Literature Review of Exercise Therapy in Non-Invasive Low Back Pain: The Role of Motor Control Exercises

By

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CHAPTER 1

INTRODUCTION

1.1. Introduction:

This chapter accounts for the definition of low back pain, its types such as acute, sub-acute and chronic according to the time period and severity. Chronic non-specific low back pain will be discussed in detail in relation to its terms and causes. There will be discussion on the low back pain and its associated direct and indirect costs in terms of work days lost and related disability. A brief review will be presented concerning conventional methods to treat low back pain. And finally, motor control exercises will be enlightened for its usefulness and long-term effects.

1.2. Low Back Pain:

Low back pain is common, whether it is measured as a symptom in the general population, as a source of disability, as a reason for seeking health care or as a cause of both short and long-term work loss (Rice and Pallord 2002). In any one year 38% of adults experience at least one day of low back pain (LBP). This does not include menstrual pain or pain accompanying a feverish illness. Some 10% of adults in any one-month experience limitations at work place or restriction on other leisure activities as a result of low back pain (Rice and Pallord 2002). The course of low back pain in an individual's lifetime is often recurrent,

intermittent and episodic and for 5% of adults it becomes a more persistently disabling condition (Rice and Pallord 2002). The type of low back pain depends upon the extent, severity and the time span of the pain. Acute low back pain or backache is the pain that lasts for six weeks or less and does not extend below the knees. It usually improves after a few days of simple care, though painful (Nicollet 2008). Low back pain that lasts for six weeks or less but which extends below the knees is called as acute sciatica. It takes long time to improve than with acute low back pain. Chronic low back pain and sciatica pain lasts longer than six weeks with no significant improvement and specialized treatment may be needed **(**Nicollet 2008). A number of factors can cause low back pain. Poor posture, twisting awkwardly, incorrect lifting, overweight, traumatic injury, congenital condition, wearing high heels, sleeping on poor quality mattress or ordinary aging of the spine can all lead to musculoskeletal low back pain. Nerve root syndromes producing symptoms of nerve impingements like sciatica, herniated discs can also be the cause of pain (Joshi and Kotwal 2008). In addition, musculoskeletal pain syndromes like myofascial pain syndromes, fibromyalgia affects low back. Other causes can be osteoporosis, vertebral fractures or tumors producing symptoms of low back pain (Joshi and Kotwal 2008).

1.3. Economic Burden:

Low Back Pain (LBP) is a major health and economic problem in modern western society. The prognosis is generally considered to be good for a new episode of low back pain with 90% of low back pain reducing within 12 weeks. However, few people will develop a chronic low back pain disorder (Dagenais et al 2008). Chronic low back pain is costly in with respect to indirect treatment costs and direct costs such income compensation with permanent disability and work days lost. It is well established that chronic low back pain is a multidimensional problem with mechanical, neurophysiologic, psychological and social factors; all influencing its

presentation and prognosis (Katz 2006). The focus and challenge of recent research is on finding effective treatment on chronic low back pain in long terms.

Low back pain (LBP) is defined as pain that is perceived as arising in the region bounded by the 12th rib and the inferior gluteal folds and may also be associated with or without leg pain (Krismer and Tulder 2007). In almost all musculoskeletal conditions, low back pain is most common. Anderson (1999) stated that 70-85% of adults will suffer at least one episode of back pain at some point in their lives. Chronic pain is defined as pain persisting with more than three months which will be developed by approximately 10-20% of the patients. Patients with chronic low back pain are usually associated with reduced physical function and psychological distress. These patients account for more than 80% of health care resources for back problems and intervention insufficient success rate (Maher et al 2005). In 2002, in recognition of the major health and economic burden; arthritis and musculoskeletal disorders were announced as the new Nationality Health Priority Area in Australian community (National Aging Research Institute 2006). Back pain is the both most prevalent and expensive disease amongst these groups of diseases. The 2001 National Health Survey revealed that chronic back pain is the most prevalent illness from the seven National Health Priorities Areas (Maher et al 2005).

1.4. Chronic Non-Specific Low Back Pain:

The term ‘chronic low back pain’ is used when the pain lasts for more than three months which is a major health problem as well as social and economic burden. Approximately 80% of all health care costs of back pain is reserved by the population of people with chronic low back pain is responsible (Maher 2004). Low back pain can be symptomatic with serious spinal pathology, nerve root compromise or damage to a serious structure of lumbar spine in a small

proportion of cases; however, valid clinical diagnosis can be decided in an estimated 5-10% of patients with low back pain (Krismer and Tulder 2007). It has identified difficult to classify as low back pain when there is no evidence of any underlying pathology, detectable tissue damage or nerve injury. This has given rise to the concept of 'non-specific low back pain' (Nordin et al 2006). Approximately 90% of low back pain including both acute and chronic is considered as non-specific (Krismer and Tulder 2007). Non-specific low back pain also known as ordinary or 'simple backache' and 'common back pain' is mechanical low back pain of musculoskeletal origin in which symptoms differ with physical activities (Waddell 2004). Non-specific low back pain may be associated with mechanical stress or dysfunction, although it often develops spontaneously and can lead painful and disabling condition. However, clinician identifies very little information about the source of pain from the severity or intensity of the pain. Back pain often advances to both buttocks or thighs and this is usually somatic referred pain which is not a sign of nerve root compression (Joshi and Kotwal 2008).

1.5. Conventional Treatment for Low Back Pain:

Traditional ways to treat low back pain are moist heat, cryotherapy, diathermy, spinal exercises like flexion, extension and mobility exercises, spinal traction and other special techniques like manipulation and mobilization (Joshi and Kotwal 2008). There is also an important role of core stability exercises for the strengthening of the corset of muscles surrounding the back and abdomen (Kisner and Colby 2002). Stability and control of the spine has been proposed as important factors in the genesis and persistence of nonspecific low back pain (Panjabi 2003). Impairments in the control of the deep trunk muscles which are responsible for maintaining the stability of the spine have been identified in the studies of individuals with low back pain (Gwendolen and Richardson 2000).

1.6. Motor Control Exercises:

Motor control exercises are specific kind of exercises which can be biased for either a local stabilizer muscle or a global stabilizer muscle (Comerford). It is a dynamic strategy that refers to the production of an appropriate sequence of movements. Eventually, motor control system determines the requirements for movement and stability and generates appropriate strategies to move the trunk and limbs in a balanced, efficient and coordinated way (Maher et al 2005). This treatment approach seems to be more effective than other commonly prescribed conservative treatment programs in patients with chronically symptomatic spondylosis or spondylolisthesis (O' Sullivan et al 1997). Motor control exercise was developed based on the principle that individuals with low back pain have a lack of control of the trunk muscles and the important factor is to adopt motor learning approach to retrain the optimal control and coordination of the spine. It is superior to minimal intervention and confers benefit when added to another therapy for pain at all phases and for disability at long-term follow-up (Maher et al 2009).

