

**UNIVERSITY OF BAHRAIN**

**College of Health  
and Sport Sciences**



**Department of  
Physiotherapy**

**The Effectiveness of Online Core Stability  
Program and Deep Breathing Training in  
Rehabilitating Female Patients with  
Lumbar Functional Instability**

**A Thesis Submitted in Partial Fulfilment of the Requirements for the  
Master of Science Degree in Physiotherapy**

**Submitted by**  
**Fatema Mohamed Jaffar Mohamed**  
University ID: 20120599

**Supervised by**  
**Dr. Yusuf Sayed Sharaf**  
(Assistant Professor)  
University of Bahrain

**Kingdom of Bahrain**  
**October 2022**

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# Defense Committee's Approval

University of Bahrain  
Deanship of Graduate Studies  
and Scientific Research



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عمادة الدراسات العليا والبحث العلمي

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The Discussion Committee met on 19<sup>th</sup> of October 2022 in MS Teams. Upon discussing the student whose details are stated above in public, the discussion committee recommends the following:

The student is awarded a grade A- in the thesis subject.

☒ Without making any changes to the thesis.

☐ After making the modifications attached with this decision.

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Approved at the University Council Meeting, 2023  
In accordance with Decision No. 196/2013 dated 14 / 5 / 2013  
Modified by University Council Decision No. 2043/2013 dated 20/11/2013

# Dissertation Deposit Form

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# Abstract

**Background:** Lumbar functional instability (LFI) may be associated with chronic low back pain (CLBP). Various therapeutic exercises were proposed to enhance spinal stability, such as core stability exercises (CSE) and deep breathing training (DBT). However, no study has examined and compared the effectiveness of delivering these exercises as an online program on patients with CLBP and LFI.

**Purpose:** To evaluate and compare the short-term effects of three online exercise programs (DBT, CSE, and combined DBT+CSE) in females with CLBP and LFI.

**Method:** A quasi-experimental study involving seventy-eight women aged between 25-40 years old. Participants were allocated into one of the three online therapeutic exercise program groups or the wait-list control group. All therapeutic programs were performed three times a week for four weeks. The intensity of LBP [Numeric Pain Rating Scale (NPRS)], functional disability [Oswestry Disability Index (ODI)], and core muscle endurance [Prone Bridge Test (PBT)] were measured at the baseline, end of the second week, and end of the fourth week of intervention.

**Results:** All outcome measurements showed improvements at the end of four weeks in all groups (NPRS:  $\geq 3.3$  points,  $P < 0.001$ ; ODI:  $\geq 12.4\%$ ,  $P < 0.001$ ; PBT:  $\geq 18.7$  sec,  $P < 0.001$ ), except the control group (NPRS: 0.3 points,  $P = 0.174$ ; ODI: 0.9%,  $P = 0.149$ ; PBT: 1.1sec,  $P = 0.079$ ). However, there were no differences between the three online therapeutic groups in any outcome measure ( $P > 0.05$ ), except that the combined DBT+CSE group showed statistically better improvement than the DBT group in PBT (19.3sec,  $P = 0.028$ ). This difference between the DBT+CSE and DBT did not reach the minimal detectable change.

**Conclusion:** The three online therapeutic exercise programs effectively reduced LBP intensity and improved functional status and core muscle endurance, with no program being superior to the others. Further investigation is required through comparing the same online exercise programs with the in-clinic exercise method.

**Keywords:** Chronic low back pain, core stability exercises, deep breathing training, lumbar functional instability, online program.

## **Publications**

Alaradi, A., Irum, S., Ebrahim, N., Mohamed, F. M. J., Hazeem, F. M. J., & Ashfaq, M. (2021). The Mental Health Impact of COVID-19 Pandemic on Health Care Workers and Coping Strategies: A Systematic Literature Review. *International journal of online and biomedical engineering*, 17(9), 48-69.

## **Dedication**

This thesis is proudly dedicated to my family and the memory of my father.  
Thank you for your endless sacrifices, prayers, support, and advice.  
I have promised to make my father and mother proud by achieving a monumental  
academic goal. I hope to have fulfilled that promise.

## **Acknowledgment**

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## List of Abbreviations

|                      |                                         |
|----------------------|-----------------------------------------|
| <b>ADIM</b>          | Abdomen Draw in Maneuver                |
| <b>ANOVA</b>         | Analysis of Variance                    |
| <b>BMI</b>           | Body Mass Index                         |
| <b>CI</b>            | Confidence interval                     |
| <b>CLBP</b>          | Chronic Low Back Pain                   |
| <b>cm</b>            | Centimetre                              |
| <b>COVID-19</b>      | Coronavirus Disease 2019                |
| <b>CSE</b>           | Core Stability Exercises                |
| <b>DBT</b>           | Deep Breathing Training                 |
| <b>H<sub>0</sub></b> | Null hypothesis                         |
| <b>H<sub>a</sub></b> | Alternative hypothesis                  |
| <b>e.g.</b>          | For Example                             |
| <b>GBD</b>           | Global Burden of Diseases               |
| <b>GCC</b>           | Gulf Cooperation Countries              |
| <b>ICC</b>           | Intra Class Coefficient                 |
| <b>LBP</b>           | Low Back Pain                           |
| <b>LFI</b>           | Lumbar Functional Instability           |
| <b>LSI</b>           | Lumbar Segmental Instability            |
| <b>MCID</b>          | Minimal clinically important difference |
| <b>MD</b>            | Mean of Difference                      |
| <b>MDC</b>           | Minimal Detectable Change               |
| <b>NPRS</b>          | Numeric Pain Rating Scale               |
| <b>ODI</b>           | Oswestry Disability Index               |
| <b>PBT</b>           | Prone Bridge Test                       |
| <b>RCT</b>           | Randomized Control Trial                |
| <b>SD</b>            | Standard Deviation                      |
| <b>sec</b>           | Seconds                                 |
| <b>SF-36</b>         | 36-Item Short Form Survey               |
| <b>SPSS</b>          | Statistical Package for Social Science  |
| <b>TBC</b>           | Treatment-based Classification          |
| <b>TrA</b>           | Transversus Abdominis muscle            |
| <b>UOB</b>           | University of Bahrain                   |
| <b>VAS</b>           | Visual Analogue Scale                   |
| <b>YLD</b>           | Years Lived with Disability             |
| <b>ZOA</b>           | Zone of Apposition                      |

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# **Chapter One**

## **Introduction to the Study**

### **1.1 Introduction and short background**

Low back pain (LBP) is one of the most prevalent musculoskeletal disorders that affect nearly 60% to 80% of people at some point in their lifetime; from children to the elderly, in developing and developed countries (Adekanmi et al., 2018; Chen et al., 2022). LBP has been ranked as the most significant contributor to global physical disability and the second most common reason for seeking medical attention (Cieza et al., 2020). Most patients with acute LBP recover spontaneously, but 20% of cases develop chronic LBP (CLBP) that lasts for more than twelve weeks resulting in high healthcare costs and low productivity (Maher et al., 2017).

CLBP is the most frequent cause of disability among young adults globally and in Gulf Cooperation Countries (GCC) (Aldera et al., 2020; Hoy et al., 2014; Tantawy, 2019). Sedentary lifestyle is considered one of the risk factors that precede CLBP in young adults, resulting in poor postural and motor control of the spine (Bo Andersen et al., 2006; Chen et al., 2009; Citko et al., 2018; Damanhuri et al., 2014).

Relatively, lumbar functional/clinical instability (LFI) is a well-documented subgroup of LBP (Alyazedi, 2021; O'Sullivan, 2000). LFI is associated with CLBP, with an incidence rate of about 13-46% (Areeudomwong et al., 2020). LFI is defined by Panjabi et al. (1994) as a decrease in the capability of the active and neuromuscular spinal stability subsystems to maintain their equilibrium and posture under physiological load.

As a result, various therapeutic exercises are prescribed to enhance spinal stability (Demoulin et al., 2007; Hall et al., 2021; Kofotolis & Kellis, 2006). Evidence by Hodges et al. (2003) supported the positive effect of core stability exercises (CSE) in promoting neuromuscular control, strength, and endurance of the core muscles; this involves the deep abdominal and back muscles, which are essential for maintaining spinal stability. Due to this effect, CSE has been widely used in reducing back-related disability and pain in patients with CLBP and LFI (Akhtar et al., 2017; Kavcic et al., 2004; Narouei et al., 2020; Puntumetakul et al., 2013).

Deep breathing training/exercises (DBT) that target deep abdominal muscles, particularly the diaphragm and transversus abdominis (TrA), were also prescribed in treating patients with CLBP and LFI (Gholami Borujeni & Yalfani, 2019; Kang et al., 2018; Rae et al., 2020).

Several published studies recommended combining DBT with CSE programs for more positive results in spine stability (Mohan et al., 2020; Oh et al., 2020; Otadi et al., 2021; Shah et al., 2020; Sini & Mohanraj, 2019). Moreover, all these studies delivered the rehabilitation programs in a clinical (face to face) setting, known as in-clinic exercise programs.

The current Coronavirus disease 2019 (COVID-19) situation has led governments and health authorities in most countries, including the Kingdom of Bahrain, to institute restrictive measures to prevent the spread of this virus (Ministry of Health, 2020). Thus, the in-clinic exercise programs previously mentioned above are no longer viable. In response, World Physiotherapy has promoted the use of telerehabilitation which refers to utilizing telecommunications networks and virtual technology to deliver patient rehabilitation (Martínez et al., 2021).

Exercise-based telerehabilitation is one of the intervention methods that can be delivered in treating patients with chronic musculoskeletal disorders, also known as online therapeutic exercises, that can be conducted through one-to-one virtual sessions or video exercises (Cottrell et al., 2017; Grona et al., 2018; Mbada et al., 2019; Turolla et al., 2020).

To the researcher's knowledge, this is the first study conducted that evaluated and compared the effectiveness of three therapeutic exercises (CSE, DBT, and combined program DBT+CSE) as online programs in rehabilitating female patients with CLBP and LFI.

## **1.2 Research Problem**

In the last few years, CLBP has been considered one of the most prevalent chronic musculoskeletal conditions in the GCC, of which the Kingdom of Bahrain is a part of; in focus, it is more common among young adults and in females than in males (Aldera et al., 2020; Maki et al., 2021; Tantawy, 2019). Moreover, CLBP is responsible for most of the costs and disabilities in high-income countries (Hartvigsen et al., 2018). This leads to increased years lived with disability (YLD) and would result in a higher frequency of sick leave and the associated psychological distress. The ubiquity of these events reduces productivity in the workplace and at home (Compare et al., 2016). Despite the importance of this topic, limited studies were published in Bahrain focusing on young adult female patients suffering from CLBP (Qareeballa et al., 2018; Tantawy et al., 2017).

Furthermore, most studies applied rehabilitation programs to non-specific CLBP, which might help some patients, but not help others because there are subgroups of LBP, and LFI is one of them (Alhowimel et al., 2020; Tantawy et al., 2019; Wang et al., 2012).

Previous literature has shown that CSE, DBT, and a combination of both in-clinic exercise programs (DBT+CSE) were prescribed for CLBP and LFI patients to enhance spine stability with lengthy intervention periods required usually ranging between 6 to 12 weeks, which makes it cost-inefficient (Chung et al., 2013; Frizziero et al., 2021). Nevertheless, the debate continues about which of these programs has the best clinical outcomes, considering that most previous research is limited to comparing only CSE to CSE +DBT (Oh et al., 2020; Shah et al., 2020).

In the same way, no evidence could clarify whether using less physically demanding exercises such as DBT can substitute for higher physical effort exercises such as CSE. It is also worth mentioning, that Gomes-Neto et al. (2017) and Wasser et al. (2017) found that limits in CSE training between CLBP patients can adversely affect performance outcomes and movement efficiency and may ultimately cause injury or pain. Physical fatigue may also arise due to the strenuous physical effort required while practicing these exercises.

Conversely, DBT yielded beneficial clinical results with less physical demands (Fernandes & Chougule, 2017; Finta et al., 2018). Most DBT required respiratory resistance devices (e.g., POWER breath or Lung Expander device, which are unavailable to every patient and may not be cost-effective. A balloon will be utilized in the current study in DBT exercises programs, as explained by (Shetty & Fathima, 2020)

Currently, government restrictions curbing the spread of the COVID-19 situation in most countries, including Bahrain, have been instituted. These restrictions have adverse effects by limiting participation in physical activities and access to in-clinic exercises (Ammar et al., 2020). In response, the use of telerehabilitation in treating chronic musculoskeletal conditions has been promoted (Seron et al., 2021). Nevertheless, there is

still an apparent dearth of studies examining the effects of online therapeutic exercises for CLBP (Castro-Sanchez et al., 2020; Dadarkhah et al., 2021; Özden et al., 2022). No study examined and/or compared the effectiveness of different online therapeutic exercise programs in rehabilitating patients with CLBP and LFI globally and locally.

Therefore, CSE and DBT Exercises will be utilized to build three online rehabilitation Programs (CSE, DBT, and DBT+CSE). This study aims to compare the effectiveness of these three online programs on female CLBP patients over a period of two and four weeks.

### **1.3 Research Questions**

1. Would the application of any of the three online therapeutic exercise programs: (DBT, CSE, or a combination of both programs DBT+CSE) have an effect on pain intensity, functional disability and core muscle endurance in females with CLBP and LFI aged 25 to 40 years, at two and four weeks of intervention periods?
2. Is there a difference between the three online therapeutic exercise programs in reducing pain intensity and improving the functional status and core muscle endurance at two and four weeks of intervention periods among females with CLBP and LFI aged between 25 and 40 years?

### **1.4 Research Aims/Objectives**

**Aim:** To evaluate and compare the short-term effects of four weeks of three online exercise programs [deep breathing training (DBT), core stability exercise (CSE) and combined program (DBT+CSE)] on pain intensity, functional disability and core muscle endurance in females with chronic low back pain (CLBP) and lumbar functional instability (LFI).

### **Objectives:**

1. To measure the changes in pain intensity, functional disability, and core muscle endurance in females with CLBP and LFI after a four-week program of three online exercise programs (DBT, CSE, and DBT+CSE).
2. To compare the differences in pain intensity, functional disability and core muscle endurance between the three online exercise programs (DBT, CSE, and DBT+CSE) and wait-list control group in females with CLBP and LFI.

## **1.5 Research Hypothesis**

First  $H_0$ : All the three online therapeutic exercise programs (DBT, CSE, and DBT+CSE) do not improve pain, functional disability and core muscle endurance after four weeks of intervention in female patients with CLBP and LFI.

First  $H_a$ : All the three online therapeutic exercise programs (DBT, CSE, and DBT+CSE) improve pain, functional disability and core muscle endurance after four weeks of intervention in female patients with CLBP and LFI.

Second  $H_0$ : Four weeks of the combined program (DBT+CSE) do not improve pain, functional disability and core muscle endurance better than DBT and CSE in female patients with CLBP and LFI.

Second  $H_a$ : Four weeks of the combined program (DBT+CSE) improve pain, functional disability and core muscle endurance better than DBT and CSE in female patients with CLBP and LFI.

## **1.6 Research Significance**

CLBP is a pervasive musculoskeletal disorder amongst the population and a major cause of YLD. Recent literature projected that CLBP would cause increasing YLD and costs in the coming decades, particularly in the middle- and high-income countries. Moreover, CLBP is increasingly seen in patients in their 20s to 40s mainly due to the economic development of society and changing working environments. Intensified research efforts and global and local initiatives are urgently needed to mitigate this increasing LBP burden and its impact on health and social systems. Hence, this study focused on females aged between 25 to 40 years.

On top of that, in the current global and local movement toward applying social distancing to limit the spread of COVID-19, we need to build online therapeutic programs that substitute the direct clinical attendance of patients while keeping the same or higher level of effectiveness.

To the researcher's knowledge, this is the first study conducted globally and locally to evaluate and compare the effectiveness of three online therapeutic exercise programs, particularly DBT, CSE and combined program DBT+CSE, on CLBP patients. Conducting such research would add a new body of knowledge on the effectiveness of non-pharmacological interventions, particularly exercise-based telerehabilitation, in treating CLBP and LFI patients to resolve the continued debate, gaps and limitations in managing this condition.

In addition to this, these online programs would provide flexible appointment times to reduce missed appointment rates and waiting times. This would allow patients to access the rehabilitation sessions despite circumstances limiting them from attending the clinic (e.g., unavailability

of transport, family responsibilities, infection with a transmissible virus, traveling, etc.), and also allow patients to self-manage.

In perspective, reducing the number of traditional in-clinic sessions appointments and lengthy waiting time queues and replacing the respiratory resistance devices with a readily available and disposable balloon is cost-effective and complies with the safety protocols required during this COVID-19 pandemic. This allows some therapies to maintain social distance while keeping therapist-patient communication and monitoring. Moreover, its importance in relation to health policy is in line with the health reform of the Kingdom of Bahrain 2030 vision.

Finally, this study might provide a solution for the limitations of CSE programs. These programs require moderate to high physical demand which might not be achievable by all CLBP patients. This inability might come from various reasons: pain severity, poor trunk stability, excessive body weight, lack of fitness, or fear of experiencing CSE. Therefore, it would be interesting and significant to investigate the possibility that low physically demanding exercises such as DBT could provide similar or better results than the CSE program.

## **1.7 Definition of Terms**

- Abdomen Draw in Maneuver (ADIM): exercise method was done by pulling the navel toward the spine (Park & Yu, 2013).
- Core muscles: muscles that stabilize and control the spine and pressure inside the trunk, which are the pelvic floor muscles, transverses abdominis, multifidus, internal and external obliques, rectus abdominis, erector spinae, and diaphragm (Willson et al., 2005).

- Core/trunk stability exercises (CSE): used to describe the muscular control required to maintain functional stability around the lumbar spine and prevent lower back pain (Davarian et al., 2012).
- Coronavirus disease 2019 (COVID-19): is an infectious disease caused by the SARS-CoV-2 distinguished in Wuhan, China since December 2019 (Li et al., 2020).
- Chronic Low back pain (CLBP): is defined as back pain lasting more than 12 weeks (Koes et al., 2010).
- Deep breathing training (DBT): Types of breathing exercises aimed to improve the respiratory muscles' function through deep inhalation and exhalation in diaphragmatic breathing patterns (Anderson & Bliven, 2017).
- Diaphragm muscle: is a dome-shaped muscle at the base of the lungs that plays an essential role in breathing (Kim & Lee, 2013).
- In-clinic exercise: is a traditional face-to-face delivery exercise method (Cramer et al., 2019).
- Lumbar Spinal Instability: an inability of the spine's stability system generally to maintain its orientation under physiological load without any initial or additional neurological deficit or major deformity (Panjabi et al., 1994).
- Lumbar functional/clinical instability (LFI): is an essential cause of LBP and can be associated with decrease in the capability of the active and neuromuscular spinal stability subsystems to maintain its equilibrium and posture under physiological load despite the absence of any radiological anomaly (Biely et al., 2006).
- Mechanical LBP: is the general term that refers to any back pain caused by abnormal strains and stresses on muscles of the spine (Will et al., 2018).
- Muscle endurance: the ability of the muscles to handle a particular resisted movement for a prolonged time (Bohannon et al., 2018).

- Treatment-based classification (TBC): is an approach to discuss the model of rehabilitation patient with LBP that can be used based on the patient's clinical presentation. TBC was firstly developed by Delitto et al. (1995), then updated by Fritz et al. (2007), and currently the last classifications updated by Alrwaily et al. (2016).
- Telerehabilitation: rehabilitation services are delivered via telecommunications networks and the Internet, allowing patients to interact with providers to receive therapy (Schmeler et al., 2009).

## **Chapter Two**

### **Literature review**

#### **2.1 Executive Summary**

LBP is a pervasive musculoskeletal disorder amongst the population and a major cause of disability. Around 90 to 95% of LBP are mechanical LBP. The Global Burden of Disease (GBD) 2019 reported an increased YLDs prevalence and incident cases of LBP globally.

CLBP has been considered one of the most prevalent musculoskeletal disorders among young adults and middle-aged groups in the Kingdom of Bahrain; in focus, it is more common in females than in males.

One important consideration when discussing LBP is spinal stability. LFI is associated with CLBP as one of its important causes. Therefore, various therapeutic exercises were proposed to enhance spinal stability, such as CSE and DBT. Nevertheless, combined DBT and CSE programs seems to be more effective.

Currently, the outbreak of COVID-19 has changed many aspects of people's lives and has pushed governments, and health authorities implemented some restrictions to prevent the spread of this virus.

Exercise-based telerehabilitation is one of the intervention methods that can be delivered in treating patients with chronic musculoskeletal disorders. Physiotherapists can provide this as an online therapeutic exercise program through one-to-one virtual sessions or video exercises.

Regarding outcome measures following patient improvement, Numeric Pain Rating Scale (NPRS), Oswestry Disability Index (ODI), and Prone Bridge Test (PBT) were reliable and valid in measuring the intensity of pain, functional disability, and core muscle endurance, respectively.

## 2.2 Prevalence of LBP

LBP is defined as pain and discomfort between the lower costal margin and above the inferior gluteal creases (Vlaeyen et al., 2018). Most guidelines proposed three different categories of LBP according to Dagenais et al. (2010): 1) Around 1% of LBP is non-mechanical LBP caused by anomalies or tumors, 2) Around 5% referred pain from internal organs, and 3) The remaining 90 to 95% are classified as mechanical/ non-specific LBP. Furthermore, mechanical LBP is categorized into three subtypes following the duration of LBP: 1) Acute LBP is defined as the LBP lasting for less than 6 weeks, 2) Subacute LBP as the LBP lasting between 6 and 12 weeks, and 3) CLBP as the LBP lasting for more than 12 weeks (Burton et al., 1995). Most patients with acute LBP recover spontaneously, but 20% of cases develop CLBP (Maher et al., 2017).

As part of the recent Global Burden of Disease (GBD), a study for Chen et al. (2022) established a systematic analysis of the global level and trends of prevalence, incidence, and YLDs for LBP from 1990 to 2019 among 204 countries. Results showed a substantially increased YLDs prevalence, and incident cases of LBP. The prevalence of LBP was greater in high-income countries than in low-income countries. Hartvigsen et al. in 2018 projected that LBP would cause increasing disability and costs in the coming decades, particularly in middle and high-income countries. Therefore, the importance of prevention to reduce this condition's future burden should be emphasized.

LBP is considered the most common musculoskeletal disorder that affects all populations at some point in their lifetime (Adekanmi et al., 2018; Hoy et al., 2014). According to Puolakka et al. (2008), patients in their 20s to 40s are increasingly experiencing CLBP, due to the economic development of society and the changing working environment.

Locally, in the Kingdom of Bahrain, CLBP is considered the most prevalent musculoskeletal disorder among young and middle-aged groups as a work-related disorder with a percentage of 45. This descriptive cross-sectional study was done by Tantawy in 2019 among 200 Ahlia University workers with different tasks in Manama, Bahrain. Participants aged 22 to 56 years, both males and females, were included. In focus, the prevalence of CLBP is more in females than in males reported by the same author in 2017, among 94 Ahlia University students aged between 18-26 years. According to Maki et al. (2021) females in Bahrain prioritized family needs over their own. Results suggest that such behavior is due to how they perceive gender roles. In the same way, Wáng et al. (2016) reported that physical stress of child-rearing, pregnancy, childbearing, and perimenopausal weight gain are considered contributing factors to a higher prevalence of CLBP among females.

