires into Albanian language were completed. All the participants gave responses to the demographic data questionnaire, completed a visual analog pain scale (VAS) regarding the frequency and intensity of the pain (Appendix 3), answered to the Oswestry Low Back Pain Disability Questionnaire (ODQ) (Appendix 4) and (Appendix 5), and finally fulfilled the Fear Avoidance Beliefs Questionnaire (FABQ) (Appendix 6). (All the questionnaires in their original and translated form are included in the Appendix, with the respective additional file number). The FABQ focuses specifically on how a patient's fear-avoidance beliefs about physical activity and work may affect and contribute to his/her low back pain (i.e. the cognitive/affective components of pain that are differentiated from specific tissue damage, injury, and nociception) and resulting disability.

3.8.4.2 Scoring instructions

As mentioned before the FABQ contains 2 scales: a work scale (FABQ-W) composed of 7 items and a physical activity scale (FABQ-PA) composed of 4 items. The two scales are scored separately. Another 5 additional items, which are not part of the scoring, complete the questionnaire. Higher FABQ scores indicate elevated fear-avoidance beliefs.

Work scale (FABQ-W)

The 7-item work scale has a point score that ranges from 0-42 points. It can be calculated as follows: (Total points for items 6, 7, 9, 10 11, 12 and 15) = Work scale score.

Physical activity scale (FABQ-PA)

The physical activity scale has point that can range from 0-24 points. Scores are calculated as follows: (Total points for items 2, 3, 4 and 5) = Physical activity scale score.

Additional questions

Items 1, 8, 13, 14 and 16 are not part of either scale and their scores are not factored into the patient's total scores.

Items not factored into the composite score, such as the additional questions and the physical activity scale, still can provide information about patients' beliefs about the cause of their pain, their physical limitations from pain, their expectations of treatment and, especially, if they have a claim for compensation (Waddell et al, 1993).

3.6.5.3. The specific stabilization exercise program

Although specific details of the stabilization exercise programs vary among studies, the principles remain the same. Their exercise approach was proceeded based on the 'spinal dysfunction' theory proposed by Panjabi, and the 'anatomical and biomechanical' theory of trunk muscle dysfunction proposed by Bergmark (Biley, Smith, and Silfies, 2006).

All study participants underwent the same stabilization exercise program, developed by Hicks et al based on current evidence from biomechanical and electromyography studies (Hick et al, 2005). The exercise program was led by an experienced exercise therapist and consisted of a 45-minutes group session with up to ten people, delivered twice a week for 12 weeks consecutively. Participants received verbal instruction and handout with written instruction for each exercise and were instructed to perform the same exercises at least 3 times per week on their own at home. For a more accurate compliance, a DVD of the standardized stabilization exercises was provided to all participants to follow at home. To ensure adherence, the participants kept an exercise log and phone calls were made time to time to each subject. Participants began with exercises appropriate to their fitness level and increased the intensity progressively. Standard training such as warm-up, cool down, and stretching were conducted both before and after the exercise program with the same method. All the participants were instructed to report any adverse problem during the study immediately.

The exercise program was designed to challenge and encourage the stabilizing motor patterns for the primary stabilizing muscle of the spine such as the rectus abdominis, transverse abdominis, internal oblique abdominis, erector spinae, multifidus, and quadratus lumborum (Hicks et al, 2005). The exercises for each muscle group and criteria for progression are shown in the **Table 3.9**.

Table: 3.9. Stabilization Exercises with Criteria for Progression of Each Exercise (Hicks et al, 2005).

Primary Muscle Group	Exercises	Criteria for Progression
Transversus abdominis	Abdominal bracing	30 repetitions with 8-s hold
	Bracing with heel slides	20 repetitions per leg with 4-s hold
	Bracing with leg lifts	20 repetitions per leg with 4-s hold
	Bracing with bridging	30 repetitions with 8-s hold, then progress to 1 leg
	Bracing in standing	30 repetitions with 8-s hold
	Bracing with standing row exercise	20 repetitions per side with 6-s hold
	Bracing with walking	
Erector spinae/multifidus	Quadruped arm lifts with bracing	30 repetitions with 8-s hold on each side
	Quadruped leg lifts with bracing	30 repetitions with 8-s hold on each side
	Quadruped alternate arm and leg lifts with bracing	30 repetitions with 8-s hold on each side
Quadratus lumborum	Side support with knees flexed	30 repetitions with 8-s hold on each side
	Side support with knees extended	30 repetitions with 8-s hold on each side
Oblique abdominals	Side support with knees flexed	30 repetitions with 8-s hold on each side
	Side support with knees extended	30 repetitions with 8-s hold on each side

In general, this approach is based on a progression exercise program through *3 stages. The first stage* applies isolated, conscious activation of the local muscles. *The second stage* is based on co-contraction of local muscles while performing extremity movements. Finally, *the third stage* integrates the local muscle system movements with daily activities.