The purpose of the present dissertation will be to review the role of motor control exercises adjunct with the conventional physical therapy in the treatment of chronic non-specific low back pain. This will be achieved by reviewing how motor control exercises applied conventional therapy can alter chronic low back pain mechanism and unique considerations of effectiveness of motor control exercise in relation with the pain and disability caused by chronic low back pain. Subsequently, current study will review the relative benefits and potential negative aspects of the motor control exercises adjunct with traditional methods for chronic low back pain prior and after the intervention. The ultimate goal is to study that how optimal effect can be achieved with motor control exercises in conjunction with the conventional therapy for chronic non-specific low back pain. The current final effect with

conventional therapy has remained sub-optimal but recent strategies including motor control exercises could further improve the condition with chronic low back pain.

The literature review gives a brief idea of the topic and helps in bringing forward any short comings in the literature, questions and trends. It may help the readers to understand the effectiveness of motor control exercises in conjunction with conventional physical therapy for chronic non-specific low back pain. The dissertation comprises of the following chapters in order to answer the research question i.e.: Chapter 1 - Introduction. In Chapter 2 - Preliminary Literature Review, the results of the various preliminary literature reviews will be discussed. The discussion of the methodology supporting the current study will be presented in Chapter 3 – Methodology. Chapter 4 – Methods comprises of the description regarding the methods used in this research. In Chapter 5 – Results, the research articles which are included in the present study will be critiqued. In Chapter 6- Analysis, analysis of the different themes will be described. Chapter 7 – Discussion consists of discussion of the research articles included and its relevant literature. In Chapter 8 – Conclusion, conclusion for the current study and further recommendations will be presented. References and appendix are provided at the end of this study.

CHAPTER 2

PRELIMINARY LITERATURE REVIEW

2.1 INTRODUCTION:

It is well established that symptoms of low back pain can arise from physical processes in the back. The development of chronic pain and disability are however attributable to a complex combination of factors that occur concurrently, these changes are outlined in the following section which includes alteration in the motor control of the lumbo-pelvic region, sensitization of the nervous system, psychological and behavioral factors. The therapeutic intervention of the motor control exercises will be explained in detail about its effect in the pain outcome and its related disability. The recent evidences will be thoroughly searched in order to find the gap in the available research about the effectiveness of the motor control exercises by comparing it with other therapies in relation to the various outcome measures such as pain, range of motion and functional independence.

2.2. DISABILITY, HEALTH CARE COSTS AND SICKNESS BENEFITS:

Low Back Pain (LBP) is a potential medical and financial crisis in the industrialized world. Low back pain and its associated disability pose an economic burden to society, mainly with respect to the large number of work days lost (indirect cost) and to lesser extent by direct treatment costs (Krismer and Tulder 2007). In New Zealand, it is estimated that 20-25% of all injuries related with workplace are responsible for low back pain (Firth et al 2002). The total costs for low back pain to New Zealand's society considering indirect cost is estimated to be NZD $500 million annually (McBride et al 2004). The total cost of low back pain has recently

been approximated to be more than AUD $9 billion per year, with a national prevalence of 65% annually, in Australia. (Dagenais et al 2008). It is crucial to analyze the estimates of chronic low back pain specifically in different countries, but to provide an alarm for the seriousness of this issue, one study in the USA identified that only 4.6-8.8% of low back pain cases lasted for more than one year; however, they accounted for 64.2-84.7% of the total costs (Hashemi et al 1998).

2.3. PATHOGENESIS OF CHRONIC LOW BACK PAIN:

Hodges and Moseley (2003) report poor postural control and changes in motor control in people with acute or chronic low back pain. Also, Jacobs et al (2009) identified that people with chronic low back pain may be more vulnerable to lose their anticipatory postural adjustments (APA) which are useful to ensure postural stability during movement. Sapsford et al (2001) stated that the principal muscles affected are those that have a role in movement and stability of the trunk and lumbo-pelvic region which are transversus abdominis, internal and external obliques, lumbar multifidus, other lumbar erector spinae and the muscles of the pelvic floor.

According to Hodges and Richardson (1996), chronic low back pain subjects exhibit over activation of the more superficial larger muscles of the trunk and under activation of the inter-segmental muscles as compared with healthy people. Inter-segmental muscles provide segmental stability and have direct control over the position of the lumbar segments which include the lumbar multifidus, quadratus lumborum, the lumbar parts of the iliocostalis and longissimus, transversus abdominis (Hodges 1999).

Hodges and Richardson in 1999(b) found out that contraction of the transversus abdominis and the lumbar multifidus, which normally occurs in preparation for subsequent movement of the extremities or the body in any direction, has been shown to be delayed, or attenuated in

those with low back pain, though the exact cause for the delay is not mentioned. Interestingly these same delays have been demonstrated with acute experimentally induced pain in subjects with no history of low back pain (Hodges et al 2003). Also in 1999(a), the results of Hodges and Richardson showed that in some subjects these changes in trunk muscle activity were continued after the remission of pain, consistent with findings of patients with recurrent low back pain that are asymptomatic at the time.

Study by Hides et al (1994) have documented that the patients with chronic low back pain have a higher proportion of type II fibers deep lumbar multifidus and also relatively smaller fiber size at the affected painful region. Furthermore in 2009, Mazis et al stated that atrophy of lumbar multifidus muscle was not due to patient inactivity. Moreover, with the natural remission of symptoms; changes in morphology and function did not resolve (MacDonald et al 2009).

Moseley et al (2002) identified that during postural and functional tasks, the activity of the deep fibers of lumbar multifidus muscle ordinarily precedes that of the superficial fibers. To substantiate this finding, MacDonald et al in 2006 stated that multifidus muscle fibers which are situated close to the center of rotation of the lumbar segments, produce compression and control inter-segmental motion, whereas the superficial fibers have a larger moment arm over which to maintain and control the lumbar lordosis and counteract flexion torques. Leinonen et al (2001) evidenced that even when the perturbation of the trunk is predictable, multifidus activation is attenuated in chronic low back pain individuals.

Research by Tsao et al (2010) demonstrated that subjects with low back pain can achieve improvements in motor control by specific training of the affected muscles. According to Critchley (2002), voluntary contraction of pelvic floor muscles are beneficial in improving the thickness of transversus abdominis muscle. Thus, pelvic floor muscles should also be

considered as a part of the trunk stability mechanism (Arab et al 2010). Also, Herbert et al in 2010, stated that reduced lumbar multifidus activation and decreased transversus abdominis activation was identified with clinical success of stabilization exercise program.

