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A Proposed Model for Writing Experimental Research Proposals for Physical Therapy Graduate Students

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Abstract:

Writing a research proposal can be a challenging task for graduate students. In this review, proposed guidelines for writing a research proposal for experimental studies are reviewed and discussed. This includes the different components of the research proposal and a brief explanation for each part. This proposed model was established to fit the needs of the physical therapy graduate students of the faculty of physical therapy, Cairo University, in an attempt to improve the quality of the work provided to the post-graduate office. A suggested new format for the "informed consent" section is also presented. At the end of the article, a suggested model for writing the "method" section is explained in detail. This template is not intended to replace any existing format, but rather to enforce the "quality" of this important section. Students are always advised to consult with their institutions for updated guidelines for the submission of their research proposals.

1.Introduction:

Writing a research proposal can be a challenging task for graduate students, especially for those who do not have enough skills or did not learn how to write a well-structured scientific research paper. Although research is being taught at most institutions as an undergraduate course, graduate students still face obstacles when they start to develop research ideas or are asked to submit their ideas in a research proposal to scientific committees at their institution.

In an attempt to improve the quality of the research proposals submitted by postgraduate students at the faculty of physical therapy, Cairo University, Egypt, and in the light of coinciding with the ongoing updates in evidence-based practice, I created this model with the hope that it will benefit postgraduate students when planning, writing, and submitting their research proposals/study plans to their corresponding departments and the postgraduate office.

In this article, I will review the components of the proposed model for the research proposal (**table 1**), briefly address each component, and present a template for writing the "method" chapter for an experimental research proposal (**Appendix I**).

Table 1: the component of the proposed research proposal

Title page	
Abstract	
Chapter I. Introduction chapter includes: • Background information • Review of relevant literature • Theories and supportive rationale • Aim of the study • Significance (need) of the study • Statement of the problem • Research question • Research hypotheses	**Chapter II:** subjects, materials, and methods • Study design, setting, ethical approval • Participant characteristics, inclusion, and exclusion criteria • Sampling, randomization, blinding (if applicable) • Methods of data collection • Procedure (assessment and intervention if applicable) • Data analysis
References	
Appendices and any supplementary materials	
Documentation of informed consent	

1.1 Title:

Titles should have the catching phrase of the proposal. Reading the title should convey information regarding the research question, study design, intervention, and the intended population. Although it should be comprehensive enough, some journals limit the number of characters in the title. After all, the title should be clear, concise, and descriptive with no abbreviations or acronyms unless universally known and agreed on. One guideline recommends that the title should be limited to 15 words (1).

1.2 Abstract:

The abstract should be short (within 150-350 words) summarizing the research proposal. It should be enough to understand the proposed work from reading just the abstract, thus students should be taught to write the abstract comprehensively yet concisely. For experimental research proposals, the abstract should include background, objectives, methods, data analyses, and keywords. The methods should be written in the future tense since the student is yet to perform the work.

1.3 Introduction section:

This is where the student review relevant background information, addresses the gap in research, introduces his/her proposed idea, and shows the significance of the proposed work. This part should not be verbose; a research paper is not a place for "textbook" explanations. It should clearly and concisely state the problem, the purpose of the study, the need for the study (significance), and the hypotheses. The introduction section may include relevant epidemiological factors and demographics that should be relevant to the population (1,5).

The text should be well-structured to show a smooth flow of information from one section/ paragraph to another. Information in the introduction section should allow a smooth flow of information, moving from broader ideas to a specific or narrower ones. Starting from what is well known and moving gradually deeper into the less known, ending with the purpose of the study. This style of presenting the information is known as the "funnel" style.

Information presented should be coherent, cohesive, consistent, and logical. Coherence refers to the logical unity of ideas in the text. A coherent paragraph addresses only one idea/thought without jumping to different thoughts at once. Cohesion refers to textual strength i.e., how the text is solid like a chain holding each part together with smooth transition between sentences using transition words. Consistency refers to a text with no contradiction of ideas or thoughts.

A coherent text is consistent, but a consistent text is not necessarily coherent i.e., Text information may be redundant addressing several ideas at once which may be consistent if it lacks contradiction. At the same time, the text is not coherent since more than one idea is discussed in the same paragraph.