Chapter IV

Results

4.1. Subjects' participation

A total of 76 subjects expressed their interest on being part of the study. After being informed about the study protocol, a total of 11 subject declined to participate because they did not want to commit to the time required. Of the 65 remaining subjects willing to participate, 24 did not meet the inclusion criteria. A total of 41 subjects were then classified as eligible for participating in the study and consecutively gave their informed consent for participation and went through the baseline assessment procedures. Two of the subjects underwent all the baseline assessments but dropped out the study for unknown reasons. Finally, 39 subjects completed the stabilization exercise program and were assessed at 4 weeks and at the end of 12 weeks of the exercise program.

4.2. Statistical analysis

All the statistical analyses were performed using SPSS version 26, IBM, USA. Descriptive frequency statistics were initially performed for each question of the questionnaire on baseline, after 4 weeks and 12 weeks. Repeated measures analysis of variance (ANOVA) and T test (Student test) were used to understand the interactions between different variables. Statistical significance was considered at $p\text{-value} < 0.05$.

4.3 Baseline assessment

4.3.1 Demographic characteristics of the participants

Table 4.1 provides descriptive information about the characteristics of the enrolled subjects. The mean age ± standard deviation (SD) was 20.9 ± 1.222 years. Of the 39 subjects 21 were males and 18 females with respective percentage of 53.8% and 46.2%, that is almost a gender balanced sample. The mean weight was 67.8 ± 12.9 kg, with minimum weight of 45 kg and maximum of 87 kg. Regarding the height of the sample the mean values are 1.72 ± 0.11 m, with minimum of 1.5 m and maximum of 1.9 m. The BMI (Body Mass Index) characteristics of the sample consisted in 77% within the normal range and 23% with abnormal values. The employment characteristics of the sample consisted of 79.5 % employed subject in a par-time/full-time job, and 20.5 % were unemployed.

Tab 4.2. Demographic characteristics of the subjects

	N	Minimum	Maximum	Mean	Std. Deviation
Age	39	19	23	20.92	1.222
Gender	39	0	1	0.54	0.505
Weight (kg)	39	45.0	87.0	67.808	12.9213
Height (m)	39	1.50	1.90	1.7233	0.11853
BMI Group	39	0	1	0.77	0.427
Sport Group	39	0	1	0.97	0.160
Employment	39	0	1	0.79	0.409

Most participant were engaged in different physical sport activities 97.4 % with only 2.6 % of the subjects not reporting any involvement in physical activities.

4.3.2 Baseline outcome of the study

In table 4.3 are presented the baseline values (T0) for each of the parameters analyzed in the study, VAS (Visual Analogue scale), ODI (Oswestry Disability Index), FABQ (Fear Avoidance Beliefs Questionnaire) presented in two subscales, FABQ-Physical Activity and FABQ-Work subscale.

Tab.4.3. Baseline values for VAS, ODI (points and %), FABQ-work and FABQ-physical activity

	Mean	Std. Deviation
VAS	6.10	1.944
ODI Points	19.67	7.730
ODI %	39.78	15.59
FABQ- Physical Activity	14.44	6.043
FABQ- Work	19.54	7.451

The mean values for VAS were 6.10 ± 1.944 SD. The ODI values in % at baseline were 39.78 ± 15.59 % SD, and the ODI values in points 19.67 ± 7.730, as presented in table 4.3. The values of FABQ at baseline specifically for FABQ-Physical Activity were 14.44 ± 6.043, (p-value 0.157) and for FABQ-Work 19.54 ± 7.451, (p-value 0.353).

4.5 Outcome results after 4 weeks (T1)

In table 4.5 are presented the values for each of the parameters at T1 level (4 weeks after starting the stabilization exercise).