Qareeballa et al. (2018) conducted a cross-sectional study to estimate CLBP prevalence among 215 female nurses working in the Salmaniya Medical Complex in Manama, Bahrain. Results showed that 92% of nurses under 30 years had the highest prevalence of LBP, followed by the 30-39 years age group. In relation ratio, the prevalence and incidence of CLBP in the Kingdom of Saudi Arabia was tracked in a systematic review study done by Aldera et al. (2020). The result showed that the prevalence of CLBP ranged between 64% to 89% among the working-aged group range between 20 and above 40 years old.

## **2.3 Lumbar functional instability (LFI)**

Clinicians and researchers have had some difficulty identifying specific structural faults in most cases of LBP that are associated with dysfunction, impairment, and pain (Abenhaim et al., 1995; Santolin, 2003).

Accordingly, researchers suggested that LBP patients are not homogeneous, but that they should be divided into subgroups with similar impairments, dysfunction, and clinical observations (Alrwaily et al., 2016a; Delitto et al., 1995). Lumbar Functional Instability (LFI) is one of the causes and subgroup of LBP (O'Sullivan, 2000).

Treatment-based classification (TBC) system for LBP, make treatment decisions according to the clinical presentation of the patient; therefore, management of LBP people would be more directed and cost-effective. TBC was firstly developed by Delitto et al. (1995), then updated by Fritz et al. (2007), and currently the latest classifications updated by Alrwaily et al. (2016), which have two levels of triage: the level of first-contact health care provider and level of the rehabilitation provider. At the first level of triage, the health care provider determines the management approach that can help candidates for the patients to either medical management, rehabilitation management, or self-care management based on red flags, serious pathological issues and physical and psychosocial risk factors status measured by Keele STarT Back Screening Tool according to Hill et al. (2008) classification scores.

STarT Back STarT Back Screening Tool is a 9-item questionnaire, each with a 0- or 1-point value, used to screen for physical and psychological risk factors for back pain disability. Accordingly, patients can be categorized into low, medium, or high risk of developing persistent LBP and activity limitations. The patient who scores 0-3 out of 9 indicates low risk (self-management strategies) and >3 on overall scores, but <4 on the psychosocial subscale is a medium risk (appropriate for physiotherapy management). However, those scoring 4 or 5 on the psychosocial subscale have a poor prognosis for persisting disabilities (suitable for management with psychologically informed interventions) (Appendix 3).

The second level of triage determines the suitable rehabilitation approach based on the level of pain, disability in daily activities, and perception of clinical presentation. A symptom modulation approach is described for patients with a recent-new or recurrent-LBP episode that has caused significant symptomatic features. A movement control approach is described for patients with moderate pain and disability status which are subgroups as LFI. Third, function optimization approach is described for patients with low pain and disability status (Table 2.1).

**Table 2.1** Triage Process and Matching Criteria for the Rehabilitation Provider (Alrwaily et al., 2016)

| Rehabilitation Approach         |                                  | Symptom Modulation             | Movement Control                         | Functional Optimization                           |
|---------------------------------|----------------------------------|--------------------------------|------------------------------------------|---------------------------------------------------|
| Triaging Variables <sup>b</sup> | Pain rating                      | High to moderate               | Moderate to low                          | Low to absent                                     |
|                                 | Disability rating <sup>c</sup>   | High                           | Medium                                   | Low                                               |
|                                 | Clinical status <sup>d</sup>     | Volatile: symptoms predominate | Stable: movement impairments predominate | Well-controlled: performance deficits predominate |
| Treatment Modifying Variables   | Psychosocial status <sup>e</sup> | +/-                            | +/-                                      | +/-                                               |
|                                 | Comorbidities <sup>f</sup>       | +/-                            | +/-                                      | +/-                                               |

Movement control impairment can fit to stabilization exercises in case of moderate to low pain measured by the pain screening tool as NPRS or Visual Analogue Scale (VAS). Medium disability can be measured by the ODI. A synonym used for motor control impairment is LFI and considered as a back problem behaving like lumbar spine instability (O'Sullivan, 2000).

Lumbar spine instability is one of the causes and a subgroup of LBP and it's highly prevalent (up to 57%) in patients with CLBP Spinal stability which is essential to bear loads, allow movement, and avoid injury and LBP (Reeves et al., 2007). According to Panjabi's neutral zone concept in 1992, the spine's stability system comprises three subsystems that are functionally interdependent and contribute to joint rotational stiffness, and thus joint stability: 1) passive subsystem, 2) active subsystem and 3) neuromuscular subsystem (Figure 2.1).

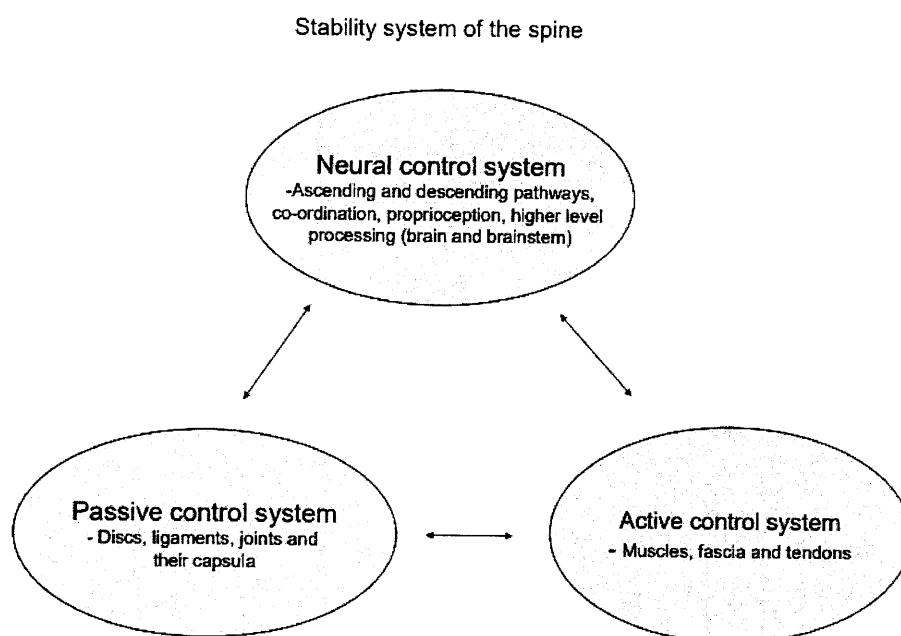


**Figure 2.1** The Spine stability system (Panjabi, 1992)

The passive spinal subsystem consists of vertebrae, intervertebral discs, ligaments, and joint capsules. However, the active subsystem comprises spine core muscles, tendons, and thoracolumbar fascia. According to an extensive literature review, the core muscles involved are multifidus, TrA internal and external oblique (IO and EO), erector spinae, quadratus lumborum, psoas, pelvic floor, and diaphragm muscles. The

neuromuscular subsystem is the neural control unit for activating and coordinating the spinal muscles to provide mechanical muscle stability.

Lumbar spinal instability is most commonly defined as an inability of the spine's stability system to maintain spine orientation under physiological load without any initial or additional neurological deficit or major deformity (Panjabi et al., 1994). Whenever one subsystem malfunctions, the stability of the entire spinal column may be compromised (Comerford & Mottram, 2001).

Lumbar spinal instability has been classified into 1) Lumbar segmental/radiographic instability (LSI), 2) Lumbar functional/clinical instability (LFI) (Demoulin et al., 2007).

LFI is defined as a decrease in the capability of the active and neuromuscular spinal stability subsystems to maintain their equilibrium and posture under physiological load that cause LBP despite the absence of any radiological anomaly (Biely et al., 2006; Panjabi et al., 1994). Panjabi in 2003 defined LFI as impaired trunk muscle activation and reduced proprioceptive acuity. LFI is a well-documented subgroup of LBP and caused 30-35% of patients' diagnosis with LBP (O'Sullivan, 2000). Consequently, several previous studies have reported poor core/trunk muscle strength and endurance in patients with CLBP and LFI (Davarian et al., 2012; Hides et al., 2010; Kong et al., 2016; Kumar, 2011).

Toward diagnosing LFI in LBP patients, there is limited relevance of static and dynamic radiographs. At the same time, several signs and tests of clinical instability have been identified in the literature but still remain controversial and have not undergone validation studies as much as the pathomechanical behaviour of lumbar spine instability, and so remain ambiguous and poorly defined. Therefore, the diagnostic 'gold standard' for instability has not yet been identified (Chatprem et al., 2021; Ferrari et al., 2015).

Hicks et al. (2003) conducted a study examining the interrater reliability of clinical examination procedures to distinguish patients with lumbar spine instability. Sixty-three participants presented with recurrent LBP and without radiculopathy were included in the study. The clinical examination included observation of trunk movements to detect painful arch during flexion, instability catch, Gower sign, and aberrant movement pattern. Two provocation tests were prone instability and posterior shear tests. The interclass correlation coefficient (ICC) was used to determine interrater reliability. Results showed prone instability test had higher reliability than the posterior shear test (ICC: 0.87). The prone instability test and aberrant movement were highly sensitive, with scores (of 72% and 78 %). Age of 40 years and less and average SLR >90 degrees were highly specific with ratings (83% and 92%).

Moreover, a Delphi study was established by Cook et al. (2006) to identify the specific subjective and objective identifiers of LFI in patients with CLBP. The study was done by 168 expert physiotherapists with at least fourteen years of experience in research and Orthopaedic Clinical Specialties or Fellows of the American Academy of Orthopaedic Manual Physiotherapy and who were classified into three workgroup members of Delphi rounds. The study's result identified 14 subjective identifiers/questionnaires, including (symptoms, and history) of LFI, shown in Table 2.2. This lumbar spine instability is found to be a screening tool and predictor of LFI. This screening tool was used in many studies in diagnosing the LFI (Araujo et al., 2017; Kumar, 2011; Leungbootnak et al., 2021; Puntumetakul et al., 2014). Furthermore, other studies have also been summarized by Biely et al. (2006) to identify a series of the most common subjective identifiers of LFI that vary in the number of common findings (Fritz et al., 2007; Hicks et al., 2005; Kumar, 2011; O'Sullivan, 2000; Paris, 1985), (Table 2.3). Accordingly, Chatprem et al. in 2020 and

2021 evaluated the validity and reliability of this questionnaires screening tool for LFI among CLBP patients score. At least 7 out of 14 had an optimized sensitivity of 100% (95% Confidence interval (CI): 100–100) and a specificity of 26.04% (95% CI: 17.84–34.24). The positive and negative predictive values were 16.47% (95% CI: 9.57–23.40) and 100% (95% CI: 100–100), respectively, and the positive likelihood ratio (LR+) and negative likelihood ratio (LR-) were 1.35 and 0.00, respectively. Interrater and interrater ICC were 0.92 (95% CI: 0.88-0.95) and 0.91 (95% CI:0.86-0.94), respectively. In another study test-retest reliability of the lumbar spine instability questionnaires was (ICC:0.84) (Saragiotto et al., 2018).

**Table 2.2** Lumbar spine instability questionnaires for patients with Chronic Low Back Pain (CLBP) (Chatprem et al., 2020)

| Items                                                                                                                              | Patient Responds |       |
|------------------------------------------------------------------------------------------------------------------------------------|------------------|-------|
|                                                                                                                                    | Yes              | Never |
| 1. You feel like your back has collapsed                                                                                           |                  |       |
| 2. You feel better with self-manipulation                                                                                          |                  |       |
| 3. Your back pain symptoms come and go all the time                                                                                |                  |       |
| 4. You have a history of stiff back or sudden back pain when twisting or bending down                                              |                  |       |
| 5. You have back pain when you change posture, for example, when standing up from sitting among others                             |                  |       |
| 6. You have increased back pain when stretching up from a bending posture                                                          |                  |       |
| 7. You have sudden back pain even with a minor movement                                                                            |                  |       |
| 8. Your back pain increases when sitting on a chair that lacks a backrest, and is alleviated when sitting on a chair with backrest |                  |       |
| 9. You have increased back pain when you are in one posture for a long time                                                        |                  |       |
| 10. Your back pain is becoming steadily worse                                                                                      |                  |       |
| 11. Your back pain is temporarily alleviated when you wear a back support                                                          |                  |       |
| 12. You frequently experience back muscle spasm                                                                                    |                  |       |
| 13. You are afraid, not wanting to move, when you have back pain                                                                   |                  |       |
| 14. You have a previous history of back pain                                                                                       |                  |       |
| <b>Total score</b>                                                                                                                 |                  |       |

**Table 2.3** Summary of Evidence Related to Symptoms, History, and Demographics (Subjective identifiers/aspect) of Patients with Lumbar Functional Instability (Biely et al., 2006)

| Symptoms, History, and Demographics                                                                     | Paris* | Cook et al** | O'Sullivan *** | Hicks et al+ | Fritz et al^ |
|---------------------------------------------------------------------------------------------------------|--------|--------------|----------------|--------------|--------------|
| Giving way or back giving out, feeling of instability                                                   | x      | x            | x              |              |              |
| Need to frequently crack or pop the back to reduced symptoms                                            | x      | x            |                |              |              |
| Frequent bouts or episodes of symptoms (recurrence, not first episode)                                  |        | x            | x              |              |              |
| History of painful catching or locking during trunk motions                                             | x      | x            | x              |              |              |
| Pain during transitional activities                                                                     | x      | x            | x              |              |              |
| Greater pain returning to erect position from flexion                                                   |        | x            | x              |              |              |
| Pain increased with sudden, trivial, or mild movements                                                  | x      | x            |                |              |              |
| Difficulty with unsupported sitting and better with supported backrest                                  |        | x            |                |              |              |
| Worse with sustained postures or a decreased likelihood of reported static position that is not painful | x      | x            | x              |              |              |
| Condition is progressively worsening                                                                    |        | x            |                |              |              |
| Long-term, chronic disorder                                                                             | x      | x            | x              | x            |              |
| Temporary relief with back brace or corset                                                              |        | x            |                |              |              |
| Frequent episodes of muscle spasm                                                                       |        | x            |                |              |              |
| Fear and decreased willingness to move, high FABQ score                                                 |        | x            |                | x            |              |
| Age less than 40 years old                                                                              |        |              |                | x            | x            |

## 2.4 Therapeutic exercises for CLBP and LFI

Recent clinical practice guidelines recommend the use of conservative non-pharmacological therapies as a first-line intervention for patients with CLBP (Kreiner et al., 2020; Qaseem et al., 2017). Therefore, therapeutic exercises with various intensities and forms are prescribed for patients with CLBP and LFI for spinal stability by improving the core muscles' strength, endurance, and/or motor control (Hall et al., 2021; Kofotolis & Kellis, 2006).

### 2.4.1 Core Stability Exercises-CSE

CSE have been considered one form of the therapeutic exercises widely used for many years for patients with CLBP and LFI (Dimer da Luz et al., 2019; Kavcic et al., 2004; Puntumetakul et al., 2013). CSE aim to enhance neuromuscular control by re-training all core/trunk muscles, including deep abdominal and back muscles that necessitate reducing stress

on the spine and improving dynamic stability (Frizziero et al., 2021; Narouei et al., 2020).

A meta-analysis study was done by Wang et al. (2012) aimed to compare the effectiveness between CSE and general exercises among patients with CLBP. From 1970 to 2011, published articles consisted of randomized control trial (RCT) studies comparing the types of exercises included in the study. The result showed that CSE was more effective in reducing LBP and improving functional status than general exercises. Simultaneously, the researcher recommended investigating core muscle endurance as an outcome to detect the improvement.

Moreover, França et al. (2012) supported the previous study where CSE is one of the practical exercises that reduced pain and functional disability and improved the thickness of trunk stabilizer core muscles mainly TrA and multifidus. However, it required long rehabilitation because of delayed activation of trunk stabilizer muscles.

In 2013, Aluko et al. investigated twelve weeks of selected CSE: Abdomen draw in maneuver (ADIM) in prone and sitting, alternated heel slides, curl up, pelvic tilt in four-point. They were all more effective than regular exercises that consisted of pelvic tilt in a hook lying and back stretching in trunk sagittal acceleration ( $P=0.02$ ). The study was limited to a small sample size of thirty-three participants, long rehabilitation period, and lack of subgroup LBP patients. The researcher agreed with previous studies' recommendation of the importance of investigating trunk performance changes over time.

However, Javadian et al. (2015) conducted RCT to examine the effect of eight weeks of selected CSE on pain, functional disability, and core muscle endurance of patients with LFI filling the gap of previous studies' limitations. Thirty patients with LFI aged 18 to 45 were randomly allocated to the experimental or control groups. Selected CSE consisted of

ADIM with bridging, kneeling, sitting, and standing beside using a Swiss ball. While heel slides, knee to chest, and stretching exercises were performed in the control group. Pain intensity was measured by VAS. Functional disability was measured by ODI, and core muscles endurance by side plank test. The study result showed significant changes in pain, functional disability, and endurance of trunk flexors in the experimental group more than in the control group ( $P < 0.001$ ). Swiss balls requirement can be limited to being practiced at home following the exercise-based telerehabilitation method due to unavailability with all participants.

Consequently, a RCT study supported the above studies done by Selkow et al. (2017), aimed to evaluate the effect of four weeks of ADIM, side plank, and bird dog exercise on activation of TrA among forty-two volunteer participants with and without LBP. Ultrasound was used to measure the thickness of TrA in hook lying position with and without ADIM. Results showed that both participants significantly improved TrA activation ( $P < 0.05$ ). While there were no significant differences in activation between participants with or without LBP. The researchers consider the importance of incorporating these four exercises in improving TrA activation. Thus, these exercises can be implemented through telerehabilitation and a home program that is easy to apply and does not require any equipment.

On the other hand, Smith et al. (2014) concluded the systematic review with a suggestion that CSE improve LBP symptoms but actually not better than other types of exercises in the long term. In addition, Gomes-Neto et al. (2017) and Wasser et al. (2017) found that limits in CSE training between CLBP patients can adversely affect performance outcomes and movement efficiency and may ultimately cause injury or pain. Physical fatigue may also arise due to the strenuous physical effort required while practicing these exercises. This adversity was also reported

in cases where the patient experienced severe pain, poor trunk stability, lack of fitness and balance, and other comorbidities, such as obesity and arthritis (Critchley et al., 2007; Koumantakis et al., 2005; Smith et al., 2014).

#### **2.4.2 Deep Breathing Training-DBT**

DBT has been considered one of the therapeutic exercise approaches/types used in rehabilitation patients with CLBP and LFI based on the role of the diaphragm as a primary muscle for respiration and trunk stabilizer which contribute to intra- abdominal pressure and the resistance of the pelvic floor (Kim & Lee, 2013).

Many studies showed a correlation between abnormal changes in respiratory muscles and CLBP. According to Kolar et al. (2012), abnormal diaphragm stabilization during movements can be a factor of spinal disorder in patients with CLBP as a result of a significant abnormal diaphragm deviation and position during breathing with upper and lower extremity movements in participants with CLBP ( $P<0.05$ ).

Hence, inspiration and expiration muscle training can improve spinal stability by activating the TrA, diaphragm, IO, and EO muscles (Ahmadnezhad et al., 2020; Cavaggioni et al., 2015; Ki et al., 2016; Strongoli et al., 2010).

In contrast with previous CSE studies, Ishida et al. (2012) conducted a cross-sectional study to compare the changes in the contraction of the TrA, IO, and EO between ADIM and breath held at the maximum expiration/exhalation. Ultrasound imaging was used to measure the thickness of TrA and IO. EMG was used to measure the activity of OE during ADIM and breath held at the level of maximum expiration. Ultrasound results showed a significant increase in TrA and IO thickness during maximum expiration compared to ADIM ( $P<0.001$ ). Moreover, OE

activity was significantly higher during maximum expiration in EMG ( $P < 0.001$ ) with a 30% maximum contraction. Hence, deep breathing training can be useful in increasing the co-activation of lateral abdominal muscles that can improve trunk stability.

Fernandes and Chougule (2017), in 2017, examined the effect of the 90-90 hemi-bridge position with a balloon blowing exercise on reduced LBP and functional disability among 29 males and females aged between 21 to 55 years suffering from CLBP for more than 12 weeks. This exercise was performed in a 90-90 wall bridge with a small ball between the knees. Patients were asked to take deep inhalation from the nose within 3 to 4 seconds, then blow out the air in the balloon within 5 to 8 seconds with ADIM at the same time and hold for 2 to 4 seconds at the end of maximum exhalation. The exercise was implemented over 3 days, and the results showed significant changes in functional disability by ODI ( $P < 0.0007$ ) and pain reduction by using VAS ( $P < 0.05$ ). Despite the importance of subgrouping patients with LBP as the LFI, limited studies follow this in DBT programs. In addition, the endurance of core muscles has not been measured in most studies.

Kim and Lee (2013) reached that deep abdominal muscle training by DBT effectively could reduce LBP intensity and improve lumbar stability. Training was conducted among twenty-two males and females with a mean age of 22 years. DBT method was used based on Richardson et al. (2004) modification; the subject was asked to take a deep inhalation and hold for 10 seconds in a hook lying position. The exercise implemented five sets of ten repetitions for four weeks, three times a week. The scores of lumbar stability were ( $41.18 \pm 1.32$ ) before the exercises and ( $44.09 \pm 3.08$ ) after four weeks, resulting in a significant improvement in lumbar stability ( $P < 0.05$ ). Study limited to regular follow up. Researchers recommended comparing this method with other useful methods in future studies.

However, Kang et al. (2018) conducted RCT to evaluate the effect of DBT in sitting and standing position on lumbar spine mobility and stability among patients with LFI, as a subgroup of LBP, to resolve previous studies' limitations. Thirty adults aged 20 to 40 years with lumbar instability were randomly allocated into DBT or CSE groups. In the DBT group, diaphragmatic breathing was applied in sitting and standing in three sets of 10 minutes, three times a week for 5 weeks. With the same repetitions period, spine stability was applied in CSE. The result showed significant improvement in spinal mobility in breathing exercises ( $P < 0.01$ ). Regarding spinal stability, there were significant differences in the sagittal plane in both groups ( $P < 0.01$ ).

Various types of DBT have been examined on patients with CLBP and showed significant changes in pain and disability. Limited studies examined these exercises in patients with LFI. Moreover, some DBT requirements respiratory resistance devices (POWER breath or Lung Expander device) are not logistically feasible to be provided to a large population. Besides this, no study examined the effect of online DBT in rehabilitating patients with CLBP and LFI by using an available respiratory resistance tool for everyone.