A good example of presenting information in the introduction section was described in the "chain of reasoning for research", originally described by Krathwohl and David (2). They recommended starting the introduction by linking to previous studies, explaining different theories behind the topic, moving to formulating questions, hypothesis, design of the study, data analysis, conclusion, and ending with a question for the next study (**figure 1**). Good research starts with a question and ends with a new question (1,5).

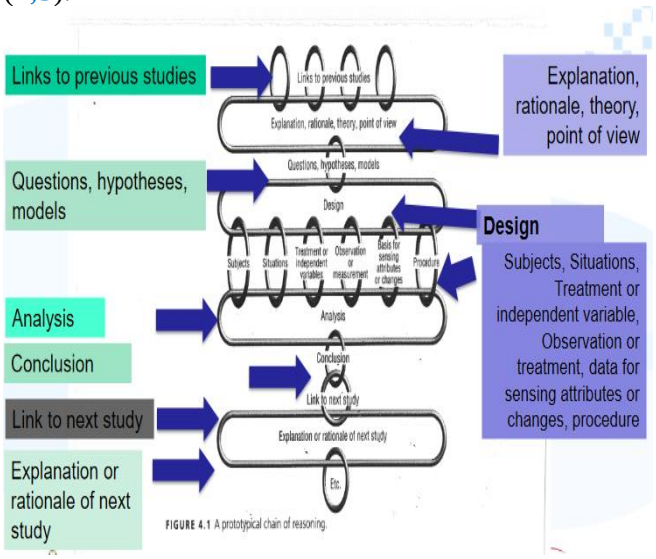

Figure 1. Chain of reasoning for research. Adopted from Krathwohl and David (2)

1.4 Significance of/ need for the study:

This part highlights the importance of conducting the study. It should answer questions such as why the current study is important to conduct. What will it add to the body of knowledge? How will it fill in the gap/paucity in research? How the proposed work is different than/similar to previous work? If the work is similar to previous work, the researchers should justify why they are conducting it and whether it will make an original contribution to knowledge. Tips to improve this section is to write on the socioeconomic impact of the current problem, the expected benefits of the current work to the community, society, researchers, healthcare personnel, and most importantly to patients (if human subjects will be used).

This part should not be an extensive essay review, rather, it should be concise and to the point addressing the rationale of the proposed work. It should also maintain a smooth flow of information and have a "funnel" transition of thoughts.

The section can be strengthened if the researchers have performed pilot testing of their work. The preliminary data of this pilot testing can be presented

here to show the need to perform the work on a larger sample.

1.5 Statement of the problem:

This section should clearly state what the problem(s) that the current study is trying to investigate is/are. Sometimes this section is confused with the research question(s). It is important, however, to distinguish between both since the statement of the problem is the explanation of the research problem and the research question is to put the problem in a question format.

An example of a statement of the problem would be like "Knee Osteoarthritis (OA) has become a major health problem recently, affecting X% of X population causing pain and functional deficits. No study has been conducted before to investigate the effect of X on Y in patients with knee osteoarthritis".

Another example is quoted from the work of Lucas et al. (3) "Motor skills are fundamental to childhood development. However, the effectiveness of treatment options for children with mild to moderate movement disorders is not clear. No study has been conducted to investigate the effectiveness of conservative interventions to improve gross motor skills in children with a range of neurodevelopmental disorders".

1.6 The research question(s):

The research question should not be answered by a simple yes/no answer, rather, it should show the systematic way of investigating the problem. For example, instead of saying "is exercise effective in the treatment of patients with knee osteoarthritis?" it is more accurate to say "What is/are the effect(s) of exercise (if any) on patients with knee osteoarthritis? A good-formulated research question should follow the PICO format (P=population being studied, I=intervention, C=comparison, and O=outcome). Of course, one study may have more than one research question but they all should follow the same format.

Example of research questions (RQ): What is/are the effect(s) (if any) of weight bearing as compared to non-weight bearing exercises in patients with knee osteoarthritis regarding improvement in:

RQ 1: functional outcome measurements (knee oxford scale) and return to work?

RQ 2: knee range of motion?

RQ 3: knee pain intensity?