Table.4.5 T1 values for VAS, ODI (points and %), FABQ-work and FABQ-physical activity

	Mean	Std. Deviation
VAS	3.59	1.874
ODI Points	10.95	4.186
ODI %	22.05	8.48
FABQ- Physical Activity	9.82	4.850
FABQ- Work	16.08	6.772

The mean values for VAS were 3.59 ± 1.874 SD.

The ODI values in % at T1 level were 22.05 ± 8.48 % and the ODI values in points 10.95 ± 4.186, as presented figure 4.5.2.

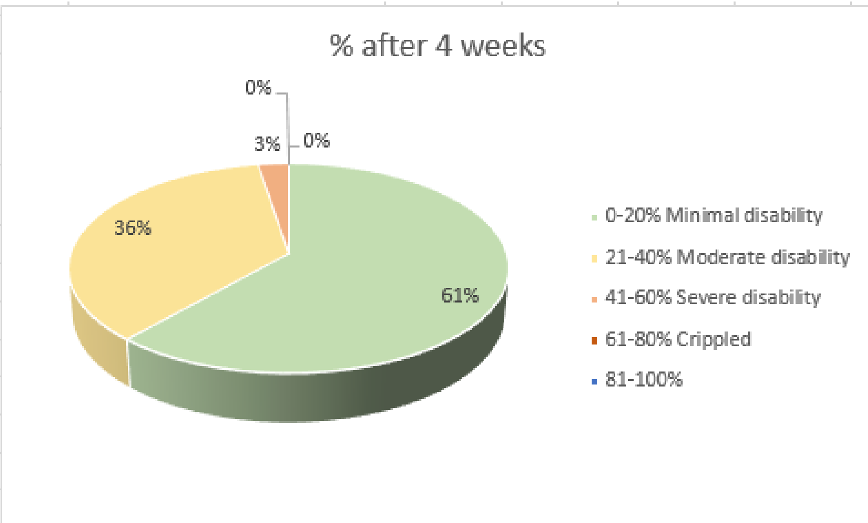

Fig 4.5.2. ODI values in percentage at T1

The values of FABQ-Physical Activity and FABQ-Work subscale at T1 level were respectively 9.82 ± 4.850, and 16.08 ± 6.772.

4.6 Outcome results after 12 weeks (T2)

In table 4.6 are presented the values for each of the parameters at T2 level (in the end of the 12 weeks' stabilization exercise).

Table.4.6 T2 values for VAS, ODI (points and %), FABQ-work and FABQ-physical activity

	Mean	Std. Deviation
VAS	1.92	1.676
ODI Points	4.26	2.926
ODI %	8.55	5.85
FABQ- Physical Activity	7.03	4.551
FABQ- Work	13.96	6.717

The mean values for VAS were 1.92 ± 1.676 SD.

The ODI values in % at T2 level were 8.55 ± 5.85 % and the ODI values in points 4.26 ± 2.926 %, as presented in figure 4.6.1.

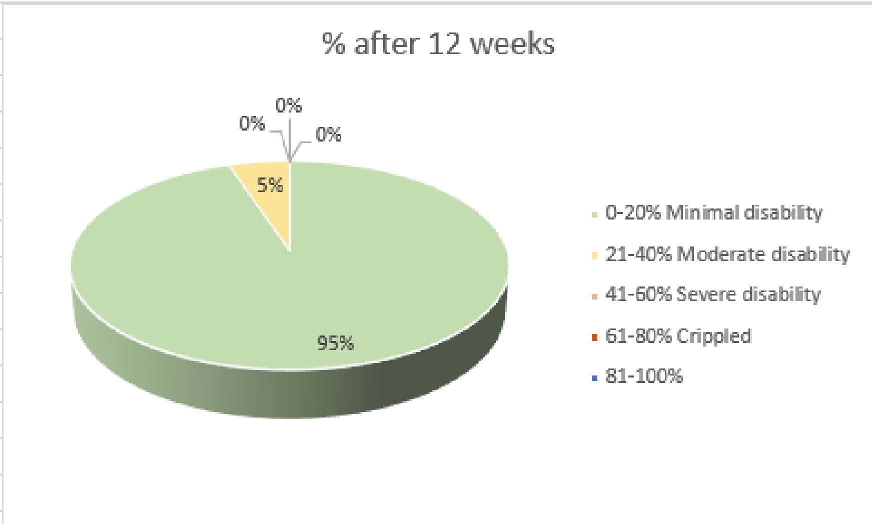

Fig 4.6.2 ODI values in percentage at T2

The values of FABQ-Physical Activity and FABQ-Work subscale at T2 level were respectively 7.03 ± 4.551, and 13.96 ± 6.717.