### **2.4.3 Combined Deep Breathing Training with Core Stability**

#### **Exercises- DBT+CSE**

Both CSE and DBT effectively reduced pain and improved functional status and core muscle endurance in patients with LBP and lumbar spine instability (Akhtar et al., 2017; Javadian et al., 2015; Kang et al., 2018; Kim & Lee, 2013). Nevertheless, recent studies proved that combining both interventions in one program yields better clinical outcomes.

Yoon and Kim (2014) reported an effectiveness of breath held at the maximum expiration/exhalation during ADIM in improving abdominal muscle activation. Thereby, Park and Lee (2019) conducted an RCT to examine the effectiveness of the progressive stabilization program carried out with breath held at maximum expiration in pain, functional disability, static balance, and pulmonary function test of the patient with LBP due to lumbar instability. Randomly, participants were allocated into the experimental or control group. Both groups performed CSE which consisted of Curl up, Dead Bug, Superman, Bird Dog, and Side Plank with knee flexion, while resisted respiration was performed along with each CSE using a resistance device in the experimental group. Results showed significant pain, functional disability, and balance changes in the experimental group ( $P < 0.05$ ). The study was limited to measuring changes in the endurance of trunk stabilizer muscles before and after the treatments which is essential for conditions with LFI to identify the percentage of improvements. Moreover, the authors noticed some difficulties in using respiratory resistance devices and performing accurate movements simultaneously. For this reason, modifying the combination of the CSE with respiration exercises was recommended.

Hence, Sini and Mohanraj in (2019) compared the effectiveness of combining the 90-90 hemi-bridge position with a balloon blowing exercise with CSE versus CSE alone on pain and functional disability in LBP patients, thirty patients aged 20-35 years with CLBP. The result showed statically significant differences between the groups ( $P < 0.05$ ). This study concluded that integrating blowing with CSE is more effective than CSE alone.

All the above exercise programs (CSE, DBT, and combined CSE and DBT) have been delivered through traditional face-to-face exercises, known as in-clinic exercises. Adding DBT with the CSE program was

evaluated in limited studies on patients with CLBP and LFI. Most of the studies showed significant back pain intensity and functional disability changes. In contrast, the same for an online program has not been examined yet. In addition, debate continues about the best program for managing patients with CLBP and LFI.

## **2.5 Exercise-based Telerehabilitation Method (online programs)**

Physiotherapy is commonly considered a hands-on profession. In the current COVID-19 pandemic, most countries, including the Kingdom of Bahrain, have implemented some restrictions to prevent the spread of this virus. Thus, physiotherapists are trying to incorporate innovative technologies to advance patient therapy and reduce the number of traditional in-clinic exercise sessions (Martínez de la Cal et al., 2021). These exercises have been delivered through exercise-based telerehabilitation (Seron et al., 2021).

Physiotherapists can provide this as an online therapeutic exercise program through one-to-one virtual sessions or video exercises that can be performed on a smartphone alone at home using an app platform extension, etc. (Cottrell et al., 2017; Grona et al., 2018; Turolla et al., 2020).

Online therapeutic exercises offer several advantages for the patient, therapist, and society. They allow patients to perform the exercises in various comfortable locations and have equal access to rehabilitation services despite their impairments and circumstances. In addition, it decreases missed appointment rates and waiting time and is more cost-effective than in-clinic rehabilitation. Moreover, this prevents the spread of infected diseases during the COVID-19 pandemic or other infectious

diseases and viruses (Covert et al., 2018; Kairy et al., 2009; Lee & Billings, 2016).

Many applications and systems offer telerehabilitation physiotherapy that works as a virtual clinic providing an online exercise program. Physitrack has been used extensively in recent clinical studies conducted in Australia, Europe, and the United States (Barton et al., 2019; Johnson et al., 2018). More than 50 leading universities worldwide utilized this application. Physitrack is used by 100,000+ healthcare professionals and physiotherapists in 102 countries. In addition, this application can offer multimedia capabilities such as (videoconference, share screen, and texting during the conference) and recording and using measurement tools for evaluation such as (a virtual goniometer to measure the joint angle). In addition to collaboration between patients and practitioners, the participant can upload exercises on schedule templates.

van Egmond et al. (2020) investigated the effect of 12 weeks of physiotherapy telerehabilitation programs through (Physitrack) system in rehabilitating patients post esophageal cancer surgery. The results of the study show good results in a shorter length of hospital stay.

Regarding the management of CLBP, limited studies investigated the effects of online therapeutic exercises in rehabilitating this condition. In turkey, Özden et al. (2022) investigated the efficacy of 8-week video exercise-based telerehabilitation compared to paper-based exercises among 50 male and female patients with CLBP. Results showed that pain, functional status, quality of life, satisfaction, and motivation reported more significant gains in telerehabilitation than in the other group ( $P < 0.05$ ).

RCT done by Dadarkhah et al. (2021) in Iran to compare the effect of three months of remoted CSE home exercise with CSE in-clinic among 56 male and female patients with CLBP. Results showed no significant

differences between the two approaches in pain and functional disability, with P-values of 0.93 and 0.74, respectively.

## **2.6 Conclusion**

Overall, previous studies showed that the CSE, DBT, and combination of both therapeutic exercises positively reduced pain and functional disability. Worthy of note measurements of the core muscle endurance was missed in most studies. In addition to this, other methodological errors were noted such as lack of randomization, small sample size, lack of subgrouping of patients with LBP, and limited comparisons between two types of exercises only. Furthermore, no study has examined and/or compared the effectiveness of practicing the CSE, DBT, and CSE+DBT as an online program on female patients with CLBP and LFI.

Therefore, CSE and DBT Exercises will be utilized to build three online rehabilitation Programs (CSE, DBT, and DBT+CSE); in addition to this, replace the respiratory resistance device with a balloon that is readily available and disposable. Consequently, there is a need to compare the effectiveness of delivering these three online programs on pain intensity, functional disability, and core muscle endurance among adult females with CLBP and LFI to resolve the continued debate, gaps, and limitations mentioned above in managing this condition.

## **Chapter Three**

### **Methods and Procedures**

#### **3.1 Study Design and Setting**

This study was a quasi- experimental study design. This study was approved by the Scientific Research and Ethics committee at the University of Bahrain (UOB) No:9/2020-21 dt. Feb 23,2021 (Appendix 1). Accordingly, the study was carried out through the telerehabilitation method (online therapeutic exercises) among volunteer participants recruited from all of Bahrain through social media networking (WhatsApp and Instagram) between March 15 and July 30, 2021.

#### **3.2 Sample Size Calculation**

The sample size was calculated using the G\*Power program version 3.1.9.2 (Heinrich-Heine-University Dusseldorf, Germany). A priori power analysis of variance (ANOVA), repeated measures, within-between interaction, an alpha level of 0.05, power ( $1-\beta$ ) of 80%, with four groups and three measurements, non-sphericity correction ( $\epsilon$ ) of 1, and moderate effect size ( $f$ ) of 0.4 was used as in previous studies (Otadi et al., 2021; Park & Lee, 2019). The required sample size was estimated at 80 participants, 20 participants per group.

### 3.3 Participants

A convenience sampling method has been used in the current study to recruit volunteer females aged between 25 and 40 years old with a history of LBP for more than 12 weeks (CLBP). Moreover, suffering from LFI symptoms for more than 12 weeks was identified according to lumbar spine instability questionnaires score  $\geq 7/14$  (Cook et al., 2006). Participants were suitable for stability exercises if they had (mild to moderate intensity of LBP ranging between 3 to 7 on the NPRS, moderate disability in daily activities between 18% to 40% on ODI, and low to the medium psychosocial risk of poor outcome  $\leq 3$  on STarT Back Screening Tool) (Alrwaily et al., 2016). In addition, they had low core muscle endurance scores between 15 to 60 seconds on PBT (Strand et al., 2014).

However, participants were excluded from the study if any of the following exclusion criteria were met: 1) a history of spine surgeries, previous spine fractures and inflammatory spine disease (Park & Lee, 2019); 2) present with neurological radiculopathy pain as sciatica; 3) had neurological problems such as multiple sclerosis, stroke, or others; 4) cardiac and respiratory problems; 5) pregnant or less than six months postpartum (Mogren, 2008); 6) smoker, and BMI>35 (Alhowimel et al., 2021); 7) present with medical issues that might interfere with the study, such as hypertension and diabetes mellitus or with a psychiatric disorder that might affect the outcomes; 8) participant under analgesic medicine or other medicine that effects the muscles or the joints; 9) under any other treatment during the training period (Noormohammadpour et al., 2018); and 10) not able to understand the program or to use technology.

### 3.4 Study Procedure

This study followed Bennell et al. (2015) participants' enrolment phases and has been done by the researcher alone (Figure 4.1). First, participants were asked to fill in an online participation form after reading and agreeing on the study procedure through Google form to verify the participants' eligibility (Appendix 2). The online participation form included 14 lumbar spine instability questionnaires, including (symptoms, history, and demographics), adapted from Cook et al. (2006) Delphi study. The English version of the lumbar spine instability questionnaires was validated and found to be highly reliable (ICC =0.84) for LFI screening (Saragiotto et al., 2018). An Arabic version of the tool, which has not been yet validated, was used in the current study. Moreover, the participant's health status, and psychosocial risk factors were screened by the STarT Back Screening Tool as of the first recommendation of clinical practice guidelines from the American College of Physicians and the American Pain Society in diagnosis and treatment LBP; also, it's the initial step of the TBC system in subgrouping patients with LBP to identify patients at risk for poor clinical outcomes (Alrwaily et al., 2016a; Chou et al., 2007) (Appendix 3).

Eligible participants were then called to confirm their participation eligibility (Appendix 4). In addition to that, the intervention procedure was explained to the participants sufficiently. Simultaneously, eligible participants were asked to read the informed consent carefully and confirm their participation agreement (Appendix 5).

Second, the eligible participants were asked to download the PhysiApp application (free downloadable application) used as a baseline to evaluate, communicate, conduct virtual sessions and follow ups (Figure 3.1).

At the same time, baseline assessments were sent through Google form, including two parameters to measure the intensity of LBP and functional disability to confirm participant eligibility according to the TBC system in management patients suitable for stability programs. Moreover, core muscle endurance was measured by video call through (Physitrack) that works as a virtual health care system. Physitrack is a clinically validated telehealth website/application connected with PhysiApp. This application has been used extensively in recent clinical studies conducted in Australia, Europe, and the United States (Barton et al., 2019; Johnson et al., 2018; van Egmond et al., 2020) (Figure 3.2).

Finally, the first batch of eligible participants who registered earlier were allocated into one of the three online therapeutic exercise program groups according to their participation sequence order through a simple sampling technique 1:1:1, (Figure 3.3). For example, participants No.1 (P1) were in the online DBT group (Group A), P2 in the online CSE group (Group B), and P3 in a combination of both online programs DBT+CSE group (Group A+B), etc. The remaining eligible participants were registered, but first allocated to the wait-list control group for four weeks. The same allocation, inclusion and exclusion criteria were done after four weeks; another batch of eligible participants who registered earlier, including the control group participants, were allocated into therapeutic groups 1:1:1 ratio, and the remaining were assigned of the control group at first. This procedure was done until the target of 80 participants was reached.



Figure 3.1 PhysiApp application for participants

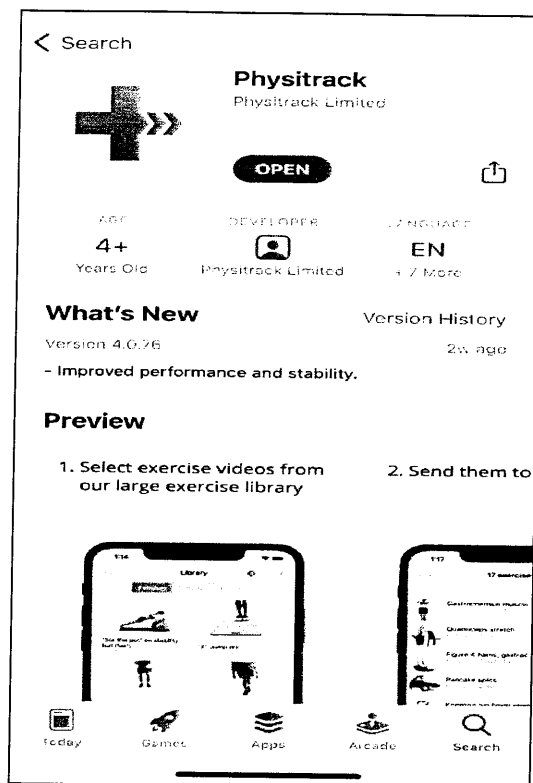


Figure 3.2 Physitrack application for the researcher

| B                             | C                          | D                         |
|-------------------------------|----------------------------|---------------------------|
| participant study number      | participant contact number | participant group (A,B,C) |
| 1                             |                            | A                         |
| 2                             |                            | B                         |
| 3                             |                            | A+B                       |
| 4                             |                            | A                         |
| 5                             |                            | B                         |
| 6                             |                            | A+B                       |
| 7                             |                            | A                         |
| 8                             |                            | B                         |
| 9                             |                            | A+B                       |
| 10                            |                            | A                         |
| 11                            |                            | B                         |
| 12                            |                            | A+B                       |
| 13                            |                            | A                         |
| 14                            |                            | B                         |
| 15                            |                            | A+B                       |
| 16                            |                            | A                         |
| 17                            |                            | B                         |
| Wait-list control group first | → 18                       | A+B                       |
|                               | → 19                       | A                         |
|                               | → 20                       | B                         |
|                               | → 21                       | A                         |

Figure 3.3 Simple sampling technique 1:1:1

### **3.5 Variables**

Independent variables of the current study were types of online therapeutic exercise programs. Dependent variables were the intensity of LBP, functional disability in activities of daily living, and endurance of core muscles. Besides this, the confounding variables which have not been controlled were the following: 1) participant daily activities; 2) type of work (office sitters need to sit for a long time; other jobs require standing); 3) nutrition, emotional and hormonal changes (menstrual cycle); 4) the number of previous deliveries and if it's normal or cesarean; and 5) current participant fitness level.

### **3.6 Intervention**

All the online therapeutic programs were implemented for four weeks, three sessions per week, for a total of twelve (12) sessions (Figure 3.4).

The 12 sessions were distributed as follows: 6 sessions under supervision were conducted under the researcher's supervision (one-to-one virtual supervised sessions) and 6 sessions alone by the participant. For the one-to-one virtual supervised sessions, 4 sessions we conducted at the beginning of each week to explain the exercises clearly. The other one-on-one virtual supervised sessions were conducted at the end of week two and week four to confirm the explanation of the exercises and to re-evaluate participants (Figure 3.5).

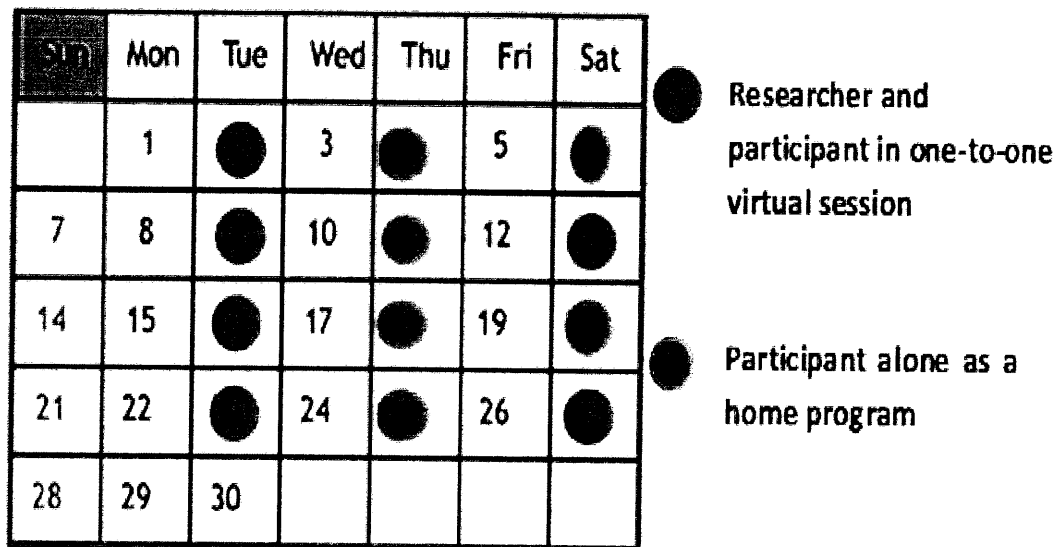


**Figure 3.4** Example of online therapeutic exercise program twelve sessions distribution



**Figure 3.5** The exercises video explained to the participant in the researcher and participant one-to-one session

The remaining 6 sessions from the total were performed by the participants alone, as a home program, following the instructional exercise videos found in the participant profile in the application of the same exercises practiced under the researcher's supervision (Figure 3.6). Once the participants completed the exercises, they were asked to press the complete button (Figure 3.7). This response is displayed in the researcher's database system (Figure 3.8). All the exercises in all groups were done in three sets of 5 repetitions with a one-minute break in between ( Park & Lee, 2019). Two to three repetitions of all the exercises were done as an orientation to ensure that the exercises were properly executed before initiating the actual record. Finally, each participant was given a progress report at the end of the program as motivation to continue the same exercises that had been practiced in this study alone at home (Appendix 12).

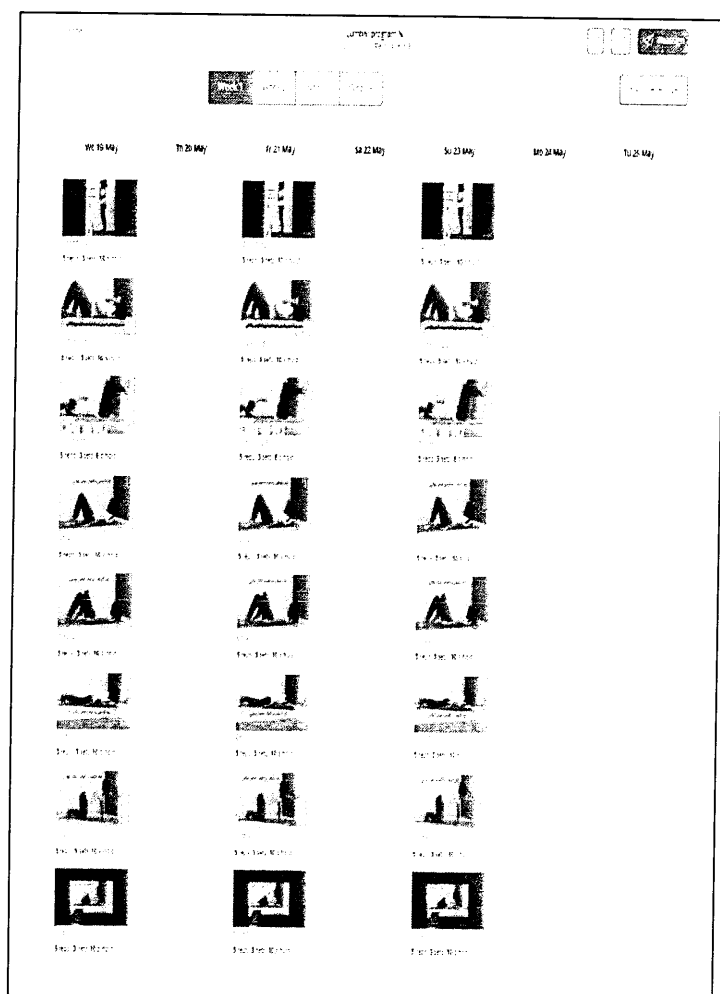


**Figure 3.6**

**Figure 3.6** An example of a participant's therapeutic program schedule on the application

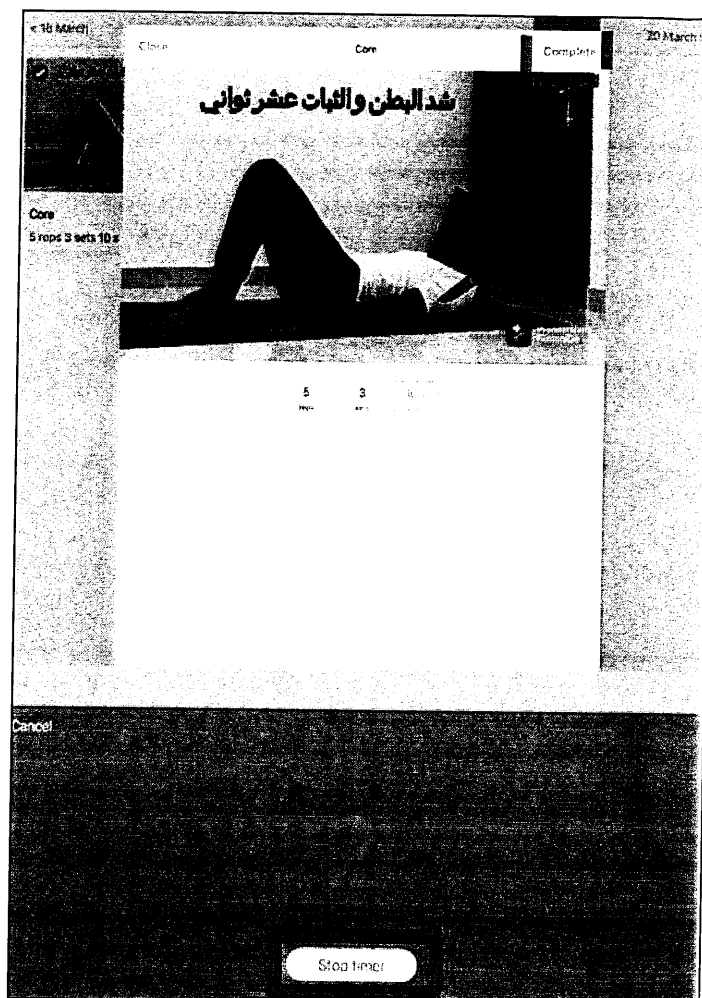


**Figure 3.7**

**Figure 3.7** A complete button was pressed once the participant completed the exercises. Timer for holding time has also been provided

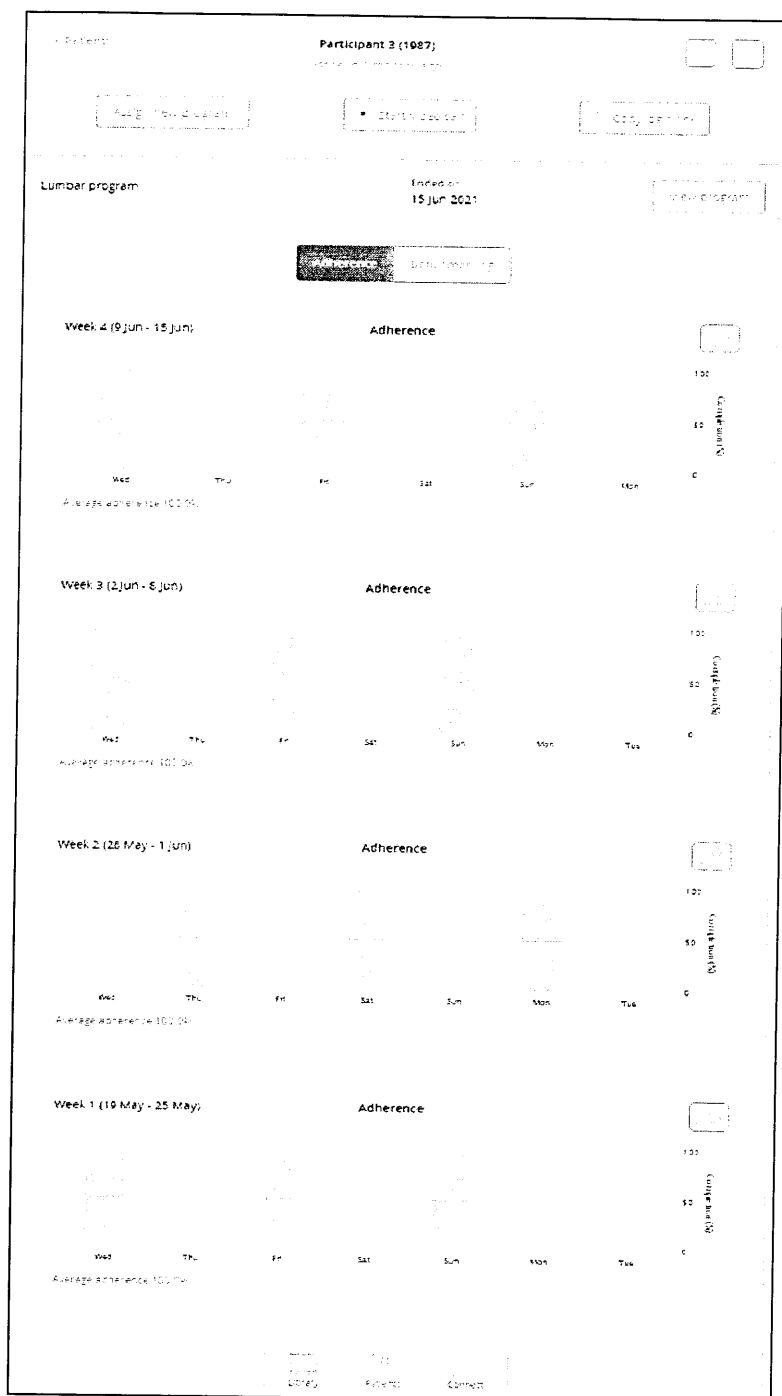


**Figure 3.8** Full four weeks participants' report in detail- completed and missed exercises displayed in the researcher application system

### **3.6.1 Online therapeutic exercise program groups**

#### **Group A: Deep breathing training (Online DBT program)**

This group's three breathing exercises/training procedures were done according to Boyle et al. (2010) and Kim and Lee (2013). In the first session, the participant was given sufficient training to practice diaphragmatic breathing techniques, followed by using the balloon as respiratory resistance. Moreover, two to three repetitions of all the exercises were done in the first session as an orientation to ensure that the exercises were properly executed before initiating the actual record. All the three DBT exercises were done in three sets of five repetitions with a one-minute break in between.