1.7 Research hypotheses:

This should be clearly stated. Research hypotheses can be non-directional, directional, and/or null. A non-directional hypothesis does not specify the direction of the relationship between the variables. The directional hypothesis on the other hand specifies the direction or the relationship between variables. The null hypothesis indicates no relationship or difference is expected between variables (1). The choice of one of these types depends on what is stated in previous literature and whether the researchers performed a pilot testing of the study and have some evidence to dictate which way to go. Examples of each are as follows:

- Null hypothesis: there will be no significant effect of exercise on the improvement of knee function in patients with knee osteoarthritis
- Directional: there will be a positive (or negative) significant effect of exercise on the improvement of knee function in patients with knee osteoarthritis
- Non-directional: there will be a significant effect of exercise on the improvement of knee function in patients with knee osteoarthritis.

students should arrange their thoughts and know the difference between each of these components. A mind map can be helpful. The research problem, research question, purpose of the study, and research hypothesis are summarized in **(figure 2**).

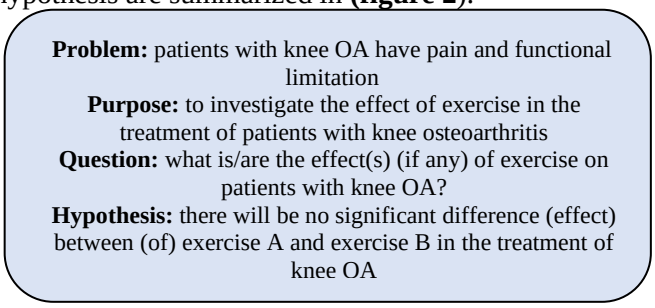

Figure 2. A mind map to distinguish between the information presented in the introduction section

General tips to consider when writing the introduction section:

- Start each paragraph with a topic sentence and build up on the same topic.
- Logically present your thoughts and move down through your trains of thoughts in a "funnel" way
- Use "people first" language; rather than describing people by their disease or disability e.g., stroke patients, say "patients who have had a stroke" or "patients with stroke"
- Comprehensively review the relevant literature, but at the same time, try to avoid redundant information. Remember that a research proposal is not a place for extensive textbook information.
- Use active voice whenever possible but stay in moderation. It is recommended, however, not to overuse the first-person active voice in describing the assessment procedure. For example, you can say "subjects were asked to fill out the assessment questionnaire", rather than "we asked the subjects to fill out the assessment questionnaire".

2. Materials and Methods:

This is the "technical" part of the proposal and should show the researchers' ability to conduct the proposed work, laying out the ground for a rigorous methodology including all the points previously

listed. The more comprehensive you are in this section, the easier for the evaluators and readers to understand the details of your proposed work. Since you are yet to conduct your study, the information presented here should be in the future tense unless you are quoting or reporting a piece of factual information that requires the use of a different tense. A proposed template for the "method" section is presented in **appendix I**.

Students should be as explicit as possible in detailing their subject characteristics, sampling technique, data collection, assessment, and intervention procedure (if applicable). Subjects should be defined according to the inclusion and exclusion criteria and how they will be recruited, the setting, and the accessible population from which they will be drawn, the timeframe for data collection, and how the subjects will be randomized into groups (if applicable), a description of the randomization technique itself, and how blinding will be incorporated (if applicable) should be all explained.

The internal validity of the study improves when both investigators and subjects are blinded to the assessment and or/intervention since investigators' and participants' knowledge of their intervention or investigator's expectations can consciously or unconsciously affect the study outcome. In some cases, however, it is impractical to establish such blinding due to the nature of the study. For example, in an experimental design where subjects are assigned to two different groups doing two different types of exercises that they see and feel the effect of, masking subjects to intervention is difficult or even impossible to attain. On the other hand, if the subjects are receiving two different drugs, one is real and one is sham and both are given in form of a medicine pill or injected into the body, then blinding can be established. If blinding cannot be established due to the nature of the study, this should be stated as well (see example in appendix I).

For any instrument to be used in the study, a description of the instrument, manufacturer information, and the metrics (psychometric properties) should be included. This will serve as guidance for those reading the proposal to easily find and evaluate them. Also, information on how the instrument will be used and calibrated is important. Instruments include any assessment or therapeutic devices or patient-reported outcome measures (e.g., questionnaires).

Care should be taken when describing the research design. Students should discriminate between experimental and observational designs. A randomized clinical trial is not a correlation study, and a correlation design cannot show a "cause and effect" relationship. Research design should not contradict the research question, purpose of the study, or hypotheses, rather, it should affirm them and should be reflected in the correct statistical design.