2.4. MOTOR CONTROL EXERCISES FOR LOW BACK PAIN:

Panjabi (2003) proposed that stability and control of the spine are important factors in the genesis and consistence of non-specific low back pain. He identified the impairments in the control of the deep trunk muscles which are responsible for maintaining the stability of the spine in the studies of individuals with low back pain. Maher et al (2009) in their systematic review suggested motor control exercises to re-establish normal control of the deep spinal muscles and to reduce the activity of more superficial muscles that tend to stiffen the spine and have increased activity in low back pain which eventually maintains normal control during progressively more demanding physical and functional tasks. However, they concluded motor control exercise as superior to minimal intervention and is effective when added to another therapy.

Macedo et al (2008) in their study stated motor control exercise (specific stabilization exercise) as a new form of exercise for low back pain. They further explained that this exercise focuses on regaining control of the trunk muscles, also known as the transversus abdominis and multifidus, which support and control the spine. Research by Hides et al (1994) evidenced that there is decreased cross-sectional area and increased fatigability with suggestion of increased intramuscular fat in the paraspinal muscles of the subjects with low back pain. Nonetheless, this research does not discuss its cause and its accelerating / attenuating factors. Furthermore in 2002, Richardson et al in their study found that weak and abnormal contraction of transversus abdominis muscle affects sacroiliac joint which produces the symptoms of low back pain. However, this study fails to explain the cause for weak and

abnormal contractions of tranversus abdominis muscle though it describes the mechanism responsible for sacroiliac joint dysfunction. These exercises were developed based on the principle that individuals with low back pain have a lack of control of the trunk muscles. The main focus is to adopt a motor learning approach to retrain the optimal control and coordination of the spine. Also, according to Maher et al (2005), functional exercises alone do not re-establish coordination of the trunk muscles. This intervention involves the training of pre-activation of the deep trunk muscles with progression towards more complex static, dynamic and functional tasks integrating the activation of deep and global trunk muscles (Hides et al 2001).

Liebenson et al (1996) identified the best way to demonstrate the motor control exercises. According to them, to begin with stabilization of the multifidus, first there should be inhibition of the over-activity of the multifidus muscle. Then perform quadruped stabilization exercises, avoiding hyperlordosis. If leg extensions cannot be performed without hyperlordosis, 'peel-back' to bridges that is, prone partial hip extension over a pillow with posterior pelvic tilt (Liebenson et al 1996). Also, if trunk extension cannot be achieved without lumbar hyperlordosis then the client can be pre-positioned over a pillow and partial trunk extension with posterior pelvic tilt can be performed. For activation of the transversus abdominis muscle, bracing and hollowing techniques are used. For bracing, an isometric contraction of the transversus abdominis by contracting the abdominal muscles is performed. While doing this, there should be holding of the muscles of the abdomen without any movement. To perform this, the client is asked to imagine himself as to get ready for a punch to his belly or preparing to lift a heavy object. The aim is to tighten the muscles without sucking in or expanding client's abdomen (Liebenson et al 1996). Quinn in 2009 suggested that to activate the transversus abdominis with bracing, the client is asked to maintain an isometric hold in this position for 6 to 10 seconds and then release. It should be repeated several times. Hollowing refers to a

technique to activate the transversus abdominis muscle that occurs as the client sucks in and compresses the abdomen. To perform this technique, the client is asked to contract his abdomen and pull his belly button back towards his spine to make his abdomen as small as possible (Quinn 2009). Once the client has completed this movement, ask him to maintain an isometric hold of this compressed position for 6 to 10 seconds, release and repeat. However, Quinn (2009) also mentioned that bracing is more effective in stabilization of the tranversus abdominis than hollowing.

Costa et al (2009) in their study identified that large number of clinical trials on specific stabilization exercises has been performed and 3 systematic reviews are now available. They further added that the most recent systematic review by Macedo et al (2008) was confined to clinical trials of motor control exercise for patients with chronic low back pain and as an advantage from the two previous systematic reviews; a meta-analysis approach was used. This review identified 13 randomized controlled trials and 1 quasi-randomized controlled trial, all of which compared motor control exercise with other treatments (e.g., spinal manipulative therapy, other exercise regimens, education, and surgery) or with no or placebo treatment.

O' Sullivan et al (1997) in their study recommended the use of specific stabilization exercise in the treatment of chronic low back pain. They also highlighted that this treatment approach appears more effective than other commonly prescribed conservative treatment programs in patients with chronically symptomatic spondylolysis or spondylolisthesis. But there is no mention about the assessment tools and the process of intervention. Also, follow up of the patients was not conducted though results were considered including all participants. Moreover, Maher et al (2009) in their systematic review state that motor control exercise was developed based on the principle that individuals with LBP have a lack of control of the trunk muscles and the main focus is to use motor learning approach to retrain the optimal control

and coordination of the spine. However, they also conclude that motor control exercise is not more effective than manual therapy or other forms of exercise. But it is superior to minimal intervention and confers benefit when added to another therapy for pain at all phases and for disability at long-term follow-up.

Also, in the study conducted by Rackwitz et al (2006), it is noted that these exercises are more effective than the treatment by general practitioner but they are not more effective than other physical therapy interventions. This outcome is debatable because the inclusion criteria required for the participants were not satisfactory. However, detailed explanation about the intervention and its results were provided in this study. A more clinically relevant description of this segmental stabilization theory has been presented by O'Sullivan et al (1997). These authors describe the function of the local musculature (lumbar multifidus and transversus abdominis) as stabilization of the lumbar spine with little respect to movement direction, magnitude or velocity. Local stabilizing musculature activation occurs automatically, in a preparatory manner, prior to movement. Failure of this preparatory stabilizing mechanism is identified as a primary cause of persistent LBP.

While Filho et al (2008) in their case report elicited the long-term benefits of a stabilization exercise therapy for a patient with chronic low back pain. In this study, there was an important decrease in pain and disability which was kept after a long period and the recovery of lumbar lordosis was able to be observed in MRI after the treatment. However, this intervention program was based according to assessment of global lumbo-pelvic muscles and classification of lumbar flexion syndrome of the patient. Thus, further research should be needed to substantiate these findings. Furthermore, in the prospective study by Luomajoki et al (2010) showed that movement control, patient specific functional complaints and disability improved significantly following specific individual exercise programs, performed with

physiotherapeutic intervention. But, since it was a pilot study, results of this study can't be generalized. Also, there was no control group allocated in this research, so results should be treated with some caution. Thus, more research is needed to apply these findings in general population. Furthermore, Stuge et al (2004) performed a trial on efficacy of specific stabilizing exercises in pelvic pain after pregnancy. They identified that specific stabilizing exercises were more effective than the physical therapy. However, this study fails to explain its possible reason. Also, reduction of pain was gained from local stabilization or global stabilization is not explained as both stabilizations were considered in this trial. Moreover, the dosage parameter and frequency of the intervention is not described.