The participant was then instructed to be in a hook-lying position in the first exercise by touching the stomach with one hand and holding the balloon in the other. Next, they were asked to take a deep inhalation through the nose with stomach expansion and stable upper chest at the same time and hold in this position for ten seconds. The air blew out in the balloon with ADIM and the stomach was held in for ten seconds. This cycle was repeated; during inhalation, the participant was then instructed to keep her tongue in the roof of the mouth and avoid pinching the balloon to prevent the air from flowing out of the balloon (Figure 3.9). The same procedure was done in a standing position after one-minute rest and considered the second exercise (Figure 3.10).

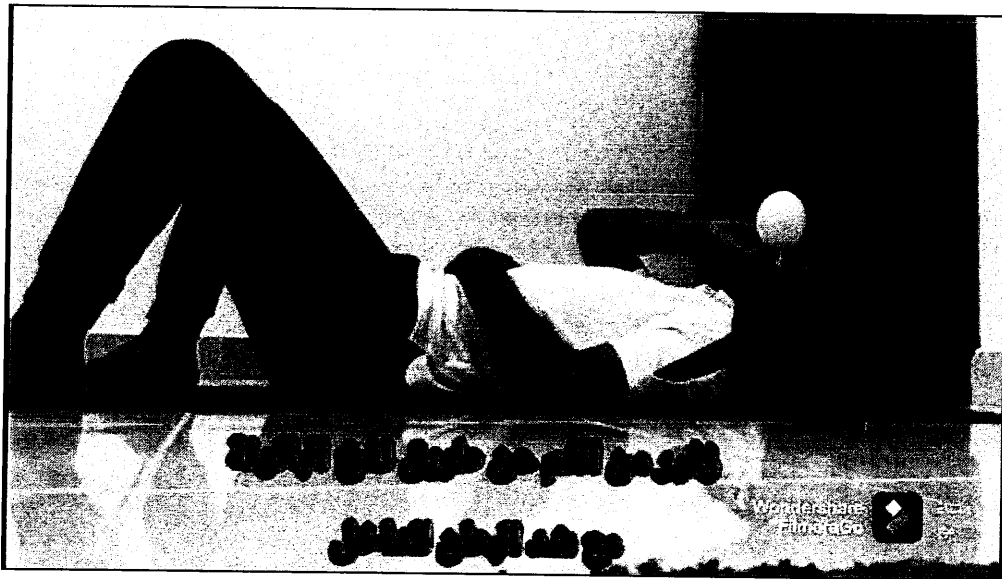


**Figure 3.9** Breathing exercises with a balloon in a hook lying position

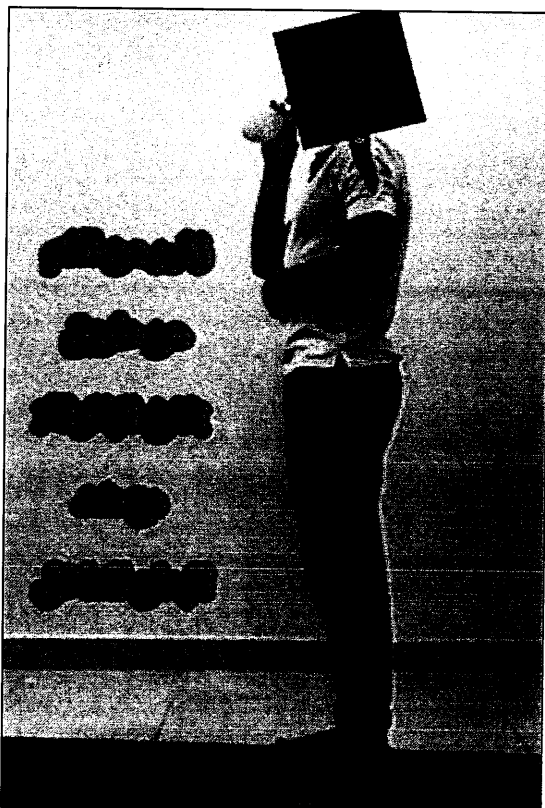


**Figure 3.10** Breathing exercises with a balloon in standing position

After one minute of rest, a 90-90 hemi-bridge position with a balloon blowing exercise was done. The participant was asked to raise both legs on the wall with flexed knees at a 90-degree position. A small ball or towel (4 to 6-inches) is placed between the knees with a small balloon on the left hand, while the right is placed above the head (Figure 3.11). Next, the participant was asked to take a hemi-bridge position with the tailbone raised slightly off the mat while the back remained flat. In the proper exercise position, the participant was asked to take deep inhalations from the nose for three to four seconds in duration (about 75% of maximum). Then the participant was asked to blow out the air in the balloon within five to eight seconds with ADIM and hold for two to four seconds at the end of maximum exhalation. As mentioned before, the neck and upper chest should be stable without movement, and the tongue should rest on the roof of the mouth, preventing the air from flowing out of the balloon without pinching the balloon during the next inhalation.

All exercises were implemented three times a week for four weeks with a 20-minute session duration in the first session and 15 minutes for the following sessions.

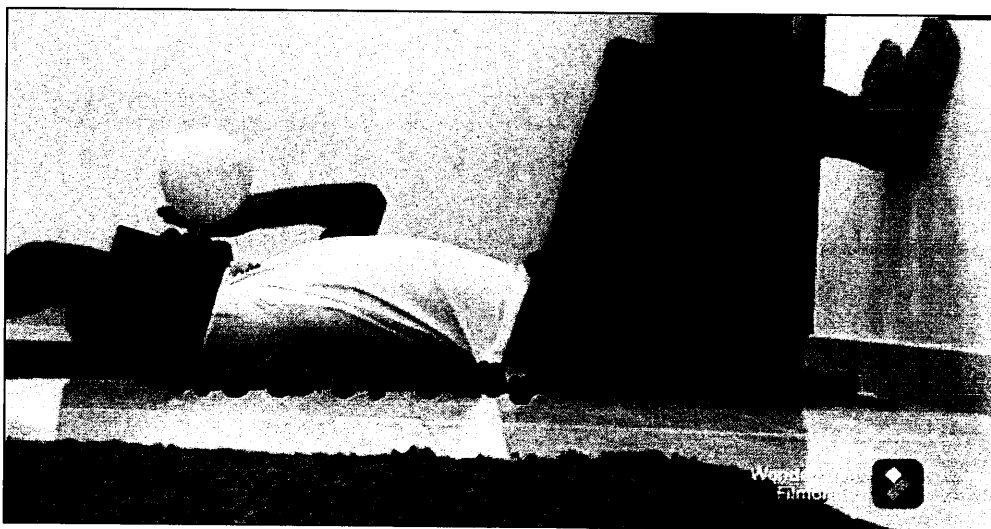


**Figure 3.11** 90-90 hemi-bridge with balloon blowing exercise

## **Group B: Core stability exercises (Online CSE program)**

The CSE program applied in this therapeutic group followed a program investigated by Park and Lee (2019) (Figure 3.12).

This program consists of four progressive weekly levels of core stability exercises: Partial Curl up, Dead bug, Superman, Bird dog, and Modified Side plank with knee flexion. Each exercise was done in 10-second holds with ADIM, three sets of five repetitions, and one-minute rest between each set. Furthermore, two to three repetitions were done in all the exercises in the first session to ensure that the exercises were properly executed before initiating the actual record. This program was implemented three times a week for four weeks with a 50-minute duration in the first session, and around 40 minutes for the following sessions. The participant progressed to the next level if she successfully performed the exercises by holding the body in a proper position for 10-seconds (80%, 4 out of 5 total exercises). If this was not achieved, the participant would stay at the same exercise level.

|                     | Start          | 1 <sup>st</sup> week       | 2 <sup>nd</sup> week       | 3 <sup>rd</sup> week       | 4 <sup>th</sup> week       |
|---------------------|----------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Curl up             | التمرين الأول  | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني |
| Dead Bug            | التمرين الثاني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني |
| Superman            | التمرين الثالث | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني |
| Bird Dog            | التمرين الرابع | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني |
| Modified Side Plank | التمرين الخامس | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني | شد البطن والكتاف عشر ثواني |

Figure 3.12 Online core stability program (online CSE program)

### **Group A+B: Combined program (Online DBT+ CSE)**

In this group, participants performed online DBT exercises followed by online CSE exercises (Figure 3.13). This order was conducted for all participants. Two to three repetitions were done in all the exercises in the first session to ensure that the exercises were properly executed before initiating the actual record. All the exercises were done in three sets of five repetitions, and one-minute rest between each set. This program was implemented three times a week for four weeks with a 65-minute duration in the first session and 55 minutes for the following sessions.

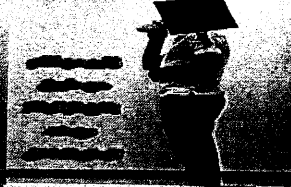
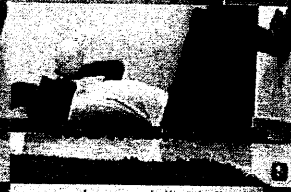
|                                |                            | 1 <sup>st</sup> week                                                                | 2 <sup>nd</sup> week                                                                | 3 <sup>rd</sup> week                                                                 | 4 <sup>th</sup> week                                                                  |
|--------------------------------|----------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Deep Breathing Training (DBT)  | Hook lying position        |    |    |    |    |
|                                | Standing position          |    |    |    |    |
|                                | 90-90 hemi-bridge position |    |    |    |    |
| Core Stability exercises (CSE) | Cur'l up                   |   |   |   |   |
|                                | Dead Bug                   |  |  |  |  |
|                                | Superman                   |  |  |  |  |
|                                | Bird Dog                   |  |  |  |  |
|                                | Modified Side Plank        |  |  |  |  |

Figure 3.13 Online combined program (online DBT+ CSE)

### **3.6.2 Control group**

#### **Group C: Wait-list control group**

Participants in this group were on the waiting list to receive the intervention (one of the three online therapeutic programs for four weeks). Participants in this group practiced the exercises after the active therapeutic exercise groups finished their four-week program (Figure 3.14). Nevertheless, the participants were instructed not to join any treatment in this waiting period. The wait-list group has been stated by Gallin and Ognibene (2012), and has also been followed in previous RCT studies (Peterson et al., 2011; Yu et al., 2014).

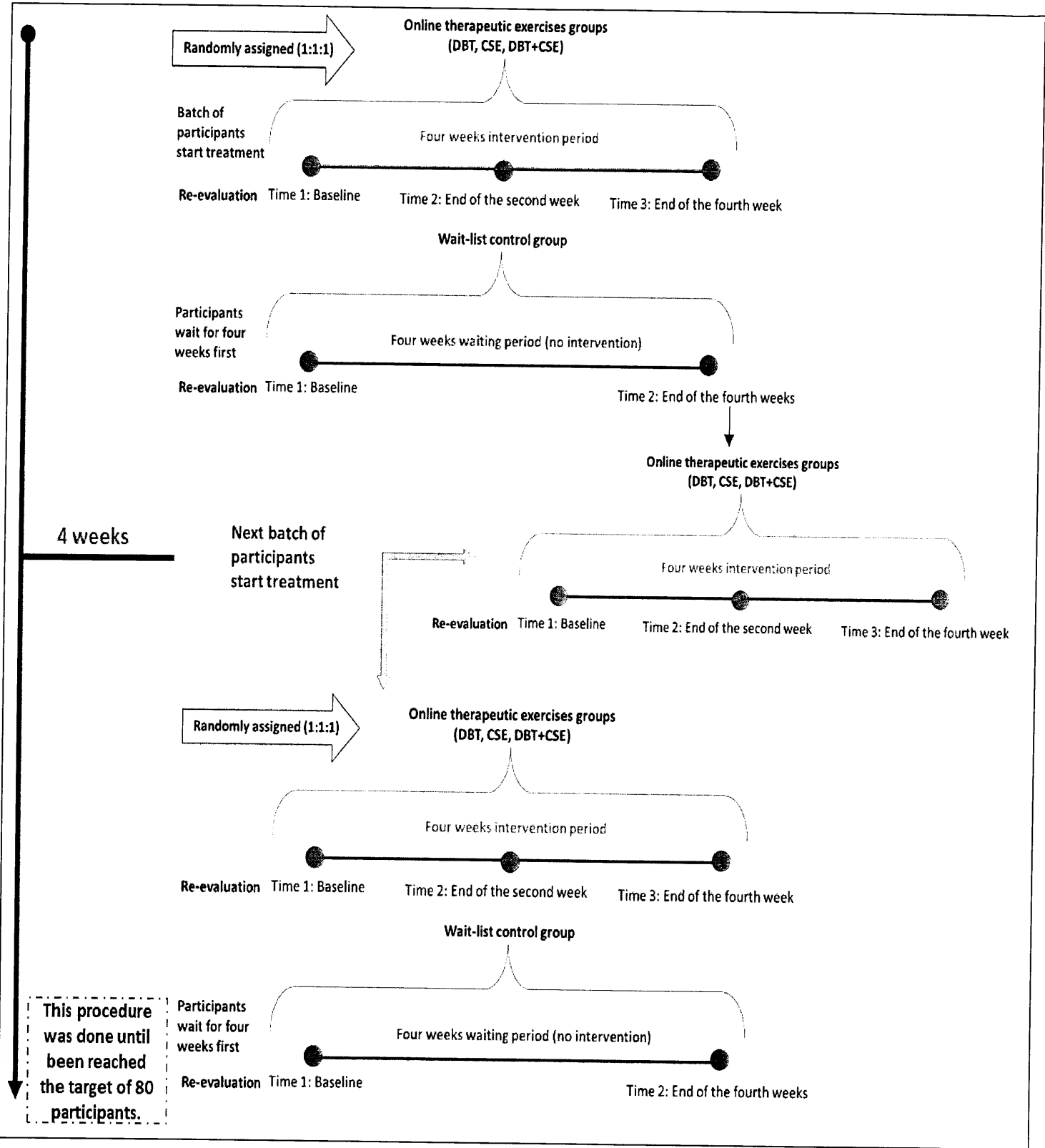


Figure 3.14 Wait-list control group

## **Potential risk**

All the participants have been informed that they might experience mild dizziness during the exercises and muscle soreness and fatigue for a couple of days by participating in the study. In case of severe back pain, muscle soreness, chest pains, or breathing difficulties, the participant was advised to contact the researcher immediately.

In response, only three participants had muscle soreness and were instructed to apply a hot pack and perform some stretching exercises to relieve the symptoms.

## **3.7 Outcome Measures**

Three outcome measures have been used in the current study and have been measured by the researcher. Numeric Pain Rating Scale (NPRS), Oswestry Disability Index (ODI), and Prone Bridge Test (PBT) were used to measure the intensity of back pain, functional disability, and core muscle endurance, respectively. All measurements were collected at three-time periods: in the baseline, at the end of the second week (Two-week intervention period), and end of the fourth week of intervention (Four-week intervention period) in all online therapeutic groups. However, in the control group, all measurements were gathered only at two-time periods; in the baseline and end of the fourth week of awaiting to compare changes in all measurements with the three online therapeutic programs, and changes at the end of four-week program period; to investigate the effectiveness of exercises to determine intervention. .

## **NPRS**

NPRS of 11-points has been used to measure the participant's intensity of LBP as a self-reported measurement. It is an 11-point numeric scale that ranges from 0 to 10 points; 0 indicates "no pain", and 10, indicates the maximum intensity of the pain felt as worst imaginable pain. The versions used for the current study were done in both English (Appendix 7) and Arabic versions (Appendix 9) through a Google form.

It has an excellent reliability [ICC: 0.991] and good to excellent concurrent validity [ICC: 0.86 to 0.95] (Childs et al., 2005; Yao et al., 2020).

Interpretability of the NPRS is high because each number means the intensity of the pain: no pain [ $<1$ ], mild pain [1-3], moderate pain [4-6], and severe pain [7– 10] (Boonstra et al., 2016).

## **ODI**

ODI is a self-reported 10-item questionnaire that takes a maximum of 5 minutes to fill up. ODI was used to evaluate the level of disability in daily living activities caused by LBP (Appendix 8). The Arabic version of the ODI has excellent intra-observer reliability [ICC:0.99] and good construct validity (Algarni et al., 2014) (Appendix 10). ODI is considered the gold standard for measuring low back functional disability with a sensitivity of 76% and specificity of 63% (Johnsen et al., 2013).

ODI is interpretable because qualitative information can be quantified. It consists of 10 sections that could be scored from 0 to 5. Zero means no pain at the moment, while 5 means the worst debilitating pain. According to the total score, the participants can be divided into

subcategories which consider 0% to 20% lowest score where the patient has a minimal disability, and 81% to 100% highest score of disability where the patient is bed-bound (Fairbank & Pynsent, 2000) (Table 3.1). The current study's score calculations have been done through this website, [www.orthotoolkit.com](http://www.orthotoolkit.com) (Appendix 11).

**Table 3.1** Subcategories criteria of Oswestry Disability Index (ODI) (Fairbank & Pynsent, 2000)

|                                       |                                                                                                                                                                                                                                                                                                       |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0% to 20%: minimal disability:</b> | The patient can cope with most living activities. Usually no treatment is indicated apart from advice on lifting sitting and exercise.                                                                                                                                                                |
| <b>21%-40%: moderate disability:</b>  | The patient experiences more pain and difficulty with sitting, lifting and standing. Travel and social life are more difficult and they may be disabled from work. Personal care, sexual activity and sleeping are not grossly affected and the patient can usually be managed by conservative means. |
| <b>41%-60%: severe disability:</b>    | Pain remains the main problem in this group but activities of daily living are affected. These patients require a detailed investigation.                                                                                                                                                             |
| <b>61%-80%: crippled:</b>             | Back pain impinges on all aspects of the patient's life. Positive intervention is required.                                                                                                                                                                                                           |
| <b>81%-100%:</b>                      | These patients are either bed-bound or exaggerating their symptoms.                                                                                                                                                                                                                                   |

## PBT

PBT was used to measure the core/trunk muscle endurance. According to Durall et al. (2012), PBT has good to excellent intraclass reliability [ICC: 0.87 to 0.99]. Good convergent validity and sensitivity correlated with survey responses, anthropometrics, and prone bridge time; the test can detect changes in abdominal endurance of young adults ( $p=0.003$ ) (Bohannon et al., 2018). Moreover, the assessment of PBT was done in this study through the telerehabilitation method (Physitrack) system. This system provided the researcher with virtual goniometer lines to detect the hip and trunk alignment in a plank position during a video call (Figure 3.15).

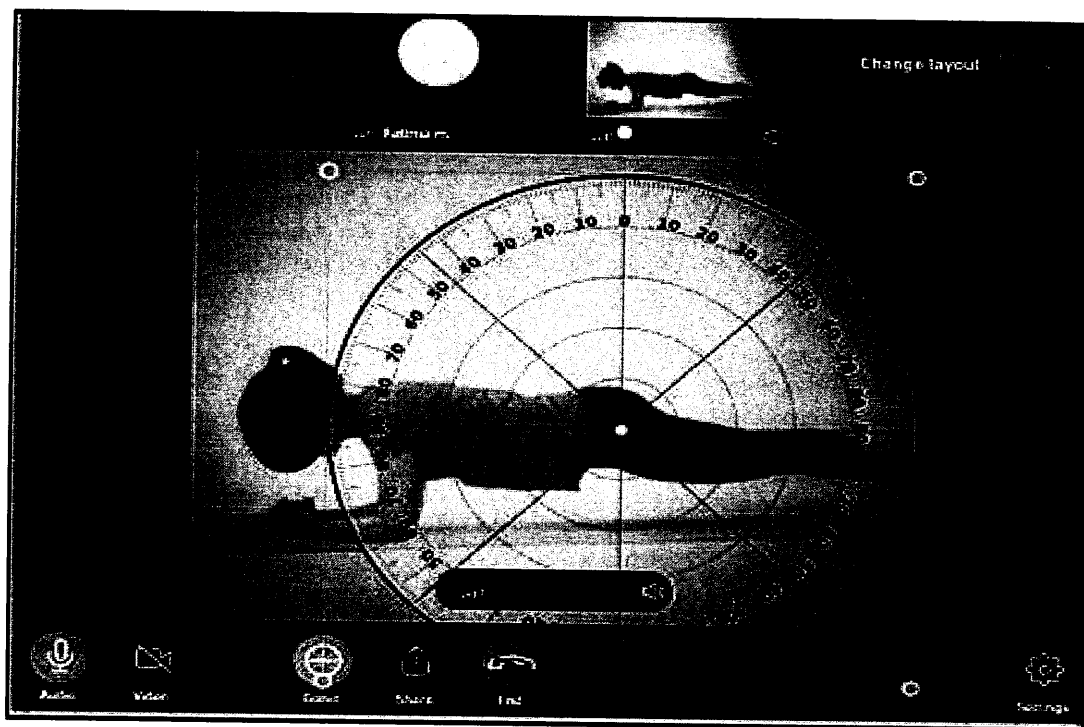


**Figure 3.15** Prone Bridge Test (PBT) on one-to-one virtual session

The BPT test is interpretable because participants' holding time in the test can be compared to the average time according to Schellenberg et al. (2007) and Strand et al. (2014) in interpreting the level of the participants' core muscle endurance (Table 3.2).