The standard for reporting various types of studies should be followed. The method to be followed should be mentioned and cited in the method section. For experimental designs, the consolidated standards of reporting trials (CONSORT) are commonly followed based on most journals' recommendations. A CONSORT (4) checklist is also available for the student to make sure that the proposal covers all the mandatory research items. Some commonly used standards for reporting different research designs can be illustrated in **table 2**.

Table 2. Standards for reporting various types of studies (1)

Randomized Trials CONSORT	Consolidated Standards of Reporting Trials: Randomized trials, N-of-1 trials, reporting of harms, pragmatic trials, non-inferiority trials
Observational Studies STROBE	Strengthening the Reporting of Observational Studies in Epidemiology: Cohort studies, case-control studies, cross-sectional studies
Systematic Reviews and Meta-Analyses PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses: Systematic reviews and meta-analyses, scoping reviews, improving harms
Diagnostic Accuracy and Prognostic Studies STARD TRIPOD	Standards for Reporting of Diagnostic Accuracy: Diagnostic/ prognostic studies Transparent Reporting of a multivariable Prediction model for individual Prognosis or Diagnosis: Checklist for prediction model development and validation
Qualitative Research SRQR COREQ	Standards for Reporting Qualitative Research Consolidated criteria for Reporting Qualitative research: Qualitative research interviews and focus groups
Case Reports CARE	Consensus-based Clinical Case Reporting
Clinical Guidelines AGREE RIGHT	Appraisal of Guidelines, Research, and Evaluation Reporting Tool for Practice Guidelines in Health Care
Study Protocols SPIRIT PRISMA-P	Standard Protocol Items: Recommendations for Intervention Trials Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols
Quality and Economic Guidelines SQUIRE CHEERS	Standards for Quality Improvement Reporting Excellence Consolidated Health Economic Evaluation Reporting Standards

Data analysis should be explicitly clear to enable readers to understand how the data will be manipulated. Proper statistical tests to examine the research hypotheses which does not contradict the purposes of the study should be stated. Sample size calculation should be explained and the method for arriving at the proposed sample size should be stated. The software for sample size calculation and data analysis should be stated along with the version and manufacturer information.

Students should follow the reference style guidelines. Different styles are available but for this proposed model, citation in the text has been proposed to include writing the author's last name followed by the year of the publication after the coma. For example (Abdelmegeed, 2022), for two authors (Abdelmegeed and Oddo, 2022), and three or more (Abdelmegeed et al., 2022). In the reference list, the reference is arranged alphabetically and not by the order they appear in the text using the American Medical Association (AMA) style.

Appendices should include any supplementary materials such as patient-reported outcome measure, tables, figures, the program for exercises to be performed, the study's timeline, and any other materials which may not be essential to be presented in the text but helps provide a thorough understanding of an item or items and needs to be explained in detail.

Consent form information should be elaborated on and include all the necessary information. The institutional review board (IRB) should be able to assess the risks and benefits of the proposed research based on the information presented in the informed consent. All subjects participating in the study should read, understand, and sign the form before data collection. Study investigators should spend enough time explaining the items that may be difficult to understand to the subjects. Each subject is entitled to have a copy of the signed consent form along with the principal investigator's contact details in case of future questions or concerns. The study should not be conducted before IRB approval. For this proposed model, informed consent is suggested to be presented in questions and answers (Q&A) format. The following questions are proposed to be included in the consent form:

1. Why is this study being done?
2. How will I be involved?
3. What are the reasonably foreseeable risks or discomforts I might have.
4. Will there be any benefit to me or others?
5. What are my rights as a subject?
6. Will I be informed of significant new findings?
7. What other choices do I have?
8. How will information about me be kept confidential?
9. What costs are involved?
10. Will I be paid if I take part in this research study?
11. Will study staff receive payment?
12. Research-related injury?
13. Why do I call if I have questions? / Impartial third party?
14. Subject's statement of consent?

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Declaration of competing interest:

The authors declare that they have no competing interests.