4.7. The comparison of pain levels, disability and quality of life between baseline, after 4 weeks and 12 weeks of stabilization exercises

4.7.1 Pain outcomes

The modification of the pain patterns (intensity and frequency) is used as one of the primary outcome measures to determine the effectiveness of the stabilization exercise program. In table 4.7.1 are shown the score changes of pain measured by VAS questionnaire, at baseline, after 4 weeks, and finally after 12 weeks of treatment protocol.

Table. 4.7.1. Pain scores on T0, T1, and T2

	Mean	Std. Deviation
VAS baseline	6.10	1.944
VAS (After 4 weeks)	3.59	1.874
VAS (After 12 weeks)	1.92	1.676

Based on the descriptive data obtained, there was a significant decline in pain levels 4 weeks after the treatment (mean values of VAS droop from 6.10 to 3.59).

The same trend was observed with the mean values of VAS from 4 weeks to 12 weeks, respectively 3.59 to 1.92. When compared the values from baseline (T0) to the end of the treatment (T2), the difference in pain changes was very clear, from 6.10 to 1.92.

In chart 4.7.1. is presented a diagram reflecting the score changes from the starting to the end of the treatment.

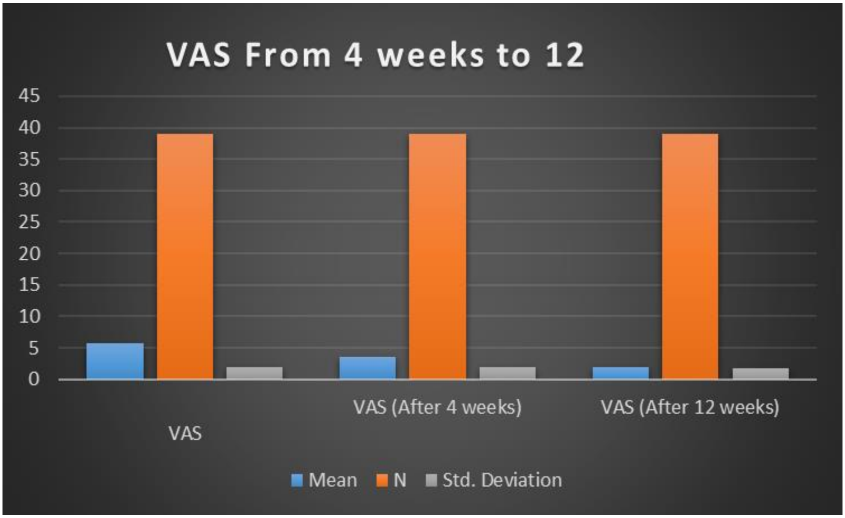

Chart.4.7.1 Differences in pain scores between T0, T1, T2

In order to statistically confirm the improvement reflected by the descriptive data, one-way ANOVA was performed on VAS T0, T1 and T2, as shown in Table. 4.7.2.

After performing ANOVA using VAS on baseline as an independent variable and then VAS after 4 weeks and 12 weeks, the results showed a statistically significant variance between groups, $p < 0.05$ in both cases (Table. 4.7.2.).

Table. 4.7.2. One-way ANOVA for VAS

		Sum of Squares	df	Mean Square	F	Sig.
VAS (After 4 weeks)	Between Groups	74.127	7	10.590	12.181	0.000
	Within Groups	26.950	31	0.869		
	Total	101.077	38			
VAS (After 12 weeks)	Between Groups	32.906	7	4.701	2.350	0.048
	Within Groups	62.017	31	2.001		
	Total	94.923	38			

4.8. Disability and quality of life model

The outcome of the stabilization exercise program strongly depended on the modifications of the disability and quality of life of the patients, monitored by the changes of the ODI (Oswestry Disability Index) scores. The data from the study show a positive trend toward the quality of life of the subject since the first 4 weeks of the stabilization program (mean values from 39.78% to 22.05 %). More impressive results were obtained in the 8 weeks to follow where the values of ODI decrease from 22.05% to 8.55%. When comparing the values from baseline levels to the end of the treatment the changes appear even more significant, from 39.78% to 8.55% as shown in table. 4.8.