PBT was conducted by asking the participant to stabilize the phone horizontally in around one meter and a half, or a distance wherein the participant's body (head to toe) was visible in the camera during the live one-to-one supervised meeting session. The participant was asked to be in a plank position by resting their body on both hands, forearms, and toes. The participant was instructed to lift the hip off the mat, while maintaining a straight line from the shoulders through the hips to the knees. The participant was then given verbal instructions to maintain a straight position monitored by virtual lines. When the hip dropped, the test recorded time stopped. The test was conducted in two trials with a thirty second rest in between (Bohannon et al., 2018). The test required a flat and clean surface, stopwatch, phone with a camera, recording sheets on excel.

**Table 3.2** Rating of Prone Bridge Test (PBT) (Strand et al., 2014)

| Rating        | Time          |
|---------------|---------------|
| Excellent     | > 6 minutes   |
| Very Good     | 4-6 minutes   |
| above average | 2-4 minutes   |
| Average       | 1-2 minutes   |
| below average | 30-60 seconds |
| poor          | 15-30 seconds |
| very poor     | < 15 seconds  |

### 3.8 Ethical Considerations

**Human Participants:** All information related to the study was written in simple and plain language that can easily be understood, (Appendix 5). Participants' safety was considered, and they were not placed in harm's way. Respect for their dignity was prioritized and they were given an option to withdraw from the study at any time without prejudice. The formulated assessment and evaluation questionnaires were in no way or shape, discriminatory, or offensive. The language was formal and respectful of the participant's cultural norms, beliefs, and values; the literature disseminated maintained a high level of objectivity in its discussion and analysis.

**Personal Data & Confidentiality:** Participant names and information were assured not to be shared with anyone. The anonymity of each participant in the study was secured through an assigned code number. Participants' faces were "overlaid" during the assessments to protect their identity, and exercise sessions were not recorded.

**Conflict of interest:** The study has no conflict of interest whatsoever.

### 3.9 Data Analysis

The data were analyzed using SPSS (Statistical Package for Social Science) version 20, and the level of significance of this study was set at ( $P < 0.05$ ). One-way ANOVA analyzed the homogeneity of all groups in the baseline comparison. For within-group differences, one-way repeated measures ANOVA was used to identify the significant differences of each group's dependent variables' (outcome measures) means scores between time 1 (baseline), time 2 (end of the second week), and time 3 (end of the fourth week) individually. The baseline (Time 1) was considered as a covariate. Except for the control group, differences compared between baseline and the end of the fourth week of waiting.

Between-group differences, mixed-design ANOVA was used to analyze the significant differences between the groups in their changes in the outcome measures (NPRS, ODI, PBT) in the two- and three-time intervals. Statistically, multiple comparisons (post-hoc tests) were used to compare mean differences (MD) of all outcome measures between the three therapeutic groups at the end of the second and the fourth weeks of intervention from the baseline (as covariate). This method was also used to compare MD at the end of the fourth week from the baseline only between three therapeutic groups and the control group. Based on the advice of Field (2018) three types of tests have been used:

Games-Howell test was used in the comparison between the three therapeutic groups and the control group of all outcome measures (NPRS, ODI, PBT) because the groups had non-homogenous variance and unequal sample size. The Bonferroni test was used in comparing the MD of all outcome measures of both intervention periods (two and four weeks) of the three therapeutic program groups because groups had homogenous variance and equal sample size. Tukey was also considered as a candidate

test for such a case, but it was recommended that Bonferroni perform better when the number of groups is small (as in the current study). Except for the MD of the PBT at the end of the second week of intervention, groups had non-homogenous variance but equal sample size; therefore, Dunnett's test was used.

# Chapter Four

## Results, Discussion, and Recommendations

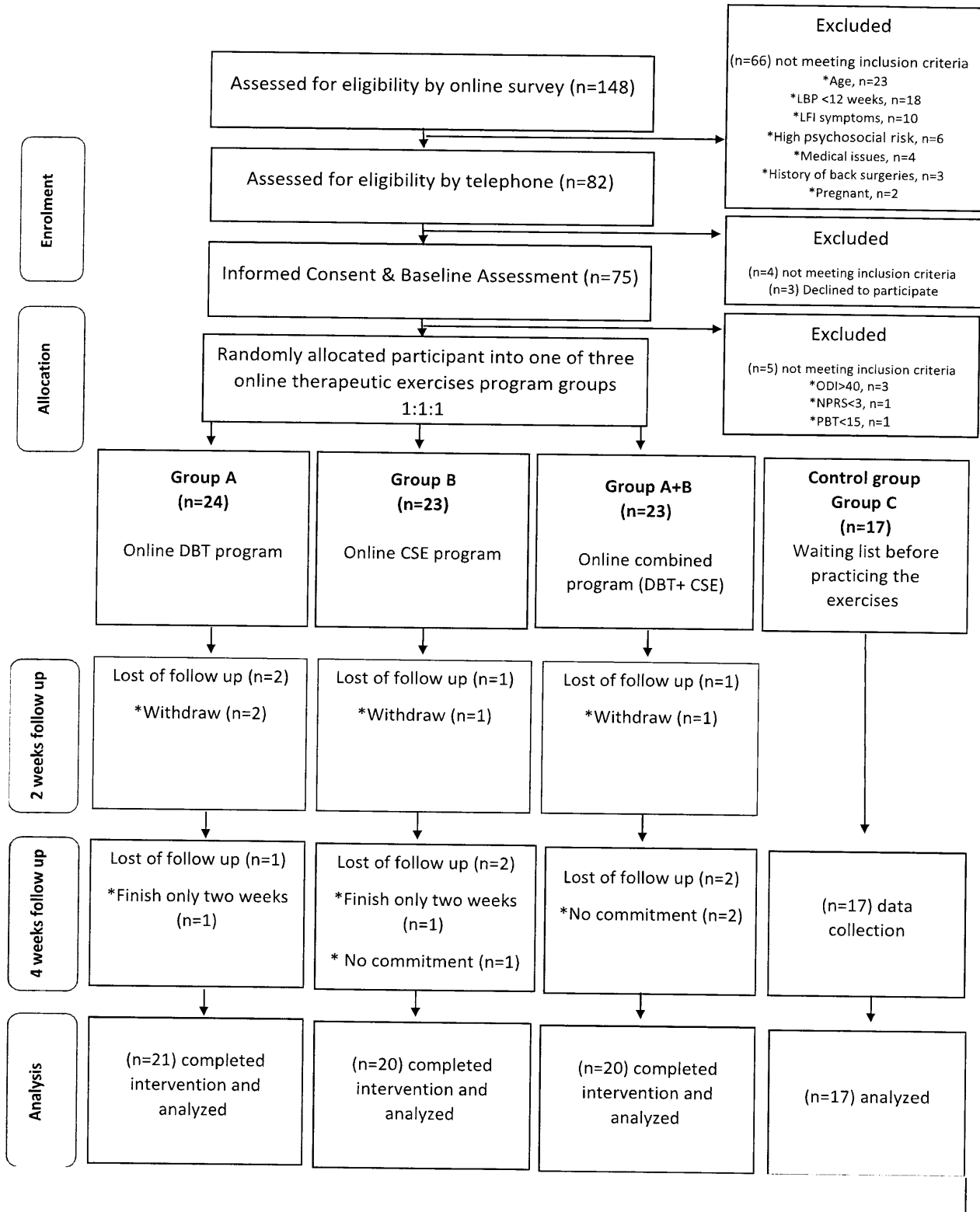


**Figure 4.1** Flowchart of the participants throughout the trial

## **4.1 Results**

### **4.1.1 Participants**

Figure 4.1 reports the flowchart of the participants throughout the trial. Out of one hundred forty-eight (148) submissions, eighty-two (82) participants meet the initial criteria (female, aged between 25-40 years, the suffering of LBP and 7/14 lumbar spine instability symptoms for more than 12 weeks and no medical issue). Those 82 participants were called by phone for further inquiries and confirmation. Consequently, eligible participants were allocated into one of the three online therapeutic exercise programs groups using a simple sampling technique (1:1:1) ratio, according to the sequence order of their participation numbers. Finally, sixty-one (61) participants completed the four weeks of the online program. Twenty-one (21) participants were in Group A, twenty (20) participants were in Group B, and twenty (20) participants were in Group A+B. Moreover, seventeen (17) participants were in the control group. Characteristics of the participants before the intervention of all the groups were homogeneous, with no statistically significant differences between them ( $P>0.05$ ) (Table 4.1).

**Table 4.1** General characteristic of the participants before the intervention (Baseline)

| Variable                                                         | Groups    | N  | Mean $\pm$ SD / characteristics | P-value |
|------------------------------------------------------------------|-----------|----|---------------------------------|---------|
| Nationality<br>(Bahraini/ non-Bahraini)                          | Group A   | 21 | 21 /0                           | N/A     |
|                                                                  | Group B   | 20 | 20 /0                           |         |
|                                                                  | Group A+B | 20 | 20 /0                           |         |
|                                                                  | Group C   | 17 | 17 /0                           |         |
| STarT Back Screening Tool<br>(low/ medium psychosocial risk)     | Group A   | 21 | 10/11                           | N/A     |
|                                                                  | Group B   | 20 | 8/12                            |         |
|                                                                  | Group A+B | 20 | 12/8                            |         |
|                                                                  | Group C   | 17 | 8/9                             |         |
| Duration of LBP (months)                                         | Group A   | 21 | 25.3 $\pm$ 13.9                 | 0.484   |
|                                                                  | Group B   | 20 | 31.4 $\pm$ 22.3                 |         |
|                                                                  | Group A+B | 20 | 33.6 $\pm$ 19.8                 |         |
|                                                                  | Group C   | 17 | 28.1 $\pm$ 14.3                 |         |
| Age (years)                                                      | Group A   | 21 | 32.1 $\pm$ 4.9                  | 0.519   |
|                                                                  | Group B   | 20 | 33.5 $\pm$ 4.5                  |         |
|                                                                  | Group A+B | 20 | 32.1 $\pm$ 4.7                  |         |
|                                                                  | Group C   | 17 | 33.8 $\pm$ 3.5                  |         |
| BMI (kg/m <sup>2</sup> )                                         | Group A   | 21 | 25.0 $\pm$ 4.0                  | 0.821   |
|                                                                  | Group B   | 20 | 26.0 $\pm$ 3.7                  |         |
|                                                                  | Group A+B | 20 | 26.0 $\pm$ 4.3                  |         |
|                                                                  | Group C   | 17 | 25.6 $\pm$ 2.7                  |         |
| Lumbar instability subjective scores<br>(Delphi checklist score) | Group A   | 21 | 10.0 $\pm$ 2.2                  | 0.517   |
|                                                                  | Group B   | 20 | 9.1 $\pm$ 2.0                   |         |
|                                                                  | Group A+B | 20 | 9.5 $\pm$ 1.7                   |         |
|                                                                  | Group C   | 17 | 9.8 $\pm$ 2.1                   |         |
| NPRS (0-10 points)                                               | Group A   | 21 | 5.2 $\pm$ 1.4                   | 0.253   |
|                                                                  | Group B   | 20 | 5.2 $\pm$ 1.8                   |         |
|                                                                  | Group A+B | 20 | 5.8 $\pm$ 1.4                   |         |
|                                                                  | Group C   | 17 | 6.2 $\pm$ 1.9                   |         |
| ODI (0%-100%)                                                    | Group A   | 21 | 24.6 $\pm$ 7.6                  | 0.386   |
|                                                                  | Group B   | 20 | 24.2 $\pm$ 7.2                  |         |
|                                                                  | Group A+B | 20 | 23.8 $\pm$ 6.4                  |         |
|                                                                  | Group C   | 17 | 27.6 $\pm$ 7.8                  |         |
| PBT (sec)                                                        | Group A   | 21 | 25.3 $\pm$ 11.4                 | 0.974   |
|                                                                  | Group B   | 20 | 26.9 $\pm$ 11.5                 |         |
|                                                                  | Group A+B | 20 | 26.6 $\pm$ 12.1                 |         |
|                                                                  | Group C   | 17 | 26.0 $\pm$ 11.2                 |         |

**Abbreviations:** *Group A* online deep breathing training; *Group B* online core stability exercises; *Group A+B* combination of online deep breathing training with online core stability exercises; *Group C* waitlist-control group; *BMI* Body mass index.; *NPRS* Numeric Pain Rating Scale; *ODI* Oswestry Disability Index; *PBT* Prone Bridge Test; *N* sample size; *SD* Standard deviation; \* Indicated significant P- value <0.05.

### **4.1.2 Studied groups**

The results of within-group differences over the study period at the end of four weeks of intervention or waiting showed that the LBP intensity, functional disability, and core muscle endurance improved in all exercise groups, but not in the control group.

The results of between-group differences over the study period (at the end of four weeks of intervention) showed that the three online therapeutic program groups demonstrated better improvements in all outcome measures than the control group. However, no differences were found between the three therapeutic groups.

#### **4.1.2a Within-group differences results**

##### **1. Online therapeutic exercise program groups**

###### **Group A: Online DBT program**

For the online DBT program, the intensity of LBP according to NPRS was reduced at the end of the fourth week of intervention with a mean difference (MD) of 3.3 points ( $P < 0.001$ ). Moreover, the NPRS changes reached to the Minimal clinically important difference (MCID) of 2 points (Childs et al., 2005) (Table 4.2). According to ODI, the functional disability at the end of the fourth week of intervention was reduced by 12.4%, ( $P < 0.001$ ), but did not reach the minimal detectable change (MDC) for ODI of 13.67% (Monticone et al., 2012). Endurance of the core muscles improved with 18.7sec at the end of the fourth week of intervention ( $P < 0.001$ ), but the changes did not reach the MDC of 20.8 /57.7 sec (39.7%), (Bohannon et al., 2018).

### **Group B: Online CSE program**

In the online CSE program, the intensity of LBP according to NPRS was significantly reduced with MD of 3.4 points at the end of the fourth week of intervention ( $P<0.001$ ) and the changes reached to the MCID of 2 points. ODI among participants in this group was reduced by 13.9% at the end of four-week intervention period ( $P<0.001$ ), and reached MDC of 13.67%. The result of the PBT in identifying the core muscles endurance was improved with 25.5sec at the fourth week of intervention reached the MDC of PBT.

### **Group A+B: Online combined program (DBT+CSE)**

For the combined program (DBT + CSE), LBP intensity reduced significantly at the end of the fourth week of intervention to 4.2 points ( $P<0.001$ ) and the changes in this group reached the MCID of 2 points. Moreover, ODI changes at the end of the fourth week reached the MDC of 13.67%, with MD of 15.5% ( $P<0.001$ ). The endurance of core muscles at the end of the fourth week of intervention improved to 38.1sec ( $P<0.001$ ) and reached the MDC of PBT 20.8 /57.7 sec (39.7%), (Table 4.2).

## **2. Control group**

### **Group C: Wait-list control group**

The result showed that all outcome measures in this wait-list control group did not change over the study period (NPRS: 0.3 points,  $P=0.174$ ; ODI: 0.9%,  $P=0.149$ ; and PBT: 1.1 sec,  $P=0.079$ ) (Table 4.2).

#### **4.1.2b Between-group differences results**

##### **Comparison between the three online therapeutic exercise program groups with the control group**

Group A showed statistically significant improvements than the control group in the intensity of LBP, functional disability, and endurance of core muscles with MD of 3.0 points (95%CI 2.1, 3.8), 11.4% (95%CI 7.4, 15.5) and 17.5sec (95%CI 10.7, 24.4), respectively. However, only the NPRS difference reached the MCID of 2 points (Table 4.2). Group B showed statistically and clinically significant improvements than the control group in NPRS (3.0 points, 95%CI 2.1, 3.8), ODI (12.9%, 95%CI 10.0, 15.8), and in PBT (24.3sec, 95%CI 16.2, 32.0). The differences in NPRS and PBT reached the MCID of 2 points and MDC of 20.8 /57.7 sec (39.7%), respectively. The results of the comparison between the combined group of A+B with the control group found that Group A+B had statistically and clinically more significant improvement than the control group in NPRS, ODI, and PBT (3.8 points, 95%CI 3.1, 4.5), (14.5%, 95%CI 11.0, 18.0) and (36.9sec, 95%CI 20.1, 53.79), respectively. All the differences in NPRS, ODI and PBT reached the MCID/MDC.

### **Comparison between the three online therapeutic exercise program groups**

The results showed that there were no differences between the three online therapeutic groups in any outcome measure at the end of four weeks of intervention ( $P \geq 0.05$ ), except that Group A+B showed statistically significant improvement in PBT than Group A (19.3 sec, 95% CI 3.1, 35.6;  $P=0.028$ ). Nevertheless, this difference did not reach the MDC.

**Table 4.2** Comparison of pain, disability, and muscle endurance between the groups

| Variable                               | Group     | N  | Baseline Mean±SD | Period from baseline | After Intervention Mean±SD | Within-group MD (95% CI) |                                       | Between-group MD (95% CI)                  |                                                   |                                           |
|----------------------------------------|-----------|----|------------------|----------------------|----------------------------|--------------------------|---------------------------------------|--------------------------------------------|---------------------------------------------------|-------------------------------------------|
|                                        |           |    |                  |                      |                            | MD from Baseline         | MD between two- and four-week periods | Group C to A, B and A+B (four-week period) | Group A+B to A and B (Two- and four-week periods) | Group A to B (Two- and four-week periods) |
| Intensity of pain<br>NPRS (Points)     | Group A   | 21 | 5.2±1.5          | Two-week             | 4.1±1.7                    | 1.2(0.6, 1.7) *          |                                       | 3.0(2.1, 3.8) *                            | 1.5(0.6, 2.3) *                                   | -0.3(-1.1, 0.5)                           |
|                                        |           |    |                  | Four-week            | 1.9±1.1                    | 3.3(2.6, 4.0) *          | 2.1(1.3, 2.9) *                       |                                            | 0.8(0.1, 1.7)                                     | -0.0(-1.1, 1.0)                           |
|                                        | Group B   | 20 | 5.2±1.9          | Two-week             | 3.8±1.9                    | 1.5(0.8, 2.1) *          |                                       | 3.0(2.1, 3.8) *                            | 1.2(0.2, 2.1) *                                   |                                           |
|                                        |           |    |                  | Four-week            | 1.9±1.5                    | 3.4(2.4, 4.3) *          | 1.8(1.1, 2.6) *                       |                                            | 0.7(-0.2, 1.8)                                    |                                           |
| Functional disability<br>ODI (%)       | Group A+B | 20 | 5.8±1.5          | Two-week             | 3.1±1.7                    | 2.7(2.0, 3.3) *          |                                       | 3.8(3.1, 4.5) *                            |                                                   |                                           |
|                                        |           |    |                  | Four-week            | 1.6±1.1                    | 4.2(3.6, 4.7) *          | 1.9(0.7, 2.2) *                       |                                            |                                                   |                                           |
|                                        | Group C   | 17 | 6.2±1.2          | Four-week            | 5.9±1.9                    | 0.3(-0.1, 0.8)           |                                       |                                            |                                                   |                                           |
|                                        |           |    |                  |                      |                            |                          |                                       |                                            |                                                   |                                           |
| Endurance of core muscles<br>PBT (sec) | Group A   | 21 | 24.6±7.6         | Two-week             | 16.0±8.0                   | 8.6(5.6, 11.5) *         |                                       | 11.4(7.4, 15.5) *                          | 2.7(-1.3, 6.9)                                    | -0.1(-3.8, 3.6)                           |
|                                        |           |    |                  | Four-week            | 12.1±8.0                   | 12.4(8.8, 15) *          | 3.8(1.6, 5.9) *                       |                                            | 3.0(-1.5, 7.7)                                    | -1.4(-5.7, 2.8)                           |
|                                        | Group B   | 20 | 24.2±7.2         | Two-week             | 15.5±10.4                  | 8.7(6.2, 11.1) *         |                                       | 12.9(10.0, 15.8) *                         | 2.7(-1.1, 6.5)                                    |                                           |
|                                        |           |    |                  | Four-week            | 10.3±7.7                   | 13.9(11.3, 16.4) *       | 5.2(2.7, 7.6) *                       |                                            | 1.6(-2.3, 5.5)                                    |                                           |
| Endurance of core muscles<br>PBT (sec) | Group A+B | 20 | 23.8±6.4         | Two-week             | 12.4±7.0                   | 11.4(8.3, 14.4) *        |                                       | 14.5(11.0, 18.0) *                         |                                                   |                                           |
|                                        |           |    |                  | Four-week            | 8.3±5.9                    | 15.5(12.3, 18.6) *       | 4.1(2.5, 5.6) *                       |                                            |                                                   |                                           |
|                                        | Group C   | 17 | 27.6±7.8         | Four-week            | 26.7±8.7                   | 0.9(-0.37, 2.25)         |                                       |                                            |                                                   |                                           |
|                                        |           |    |                  |                      |                            |                          |                                       |                                            |                                                   |                                           |
| Endurance of core muscles<br>PBT (sec) | Group A   | 21 | 25.3±11.4        | Two-week             | 28.3±11.1                  | 3.0(2.1, 3.8) *          |                                       | 17.5(10.7, 24.4) *                         | 14.9(7.5, 22.3) *                                 | -10.7(-16.5, -5.0) *                      |
|                                        |           |    |                  | Four-week            | 44.1±20.5                  | 18.7(12.4, 24.9) *       | 15.7(9.6, 21.8) *                     |                                            | 19.3(3.1, 35.6) *                                 | -6.7(-16.2, 2.7)                          |
|                                        | Group B   | 20 | 26.9±11.5        | Two-week             | 40.7±19.4                  | 13.7(7.7, 19.8) *        |                                       | 24.3(16.2, 32.0) *                         | 4.1(-5.3, 13.6)                                   |                                           |
|                                        |           |    |                  | Four-week            | 52.4±21.6                  | 25.5(17.8, 33.1) *       | 11.7(7.4, 15.9) *                     |                                            | 12.6(-4.4, 29.6)                                  |                                           |
| Endurance of core muscles<br>PBT (sec) | Group A+B | 20 | 26.6±12.3        | Two-week             | 44.5±22.0                  | 17.9(10.1, 25.7) *       |                                       | 36.9(20.1, 53.79) *                        |                                                   |                                           |
|                                        |           |    |                  | Four-week            | 64.7±36.3                  | 38.1(22.1, 54.0) *       | 20.1(7.7, 32.6) *                     |                                            |                                                   |                                           |
|                                        | Group C   | 17 | 26.0±11.2        | Four-week            | 27.1±12.0                  | 1.1(0.15, 2.4)           |                                       |                                            |                                                   |                                           |
|                                        |           |    |                  |                      |                            |                          |                                       |                                            |                                                   |                                           |

**Abbreviations:** *Group A* online deep breathing training; *Group B* online core stability exercises; *Group A+B* combination of online deep breathing training with online core stability exercises; *Group C* waitlist-control group; *NPRS* Numeric Pain Rating Scale; *ODI* Oswestry Disability Index; *PBT* Prone Bridge Test; *sec* Seconds; *N* sample size; *MD* Mean of difference/changes; *Two and four week periods* Differences in changes between two- and four-weeks intervention periods results; *CI* Confidence interval; *SD* Standard deviation; \* Indicated significant P- value <0.05.