Reference:

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Appendix I
Sample "method section"

Disclaimer:

Please use this sample at your discretion. This is not intended to replace any other forms of the research proposal, nor to replace your institutional guidelines. It is just a sample to show the different components of the chapter to improve the quality of work submitted by graduate students. It was collected from different sources and is not intended to fit as one piece, nor to convey information on a single topic. These are bits and pieces from different proposals to show what information should be included in the chapter. Please do not copy or reproduce any of the included material. This is copyrighted material. Please contact the author if you have any questions.

CHAPTER II
SUBJECTS, MATERIALS, AND METHODS

This study will be conducted at the outpatient clinic of the faculty of physical therapy, Cairo University, to investigate the effect of core muscle training on subjects with chronic mechanical low back pain (CMLBP). The study is estimated to run between January 2022 and December 2022 after obtaining the ethical committee approval.

3.1 Study Design:

This will be a single-blinded, randomized clinical trial (therapy, level 1B). Due to the nature of the study, participants will not be blinded to the group assignment or to the treatment they will receive. The principal investigator (PI), however, will be blinded to the group assignment as it will be performed by a research assistant who will be trained for the group allocation. A flow diagram according to the Consolidated Standards of Reporting Trials (CONSORT) statement will be presented to illustrate the progression of this clinical trial (Schulz et al., 2010). Also, this trial will be registered at one of the clinical trial registries.

3.2 Participants:

Fifty-two male and female patients, aged between 20 and 50 years, diagnosed with CMLBP will be recruited through direct referrals based on their availability to participate, thus, a sample of convenience will be used. They will be asked to sign the informed consent form. Participants will be randomly allocated to experimental and control groups as follows:

Group A (n=30): will receive a program of core training exercises for 12 sessions (3 sessions per week for four weeks)

Group B (n=30): will receive no treatment for the study period. As an ethical consideration, subjects in this group will receive the full treatment after the end of the study and after data has been collected.

3.3 Randomization:

Patients will be randomly assigned to one of the two groups. We will use a simple randomization method to allocate participants to the groups. A random number generator available online from www.randomization.com will be used.

3.4 Sample size calculation:

In order to detect an effect size of Cohen's d= 0.80 with 80% power (alpha= 0.05), G*power software (version 3.1.9.7; Franz Faul, Universitat Kiel, Germany) suggests we will need 52 participants (26 per group) using a two independent sample t-test as shown in the (**figure 3**).

The effect size was calculated by dividing the reported average minimal clinically important difference (MCID) of the NDI which is 7.25 points (range from 5 to 9.5 points) by the standard deviation of change in the NDI for a sample of 30 subjects from a previous study which was 9.7 (Young et al., 2009; Celenay et al., 2016).

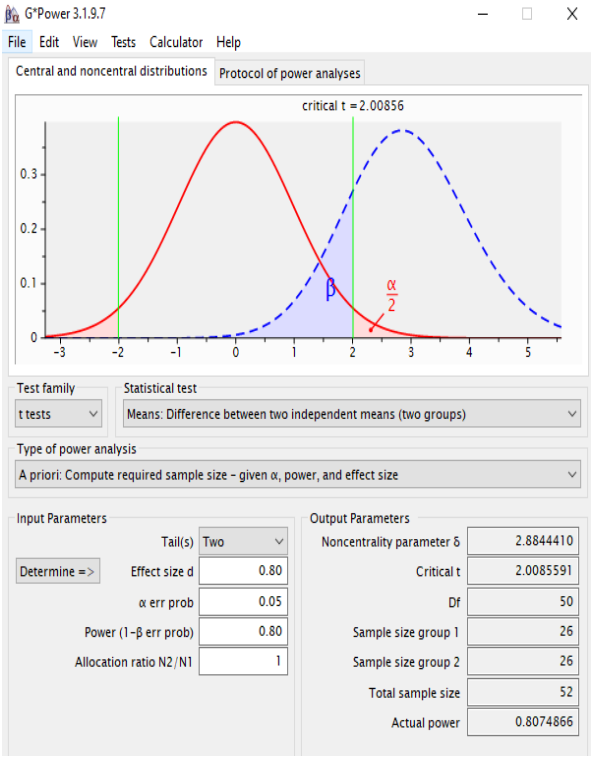

Figure 3: Sample size calculation

3.5 Inclusion criteria

Patients will be included if they have the following criteria:

1. Sixty male and female patients with CMLBP of more than 3 months duration (Kreiner et al., 2014; Ma et al., 2013; Jordon et al., 2009)
2. Patients with body mass between 18-25
3. Patients aged between 20-50 years old
4. Moderate level of pain (4-6 on VAS)
5. Minimal level of disability (0% to 20%) on Oswestry disability index (ODI) which is defined as "the patient can cope with most living activities. Usually, no treatment is indicated apart from advice on lifting, sitting, and exercise".