However, despite all these views, it is interesting to note that though all the studies supported the motor control exercises for persistent non-specific low back pain, they have also recommended the use of other forms of physical therapy management adjunct to specific stabilization exercises for better recovery. Moreover, there is no or very few studies conducted commenting on the combined effect of conventional therapy and specific stabilization exercises for chronic non-specific low back pain. Hence, the current study is carried out with the research question – 'Are motor control exercises effective in conjunction with conventional physical therapy for chronic non-specific low back pain?' to fill in the gap in the available literature and evidence on this topic. With the help of this study, it will be beneficial to recommend the use of combined treatment of conventional physical therapy and motor control exercise regime as an effective intervention for chronic low back pain patients.

Thus from the above literature evidences, it can be stated that chronic low back pain is a potential concern with its associated disability and loss of postural control. However, evidences provide that these symptoms can be treated with motor control exercise. But very few research articles have enlightened the combined effect of motor control exercises and

conventional physical therapy which is the framework of the present study. So, systematic search will be conducted to obtain significant studies by applying inclusion and exclusion criteria and by using various databases with search terms which will be discussed in the next chapter.

CHAPTER 3

METHODOLOGY

3.1. INTRODUCTION:

The focus of this chapter is to understand the philosophical approach that needs to be chosen to answer the research questions, determine an appropriate research methodology which will help to carry out this research. The methodology selected will ultimately decide the appropriate data collection methods, which need to be applied for the execution of the above research. A correct methodological strategy will help to collect data which is relevant to the research question which in turn is required for obtaining the appropriate results.

3.2. RESEARCH QUESTION:

Can motor control exercises along with conventional physical therapy effectively treat chronic non-specific low back pain? A mapping review with meta-analysis

3.3. RESEARCH METHODOLOGY:

Research methodology is an assembled term for the structured process for carrying out research which generally includes the process of research design, data collection, and data analysis (Kumar 2008). Research is the induction of how to start, adopt and conduct about the theories, ideas, concepts and defining the topic and thus lies at the grass root level. It comprises of making the right decision concerning nature and character of the social world (Hart 1998). Most researches will be part of one of the following categories of existing

paradigms. They are Positivism, Post positivism, Critical Theory and Constructivism. Paradigm is an interpretative framework of assumptions and considerations about the world and how it should be comprehended and learned (Guba 1990). Wisker (2009) described research paradigms as underlying suppositions which help to understand how the research area fit together and from which meaning to our discoveries can be explored. It is a set of assumptions and research strategy that is shared even though taken into account by the society. Denzin and Lincoln (2001) arranged three categories of those assumptions: Ontology; dealing with the question, what is a reality), Epistemology which provides the nature of knowledge and the process by

which knowledge is acquired, Methodology which accounts for how do we gain the knowledge of it. And the answers to these questions are considered as sets, basic belief system or a 'paradigm' that may be adopted (Guba 1990). There are many ways to answer these questions. The answers are developed by finding out how things really are? And how things really work?

The aim of positivistic paradigm is to bring out the truth (realist ontology) and facts and also remit the vital stage of quantification which lets observations to be transferred into numerical data. The scientific method is based on the fact that it is a deductive mode of an analysis with a combination of observation and experiment in the practical world to abolish suggestions and make sure casual laws which are probable and adoptable to make an approach about the type of phenomenon (Neuman 1994). The objective of such research is to test the hypothesis that has been derived before the conclusions and can be co-related to situations that will be challenged in the future of the research in question (Forbes et al 1999). Therefore, the reliability and the accuracy of the tool used are a key to test how correct the measurements are, that will further illustrate the outcome and the data collection procedure (Portney and Watkins 2000). Positivistic paradigm does not provide a complete understanding of the

subjective experience and the interaction between subjects. A potential drawback of the positivistic paradigm lies in the fact that it is considered that a truth is present which does not depend upon the individuals doing the analysis (Clark 1998).

Nevertheless, post positivism has been developed recently from positivism, it agrees with positivism into assuming that an objective world is there but it also presumes that the world might not be easily believed and that the world may have variable affiliations or appreances (Forbes et al 1999). It is all dependent on the ways that are acknowledged to be objective, neutral to beliefs, should anticipate and describe how, when and where these individual components come into an action (Higgs 1995). It provides a different way of approach to positivism and breaks the trend which is a tradition for performing a disciplined enquiry (Forbes et al 1999). A qualitative approach along with a quantitative approach is combined in post positivism, finding out and understanding the meaning of human actions. It is featured along with observations and knowing the meaning from the inquirer's point of view. According to Letourneau and Allen (1999) quantitative and qualitative methods, both can be approximated by adopting the post-positivistic approach. Therefore, for understanding the view-point of the aspect with which things work in today's world, multidimensional way of accessing the things is required. Information from as many sources and databases should be collected together to increase the knowledge and makes sense. Apart from the research project just being quantitative research, the main aim is to disclose the facts and figures concerning the research question and to empower the reader with the knowledge. Such type of approach aims to describe and understand the existence of observable facts and not just to test the hypothesis (Clark 1998). It recognizes what the people have to say and not to keep them anonymous. Post positivist researchers can adopt the reality in any flexible direction. Conclusions are derived from results which can be used in the future in situations rather than making assumptions (Forbes et al 1999). Post Positivist researchers believe that the

loopholes in quantitative research can be overcome by considering qualitative methods in the study. Forbes et al (1999) suggest that post positivism deals with forming and looking for 'warranted assertibility' which means proof which is true and shows that the phenomenon does exist in reality (Philips 1990). This is known as critical multiplism (Guba and Lincoln 1994).

After careful consideration and from the above information it can be concluded that the theoretical perspective which is best suited for the above research is post-positivism; ontologically, this paradigm assumes that reality exists and it can be found but circumstances and differences on an individual level have an effect on it. Post-positivistic research allows methodological cultural diversity. It is based on the supposition that the method to be administered in a specific study should be chosen based on the research question being focused. Thus, present study considers post-positivism as its theoretical perspective.

3.4. LITERATURE REVIEW AS A RESEARCH METHODOLOGY:

In a research methodology the solution to a research problem is identified through a systematic approach (Kumar 1999). Hart (1998) defines literature review as collecting a number of published or unpublished documents or articles which are relevant to the research question and evaluation of these documents or articles.