## 4.2 Discussion

The current study result of within-group differences over the study period (at the end of the four weeks) demonstrated that the LBP intensity improved statistically and clinically in all the three online therapeutic programs but not in the waiting control group (non-intervention). Nevertheless, functional disability and core muscle endurance improved statistically in all online therapeutic programs, but clinically in only online CSE and combined program (online DBT+CSE) that reached the MDC of ODI and PBT. Moreover, no improvement was demonstrated in the waiting control group in either outcome. These results accept the first  $H_a$ .

On the other hand, the results of between-group differences over the study period (at the end of four weeks of intervention) showed that the three online therapeutic programs group demonstrated better improvements in all outcome measures (NPRS, ODI, PBT) than the waiting control group. However, no clinical differences were found between the three therapeutic programs. Therefore, the result of the between-group rejects the second  $H_a$ .

### **4.2.1 Within-group differences**

#### **Online DBT program**

Many studies investigated the relationship between respiratory muscles and CLBP. Higher diaphragm position and smaller excursion characterized by greater diaphragm fatigability were observed more in patients with CLBP (Beeckmans et al., 2016; Bradley & Esformes, 2014). The study of Hodges et al. (2003) reported that respiratory muscles are the principal factor affecting spinal stabilization. Accordingly, previous studies proved that DBT, including diaphragm breathing training, can improve diaphragm activity, thickness, and position in patients with CLBP (Finta et al., 2018; Ziaieifar et al., 2021). Hence, DBT is considered one of the practical exercise approaches used with CLBP and lumbar instability patients based on the role of the diaphragm as a primary muscle for respiration and trunk stabilization that contribute to the intra- abdominal pressure and the resistance of the pelvic floor (Kim & Lee, 2013).

The present study found that four weeks of an online DBT program effectively reduced pain in CLBP and LFI patients as the NPRS changes reached the MCID of 2 points (Childs et al., 2005). While the functional status improved statistically but not clinically as the changes did not reach the MDC for ODI of 13.67% (Monticone et al., 2012).

Interestingly, there are similarities in the LBP intensity and functional disability changes between the current online DBT and in-clinic DBT programs examined in previous studies. The MD of NPRS and ODI in the current study reached 3.3 points and 12.4% at the end of the four-week intervention period. Shetty and Fathima (2020) reported changes that reached 3.4 points and 10.5% after four weeks of practicing in-clinic hemi-bridge 90/90 position with ball and balloon blowing exercise three times a

week. Thus, this result indicates that online DBT could have a similar effect on pain and functional disability reduction as the supervised traditional in-clinic DBT.

Furthermore, in terms of core muscle endurance changes after applying online DBT, results showed only statistically significant improvements at the end of four weeks of intervention, as the improvement did not reach the MDC of 20.8 / 57.7 sec (39.7%) (Bohannon et al., 2018).

To the researcher's knowledge, the current study successfully collected various practical diaphragmatic DBT practiced in different body positions (hemi-bridge 90/90, standing and hook lying position with balloon blowing during inhalation) in one online program and replaced the respiratory resistance device with a balloon, which is readily available and disposable to investigate effectiveness of the program. Kang et al. (2018) reported that five weeks of DBT using a respiratory resistance device practiced in a standing position positively affects spinal stability among patients with lumbar instability. Finta et al. (2018), also found that diaphragmatic breathing in a hook lying position had more activation of the core muscles than in a sitting position.

## Online CSE program

The online CSE program results in the present study show statistically and clinically significant reductions in LBP intensity and functional disability from moderate to mild pain and disability at the end of four weeks of the intervention period with MD 3.4 points and 13.9% reached the MCID and MDC of NPRS and ODI. The same CSE program was practiced in-clinic in Park and Lee (2019) experimental study, but only LBP reduced clinically, NPRS changes by 3.2 points, but the ODI changed by only 4.9%.

A systematic review established by Jamali Brayjani and Daneshmandi (2021) supports the current result on the effectiveness of CSE in reducing back-related disability and pain of patients with CLBP. Thus, this result indicates that online CSE could have a similar effect in pain reduction as supervised in-clinic CSE but has more reduction in functional disability.

Additionally, the endurance of core muscles also improved in the current online CSE program statistically and clinically, with the MD of 25.5sec after four weeks of intervention, reaching the MDC of 20.8 / 57.7 sec (39.7%). This result has almost similar results and has been proven in-clinic CSE in previous studies (Dimer da Luz et al., 2019; Narouei et al., 2020; Shamsi et al., 2016).

CSE works to enhance coordination and control of the trunk stabilizer muscles. It stimulates spinal proprioception, which eventually impacts the ability of postural maintenance and increases the sense of balance (Aggarwal et al., 2010).

### **Combined program (Online DBT+ CSE)**

The current study found that practicing online DBT using a balloon resistance combined with an online CSE program yielded a significant achievement of LBP intensity, functional disability and core muscle endurance after four weeks of the intervention period statically and clinically.

These improvements were similar to an earlier study done by Sini and Mohanraj (2019) that combined 90/90 hemi-bridge position with ball and balloon blowing exercise, with a four-week CSE program practiced through a supervised in-clinic method in managing CLBP patients. The authors reported that their study was the first to combine this breathing exercise with CSE. However, in the current COVID-19 pandemic, the present study modified this combined program by adding more DBT exercises and then delivered it through the telerehabilitation method as an online program on CLBP and LFI patients.

#### **4.2.2 Between-group differences**

##### **Differences between three online therapeutic exercise programs and the wait-list control group**

The result of the current study over the study period (at the end of four weeks) showed that the three online therapeutic exercise programs demonstrated a better reduction in LBP and improvement of functional status and core muscle endurance than the control group among individuals with CLBP and LFI. Several studies support the exercises' effectiveness compared to minimal or no intervention (Abass et al., 2020; Gordon & Bloxham, 2016; Qaseem et al., 2017). Thus, improper inactivity should be avoided, while programmed exercises are advised and encouraged for patients with CLBP.

Moreover, the result of the current research is well supported by a previous systematic review study conducted by Frizziero et al. in 2021; there is available evidence relating to the CSE program in reducing back pain and functional disability of patients suffering from CLBP.

To the researcher's knowledge, this is the first study conducted to compare the effectiveness of online therapeutic exercise programs with the wait-list control group on CLBP or LFI patients. Thus, no available results from the previous study can be compared with the result of the current study.

## **Differences between the three online therapeutic exercise programs**

The results of between-group differences at the end of four weeks of intervention showed that no statistical or clinical differences in the improvement of all outcome measures were found between the three online therapeutic program groups. Placing this in perspective comparison between both single programs (online DBT and online CSE), in addition to the comparison between single programs and combined both (online DBT+CSE). Therefore, the result of the study rejects the second  $H_a$ .

Contrary to expectation, this study did not find any statistically or clinically significant differences between practicing online DBT or online CSE programs in reducing back pain, functional disability and core muscle endurance in four-week intervention periods. Moreover, MD between the groups did not reach the MCID for NPRS and MDC for ODI and PBT. This finding indicates that the DBT program, which requires less effort, has almost similar results in reducing pain and improving functional status and core muscle endurance to CSE, which requires more physical effort. Therefore, this finding can resolve one of the current study research problems, where DBT can substitute CSE, especially when the application of CSE is not recommended due to pain and injury limitations (Gomes-Neto et al., 2017). In addition, the DBT program could limit the physical fatigue that may also arise due to the strenuous physical effort required while practicing CSE (Wasser et al., 2017).

The possible reason for the improvements in pain, functional status, and core muscle endurance after the DBT program is the positive role in restoring the Zone of Apposition (ZOA) of the diaphragm and spine in the proper position. This occurs through the co-contraction of the diaphragm

and the deep abdominal muscles, mainly transverse abdominal muscles, and internal and external oblique muscles during the inhalation with stomach expanding and exhalation with ADIM and blowing balloon in DBT (Cavaggioni et al., 2015; Strongoli et al., 2010). Consequently, the pain pressure threshold can reduce, and the dynamic stability of the spine can improve in different body positions (Boynton et al., 1991; Granata & England, 2006). In addition, diaphragmatic DBT can stimulate the parasympathetic nervous system's relaxation response due to the role of breathing exercises in the feedback loop and vagal tone improvement (Lehrer & Gevirtz, 2014).

Similarly, CSE can enhance neuromuscular control by re-training core muscles, including deep abdominal and back muscles that necessitate reducing stress on the spine and improving dynamic stability (Hodges et al., 2003). CSE can provoke spinal proprioception to the maximum, leading to enhanced spinal stiffness due to co-contraction and activation of core muscles in CSE with ADIM (Souza et al., 2001). Thus, all this allows the trunk to move in multiple planes and enhances the lumbar spine's stability and curvature.

Based on the present study results and supporting evidence, DBT exercises are suitable for those recommended for stability exercises but unable to practice the conventional CSE because of pain severity, poor trunk stability, loss of balance to maintain the body in four points position, and/or comorbidities such as obesity and lack of fitness, etc.

The online CSE program alone can be utilized in rehabilitating patients with CLBP and lumbar instability in cases where the patient can practice the core exercises. When the patient encounters difficulties in understanding breathing techniques, fear, and/or allergies to the balloon, it is suggested that they use only the online CSE program.

Moreover, the comparison findings in the changes of pain, functional disability, and core muscle endurance at the end of four weeks showed no differences between the three online programs whether the combined or single programs, except that the combined program showed statistically significant improvement in PBT than online DBT with MD 19.3sec (95%CI 3.1, 35.6;  $P=0.028$ ). Nevertheless, the differences did not reach the MDC of PBT. Similarly, Shah et al. (2020) compared four weeks of combined simple in-clinic diaphragmatic breathing exercises with CSE versus CSE alone. The results showed no clinical differences between the groups in the improvements of pain, functional disability, and abdominal holding time of patients with CLBP for more than 12 weeks. In addition, Oh et al. findings in 2020 showed no significant difference between four-week CSE with and without respiratory resistance in reducing LBP intensity among forty-five female patients presented with CLBP and LFI.

The possible explanation of the results is that all programs can stimulate the diaphragm and TrA muscles concentrically and eccentrically during the inhalation and exhalation phases in diaphragmatic breathing and during the ADIM in the CSE in different body positions. This led to increased integration of all stabilizer muscles and the thoracolumbar fascia that naturally stabilizes the low back area and plays an essential role in controlling vertebral shearing forces (Willard et al., 2012).

### **4.3 Clinical Implications**

Four- weeks of online CSE, DBT, or a combination of both programs can be prescribed for patients with CLBP and LFI to reduce pain and improve functional status and core endurance as no program is superior to other programs. Therefore, an online DBT program alone, for example, can be utilized even for a patient who encounters difficulty in practicing the conventional CSE and online CSE program alone when there is difficulty in understanding breathing techniques, fear, and/or allergies to the balloon.

### **4.4 Study Strengths and Limitations**

This study has several strengths. First, To the researcher's knowledge, this is the first study conducted globally and locally to evaluate and compare the effectiveness of three online therapeutic exercise programs on LFI patients. Second, this study included no intervention (wait-list group), which would strengthen the validity of the results. Third, psychosocial risk factors were screened in the baseline assessment in order to identify patients at risk for poor clinical outcomes also it is considered as a potential way to improve quality and efficiency in patient care.

However, this study is limited to a quasi-experimental design because the control group did not follow the 1:1:1 allocation sequence. This study has bias because the same researcher conducted all study procedures. The study was conducted only on female participants aged 25 to 40 years, that cannot be generalized to males and among different age groups. The control group contains less than 20 participants which are less than the required number of participants per group according to the sample size calculation results. Apart from the baseline assessment in evaluating the eligibility of the participants with LFI, this study was limited to subjective

findings (symptoms, history, and demographics) and core muscle endurance with no further LFI physical special tests being done. Because this is a general limitation of telerehabilitation, physical tests the therapist performs are difficult. In addition, the Arabic version of the lumbar spine instability questionnaires was not validated in the Arabic language yet. Moreover, the number of participating questionnaires sent via WhatsApp and Instagram was not reported, and confounding variables were not controlled.

## **4.5 Conclusion**

In summary, a four-week intervention period of any of the three online therapeutic exercise programs (DBT, CSE, or combined DBT+CSE) could effectively reduce LBP intensity and functional disability and improve core muscle endurance of individuals with CLBP and LFI in comparison to non-intervention. However, all three online therapeutic exercise programs have the same effect at four weeks of intervention, and no program is superior to another. The application of the online DBT program, which requires less physical demands, could provide similar pain and functional disability reduction to the online CSE program, which requires more physical demands at the end of the four-week intervention period. The current study recommends that physiotherapists, sports therapists, and trainers prescribe any of the three online therapeutic programs for CLBP and LFI patients.

## **4.6 Future Recommendations**

Future studies should address this study's limitations when modifying online programs to rehabilitate patients with CLBP and LFI; a long-term follow-up of more than four weeks is recommended to strengthen the findings' credibility. Moreover, the current thesis researcher recommends conducting further online therapeutic exercise programs in rehabilitating CLBP and LFI patients. In addition to this, it recommends comparing the effectiveness of DBT, which utilizes respiratory resistive devices, with a balloon that is readily available and more cost-effective. The efficiency of practicing the three online therapeutic programs through one-to-one virtual sessions can be compared to supervised traditional face-to-face in-clinic sessions. Diagnostic ultrasound or electromyography can be used to measure trunk muscles' activation and thickness which may have accurate results.

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# Appendices

## Appendix 1 Ethical Approval



University of Bahrain  
College of Health and Sports Sciences  
Scientific Research and Publication Committee

---

February 23, 2021

To: The Chairperson of the Research and Ethics Committee  
Ministry of Health  
Kingdom of Bahrain

Dear Madam/Sir,

Greetings from the College of Health and Sport Sciences, University of Bahrain!

RE: Research study on "The Effectiveness of Online Core Stability Program and Deep Breathing Training in Rehabilitating Female Patients with Functional Lumbar Instability"- CHSS SRPC Recommendation No: 9/2020-21 dt Feb 23, 2021.

The Scientific Research and Publication Committee, College of Health and Sport Sciences (CHSS), University of Bahrain (UOB), has reviewed and recommended the research proposal (CHSS SRPC Recommendation No: 9/2020-21 dt Feb 23, 2021) entitled "The Effectiveness of Online Core Stability Program and Deep Breathing Training in Rehabilitating Female Patients with Functional Lumbar Instability" to the MoH RTST. Ms. Fatima Mohamed Jaffar Mohamed, a student enrolled in MSc Physiotherapy Program of CHSS, UoB would be carrying out the study under the supervision of Dr. Mohammed Abdulla, Assistant Professor, Physiotherapy Program, CHSS, UoB as Master's Thesis. Notably, the outcome of the research is expected to benefit the patients in the Kingdom of Bahrain. Therefore, I request to do the needful considering the paucity of time to complete the Master Thesis.

Thank you for supporting scientific research at the CHSS, UOB.

Kind Regards,

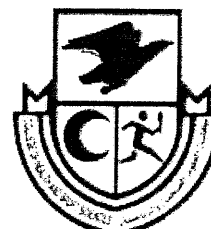
Prof. Adnan Bekhit PhD  
Chairperson, Scientific Research and Publication Committee  
College of Health and Sport Sciences  
University of Bahrain

## Appendix 2 Online participating form on Google form – English and Arabic versions

(<https://forms.gle/UAsAg4e1XumAeMqb6>)



University of Bahrain  
College of Health and Sport Sciences  
Allied Health Department



---

### Participating form

I'm Fatima Mohamed, a master student at the University of Bahrain. I invite you to participate in my research study with the title of The Effectiveness of Online Core Stability Program and Deep Breathing Training in Rehabilitating Female Patients with Functional Lumbar Instability.

The purpose of this study is to compare three online programs on the intensity of back pain, functional disability, quality of life, and endurance of core muscles during rehabilitating female patients with chronic LBP and lumbar spine instability aged 25 to 40 years at two and four weeks.

Study description: When you enter the study, you will be examined by this survey for eligibility; since you are matched with the study including criteria partially, you will be contacted with the physiotherapist (researcher) to read and sign the consent form and to have the evaluation and treatment in a video call. You will then be under four weeks of program training that will be implemented three times a week (12 sessions). Following criteria of attending 20 to maximum 50 minutes online physiotherapy sessions under the supervision of the physiotherapist in a video call beginning of each week and end of second and fourth weeks. At the same time, the rest sessions will be done individually by the participant following the instructed video given to you.

Study participants: I'm looking for 60 female participants in Bahrain, aged between 25 to 40 years, medically stable, suffering from low back pain for more than three months, with the availability of lumbar instability symptoms.

Participation in this study is entirely voluntary. With no risks to your safety. And all your information details will be ensured.

For help and inquires

Phone number: 37330177 / Email: [fphysio8@gmail.com](mailto:fphysio8@gmail.com)

\*Required

Name

Your answer

Date of birth \*

Date

mm/dd/yyyy 

Contact number \*

Your answer

Email

Your answer

Do you complain of low back pain with a period of more than 12 weeks (3 months)? \*

☐ Yes

☐ No

Next

 Page 1 of 4



## Participating form

fatimalkhouzaei@gmail.com [Switch accounts](#)



\*Required

### Symptoms of functional lumbar instability

Please answer the following questions to identify if you are suffering from functional lumbar instability. IF 7 out of 13 symptoms match with your condition, you have a chance of having functional lumbar instability.

1- Reports feelings of "giving way" or back "giving out" \*

☐ Yes

☐ No

2- Self manipulators who feel the need to crack or pop the back frequently \*

☐ Yes

☐ No

3- Frequent bouts or episodes of symptoms \*

☐ Yes

☐ No

4- History of painful catching or locking during twisting or bending of the spine \*

☐ Yes

☐ No

5- Pain during transitional activities (e. g sit to stand) \*

☐ Yes

☐ No

6- Greater pain returning to erector position from flexion (from bend to straight back) \*

☐ Yes

☐ No

7- Pain increased with sudden, trivial, or mild movement \*

☐ Yes

☐ No

8- Difficulty with unsupported sitting and better with supported backrest \*

☐ Yes

☐ No

9- Worse with sustained posture and decreased likelihood of reported static position that is not painful \*

☐ Yes

☐ No

10- Condition is progressively worsening ( e.g., shorter intervals between bouts) \*

☐ Yes

☐ No

11- Long term, chronic history of a back disorder \*

☐ Yes

☐ No

12- Temporary relief with back brace or corset \*

☐ Yes

☐ No

13- Reports frequent episodes of muscle spasms \*

☐ Yes

☐ No

[Back](#)

[Next](#)

Page 2 of 4



University of Bahrain  
College of Health and Sport Sciences  
Allied Health Department



## Participating form

\*Required

### Medical status

Please answer the following questions regard your medical status with yes or no

History of spine surgeries, previous spine fractures, inflammatory spine disease \*

☐ Yes

☐ No

Suffering now with a severe leg coming pain from the back or diagnostic with severe disc herniation \*

☐ Yes

☐ No

Suffering from neurological problems (e.g., present or history of stroke, multiple sclerosis, or others) \*

☐ Yes

☐ No

Suffering from serious organ diseases (e.g., kidney, livers, or others) \*

☐ Yes

☐ No

Suffering from cardiac or respiratory problems \*

☐ Yes

☐ No

Complain of any medical issues (e.g., diabetic, hypertension, or others) \*

☐ Yes

☐ No

Smoker \*

☐ Yes

☐ No

Pregnant or less than 6 months postpartum \*

☐ Yes

☐ No

[Back](#)

[Next](#)

Page 3 of 4

Never submit passwords through Google Forms.



## Participating form

\*Required

### Psychosocial status

STarT Back Screening Tool

for each statement please choose either disagree or agree

My back pain has spread down my leg(s) at some time in the last 2 weeks \*

- ☐ Agree
- ☐ Disagree

I have had pain in the shoulder or neck at some time in the last 2 weeks \*

- ☐ Agree
- ☐ Disagree

I have only walked short distances because of my back pain \*

- ☐ Agree
- ☐ Disagree

In the last 2 weeks, I have dressed more slowly than usual because of back pain \*

- ☐ Agree
- ☐ Disagree

It's not really safe for a person with a condition like mine to be physically active. \*

- ☐ Agree
- ☐ Disagree

Worrying thoughts have been going through my mind a lot of the time. \*

- ☐ Agree
- ☐ Disagree

I feel that my back pain is terrible, and it's never going to get any better. \*

- ☐ Agree
- ☐ Disagree

In general, I have not enjoyed all the things I used to enjoy. \*

- ☐ Agree
- ☐ Disagree

Overall, how bothersome has your back pain in the last 2 weeks? \*

Choose ▼

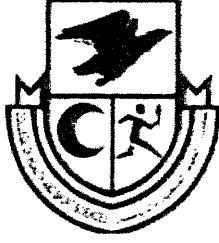
[Back](#)

**Submit**

Page 4 of 4

Never submit passwords through Google Forms.

Arabic version of participating form on Google form  
(<https://forms.gle/jgxrESnuC4xfJKs48>)



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قسم العلاج الطبيعي



## استمارة المشاركة

أنا فاطمة محمد، طالبة ماجستير في جامعة البحرين. أود دعوتكم للمشاركة في الدراسة البحثية الذي بعنوان: فعالية برنامج الثبات الوظيفي وتمرين التنفس العميقة عن بعد في تأهيل النساء الاتي يعانين من عدم الاستقرار القطني الوظيفي. الغرض من البحث هو المقارنة بين ثلاث طرق فعالة في تخفيف شدة آلام الظهر والصعوبات الوظيفية بالإضافة الى قدرة تحمل عضلات البطن أثناء إعادة تأهيل النساء الاتي يعانين من آلام الظهر بسبب عدم الاستقرار القطني الوظيفي البالغات من العمر 25 إلى 40 سنة.