Table.4.8. ODI values in T0, T1, T2

	Mean	Std. Deviation
ODI Points Baseline	19.67	7.730
ODI Points (After 4 weeks)	10.95	4.186
ODI Points (After 12 weeks)	4.26	2.926
ODI % Baseline	39.78%	15.59%
ODI % (After 4 weeks)	22.05%	8.48%
ODI % (After 12 weeks)	8.55%	5.85%

After performing ANOVA using ODI on baseline as an independent variable and then ODI after 4 weeks and 12 weeks, the results demonstrated a statistically significant variance between groups, $p < 0.05$ in each of the cases.

As mentioned in chapter 3, depending on the scores gained after responding to each of the ten sections of the questionnaire, the disability is expressed on percentage and divided in five clinical categories. The data analysis of the sample characteristics at baseline showed a heterogeneity of disability pattern with nearly 30% of the subject having minimal disability, 41% moderate disability, 18% severe disability and only 10% with crippled status.

After 4 weeks following the stabilization program the improvement in the quality of life indicators are supported by the data from the results of the ODI (T1) questionnaires. As shown in chart. 4.8.1. after 4 weeks of treatment there were no more subjects with crippled status and only 2.5% with severe disability. There was also a slight decrease in the moderate disability group with 36% of the subject, while most of the subjects stand in the minimal disability category with 61.5%.

Table.4.8.1. One-way ANOVA for ODI

		Sum of Squares	df	Mean Square	F	Sig.
ODI % (After 4 weeks)	Between Groups	3111.817	23	135.296	15.236	0.000
	Within Groups	133.200	15	8.880		
	Total	3245.017	38			
ODI % (After 12 weeks)	Between Groups	1261.652	23	54.854	7.021	0.000
	Within Groups	117.200	15	7.813		
	Total	1378.852	38			

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4.9. Fear avoidance beliefs pattern

The FABQ was assessed at baseline (T0), after 4-weeks of treatment (T1), and at the end of the 12-weeks (T2) stabilization exercise program and, as mentioned in chapter 3, is considered as a secondary outcome measurement of the stabilization exercise program. The results obtained from the FABQ questionnaires indicate an improvement in the fear avoidance beliefs of the patient in the two subscales from baseline to T1. This improvement is particularly noticed in physical activity subscale suggesting that the stabilization exercise program positively impacted the patient's beliefs regarding exercises harming their back. The scores drop from 14.44 to 9.82 for FABQ-pa and for FABQ-w 19.54 to 16.08. After the 12 weeks of the stabilization exercise program the tendency of the reduction in scores is maintained but not in the same extend as the first four weeks with respective values from 9.82 to 7.03 for FABQ-pa and for FABQ-w from 16.08 to 13.69. Certainly, when comparing the scores from T0 to T2 the amelioration of fear avoidance beliefs is more evident with respective values, 14.44 to 7.03 for FABQ-pa and for FABQ-w 19.54 to 13.69. All the data mentioned above are submitted in Table 4.9 and shown in Chart. 4.9.1.

Table 4.9. FABQ-pa and FABQ-w values in T0, T1, and T2

	Mean	Std. Deviation
FABQ **physical activity** baseline	14.44	6.043
FABQ physical activity After 4 weeks	9.82	4.850
FABQ physical activity After 12 weeks	7.03	4.551
FABQ **work activity** baseline	19.54	7.451
FABQ work activity After 4 weeks	16.08	6.772
FABQ work activity After 12 weeks	13.69	6.717

After performing ANOVA using FABQ-Physical Activity on baseline as an independent variable and then FABQ-Physical Activity after 4 weeks and 12 weeks, the results demonstrated a statistically significant variance between groups, $p < 0.05$ in each of the cases. The same procedure was applied for FABQ-Work as shown in Tab 4.9.3 After performing ANOVA using FABQ-Work on baseline as an independent variable and then FABQ-Work after 4 weeks and 12 weeks, the results demonstrated a statistically significant variance between groups, $p < 0.05$ in each of the cases.