As a research method, literature review can be used to critically analyze and summarize existing research (Blaxter et al 2001). Aveyard (2007) describes literature review as a methodology by itself if the literature review is done in a systematic way. Hart (1998) states that literature reviews are important to understand and summarize the key issues of the research topic.

Therefore when compared to other research methodologies, a literature review was found to be the most appropriate methodology to answer the research question. Randomized Controlled Trial was one of the other methodologies considered which are at the hierarchy for addressing the above research question on the effectiveness of interventions (Evans 2002). However, they were ruled out considering the fact that an ethical approval has to be taken from an ethics committee. The above research question will be studied by searching, analyzing and summarizing the appropriate literature which defines the research question. During the course of the literature review; existing data will be dealt which will aid in making conclusions and summarizing the existing knowledge concerning the subject that is being studied.

Apart from the above-mentioned points, doing a literature review helps to bridge the gap of knowledge between the known and unknown areas of the research topic (Burns and Groove 1997). It also helps to compare data found from various researchers, review it, summarize it and concise it into one literature review study. It is vital that the research question should be addressed precisely with the appropriate and relevant evidences. It allows one piece of research to be reviewed within the wider context of others and hence is considered as an essential tool in health and social care professionals (Aveyard 2007). The literature review will help in future references and in treatment options on the research topic.

However, disadvantages of literature review such as lack of information concerning current knowledge about the condition, presence of large volume of data which may lead to confusion and distraction of the researcher from the research question, and susceptibility to judgments and preferences of the reviewers are taken into account.

3.5. INCLUSION / EXCLUSION CRITERIA:

It is important to identify the inclusion / exclusion criteria before starting the study. Determining inclusion / exclusion criteria can depend on the reviewer's definition of evidence. The inclusion and exclusion criteria for the selected research question are the key tasks to search the literature. According to Parahoo (1997), the question set and the available resources are highly responsible for the scope of the review. Therefore, inclusion and exclusion criteria are set to define the boundaries of the review. There are four specific criteria to be considered – 1 – Study participants, 2 – Intervention, 3 – Outcomes, 4 – Study design. These need to be made specific before starting the research. According to Oxman and Guyatt (1998), rigor in this process ensures that the research is focused and helps to confirm that papers are included because of their relevance to the topic rather than how much the authors agree or disagree with studies. The inclusion and exclusion criteria should be clearly focused on the research question so that the readers can understand the literature without any difficulty. Inclusion criteria provide objectivity to strategy. In order to choose literature with specific time period, it should be searched accordingly. French et al (2001) states that defining a time period results in obtaining literature within the specific time period relevant to study.

While considering the exclusion criteria, care must be taken in order to eliminate the literature from the studies which is not relevant to research question, so that it becomes more focused with clear ideas. The generalization of the findings depends on how exclusive the review is in its identification and selection of evidence (Parahoo 1997). While excluding the literature, care must be taken not to place too many limitations on inclusion / exclusion criteria that might affect the purpose of the study.

3.6. LITERATURE SEARCH RESOURCES:

According to French et al (2001), relevant information can be retrieved from textbooks, references from articles and library journals. Journals are essential sources of information to the researcher (Drummond 1996). According to Sim and Wright (2000), searches of data bases and web sources are one of the modern technology aids for searching literature and can be considered the most efficient way to begin a literature search. The literature review should be comprehensible and cover bibliographic.

Sim and wright (2000) suggested that the researcher should use specific search terms or key words which should be relevant to the main topic question or a single word related to the main theme of the study which can be used for an advanced literature search. The search should concentrate identifying best information on relevant studies on the topic as well as derive the research methodologies and data collection (Hart 2001). The researcher should search an article which is more relevant to the study topic and support the ideas of the study (French et al 2001). So it is necessary to consider a search term used for search to look at any material required for the study. The fundamental or the first step is search through keywords. The researcher should start investigating the terminology by using the key words with association of the required field (French et al 2001). A specific word search will save time and will locate relevant articles for the study. Computerized vocabulary avoids synonyms in the data bases. Though this search method is easier for the researcher to identify the data from the data base it is necessary to be focused on systematic search using Boolean operators like ‘OR’, ‘AND’ ‘NOT’ and truncation (*) this will help to locate for alternative terms of the key words (Aveyard 2007). To focus on the research question; this systematic search helps the author to locate a relevant article which supports the main study.

To demonstrate a systematic approach, it is necessary to keep a record of the search strategy (Aveyard 2007). This is shown in the table below how the search terms in different data bases get recorded.

Table 1: Search Terms

Search term	Database 1: No. of hits	Database 2: No. of hits	Database 3: No. of hits
Search 1			
Search 2			
Search 3			
Search 4			

It is important that a proper strategy is developed during the process of data searching which will automatically lead to comprehensive and thorough search which might enable further to identify the focused literature that can be reproducible.

Following databases will be searched to obtain relevant evidences.

Table 2: Databases with Characteristics

Databases	Focus
AMED: allied and complementary medicine.	Allied and alternative medicine. Covers material published since 1985
Cochrane databases of Systematic Reviews	Provides health care providers, policy makers, patients, their advocates and carers, best available research evidence, about health care which is considered as the high-quality evidence
MEDLINE (Medical Literature Analysis and Retrieval System) (via PubMed)	Provides academic journals covering medicine, biomedicine and life sciences, bio-engineering, public health, nursing, pharmacy, dentistry, veterinary medicine and health care
Sage Premiere	Covering a wide range of subjects within the social sciences, humanities and life sciences.
Science Direct	Provides unprecedented access to a constantly expanding universe of content and solutions from the field of physical sciences and engineering, life sciences, health sciences, social sciences and Humanities

Reference list helps in recognizing a particular search strategy. Greenhalgh and Peacock (2005) stated that a systematic literature review will be effective with 'snowball sampling'. All latest reference articles will help in obtaining all relevant articles related to the study. Aveyard (2007) highlighted that hand searching articles and author search can identify more relevant information about the topic.

Finally, Cresswell (2009) stressed on reliability. So, it is necessary to set priority how and from where the entire article will be searched, the priority is given in the following order - journal

articles have the highest priority followed by books, conference papers then abstracts from dissertations and web search has the least priority.