وصف بسيط للبحث: عند دخولك للدراسة، سيتم فحصك أولاً من قبل أخصائية العلاج الطبيعي (الباحثة) من خلال اتصال بالفيديو عند تنزيلك للتطبيق على هاتفك والإجابة على بعض التقييمات التي سوف ترسل لك على هاتفك. فبداءاً على ذلك ستتأهل للمشاركة في البرنامج تأهيلي لمدة أربعة أسابيع الذي يتكون من ثلاث جلسات كل أسبوع. حيث تستدعي حضور جلسة واحدة من بداية كل أسبوع مع أخصائية العلاج الطبيعي عن طريق اتصال فيديو لشرح التمارين ولكن باقي الجلسات من كل أسبوع ستطبق بشكل فردي ملتزمين بنصائح الإخصائية والاستعانة بالفيديو المرفق كمرجع.

مواصفات المشاركين في البحث: نحن نقدر مشاركة 60 مشاركاً أو أكثر من النساء في البحرين اللاتي تتراوح أعمارهم بين 25-40 سنة ممن يشكون من آلام أسفل الظهر المزمنة أكثر من ثلاث شهور بالإضافة الى وجود اعراض عدم الاستقرار القطني الوظيفي.

إن قرارك بالمشاركة في هذه الدراسة طوعي تماماً، حيث لا توجد مخاطر على سلامتك أثناء مشاركتك في البحث

للمساعدة و الاستفسار

هاتف : 37330177/ البريد الالكتروني : [fphysio8@gmail.com](mailto:fphysio8@gmail.com)

\*مضروب

الاسم

إجابتك

تاريخ الميلاد \*

التاريخ

mm/dd/yyyy 

رقم التواصل ( موبايل ) \*

إجابتك

البريد الإلكتروني

إجابتك

هل تعاني من ألم مزمن في أسفل الظهر لأكثر من ثلاث شهور ( 12 اسبوع)؟ \*

نعم ☐

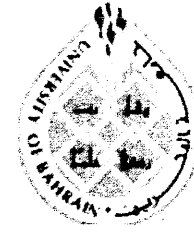
لا ☐

صفحة 1 من 4

التالي



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قسم العلاج الطبيعي



## استمارة المشاركة



fatimalkhouzaei@gmail.com (لا تترك مشاركتك) عين الحساب

مختوب

### أعراض عدم الاستقرار القلبي الوعائي

جب عن الأسئلة التالية لمعرفة إن كنت تعاني من عدم الاستقرار القلبي الوعائي  
في حال 7 من الأعراض التالية تطابق معك. فهناك احتمالية عدم الاستقرار القلبي الوعائي بسبب ضعف عضلات البطن و الظهر العميقة

1- هل تعاني من عدم استقرار الظهر ( الشعور المفاجئ بانثناء الظهر و عدم القدرة على السيطرة لفترة بسيطة)؟ \*

نعم ☐

لا ☐

2- هل تشعر بألم مفاجئ أو قفل في الظهر أثناء ثني الظهر للأسفل ( مثل الركوع و غيرها) أو أثناء دوران الظهر ؟ \*

نعم ☐

لا ☐

3- هل تعاني من نبضات الظهر المتكررة بين كل فترة ؟ \*

نعم ☐

لا ☐

4- هل تعاني من الشعور المتكرر بالحاجة إلى فرقة الظهر؟ \*

نعم ☐

لا ☐

5- الشعور بالألم أثناء تغير وضعية الجسم (مثل الانتقال من الجلوس إلى الوقوف و غيرها)؟ \*

نعم ☐

لا ☐

6- الشعور بالألم بالظهر أثناء استقامة الظهر بعد الثني (مثل الاستقامة من الركوع)؟ \*

نعم ☐

لا ☐

7- ألم أو أعراض الظهر تتفاقم أثناء الحركات السريعة المفاجئة ؟ \*

نعم ☐

لا ☐

8- شعور بصعوبة و عدم الاتزان عند الجلوس بدون استناد للظهر و بالمقابل الشعور بالراحة عند استناد الظهر بالكرسي، وسادة أو أي شيء ؟ \*

نعم ☐

لا ☐

9- أعراض الظهر تتزايد مع الثابت في وضعيات معينة (مثلا الجلوس أو الوقوف لفترة و غيرها)؟ \*

نعم ☐

لا ☐

10- حالة الظهر في تزايد بشكل تدريجي لاسوء (مثلا فترات متقارب بين نوبات الظهر)؟ \*

نعم ☐

لا ☐

11- مشاكل الظهر مزمنة لديك؟ \*

نعم ☐

لا ☐

12- الشعور براحة مؤقتة عند لبس حزام الظهر او المشد؟ \*

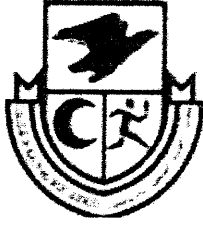
نعم ☐

لا ☐

13- الشعور المتكرر بتشنجات في عضلات الظهر؟ \*

نعم ☐

لا ☐



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## استمارة المشاركة

مفتوح

### الحالة لأصحية للمشارك

جاء على أساس صحة المتعلقة بالحالة الصحية بعد أو لا

أجريت عملياتك في العمود الفقري، أو وجود كسور سابقة أو التهابات بالعمود الفقري؟ \*

نعم ☐

لا ☐

تعالني حالياً بآلام شديدة في الرجل كآلام من الظهر ( عرق النسا ) أو تم تشخيصك بآلام لآل عضروف في شديدة؟ \*

نعم ☐

لا ☐

تعالني من مشاكل في الجهاز العصبي ( جفطات متاعبة، التصلب اللويحي و غيره )؟ \*

نعم ☐

لا ☐

تعالني من مشاكل عضوية ( مثل مشاكل بالكبد ، الكلى و غيره )؟ \*

نعم ☐

لا ☐

مُعاني من مشاكل في القلب أو الرئة؟ \*

نعم ☐

لا ☐

مُعاني من مشاكل صحية مزمنة ( ارتفاع ضغط الدم، السكري أو غيرها)؟ \*

نعم ☐

لا ☐

هل أنت متخلى (سجائر، شيشة أو غيرها)؟ \*

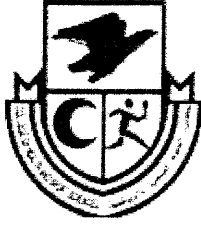
نعم ☐

لا ☐

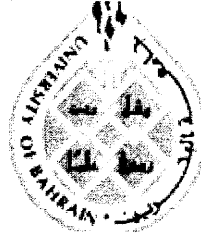
هل أنت حامل الآن؟ أو في فترة أقل من 6 شهور بعد الولادة؟ \*

نعم ☐

لا ☐



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## استمارة المشاركة

المطلوب

### الحالة النضجية و الجسمية المشتركة

عليك قراءة الاسئلة التالية و اختيار موافق او غير موافق توافقاً مع وضعك الحالي / موافق (نعم) و غير موافق (لا)

امتد ألم ظهري إلى إحدى أو كلا ساقي في وقت ما خلال الأسبوع الماضيين؟ \*

☐ موافق

☐ غير موافق

شعرت بالألم في كعفي أو رقبتي في وقت ما خلال الأسبوعين الماضيين؟ \*

☐ موافق

☐ غير موافق

استطعت المشي لمسافات قصيرة فقط بسبب ألم ظهري؟ \*

☐ موافق

☐ غير موافق

ارتكبت ملاطبي أكثر بطل من المعتاد بسبب ألم ظهري خلال الأسبوعين الماضيين؟ \*

☐ موافق

☐ غير موافق

من الخطر لشخص في مثل حالتي أن يكون شيطاً حركياً؟ \*

☐ موافق

☐ غير موافق

تصور في ذهني الأفكار المتعلقة معظم الأحيان؟ \*

☐ موافق

☐ غير موافق

أشعر أن ألم ظهري شديد (فظيع) ولن يتحسن أبداً؟ \*

☐ موافق

☐ غير موافق

بشكل عام لم أعد أستمع بجميع الأشياء التي كنت متعوداً على الاستماع بها (كاستماع بالآكل أو الزيارات أو الحيوانات أو العمل)؟ \*

☐ موافق

☐ غير موافق

اجماداً، إلى أي مدى كان ألم ظهرك مزعجاً خلال الأسبوعين الماضيين؟ \*

خبر

صفحة 4 من 4

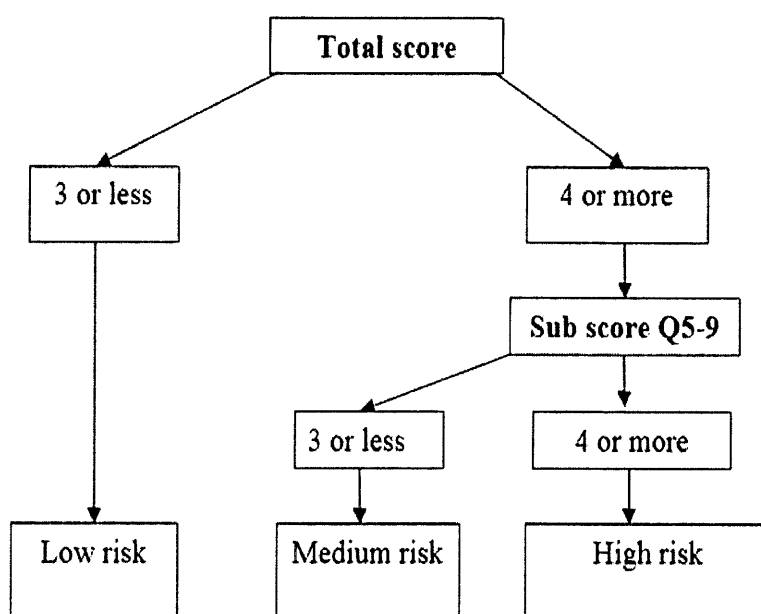
إرسال

رجوع

نقد إرسال كلمات المرور عبر نموذج Google مطلقاً.

**Appendix 3** STarT Back Screening Tool criteria used in the online participating form as shown above in appendix 1 (page 4 on google form of both versions)

**The STarT Back Tool Scoring System**



© Keele University 01/08/07  
Funded by Arthritis Research UK

## Appendix 4 Screening Assessment Sheet (re-evaluated by the researcher for confirmation)



University of Bahrain  
College of Health and Sport Sciences  
Allied Health Department



### Screening Assessment Sheet

Participant Number: -----

Date: -----

Participant contact number/ email:-----

|                                                                                             |     |    |
|---------------------------------------------------------------------------------------------|-----|----|
| Female                                                                                      | Yes | No |
| Participant age between 25-40 years                                                         | Yes | No |
| Complain of chronic low back pain >12 weeks                                                 | Yes | No |
| Lumbar instability symptoms > 5/13 (re-evaluate)                                            | Yes | No |
| Medically stable                                                                            | Yes | No |
| Participant not under any other treatments during training period time                      | Yes | No |
| History of spine surgeries, previous spine fractures, inflammatory spine disease            | Yes | No |
| Present with spinal disc herniation, spinal deformities, or neurological radiculopathy pain | Yes | No |
| Neurological problems such as multiple sclerosis, stroke, and others                        | Yes | No |
| Vertigo, cardiac and respiratory problems                                                   | Yes | No |
| Serious organ diseases                                                                      | Yes | No |
| Pregnant or 6 months postpartum                                                             | Yes | No |
| Smoker                                                                                      | Yes | No |
| Present with psychiatric disorder which might effect on the outcomes                        | Yes | No |
| Able to follow comment                                                                      | Yes | No |

Notes: -----  
-----  
-----

## Appendix 5 Online information sheet and consent form on Google form (English and Arabic visions) (<https://forms.gle/GsKkYpJehMZqXf5a7>)



University of Bahrain  
College of Health and Sport Sciences  
Allied Health Department



### Information and Consent Sheets

We invite you to take part in a research study conducted by Fatima Mohamed a masters degree student at the University of Bahrain, as part of her study to examine and compare The Effectiveness of Online Core Stability Program and Deep Breathing Training in Rehabilitating Female Patients with Functional Lumbar Instability

#### 1. Introduction and Purpose of the Study

Low back pain is a recurrent issue faced by most people at some point in their lifetime. The purpose of this study is to compare three effective methods on the intensity of back pain, functional disability, quality of life and endurance of core muscles during rehabilitating female patients with chronic LBP and lumbar spine instability aged 25 to 40 years at two and four weeks.

#### 2. Description of the Research

When you enter the study will be examined by a specialist physiotherapist (researcher) in a video call after uploading the application and answering the questionnaires. Then, you will be under four weeks of program training that will be implemented three times in a week. Following the criteria of attending 20 to maximum 50 minutes online physiotherapy sessions under the supervision of the physiotherapist in a video call once a week, while the rest sessions will be done in an individual by the participant following instructed video given by the physiotherapist.

#### 3. Subject Participation

We estimate 60 participants or more who complain of chronic low back pain and lumbar instability symptoms will enroll in this study. Participants must be

- o Female and aged between 25 to 40 years.
- o Complain of chronic low back pain started from a minimum of 12 weeks (No previous spine surgeries, fractures, or other serious issues)
- o Suffering of lumbar instability symptoms and low endurance of abdominal muscles
- o Medically stable
- o Participant not under any other treatments during training period time

#### 4. Potential Risks and Discomforts:

There are no risks to your safety. You might have mild dizziness during the exercises and muscle sourness and fatigue after the exercises and for a couple of days. In this case, you can apply a hot pack, apply stretching, and breathing exercises to relieve the symptoms. Nevertheless, in case of severe back pain, muscle sourness, or chest pain and difficulty in breathing for more than two days, you should inform the researcher.

#### 5. Potential Benefits

Participate in this study may have less back pain, functional disability, and stronger deep abdomen muscles.

#### 6. Confidentiality

All your information details will be ensured

#### Authorization

#### 7. Voluntary Participation and Authorization Participants

Your decision to participate in this study is completely voluntary. If you decide not to participate in this study, it will not affect the care, services, or benefits you are entitled to

#### 8. Withdrawal from the Study and/or Withdrawal of Authorization Participants

If you decide to participate in this study, you may withdraw from your participation at any time without penalty.

#### 9. Cost/Reimbursements

There is no cost for participating in this study.

#### 10. Conflict of Interest

Study no conflict any interest

### Informed Consent Sheet

I hereby gave my consent to participate in the research project:

Researcher's Name: Fatima Mohammed J

Course Title: Applied Research Project

I, the undersigned, confirm that: (please circle as appropriate)

1. I have read and understood the information regarding the study and full procedure well explained in the information sheet. \*

☐ Yes

☐ No

2. I understand the benefit of participating in the study. \*

☐ Yes

☐ No

3. I understand that there might be some adverse effects of participating in the exercises program and that the possible risk was explained well to me. \*

☐ Yes

☐ No

4. The procedure regarding confidentiality clearly explained to me (anonymization of name, personal information and etc.) \*

☐ Yes

☐ No

5. I voluntarily agree to participate in all stages of the study. \*

☐ Yes

☐ No

6. understand that I have the right to withdraw at any time without asking for clarification. \*

☐ Yes

☐ No

7. I have been allowed to ask questions and the project and my participation. I have the right to ask further questions in the future. \*

☐ Yes

☐ No

8. I understand that, if there is any concern about the appropriateness of my continuing in this research, I may be asked to withdraw my involvement at any stage. \*

☐ Yes

☐ No

9. All the information that I gave to the researcher are true and accurate to the best of my knowledge and I understand that must notify if there are any changes of the information. \*

☐ Yes

☐ No

10. I, along with the researcher, agree to sign and date this informed consent. \*

☐ Yes

☐ No

11. I have been agreed to have a video call with the therapist for assessment and treatment. \*

☐ Yes

☐ No

11. I have been agreed to have a video call with the therapist for assessment and treatment. \*

☐ Yes

☐ No

12. What is a good time for you to attend an online physiotherapy session. \*

☐ Morning

☐ Afternoon

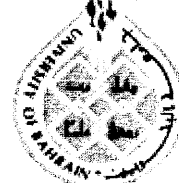
☐ Night

☐ Any time

# Arabic version of information and consent forms on Google form (<https://forms.gle/KeyNSWbGwp6SyDJi7>)



جامعة البحرين  
كلية العلوم الصحية والرياضية  
قسم العلاج الطبيعي



## مختصر للبحث و إستمارة موافقة المشاركة

تتبعكم للمشاركة في دراسة بحثية تجريبية فظنية محمد جعفر - طالبة ماجستير في جامعة البحرين، كجزء من دراستها قبلد فاعلية برنامج التثقيف الوظيفي وتدريب على التنفس العميقة عن بعد في تأهيل النساء الاتي يحتن من عدم الاستقرار القلبي الوظيفي.

1. مقدمة للدراسة  
الدراسة تهدف الى معرفة مدى فاعلية برنامج التثقيف الوظيفي وتدريب على التنفس العميقة عن بعد في تأهيل النساء الاتي يحتن من عدم الاستقرار القلبي الوظيفي. الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين. الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين. الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين.
2. وصف البحث  
الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين. الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين. الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين.
3. موصفات المشاركين في البحث  
تتبعكم للمشاركة في دراسة بحثية تجريبية فظنية محمد جعفر - طالبة ماجستير في جامعة البحرين، كجزء من دراستها قبلد فاعلية برنامج التثقيف الوظيفي وتدريب على التنفس العميقة عن بعد في تأهيل النساء الاتي يحتن من عدم الاستقرار القلبي الوظيفي.
4. موصفات المشاركين  
1- خلت ترويج اعمارهم بين 25 و 40 سنة  
2- يشكون من آلام أسفل الظهر المزمنة التي بدأت من 12 أسبوعاً على الأقل (بعد الخضوع لأي عمليات جراحية في الموضع)  
3- لا يعانون من مشاكل خطيرة أخرى.  
4- لا يعانون من أمراض مزمنة.  
5- لا يعانون من مشاكل أخرى خلال فترة التقييم.
5. فوائد المحتملة  
الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين. الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين. الدراسة هي دراسة تجريبية فظنية تجرى في جامعة البحرين.
6. السرية  
سيتم ضمان جميع تفاصيل معلوماتكم الخاصة.
7. الموافقة  
المشاركة الطوعية والتفويض للمشاركين  
إن قراركم بالمشاركة في هذه الدراسة طوعي تماماً. وفي حال عدم مشاركتكم في هذه الدراسة لن يؤثر ذلك على الرعاية أو الخدمات التي تحصلون عليها.
8. الانسحاب من الدراسة و / أو الانسحاب من المشاركين في التقييم  
إن قراركم بالمشاركة في هذه الدراسة، يمكنكم الانسحاب في أي وقت دون عاقبة.
9. التكلفة / الحد  
لا توجد تكلفة للمشاركة في هذه الدراسة.
10. تضارب المصالح  
دراسة أي تضارب في أي مصلحة.

الموافق

إستمارة مؤهلة للمشاركة  
 مع اسماء: فضيلة محمد  
 عنوان المقر: مشروع تحت التطوير

أنتج لنا مؤلفتي على المشاركة في البحث موارد: قاعدة برنامج الثالث بوسيطي ونتمرد على التفكير العسفة عن بعد في تأمل فلسفي. أنتج  
 بحثي من عند الاستغناء للفكر المؤسسي.

الاسم \*

إجابتي

1. لقد قرأت وفهمت المعلومات المتعلقة بالدراسة والإجراءات الكاملة الموضحة جيداً في ورقة المعلومات السابقة \*

نعم ☐

لا ☐

2. لقد فهمت الفائدة من المشاركة في الدراسة \*

نعم ☐

لا ☐

3. أظن أعلم بأن بكاء يكون هناك بعض الآثار السلبية البسيطة للمشاركة في برنامجي: التمارين وأن الخطر المحتمل قد  
 تم شرحه جيداً بنسبة لي. \*

نعم ☐

لا ☐

4. تم شرح لي الإجراءات المتعلقة بالسرية بوضوح (استخدام الاسم ، المعلومات الشخصية ، وما إلى ذلك) \*

نعم ☐

لا ☐

5. أظن أوافق على المشاركة المطلوبة في جميع مراحل الدراسة \*

نعم ☐

لا ☐

6. الذي اعطى ان الحق لي الانسحاب في أى وقت دون طلب التوضيح \*

☐ نعم

☐ لا

7. سمح لي بطرح الأسئلة. وندى الحق في طرح المزيد من الأسئلة في المستقبل \*

☐ نعم

☐ لا

8. أفهم أنه إذا كان هناك أى قلق بشأن مدى ملائمة استمراري في هذا البحث، فقد يُطلب منى سحب مشاركتي في أى مرحلة \*

☐ نعم

☐ لا

9. جميع المعلومات التي قدمتها للباحث صحيحة ودقيقة على حد علمي وأفهم أنه يجب أن يخطر بذا كانت هناك أى تغييرات في المعلومات \*

☐ نعم

☐ لا

10. أوافق مع الباحث على توقيع هذه الموافقة المستنيرة وتاريخها \*

☐ نعم

☐ لا

11. أوافق حضور الجلسة بفتح الكاميرا مع الباحث للتحقق والتشخيص والدلاج \*

☐ نعم

☐ لا

12. ماهي الاوقات المناسبة لك لحضور جلسة العلاج الطبيعي عن بعد \*

☐ صبيحا

☐ عصرا

☐ ليل

☐ جميع ما ذكر نفسي

## Appendix 6 Researcher re-evaluation sheet (Baseline, after two and four weeks of intervention)



University of Bahrain  
College of Health and Sport Sciences  
Allied Health Department



### Evaluation and Re- Evaluation Sheet

Participant Number: -----

Date: -----

Participant contact number/ email: -----

#### *Outcome measure and examination scores*

- VAS -----
- ODI score -----
- Endurance of core muscle PBT score -----

Comments/ notes -----

-----

## Appendix 7 Numeric Pain Rating Scale (NPRS) English version on (Google form) (page 1 and 2) (<https://forms.gle/SKpRcQGUEtYVPdVC8>)

### Evaluation sheet

The current form consists of three parts

- 1) Intensity of back pain
- 2) Functional disabilities due to back disorders and pain
- 3) Quality of life

\*Required

Today's date \*

Date

mm/dd/yyyy 

Serial participation number ( given by the physiotherapist) \*

Your answer

### Evaluation sheet

\*Required

#### First part ( intensity of back pain)

How much you can express your back pain within these two days \*



#### Scoring and interpretation:

(0 - 0.4 cm) = No pain

(0.5 cm - 4.4 cm) = Moderate pain

(4.5 cm - 7.4 cm) = Moderate pain

(7.5 cm - 10 cm) = Severe pain

your answer need to be a number (e.g 4.1)

Your answer

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## Appendix 8 Oswestry Disability Index (ODI) English version on (Google form) (page 3)

### Evaluation sheet

\*Required

#### Second part ( functional disabilities)

This part consist of 10 questions/sections  
You need to answer one question  
0= no pain and disability  
5= more pain and highest disability

##### Section 1 - Pain Intensity \*

- ☐ 0= I have no pain at the moment
- ☐ 1= The pain is very mild at the moment
- ☐ 2= The pain is moderate at the moment
- ☐ 3= The pain is fairly severe at the moment
- ☐ 4= The pain is very severe at the moment
- ☐ 5= The pain is the worst imaginable at the moment

##### Section 2 - Personal Care (e.g., Washing, Dressing) \*

- ☐ 0= I can look after myself normally without causing extra pain
- ☐ 1= I can look after myself normally but it is very painful
- ☐ 2= It is painful to look after myself and I am slow and careful
- ☐ 3= I need some help but manage most of my personal care
- ☐ 4= I need help every day in most aspects of self care
- ☐ 5= I do not get dressed, wash with difficulty and stay in bed

### Section 3 - Lifting \*

- ☐ 0= I can lift heavy weights without extra pain
- ☐ 1= I can lift heavy weights but it gives extra pain
- ☐ 2= Pain prevents me lifting heavy weights off the floor, but I can manage if they are conveniently placed, for example on a table
- ☐ 3= Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned.
- ☐ 4= I can lift only very light weights.
- ☐ 5= I cannot lift or carry anything at all.