Table. 4.9.2. One-way ANOVA for FABQ-PA

		Sum of Squares	df	Mean Square	F	Sig.
FABQ Physical Activity 4 weeks	Between Groups	765.244	18	42.514	6.617	0.000
	Within Groups	128.500	20	6.425		
	Total	893.744	38			
FABQ Physical Activity 12 weeks	Between Groups	594.641	18	33.036	3.435	0.005
	Within Groups	192.333	20	9.617		
	Total	786.974	38			

Bivariate correlation using Pearson's coefficient was conducted in order to find any possible relationship between different variables used in the study: correlation between VAS and BMI using T-test; between VAS and Gender using T-test; between VAS and age using ANOVA; between VAS and ODI; between VAS and FABQ. The Person correlation test showed that higher pain intensity scores (VAS) correlated with higher ODI scores ($r = 0.410$, $p = 0.009$). The same positive correlation was observed between VAS and the two FABQ subscales. Higher pain intensity scores were associated with higher FABQ-PA scores ($r = 0.399$, $p = 0.012$) and higher FABQ-W scores ($r = 0.359$, $p = 0.025$). These findings of the thesis could be used as a predictable factor for both the physician and the patient when deciding the appropriate treatment for the LBP patients.

Chapter V

Discussion and Thesis Limitation

5.1 Discussion

Stabilization exercises for the spine are one of the most popular conservative treatments for CLBP patients but data from different studies supporting their effectiveness are controversial (BenDebba, Torgerson, & Long, 2000).

The results of this thesis suggested that the stabilization exercise program demonstrated a significant reduction of pain, disability, and amelioration on the quality of life of non-specific low back pain patients.

Some studies support the efficiency of specific stabilization exercise of the spine like those used by Hides and colleagues, in patients with unilateral LBP. They used spine stabilization exercises to strengthen the lumbar multifidus muscle and results showed no significant changes in pain and related disability after four weeks of treatment but significant lower recurrences after two to three years post treatment check-ups (Hides et al, 2001). Similar results were obtained in a study by O'Sullivan and colleagues, where stabilization exercises led to significant reduction in pain and disability of patients with CLBP, till 30 months follow- up (O'Sullivan et al, 1997). A study of Inani and Selkar showed a significant improvement on pain levels, disability and quality of life of patients suffering from CLBP after 12 weeks of spinal stabilization exercise program (Inani & Selkar, 2013). As in this thesis ours results demonstrated an important improvement in pain scores assessed by VAS and in disability assessed by ODI.

The results of this thesis indicated a significant reduction in pain intensity after 12 weeks of spinal stabilization exercise program among adolescent population. These findings are supported by the results of a study from Zapata and colleagues, that demonstrated a significant reduction on pain levels even after 6-months following an 8 weeks' stabilization exercise program on adolescents with LBP in idiopathic scoliosis (Zapata, Wang-Price, & Sucato, 2017).

Furthermore, different studies have shown that core stabilization exercises on adolescent population with LBP, designed to active the back extensor muscles and deep abdominal muscles (spine stabilizers), have been very effective on preventing future recurrence of LBP episodes on adult population (Fritz & Irrgang, 2001; Hides et al, 2001; Cairns, Foster & Wright, 2006).

As mentioned in the previous chapters, patients suffering from chronic low back pain may have also different anatomo-physiological abnormalities of the spine, reflected in an aberrant maintenance of the spine stability. Based on the results of this thesis, it can be hypothesized that the stabilization exercise program led to the restoration of the proper functioning of the local stabilizers muscles of the spine (Lumbar Multifidus and Transversus Abdominis). This improvement was associated with reduction of the lumbar soft tissues (muscles, cartilages, intervertebral discs, etc.) inflammation and consequently in pain perception.

The data from this thesis outline the benefits of stabilization exercise program on the quality of life and disability of the patients. As observed from the results obtained, the improvement can be perceived since the first four weeks of the stabilization program. These findings are supported by a study from Sethi and colleagues, who showed a significant improvement of quality of life patterns like depression, stress and anxiety, in CLBP patients, after a four weeks' core stabilization exercise treatment (Sethi, 2012). Our findings were further supported by the results of Sung, who showed significant improvements on the quality of life patients with CLBP (assessed by Oswestry Low Back Pain Disability questionnaire), after a 4 week supervised spine stabilization exercise (Sung, 2003).

Similar results with this thesis are found in the study of Akodu and Akindutire, who conducted the same stabilization exercise protocol on LBP subjects and found significant improvement in pain-related disability, after four and eight weeks of the treatment (Akodu & Akindutire, 2018).