3.6 Exclusion criteria:

Participants will be excluded if they did not meet the inclusion criteria mentioned above.

3.7 Instrumentations:

3.7.1 Instrumentation used for assessment:

The following instrumentation will be used for the assessment

1. Bubble inclinometer
2. Hand-held dynamometer.
3. Arabic version of Visual analog scale (VAS).
4. Arabic version of Oswestry disability index (ODI- AR).

3.7.1.1 Bubble inclinometer:

The bubble inclinometer (**figure 4**) is a plastic rounded measurement tool that has a 360-degree

rotating dial with a fluid indicator (Baseline Bubble Inclinometer, Fabrication Enterprises INC, White Plains, New York 10602, USA) (Roger and Thomas, 2009). The bubble inclinometer method is a reliable, valid, affordable, and accurate measure of the back range of motion. It is a lightweight, portable, cheap, and time-saving tool (Vafadar et al., 2015; Dover and Powers, 2003).

Figure 4: Baseline bubble inclinometer (Adopted from Salamh and Kolber, 2014).

3.7.1.2 Hand-held dynamometer (HHD):

The hand-held dynamometer (Model 01165, Lafayette Instrument Company, Indiana) (**figure 5**) is an easy and reliable device to assess isometric muscle strength in both clinical and research settings, showed good to excellent reliability for measurement of muscle strength in flexion, extension, and lateral flexion (Vannebo et al., 2018).

Figure 5: Lafayette Handheld dynamometer (Adopted from Celik et al., 2012).

3.7.1.3 Visual analog scale- Arabic version (**Appendix III**):

Pain intensity will be assessed using the Arabic version of the visual analog scale (VAS-AR). The VAS is a unidimensional measure of pain intensity. It is a continuous scale comprised of a horizontal line of 10 cm in length (**figure 6**). The scale is anchored by "no pain" (score of 0) and "worst imaginable pain" (score of 10). A higher score indicates greater pain intensity (Hawker et al., 2011)

The validity of the VAS-AR is excellent (r=0.94, P<0.001). VAS scores are shown to highly correlate with other pain measure scores e.g., a numeric rating scale for pain, McGill pain questionnaire, short-form McGill pain questionnaire, and chronic pain grade scale (r= 0.62–0.91) (Hawker et al., 2011).

The reliability of the VAS for pain measurement as assessed by the interclass correlation coefficient (ICC) for the test-retest reliability was 0.97 [95% CI = 0.96 to 0.98]. This data suggest that the VAS is sufficiently reliable to be used to assess pain. (Bijur et al, 2001; Donald et al., 1983).

Figure 6: the Arabic version of the visual analog scale (VAS-AR)

3.7.1.4 Arabic version of Oswestry disability index (ODI-AR):

Functional disability will be estimated using the cross-culturally adapted Arabic version of the Oswestry disability questionnaire (ODI-AR). The ODI assesses the impact of low back pain on daily activities. It has 10 items including pain, sleep, walking, carrying, self-help and private life ability, standing, sitting, social and sexual life, and traveling. Every item is scored 0–5 points, with a total score from 0 to 50, and earnest dysfunction means a high score (Lee et al.,2017). The validity of the ODI-AR is good (r=0.65, p< 0.001) (Ramzy, 2008) (**Appendix IV**).

3.7.2 Instrumentation used for treatment:

3.8 Procedure:

At baseline, the study purpose will be explained to eligible participants, and the principal investigator (PI) will clearly explain all the items in the informed consent form and will address any question or concern. The subject will then be asked to sign the informed consent form and will then be randomly assigned to one of the two groups. After group assignment, patients' demographics will be collected, and then an assessment of pain, function, strength, and posture will be performed. The same assessment procedure will be conducted by the end of the treatment (by the end of the 12th visit)

3.8.1 Assessment procedure

3.8.1.1 Assessment of pain intensity:

Using the visual analog scale (VAS-AR), shown in appendix III, we will ask the patient to place a mark

on a continuous 10 cm line to indicate pain intensity, ranging from no pain or discomfort to the worst pain they could feel. A ruler will be then used to measure the distance from zero, and the recorded number will be rounded to the nearest number, for example, a measure of 5.7cm will be rounded to 6cm (Hawker et al., 2011).