3.6. CRITICAL APPRAISAL:

Research involves gathering data, then collating and analyzing it to derive meaningful information. However, not all research is good quality and many studies are biased and their results are untrue. This may lead to draw false conclusions. Hence it is important that the piece of research selected has been conducted properly and that the information it reports is reliable and valid. These are the factors that determine the quality of the study. Polit et al (2001) identified that critical appraisal is a process of carefully and systematically scrutinizing research to judge its value and worthiness in a particular situation. It provides the reliability and the validity to the study. Burls (2009) explains critical appraisal as the process of examining the evidence to assess its validity and results to inform the relevance of the study. Critiquing an article is imperative so that there can be presentation of the sound argument with advocacy that will justify the research question (Machi and McEvoy 2009) and hence is considered as an important feature of a literature review. The critique argument uses implicative reasoning defined as “a logical interpretation of evidence to produce propositions that signal a specific conclusion” (Machi and McEvoy 2009 .pg 106).

According to Aveyard (2007), several tools can be used to deliver a research design and it can be specific or non-specific to the research study. In order to avoid any part of research paper unidentified; there are some critical appraisal tools which help to study an article in a systematic way by answering sets of questions so that whole article is viewed. There are many different types of tools recommended for critiquing an article such as CASP, LAW et al, PEDro, CEBM, etc. The questions seek more than a simple ’yes’ or ‘no’ answer. These

questions are posed to stimulate the reviewer to consider the implications of what the researcher has reported in the study. However, the CASP tool provides the individuals to expand the skills to find understand and relate research evidences helping them to apply knowledge into clinical practice. Hence, present study considered Critical Appraisal Skills Programme (CASP) tool to critique selected research articles.

3.7. DATA ANALYSIS:

According to Aveyard (2007), it is necessary to summarize the findings by bringing all possible results together. The summary of the articles and their findings which bring out the strengths and weaknesses will be included in the chapter Results. The summary for the appraisal has to be carefully understood as it is an important part of the study. While summarizing the data; the strengths, weaknesses and limitations of the study have to be analyzed. A conclusion should be drawn and it should be clearly stated in the findings whether the framework of the study is supported or not (Nieswiadomy 1993).

By synthesizing the studies, it is possible to group together and bring out the issues from the various studies which will update the knowledge regarding the research study. This includes simplifying the meaning and paraphrasing the data from the relevant studies for the research question (Burns and Groove 1997). Analyzing the information obtained from various articles and finding a connection among the information is called synthesis. It involves rearranging the information in the proper order and forming conclusions. The rearrangement and making connections should be unique to the current study, which has never been performed earlier. Organizing the information gathered from various articles into sections and subsections will help the reader or reviewer to form a pattern and pursue an idea behind the research. The reviewer's interpretation of the research study and its critical analysis are important.

Analysis of research findings can bring out various themes. Themes are developed from the research findings and their analysis is done by using thematic analysis (Reid 1993). Identifying the themes and classifying them depends upon the strength of the articles. The themes can be compared and contrasted by using the taxonomic map. Hart (1998) recommends using the mapping tool to find connections between ideas and arguments that have been identified from the articles. Mind mapping helps to organize the key themes and issues in a multidimensional fashion (Hart 1998). Forming themes helps by making it easy for future reference to identify key words or themes which have been specified in the research making the evidence more objective rather than a narrative review (Hart 1998).

3.8. ETHICAL ISSUES:

Ethical approval is not required for the research methodology adopted because secondary data is being collected by evaluating primary research and there is no interaction with the participants of the primary study. It will be made sure that the data provides here is accurate, as ethical issues apply for writing and disseminating data (Cresswell 2009). The data will be put forward in an unbiased language. The author's findings will not be falsified or suppressed. The information will not be discriminating against any age, gender, race or religion. The study design will help the readers to decide the quality and worthiness. Plagiarism will be avoided by acknowledging the authors of the various articles used and the source from where they are obtained will be specified even if the information is paraphrased. Sincere efforts will be made to abide by the rules and perform the study in an ethical manner.

Thus, now it is clear that literature review with the post-positivism paradigm is appropriate for this study. Also, CASP tool will be used to critique all research articles. Inclusion and

exclusion criteria are the key factors to give objectivity to search strategy with focused ideas and to avoid irrelevance. Databases with key terms will be searched considering these inclusion and exclusion criteria. Critical appraisal of the selected articles and data analysis will be carried out to obtain an objective and unbiased result. While, next chapter deals with the methods, inclusion and exclusion criteria and search strategy with search terms used for the research. There will be presentation of the method of data analysis used for this research.

CHAPTRE 4

METHODS

4.1. INTRODUCTION:

A number of websites, journals and articles were searched to obtain an optimum result. The following chapter provides description regarding the methods used for the research which includes inclusion and exclusion criteria, critiquing the literature, search strategy and method of analysis. According to Wisker (2008) methods are the ways in which data is collected.

4.2. RESEARCH QUESTION:

Can motor control exercises along with conventional physical therapy effectively treat chronic non-specific low back pain? A mapping review with meta-analysis

4.3. INCLUSION AND EXCLUSION CRITERIA:

After application of the search terms in the relevant databases, the inclusion and exclusion criteria need to be adopted to identify the relevant articles which are appropriate and targeted for the research question. The inclusion and exclusion criteria are listed below in Table 3.

Table 3: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Primary research directly related to motor control exercises	Primary research not directly related to motor control exercises
Studies aiming at low back pain (LBP) only English articles	Studies which are not related to low back pain Non English articles
Studies having randomizes controlled trials (RCTs) only	Studies other than RCTs
Studies after year 2000	Studies before year 2000
Studies with age group above 18 years	Studies with age group below 18 years
Articles with motor control exercise as treatment approach	Articles without motor control exercise as treatment approach
Researches containing manual therapy, general exercise, ultrasound and other forms of conventional physical therapy as choice of intervention with motor control exercises.	Researches containing manual therapy, general exercise, ultrasound and other forms of conventional physical therapy as choice of intervention without motor control exercises.

4.4. SEARCH STRATEGY:

The key words with the alternate terms relevant to the research question are identified as described below in 'Table 4':

Table 4: Search Strategy

Effect	Motor control exercises	Conventional therapy	Low back pain	Evidence
Effectiveness or Efficacy	Specific stabilization exercises or Spinal stabilization exercises or Stabilization exercises or Exercise program	Traditional treatment or Traditional therapy or Conventional treatment or Conventional management or Traditional management	Low backache or Back pain or Backache or Chronic low back pain or Persistent low back pain	RCT, Randomized control trial

Boolean operators will be used for the above key terms. The search terms are described below in 'Table 5'. The word 'OR' will be used between each term because the authors of the articles might have used synonyms. To start the database search, the terms will be added one by one in a basic search and later combined with Boolean operator 'AND' in advanced search. Truncation (*) will be used in terms like back*, effect* so the databases will search for low back pain, low backache, effectiveness, efficacy.