These improvements could be attributed to the reestablishment of the normal co-contraction between lumbar multifidus and transversus abdominis muscles (local stabilizers). It has been proven that subjects with LBP show abnormality patterns in the activation of these muscles compared to healthy individuals (Mayer, Mooney, & Dagenais, 2008). The restoration of these muscles could influence the activity of the superficial muscles (global stabilizers) such as rectus abdominis, internal and external oblique, which contribute in the further stabilization of the spine. All these improved functioning of the spine could lead to decreased pain-related disability levels and amelioration in the quality of life aspects of the patients.

If we have a closer look at the different section of ODI, the best outcomes were observed in sitting (difference of 1.57 points from T0 to T1), pain intensity (1,56 difference), travelling (1.49 points difference), standing (1.36 points difference) and lifting (1.25 points difference). The possible cause of these improvements could be attributed to the restoration of the spine posture. Different studies have shown poor posture patterns on LBP patients that leads to the inability to sit for a long period. The core stabilization exercises by improving the incapacity and biomechanical deficiency of the lumbar multifidus and iliopsoas muscle, could contribute in better sitting capabilities of the patients (McGill, 1991). The same logic can be used to explain the improvements of the standing section outcomes. Meanwhile regarding the lifting process, studies have shown that lumbar multifidus and transversus abdominis are among the first muscles to get activated during this movement process (Hodges & Richardson, 1997). The improvements in endurance and strength of these muscles from the stabilization exercise can lead to better outcomes on lifting patterns of LBP subjects. As mentioned above the improvements in pain patterns are due to reduction of lumbar inflammation which leads to lower neurological stimulus for pain perception. It could be hypothesized that all these improvements in pain intensity, better sitting and standing processes together with lifting outcomes could contribute to the ability of the patients to gain security and plan to execute longer distance travels. This thesis results are in accordance with the findings reported by Inani and Selkar, who reported improvements in the lifting, sitting and home-making sections of ODI, after a twelve-week stabilization exercise program (Inani & Selkar, 2013).

Some other studies, as described by Macedo and colleagues, emphasize the role of stabilization exercises in the reduction of pain and functional disability of LBP patients, but they didn't overcome other different types of treatments such as manual therapy or lumbar fusion surgery (Macedo et al, 2009).

Results from Cairns and colleagues also did not show any statistically significant improvement among programs using spine stabilization exercise, manual therapy or general exercises. They hypothesized that either stabilization exercise may have not been as beneficent as expected or general exercise may have been as effective as the data of the study showed (Cairns, Foster, and Wright, 2006).

The results of this thesis indicated the positive impact of the stabilization exercises in improving the Fear Avoidance Beliefs characteristics of the patients suffering from low back pain. Many different early studies have emphasized the fear avoidance model of increased pain perception in chronic low back pain (Lethem et al, 1983; Troup et al, 1987). Also low back pain patients have the tendency to demonstrate lower physical performance levels but the perception of their physical capability is reduced more than their actual performance (Fordyce et al, 1981; Linton,1985). Based on the results of the data analysis of the FABQ scores, the majority of the subjects in this thesis were classified with low levels of fear-avoidance beliefs. The findings of the thesis demonstrated statistically significant improvements in both FABQ subscales outcomes. These finding are consistent with the results of the studies from George and colleagues, who showed that subjects with low FABQ scores were associated with increased odds of improvement at six months' follow-up (George, Fritz & Childs, 2008).

We can hypothesize that the low levels of FABQ scores could be attributed to the young age of the subjects and their relatively early stages of chronicity of LBP. Maybe the relative short period of their life living with back pain hasn't yet impacted all aspect of their daily living.

The results of this thesis displayed a statistically significant positive correlation between pain and fear avoidance beliefs, with high scores of VAS corresponding to increased FABQ scores. These findings suggest that stabilization exercise might help patients with LBP overcome their fear and improve their disability levels. This is clearly emphasized in the fear avoidance beliefs related to physical activity. Due to their relatively young age our subjects are more familiar to different types of physical and sport related activities. The core stabilization exercise program, enhancing the function and performance of local and global muscles of the spine stabilizers, could have contributed to the reduction of the pain intensity levels and improvement of the pain-related disability of the patients. That could further lead to decrease fear avoidance activity levels beliefs and push the subjects to increase their daily physical activity dosage contributing even more to the improvement of the disability patterns and also maintain this improvement in the future.

5.2 Thesis Limitation

One of the limitations of the thesis can be considered the relatively small size of the sample, composed of only 39 subjects. This is known to affect the generalizability and validity of the results so the generalizations on population should be made cautiously.