3.8.1.2 Assessment of functional disability:

For each item of the ODI-AR, the participants will be asked to choose one answer that best defines his/her back function. The index is calculated by dividing the summed score by the total possible score, which is then multiplied by 100 and expressed as a percentage. Also, for every question not answered, the denominator will be reduced by 5. If a patient marks more than one statement in a question, the highest scoring statement will be recorded as a true indication of disability. Scores for each item will be tallied and the total score will be recorded. A total score from 0-20 to indicate "minimal disability", 20-40 to indicate "moderate disability," 40-60 to indicate "severe disability", 60-80 to indicate "housebound", and 80-100 to indicate "bedbound" (Mehra et al., 2008).

3.8.1.3 Assessment of posture

3.8.1.3.a Vertical compression test (VCT): (Saliba and Johnson, 1983) (figure 7).

Patient position: the patient will be asked to stand in a natural position and relax everything but the knees (so as not to buckle and collapse when pressure is applied)

Therapist's position and manual contact: Standing side by side or stride position, the therapist may be positioned on a stool, chair, or table. Therapist positions: forearms vertical then hovers and place hands on the patient's shoulders, between the acromion and the first rib insertion. Therapist must ensure that all force is directed to patient and not allow movement in his or her body unless patient buckles.

Therapist's action and verbal command: after instruction, the therapist applies gentle, sustained pressure vertically through the patient's trunk or pelvis. The pressure will be gradually built from a grade of (1) which is at the point. Where the therapist feels the pressure of the patient's bony surfaces through the soft tissue covering the carpal ridge, to a (2) which is double the pressure of (1), and then to a (3) which is triple the pressure of (1), and so on until full force is applied which would be a grade of (5).

An efficient response is one in which the pressure applied by the therapist translates evenly to the base of support. In standing that would be to the arch of the foot, translating into the second ray. An efficient response is a springy end feel.

An inefficient response (failure) will be noted when the pressure applied by the therapist causes the spine to side bend, backward bend, shear or rotate. In addition, an inefficient response is a hard end feel.

Figure 7: the vertical compression test.

3.8.2 Treatment procedures:

The sessions will be conducted three times per week for four weeks and each exercise will be performed for two sets of 10 repetitions. For the static exercises, the final position will be held for 6 sec. There will be a pause of 3 sec between repetitions, and a 60-sec rest between each exercise. The exercises will be performed in three stages: abdominal bracing, dynamic stabilization, and advanced core strengthening.

3.8.2.1 Abdominal bracing exercise:

The abdominal bracing exercises are based on the concept of tonic spread as described by Saliba and Johnson (1985). The patient will be lying in a hook lying position and the therapist will begin applying resistance to the upper extremity. The therapist will apply the resistance very slowly, with an emphasis on the timing of scapula stabilizers first, then trunk stabilizers, then hip stabilizers. Allowing the patient to feel the recruitment pattern, relax, and re-facilitate. Each subsequent facilitation should result in a quicker and stronger response by the patient's core stabilizers.

Once the patient can "lock in" the trunk response with what is defined by Saliba and Johnson as the "magnetic click", the therapist will repeat this sequence 10 times to ensure the patient's core strategy is firing automatically. The magnetic click is a response that allows the therapist to feel the response of the upper and lower body as one segment (**figure 8**).

3.8.2.2 Dynamic stabilization: (Saliba and Johnson, 198٠)

3.8.2.2.1 Basic marching with abdominal bracing:

Patients will be in a hook lying position, once the patient can initiate a solid bracing contraction, using fingers for feedback and to make sure the contraction is solid. Then, while maintaining the brace, slowly begin to march in place, lifting one leg at a time. Instructions will be given not to lift the second leg until the first leg is on the mat (**figure 9**).