Table 5: Search Terms

Search 1	Motor control exercise OR specific stable* exercise
Search 2	Chronic low back* OR persistent low back*
Search 3	Pain reduction OR decrease in pain
Search 4	Motor control exercise AND chronic low back pain
Search 5	Specific stabilization exercise AND chronic low backache
Search 6	Motor control exercise AND chronic low backache
Search 7	Specific stabilization exercise AND chronic low back pain
Search 8	Search 1 AND search 2 AND search 3 AND search 4 AND search 5 AND search 6 AND search 7

The search results were documented in each of the databases. Filters were applied and limitations such as English language articles only, journal publications, peer reviews, primary

research articles. The search was refined by using the above methods. The details are given in ‘Table 6’.

Table 6: Databases and No. of Articles

Databases searched	Search terms	No. of articles found	Relevant articles	No. of articles excluded	No. of articles included
AMED	Spinal stabilization exercises, chronic low back pain, conventional physical therapy	11	4	2	2
Cochrane databases of systematic reviews	Motor control exercise, specific stabilization exercise, low back pain, traditional treatment	8	3	3	0
MEDLINE (via PubMed)	Specific segmental exercise, low back chronic low back pain	9	4	1	3
Sage Premiere	Motor control exercise, conventional physical therapy, non specific low back pain	2	0	0	0
Science Direct	Low back pain, conventional treatment, specific stabilization exercise,	7	5	3	2

4.5. CRITIQUE METHOD:

The search resulted in Randomized control trials (RCTs) which were relevant to the research question. To the critique the articles Critical Appraisal Skills Program (CASP) tool was used.

CASP tool was found to be very effective to critically appraise the articles. The CASP tool has been attached along with the research in the ‘Appendix’ section.

4.6. DATA ANALYSIS:

The thematic analysis method will be used to critique the articles found in order to answer the research question. Studies included will be thoroughly read to find the common ideas focused in them. These themes will eventually help to answer research question which will be represented in the form of mind map analysis as a thematic tool. Steps undertaken in analyzing the articles in the study will be familiarized with the information provided in these articles to identify their strengths and weaknesses. Finally, all articles will be compared and contrasted by similarities and differences as suggested by Aveyard (2007).

Thus from the above presentation, it is evident that for the present study, the data will be collected using appropriate inclusion and exclusion criteria with relevant search terms. All the suitable studies will be included which will be analyzed by the CASP tool. While, the next chapter will provide the detail discussion concerning all relevant articles, their reason for exclusion and finally the list of selected studies with their findings and conclusion.

CHAPTER 5

RESULTS

5.1. Introduction:

This aim of this research is to answer the question ‘Can motor control exercises along with conventional physical therapy effectively treat chronic non-specific low back pain? A mapping review with meta-analysis’ In order to achieve this, a systematic search was done as discussed in the previous chapters. Seven articles were selected after carefully applying the inclusion and exclusion criteria. The summary of these articles is provided in table 7 at the end of this chapter.

To fulfill the inclusion criteria, 17 articles were excluded from the total articles as they only discussed the literature related to low back pain with conventional treatment. However, some of the literature from these excluded studies is used to discuss the preliminary literature review in order to develop the research question. From remaining 14 articles, 2 articles were excluded as they did not fulfill the inclusion and exclusion criteria. There were 3 systematic reviews related to this study. But these systematic reviews were not able to answer the research question which thus helped the present study to find out the gap in the evidences available. So these systematic reviews were excluded from the study. 1 article was again dropped which was prospective study. 1 relevant article was a case report and thus excluded.

Also, there were some articles with motor control exercise as an intervention but the population they studied was not suitable for the inclusion criteria. For instance, there were some articles targeting pelvic pain in pregnancy or patients with spondylolisthesis and spondylolysis with motor control exercise as a treatment. But, as the present study is purely based on the subjects with chronic non-specific low back pain, these articles were discarded. Moreover, there were two more articles with suitable population and intervention. However,

their research is still in progress and thus findings of these researches were unavailable, hence excluded. Thus, with an intended intervention and population, the articles which were selected are listed below:

5.2. List of Selected Articles:

1. Motor control exercises for chronic low back pain: A randomized placebo-controlled Trial – Costa et al, 2009.
2. Long term effects of specific stabilizing exercises for first-episode low back pain – Hides et al, 2011.
3. Segmental stabilization and muscular strengthening in chronic low back pain – a comparative study – Franca et al, 2010.
4. Randomized controlled trial of specific spinal stabilization exercises and conventional physiotherapy for recurrent low back pain – Cairns et al, 2006.
5. Comparison of general exercise, motor control exercise and spinal manipulative therapy for chronic low back pain: a randomized trial – Ferreira et al, 2006 (a).
6. Trunk muscle stabilization training plus general exercise versus general exercise only: randomized controlled trial of patients with recurrent low back pain – Koumantakis et al, (2005).
7. Motor control exercises, sling exercises, and general exercises for patients with chronic low back pain: a randomized controlled trial with 1-year follow-up – Fladmark et al, (2010).

5.3. General Findings of Selected Studies:

Overall, it was identified that all these articles report contrasting results about the effect of motor control exercises or combined effect of motor control exercises and conventional physical therapy for low back pain. In some studies, it was found that motor control exercises augmented pain intensity. On the other hand, few studies also stated that there was no significant effect of adding motor control exercises to conventional physical therapy in low back pain. However, functional outcome and trunk muscles activation were seemed to be improved in almost all studies which considered these outcome measures, though there were diverging results noted in relation to the pain intensity.

5.4. Results of Selected Studies:

1) Motor control exercises for chronic low back pain: A randomized placebo-controlled Trial – Costa et al, 2009.

The aim of this study was to investigate the efficacy of motor control exercise for people with chronic low back pain. Consecutive patients seeking care for chronic low back pain were screened for eligibility and 154 patients were selected from Sydney, Australia. There is no mention about the informed consents gained from the patients and ethical approval for this study. The intervention given was motor control exercise for one group and placebo treatment for other group. Primary outcomes were pain intensity, activity and patient's global impression of recovery measured at 2 months. Secondary outcomes were pain, activity, and patient's global impression of recovery measured at 6 and 12 months, activity limitation at 2, 6, and 12 months and risk of persistent or recurrent pain at 12 months. Patients' activity, pain intensity were measured by the Patient-Specific Functional scale. Roland-Morris Disability