Furthermore, the absence of a true control group makes it difficult for the proper interpretation of the results because the positive outcomes of the thesis can be equally attributed either to the stabilization exercise or the natural course of the low back pain. However, the majority of our subjects had a relatively long history of LBP, suggesting that their back pain was not spontaneously ameliorated over time.

As a non-invasive and non-expensive method, the findings of this thesis could be taken into consideration to be integrated in the long-term development of interventions for the management of LBP.

Chapter VI

Conclusions and Further Implications

6.1 Conclusions

1. The principal results of the thesis showed that patients treated with spine stabilization exercises presented significant improvements after the treatment in all the assessed variables.

2. There was notable reduction of pain levels (measured using VAS) and significant improvements in functional disability (measured by ODI and FABQ).

3. The statistical analysis of the data pointed out a positive correlation between the pain intensity scores (VAS) and ODI scores, the VAS and the two FABQ subscales. These findings of the

thesis could be used as a predictable factor for both the physician and the patient when deciding the appropriate treatment for the LBP patients.

4. The results of the thesis suggest that the restoration of the lumbar multifidus and transversus abdominis proper functioning seems to be the key to the success of the stabilization exercise program.

5. The improvement in the spine muscle contraction contributes to the reduction of pain and pain-related disability, thus directly impacting in the quality of life of the patients.

6. The findings of this thesis emphasize the importance of the improvements in the pain-related disability in helping the subjects overcome their fear avoidance beliefs, further positively affecting the work and physical activity aspects of the subject's quality of life.

6.2 Further implications

There is still the necessity for more high-quality studies in the future exploring the beneficiary effects of spine stabilization exercises.

A more appropriate sample size, with a larger number of subjects participating in the stabilization program could contribute to a more suitable generalization of the results for widespread use.

Further investigation using randomized control trials with a true control group should be carried out in order to better interpretation of the thesis results.

A twelve-week program can be considered a relatively short time follow-up taking into account the long-term nature of the LBP. Longer term stabilization programs and follow-up periods should be conducted in order to examine the time duration effects of the stabilization exercise.

CONTRIBUTIONS OF THE DOCTORAL THESIS

1. An essential aspect that our research has provided is the accurate assessment of pain and features cognitive-emotional that can affect its intensity and evolution.

2. In general, the treatment that has given the best results is physical exercise.

3. This doctoral thesis made an important contribution in the context of back pain treatments through collaboration with doctors, physiotherapists, osteopaths and psychologists, aware of the effectiveness of a personalized intervention program.

4. Our research noted the benefits of a specific back pain exercise program that reduces chronicity and helps improve daily activities by reducing pain and discomfort.

5. The protocol used in this doctoral study, which is based on improving pain and muscle activity, served as an education and counselling program for young athletes in our country.

LIST OF SCIENTIFIC PUBLICATIONS IN RELATION TO THE TOPIC OF THE DISSERTATION

1. Conference Reports

During three year I have produced written work in two papers which i presented at international sports scientific conferences. The topics presented are:

14-15 November 2019

1. Participant in International scientific congress "Applied Sport Sciences, Balkan Scientific congress" Physical Education, Sports, Health, Sofia, Bulgaria. "Effect of stabilization exercises on back pain among adolescents aged 19-23".

6-7 December 2019

2. Participant in 16th International Conference in Social Science ICSS, "Sport toward the future" Tirana, Albania. "Back Pain and Associated disability in adolescent among 19-23 years".

2. Publications

1. Metolli, S., Dimitrova, E. (2019). Effect of stabilization exercises on back pain among adolescents aged 19-23. International Scientific Congress “Applied Sports Sciences” and the Balkan Scientific Congress “Physical Education, Sports, Health”, *Proceeding book*, ISSN (Online): 978-954-718-601-9, ISSN (Print): 978-954-718-602-6, NSA Press, 2019, pp. 550-552. Ref. in Web of science.

2. Metolli, S., Oseku, A. (2021). Efficacy of stabilization exercise on Back Pain and Associated disability in patients with back pain among adolescent 19-23 years. *European Journal of Health & Science in Sports* Volume 8 Issue 2, pp. 1-5.

3. Metolli, S., Oseku, A. (2021). Chronic Back Pain- Effects of the stabilization exercises on pain, range of motion and functional disability, the management of the patients. European Journal of Health & Science in Sports Volume 7 Issue 4, pp….. DOI: 10.46827/ejpe.v7i4.3885.