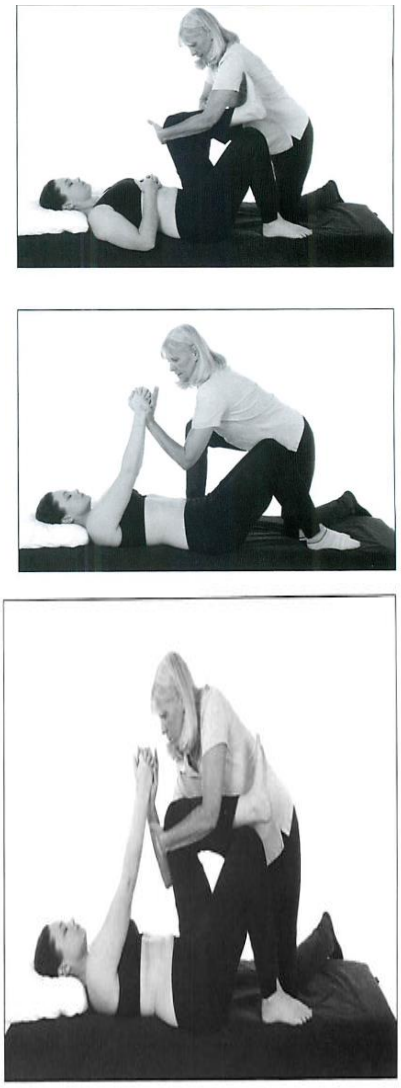

Figure 8: Tonic spread exercise.

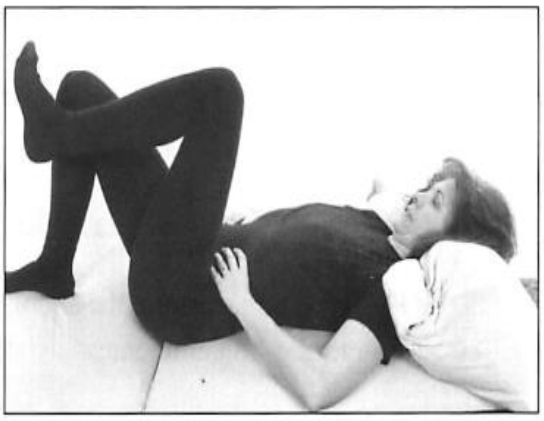

Figure 9: Basic marching with abdominal bracing.

3.8.2.3 Advanced core strengthening exercises:

3.8.2.3.1 The Advanced Side Bridge:

This will be performed by having the participants rotate from a left-side bridge to a right-side bridge and then to a prone bridge and completing the repetition by rotating to a left-side bridge. The therapist will make sure the pelvis and spine move simultaneously (**figure 10**).

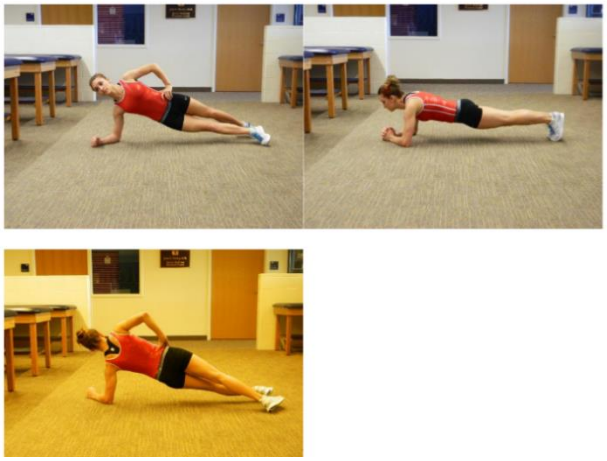

Figure 10: Advanced Side Bridge.

3.9 Statistical analyses:

- Descriptive statistics will be expressed as mean ± standard deviation for continuous variables and frequency distribution (%) for categorical variables.
- The normality of the data will be examined using Kolmogorov Smirnov statistical test.
- Comparisons between the two groups will be performed using unpaired student t-tests pre and post-intervention for pain, function, and core strength.
- Comparison between groups pre and post-treatment will be performed using the analysis of variance (ANOVA) test
- If a significant difference is found, a post hoc analysis using Bonferroni, Scheffe, or Tuckey correction will be performed.
- The alpha level will be set at 0.05.
- To control for the effect of the age variable, an analysis of covariance (ANCOVA) will be conducted.
- Data will be analyzed using the statistical package for social sciences (SPSS) computer program version 27 software (IBM SPSS Inc., Chicago, IL, USA).