### Section 4 - Walking \*

- ☐ 0= Pain does not prevent me from walking any distance.
- ☐ 1= Pain prevents me from walking more than 1 mile. (1 mile = 1.6 km)
- ☐ 2= Pain prevents me from walking more than 1/4 mile.
- ☐ 3= Pain prevents me from walking more than 100 yards.
- ☐ 4= I can walk only with crutches or a stick.
- ☐ 5= I am in bed most of the time and have to crawl to the toilet.

### Section 5 - Sitting \*

- ☐ 0= I can sit in any chair as long as I like
- ☐ 1= I can sit in my favourite chair for as long as I like
- ☐ 2= Pain prevents me from sitting for more than 1 hour.
- ☐ 3= Pain prevents me from sitting for more than ½ an hour
- ☐ 4= Pain prevents me from sitting for more than 10 minutes
- ☐ 5= Pain prevents me from sitting at all.

Section 6 - Standing \*

- ☐ 0= I can stand as long as I want without extra pain.
- ☐ 1= I can stand as long as I want but it extra my pain.
- ☐ 2= Pain prevents me from standing for more than 1 hour.
- ☐ 3= Pain prevents me from standing for more than ½ an hour.
- ☐ 4= Pain prevents me from standing for more than 10 minutes.
- ☐ 5= Pain prevents me from standing at all.

Section 7 - Sleeping \*

- ☐ 0= My sleep is never disturbed by pain.
- ☐ 1= My sleep is occasionally disturbed by pain.
- ☐ 2= Because of pain I have less than 6 hours sleep.
- ☐ 3= Because of pain I have less than 4 hours sleep.
- ☐ 4= Because of pain I have less than 2 hours sleep.
- ☐ 5= Pain prevents me from sleeping at all.

Section 8 - Sex Life ( if applicable )

- ☐ 0= My sex life is normal and causes no extra pain.
- ☐ 1= My sex life is normal but causes some extra pain.
- ☐ 2= My sex life is nearly normal but is very painful.
- ☐ 3= My sex life is severely restricted by pain.
- ☐ 4= My sex life is nearly absent because of pain.
- ☐ 5= Pain prevents any sex life at all

Section 9 - Social Life \*

- ☐ 0= My social life is normal and causes me no extra pain.
- ☐ 1= My social life is normal, but increases the degree of pain.
- ☐ 2= Pain has no significant effect on my social life apart from limiting my more energetic interests (e.g., sports, dancing).
- ☐ 3= Pain has restricted my social life and I do not go out as often.
- ☐ 4= Pain has restricted my social life to my home.
- ☐ 5= I have no social life because of my pain.

Section 10 - Traveling `

- ☐ 0= I can travel anywhere without pain.
- ☐ 1= I can travel anywhere, but it gives extra pain.
- ☐ 2= Pain is bad but I manage journeys of over 2 hours.
- ☐ 3= Pain restricts me to journeys of less than 1 hour.
- ☐ 4= Pain restricts me to short necessary journeys under 30 minutes
- ☐ 5= Pain prevents me from travelling except to receive treatment

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**Appendix 9** Numeric Pain Rating Scale (NPRS)- Arabic  
version on (Google form) (page 1 and 2) (  
<https://forms.gle/jXXDTko85Lgx9bsBA> )

**استمارة التقييم**

الاستمارة التالية تتكون من ثلاثة اقسام

(1) تقييم شدة ألم الظهر  
(2) قياس مدى تأثير مشاكل و ألم الظهر على حياتك  
(3) قياس جودة الحياة

مطلوب

التاريخ \*

التاريخ

mm/dd/yyyy

رقم الكشيشن ( الرقم المعطى من الأخصائية ) \*

إحداثك

صفحة 1 من 4

**استمارة التقييم**

مطلوب

**القسم الأول ( تقييم شدة ألم الظهر )**

كم تقييم نسبة ألم الظهر خلال هذا الاسبوع \*

10 9 8 7 6 5 4 3 2 1 لا يوجد ألم

ألم شديد جداً (أكثر مما تتصور)

**التقييم:**

(صفر - 0,4 سم ) = لا يوجد ألم

( 4,5 سم - 6,4 سم ) = ألم متوسط

( 6,5 سم - 10 سم ) = ألم شديد جداً

قياسية الألف مرقمة ( مثلا : 4,1 )

إحداثك

صفحة 2 من 4

## Appendix 10 Oswestry Disability Index (ODI)- Arabic version on (Google form) (page 3)

### استمارة التقييم

\*مطلوب

#### القسم الثاني (عنا مدى تأثير مشاكل وآلم الظهر على حياتك)

القسم الثاني يتكون من عشر أسئلة فقرات عليك اختيار اجابة واحدة في كل قسم (من 0 الى 5)  
0 = أقل شدة و تعيد  
5 = أكثر شدة و تعيد

#### الفقرة الاولى: شدة الآلام \*

- ☐ 0 = ليس لدي آلام في أسفل ظهري حثيثا.
- ☐ 1 = أشعر حثيثا بالآلام خفيفة في أسفل ظهري.
- ☐ 2 = أشعر حثيثا بالآلام متوسطة في أسفل ظهري.
- ☐ 3 = أشعر حثيثا بالآلام شديدة إلى حد ما في أسفل ظهري.
- ☐ 4 = أشعر حثيثا بالآلام شديدة أسفل ظهري.
- ☐ 5 = أشعر حثيثا بالآلام في أسفل ظهري أكثر مما يمكن تصورها.

#### الفقرة الثانية: العداية الشخصية – كالأعمال وليس التثايل \*

- ☐ 0 = يمكنني أن أصني بنفسى وأهمل بالأمورى الخاصة بشكل طبيعى دون أن يزيد ذلك فى الآلام أسفل ظهري.
- ☐ 1 = يمكنني أن أصني بنفسى وأهمل بالأمورى الخاصة ولكن أن يزيد ذلك فى الآلام أسفل ظهري.
- ☐ 2 = يمكنني أن أصني بنفسى وأهمل بالأمورى الخاصة ولكن بأخذ ذلك منى وقتا أطول من المعتاد.
- ☐ 3 = أحتاج إلى بعض المساعدة ولكن يمكننى القيام ببعض أمورى الخاصة بنفسى.
- ☐ 4 = أحتاج إلى المساعدة بشكل يومى لتقيام بالأمورى الخاصة.
- ☐ 5 = أبقى فى سريري وأصل بصعوبة ولا أستطيع أن أليس ثيابى.

الفقرة الثالثة: رفع الأشياء ونقلها \*

- ☐ 0= أَسْطِيعُ أَنْ أَرْفَعَ الْأَشْيَاءَ الثَّقِيلَةَ مِنْ غَيْرِ أَنْ يَزِيدَ ذَلِكَ الْأَلَامَ أَسْفَلَ ظَهْرِي.
- ☐ 1= أَسْطِيعُ أَنْ أَرْفَعَ الْأَشْيَاءَ الثَّقِيلَةَ وَلَكِنْ ذَلِكَ يَزِيدُ ذَلِكَ الْأَلَامَ أَسْفَلَ ظَهْرِي.
- ☐ 2= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنْ رَفْعِ الْأَشْيَاءِ الثَّقِيلَةِ إِذَا كَانَتْ عَلَى الْأَرْضِ لَكِنْ يَمَكِّنُنِي رَفْعُهَا إِذَا كَانَتْ فِي مَكَانٍ مَرْتَفِعٍ - عَالٍ - كَالطَّوَلَةِ مَثَلًا.
- ☐ 3= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنْ رَفْعِ الْأَشْيَاءِ الثَّقِيلَةِ لَكِنْ يَمَكِّنُنِي رَفْعِ الْأَشْيَاءِ الْخَفِيفَةِ وَمُتَوَسِّطَةِ الْوِزْنِ إِذَا كَانَتْ فِي مَكَانٍ مَرْتَفِعٍ - عَالٍ.
- ☐ 4= أَسْطِيعُ رَفْعَ الْأَشْيَاءِ خَفِيفَةِ الْوِزْنِ فَحَسْبُ.
- ☐ 5= لَا أَسْطِيعُ رَفْعَ أَوْ حَمْلَ أَيِّ شَيْءٍ عَلَى الْأَضْطِّاقِ.

الفقرة الرابعة: المشي \*

- ☐ 0= لَا تَمْنَعُنِي الْأَلَامَ أَسْفَلَ ظَهْرِي مِنَ الْمَشْيِ لِأَيِّ مَسَافَةٍ (كَالْمَشْيِ بِجَوَارِ الْمَنْزِلِ).
- ☐ 1= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنَ الْمَشْيِ أَكْثَرَ مِنْ أَلْفٍ وَخَمْسَمِائَةِ مِترٍ (كَيْلُو وَنِصْفَ).
- ☐ 2= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنَ الْمَشْيِ أَكْثَرَ مِنْ أَلْفِ مِترٍ (كَيْلُو وَاحِدَ).
- ☐ 3= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنَ الْمَشْيِ أَكْثَرَ مِنْ أَرْبَعَمِائَةِ مِترٍ (400 مِترَ).
- ☐ 4= لَا أَسْطِيعُ الْمَشْيَ دُونَ الْأَسْعَادَةِ بِعَصَا أَوْ عَكَازٍ.
- ☐ 5= أَبْقَى فِي الْفَرَاشِ مَعْظَمَ الْوَقْتِ وَتَرْجُفُ التَّوَصُّلُ إِلَى الْمَرَحَضِ (نُورَةِ الْمِيَاهِ).

الفقرة الخامسة: الجلوس \*

- ☐ 0= يَمَكِّنُنِي الْجُلُوسُ عَلَى أَيِّ كُرْسِيٍّ الْمُدَّةَ الَّتِي أُرِيدُهَا.
- ☐ 1= يَمَكِّنُنِي الْجُلُوسُ فَقَطْ عَلَى كُرْسِيٍّ مَرِيجِ الْمُدَّةَ الَّتِي أُرِيدُهَا.
- ☐ 2= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنَ الْبَقَاءِ جَالِسًا عَلَى أَيِّ كُرْسِيٍّ أَكْثَرَ مِنْ سَاعَةٍ.
- ☐ 3= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنَ الْبَقَاءِ جَالِسًا عَلَى أَيِّ كُرْسِيٍّ أَكْثَرَ مِنْ نِصْفِ سَاعَةٍ.
- ☐ 4= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنَ الْجُلُوسِ لِأَكْثَرَ مِنْ عَشْرِ دَقَائِقَ.
- ☐ 5= الْأَلَامَ أَسْفَلَ ظَهْرِي تَمْنَعُنِي مِنَ الْجُلُوسِ مُطْلَقًا.

الفقرة السادسة: الوقوف \*

- ☐ 0 = أستطيع البقاء واقفا المدة التي أريدها دون أن يزيد ذلك في الأيام أسفل ظهري.
- ☐ 1 = أستطيع البقاء واقفا المدة التي أريدها ولكن ذلك يزيد ذلك في الأيام أسفل ظهري.
- ☐ 2 = الأيام أسفل ظهري تمنعني من الوقوف لأكثر من ساعة.
- ☐ 3 = الأيام أسفل ظهري تمنعني من الوقوف لأكثر من نصف ساعة.
- ☐ 4 = الأيام أسفل ظهري تمنعني من الوقوف لأكثر من عشر دقائق.
- ☐ 5 = الأيام أسفل ظهري تمنعني من الوقوف مطلقا.

الفقرة السابعة: النوم \*

- ☐ 0 = نومي لا يضطرب أبدا بسبب الأيام أسفل ظهري.
- ☐ 1 = يضطرب نومي أحيانا بسبب الأيام أسفل ظهري.
- ☐ 2 = أنام أقل من 6 ساعات يوميا بسبب الأيام أسفل ظهري.
- ☐ 3 = أنام أقل من 4 ساعات يوميا بسبب الأيام أسفل ظهري.
- ☐ 4 = أنام أقل من ساعتين يوميا بسبب الأيام أسفل ظهري.
- ☐ 5 = لا أستطيع النوم مطلقا بسبب الأيام أسفل ظهري.

لفقرة الثامنة: الحياة الجنسية (هذه الفقرة للمتزوجين أو من سبق لهم الزواج ومزسوا الحياة الجنسية، إذا لم ينطبق عليك هذا الشرط الرجاء الانتقال للفقرة الثانية 9)

- ☐ 0 = حياتي الجنسية عادية ولا تسبب زياده في الأيام أسفل ظهري.
- ☐ 1 = حياتي الجنسية عادية ولكنها تسبب زياده في بعض الأيام أسفل ظهري.
- ☐ 2 = حياتي الجنسية تكاد تكون عادية ولكنها تسبب ولكنها تسبب لي آلاما شديدة أسفل ظهري.
- ☐ 3 = حياتي الجنسية تارة جدا بسبب الأيام أسفل ظهري.
- ☐ 4 = حياتي الجنسية تقريبا مقطوعة بسبب الأيام أسفل ظهري.
- ☐ 5 = الأيام أسفل ظهري تمنعني من الحياة الجنسية مطلقا.

الفقرة التاسعة: الحياة الاجتماعية (زيارة واستقبال الأقارب والأصحاب والخروج مع الأصدقاء والمشاركة في الاحتفالات أو الأنشطة الاجتماعية ... الخ) \*

- ☐ 0= حياتي الاجتماعية عادية ولا تزيد في الألام أسفل ظهري.
- ☐ 1=حياتي الاجتماعية عادية ولكنها تزيد في الألام أسفل ظهري.
- ☐ 2= الألام أسفل ظهري لا تؤثر على حياتي الاجتماعية ولكنها تقلل من أعمالي التي تتطلب مجهوداً كبيراً.
- ☐ 3= تكثر حياتي الاجتماعية وتقلصت علاقتي مع الآخرين بسبب الألام أسفل ظهري.
- ☐ 4= بسبب الألام أسفل ظهري أصبح حياتي الاجتماعية منحصرة في المنزل.
- ☐ 5= حياتي الاجتماعية انقطعت بسبب الألام أسفل ظهري.

الفقرة العاشرة: السفر \*

- ☐ 0= أستطيع السفر إلى أي مكان من غير أن يزيد في الألام أسفل ظهري.
- ☐ 1=أستطيع السفر إلى أي مكان ولكنه يزيد في الألام أسفل ظهري.
- ☐ 2=الألام أسفل ظهري شديدة ولكني أستطيع تحمل السفر في حدود ساعة.
- ☐ 3= الألام أسفل ظهري تقيد رحلتي (سفري) لأقل من ساعة.
- ☐ 4= الألام أسفل ظهري تقيد رحلتي القصيرة الضرورية (سفري القصير) لأقل من نصف ساعة.
- ☐ 5= الألام أسفل ظهري تمنعني من السفر ماعدا الذهاب إلى العلاج.

## Appendix 11 Example of calculating outcome measures scores through (www.orthotoolkit.com)

orthotoolkit 

### Oswestry Disability Index Score Summary

Patient ID: participant 1

Date Completed: 10/30/2020

Section 1: Pain Intensity (2 points)  
The pain is moderate at the moment

Section 2: Personal Care (Washing, Dressing, etc.) (2 points)  
It is painful to look after myself but I am slow and careful

Section 3: Lifting (1 points)  
I can lift heavy weights but it gives extra pain

Section 4: Walking (0 points)  
Pain does not prevent me walking any distance

Section 5: Sitting (1 points)  
I can only sit in my favorite chair as long as I like

Section 6: Standing (1 points)  
I can stand as long as I want but it gives me extra pain

Section 7: Sleeping (1 points)  
My sleep is occasionally disturbed by pain

Section 8: Sex life (if applicable) (0 points)  
My sex life is normal and causes no extra pain

Section 9: Social life (2 points)  
Pain has no significant effect on my social life apart from limiting my more energetic interests eg. sport

Section 10: Travelling (0 points)  
I can travel anywhere without pain

Pertinent Negative

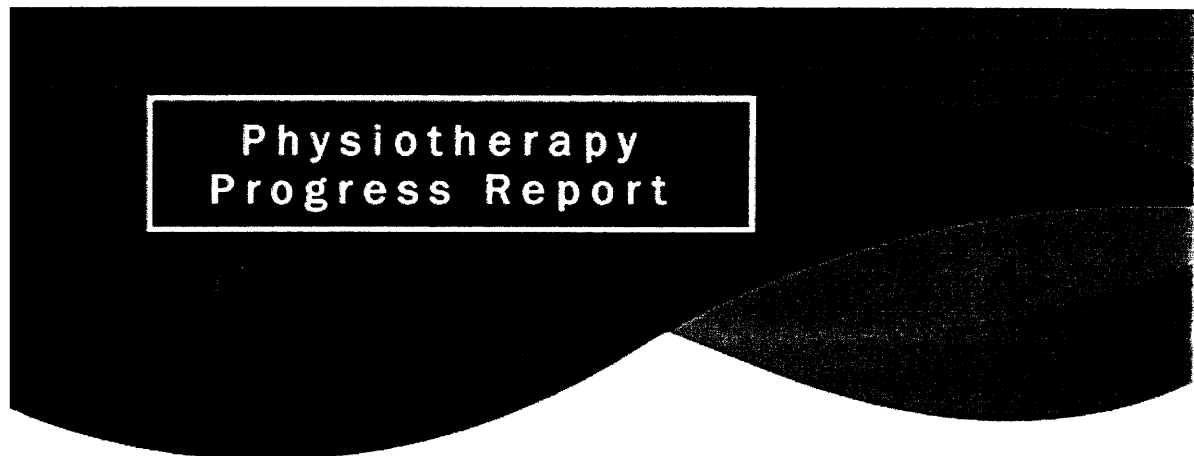
Pertinent Positive

Pertinent Positive

**Oswestry Disability Index Score:**  
10 points or 20 percent.

**Graphical Oswestry Disability Index Score**

## Appendix 12 An example of a patient's progress report



To: Whom It may concern  
Re: [REDACTED]

18/6/2021

Four weeks of online Physiotherapy rehabilitation have been given to the participant shows the following differences:

|                            | Before rehabilitation | After Two weeks | After four weeks |
|----------------------------|-----------------------|-----------------|------------------|
| The intensity of back pain | 5                     | 2.5             | 1                |
| Functional disabilities    | 24%                   | 8%              | 6%               |
| Core muscles Endurance     | 32.5 sec              | 65 sec          | 96 sec           |

Fatima Alkhouzael  
Physiotherapist

## الملخص

**المقدمة:** يوجد علاقة بين عدم ثبات فقرات الظهر القطنية المرتبط بالوظائف مع ألم أسفل الظهر المزمن. توجد تمارين علاجية مختلفة لتعزيز ثبات العمود الفقري، مثل تمارين ثبات الجذع وتمارين التنفس العميقة. رغم ذلك، لا توجد دراسات اختبرت فعالية هذه التمارين كبرنامج عن بعد عبر الإنترنت على المرضى الذين يعانون من ألم أسفل الظهر المزمن عدم ثبات فقرات الظهر القطنية المرتبط بالوظائف.

**الهدف:** تقييم ومقارنة الفاعلية قصيرة المدى لثلاثة أنواع من التمارين العلاجية التي تقدم عن بعد: (١) تمارين ثبات الجذع (CSE)، (٢) تمارين التنفس العميقة (DBT)، (٣) والجمع بين البرنامجين (DBT+CSE) في الإناث البالغات اللاتي يشتكون من ألم أسفل الظهر المزمن عدم ثبات فقرات الظهر القطنية المرتبط بالوظائف.

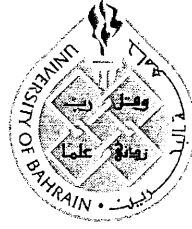
**المنهجية:** كانت هذه دراسة شبه تجريبية شملت ثمانية وسبعين امرأة تتراوح أعمارهن بين ٢٥ و ٤٠ سنة، تم توزيعهن على واحدة من الثلاث البرامج العلاجية أو في مجموعة التحكم (قائمة الانتظار). أدت المريضات التمارين في البرامج العلاجية ثلاث مرات في الأسبوع لمدة أربعة أسابيع، وقد تم قياس شدة ألم أسفل الظهر، والإعاقة الوظيفية، وقدرة تحمل ثبات عضلات الجذع. جميع القياسات الثلاث أجريت قبل بدء البرنامج، وفي الأسبوع الثاني، وفي الأسبوع الرابع من العلاج.

**النتائج:** أظهر المريضات في المجموعات العلاجية الثلاث تحسناً ملحوظاً في جميع القياسات في نهاية الأسبوع الرابع من العلاج، ماعدا المريضات في مجموعة التحكم حيث لم يظهر عليهن التحسن في أي من هذه القياسات. رغم ذلك، لم توجد فروقات إحصائية أو سريرية بين البرامج العلاجية الثلاثة في أي من القياسات، عدا أن مجموعة الجمع بين البرنامجين (DBT+CSE) تفوقت إحصائياً (وليس سريرياً) على تمارين التنفس العميقة (DBT) في قدرة ثبات عضلات الجذع (PBT).

**الخلاصة:** أظهرت النتائج أن أي من البرامج العلاجية الثلاثة عن بعد خفف شدة ألم أسفل الظهر وحسن الحالة الوظيفية وقدرة تحمل عضلات الجذع بشكل فعال، وبدون تفوق أي برنامج عن الثاني في الفاعلية. عليه، نوصي بمزيد من الدراسات للتحقق من فعالية هذه التمارين عن بعد من خلال مقارنة هذه البرامج العلاجية عن بعد مع البرامج التقليدية التي تطبق داخل العيادة.

جامعة البحرين

قسم العلاج الطبيعي



كلية العلوم الصحية والرياضية

## فعالية برنامج الثبات الوسطي وتمارين التنفس العميقة عن بعد في تأهيل النساء الاتي يعانين من عدم الاستقرار القطني الوظيفي

أطروحة مقدمة كجزء من متطلبات الحصول على درجة الماجستير في العلاج الطبيعي

اعداد

فاطمة محمد جعفر محمد

الرقم الجامعي: ٢٠١٢٠٥٩٩

اشراف

د. يوسف سيد شرف

(أستاذ مساعد)

جامعة البحرين

مملكة البحرين

اكتوبر ٢٠٢٢