Questionnaire was used to assess activity limitation of the subjects. Baseline scores were noted prior to intervention. It is a randomized controlled trial and it is appropriate for this study as its objective is to find out an efficacy of treatment. The allocation of the participants was random. It was concealed allocation. Equal numbers of participants were allocated in each group with balance in the groups at report of the trial. Concealed allocation was achieved by using block randomization sequence. The participants were blinded in this study. The trial therapists were not blinded to the treatment allocation. An effort is made to minimize the effect of unblinding by training the trial therapists to provide a credible placebo treatment and by auditing placebo treatment sessions. However, this may lead to some degree of 'observer bias' into result. Also, there is no mention about the blinding of the assessor for outcome measures. There were total 154 participants. With the balanced groups, 77 participants were in each group. 75 participants from the motor control exercise group and 77 participants from the placebo group followed up the first session at 2 months. Similarly, at 6 months and 12 months there was further loss to follow up sessions. However at the end, all the participants were analyzed in relation to their respective groups. The therapists were unable to monitor the home exercise program session for the participants from the experimental group which could result in the 'performance bias'. This study allowed for 15% non-adherence to treatment and 15% loss to follow-up. Correlation of 0.5 was assumed between baseline scores and outcomes. The sample size of this trial provided 80% power to detect an effect of exercise of 1 unit on the pain intensity scale, 1 unit on the PSFS, 1 unit on the global perceived effect and 4 units on the Roland-Morris Disability Questionnaire. These values were smaller than the estimated values for each outcome. The results are presented in statistical manner. The exercise intervention improved activity and the patient's global impressions of recovery at 2 months. But there was not significant effect of exercise on pain intensity. However, there was statistically significant improvement in pain at 12 months. Exercise improved activity limitation at 2 months but at 12 months; there was no significant improvement. Statistical data was

reported in this study in detail and was expressed as mean (range) and standard deviation (SD). Confidence intervals at 2 months were reported as 1.1 (1.8 to 0.3) for improved activity, 1.5 (2.5 to 0.4) for global impression of recovery and -0.9 (-1.8 to 0.0) for pain intensity. But there is a wide interval of global impression of recovery at 2 months (CI = 2.5 to 0.4) which suggests that more data should be collected for its clinical application. Thus, motor control exercise produced short-term improvements in global impression of recovery and activity, but not pain, for people with chronic low back pain. However, long term use of these exercises seemed to add benefit in decreasing pain intensity. Nonetheless, due to inadequate sample size, the results of this study cannot be applied to general population.

2) Long term effects of specific stabilizing exercises for first-episode low back pain – Hides et al, 2011.

This study has a clearly focused question about the long term effects of specific stabilizing exercises for low back pain. The purpose of this study was to report a specific exercise intervention's long-term effects on recurrence rates in acute, first-episode low back pain patients. Population studied was patients between age 18 to 45 having mechanical low back pain for less than 3 months. The primary outcome of this study was to assess the effectiveness of stabilization exercises in long term follow-ups at 1 year and 3 year. Other outcomes were disability, range of motion, habitual activity levels and muscle cross-sectional area. Pain was measured by McGill Pain Questionnaire and Visual Analogue Scale. Disability was measured by Roland Morris Disability Questionnaire and range of motion by inclinometer. Ultrasound imaging was used to assess muscle cross sectional area. Baseline characteristics were noted using these scales n tools. The study design was randomized controlled trial with 39 participants in this trial. The study was ethically approved and all the patients gave their consent. Patients were randomly allocated to experimental and control group with 20 subjects

in an experimental group and 19 subjects in control group. Method of randomization is not described which may result in bias. Also, there is no information provided about the blinding of the person who participated in allocating the patients in these groups. The response rate for short term follow-up and 1-year long term follow-up was 100%. However, at 3 year long term follow-up, three patients could not be contacted and all three were from the control group which can again bias the analysis and result. Assessments for the short-term phase of the trial were performed by two examiners who were blinded to group allocation and patient presentation. Nevertheless, there is no mention about the blinding of the participants and the staff who analyzed the final result. Furthermore, no information is provided about the efforts to achieve blinding or to minimize its effect which can lead to 'performance bias or 'observer bias.' Out of 39 patients, 3 patients could not be contacted. Henceforth, final data was collected from 36 patients. All the participants' outcomes were analyzed by the groups to which they originally allocated. Though, the data of both groups was collected in a similar manner that is by telephone interview; ideally it would have been useful to image the patients' multifidus muscles as muscle cross-sectional area was one of the outcomes of this study. This was the potential limitation of this trial. Also, long term follow-ups about the range of motion are not practically possible on telephone interviews; which also was one of the outcomes of this study. Thus, though the outcomes considered by authors of this study were appreciable; they could be recorded on 'long term' follow-up and which was the primary outcome of this study. This was a pilot study which could not exclude the possibility of play of chance. Power calculation is not mentioned in this paper. Data analysis was performed using the Statistical Program for the Social Sciences (SPSS). Comparability of baseline measurements between the two groups and examination of the differences between groups over time for all outcome measures was assessed by analysis of variance (ANOVA). The significance of treatment was determined with a λ^2 test. Results at follow-up immediately after the intervention and at 10-week follow-up examination revealed that multifidus muscle recovery was not spontaneous on

remission of painful symptoms in control group patients. However, it was more rapid and complete in patients with experimental group with significant P value (P=0.0001). The other outcome measures; disability and physical function were similar for both groups at 4-week examination. The results also showed that patients in control group were 9 times more likely to experience LBP recurrences in years 2-3 than in experimental group patients (P<0.01). A repeat analysis of the data using best case analysis revealed that control group patients were still 5.9 times more likely to experience low back pain recurrences than in experimental group patients in years 2-3 (P=0.015). Thus in this study, all mentioned outcomes were considered for short-term phase but it failed to consider those in long term follow-up as the method (telephone interview) selected by the authors for follow-up could not allow to keep record of those outcomes (range of motion and muscle cross sectional area). Also, this trial focuses more on muscle cross-sectional area and doesn't consider describing the detailed results of other mentioned outcomes. Thus, more research is needed to generalize this result as power analysis is not mentioned in this study.

3) Segmental stabilization and muscular strengthening in chronic low back pain – a comparative study – Franca et al, 2010.

This paper has clearly focused on comparison between segmental stabilization and muscular strengthening in chronic low back pain. This study was carried out in Department of Physical Therapy, Sao Paulo University, Brazil. The participants were 30 with non-specific chronic low back pain. The outcomes considered were pain, functional disability and activation of transversus abdominis muscle in chronic low back pain individuals. Pain was assessed using Visual Analogical Scale. Functional disability was estimated by the Oswestry disability questionnaire and transversus abdominis activation was assessed by using the Stabilizer pressure Biofeedback Unit. The study design was randomized controlled trial with 30 patients.

This study was ethically approved by University of Sao Paulo and all participants signed informed consent forms. The subjects were randomly selected for both exercise groups with concealed allocation. The intervention groups were balanced. However, there is no mention about the drop outs till final result. Also, there is no information provided about blinding of the participants staff and study personnel except the assessor for the pre-treatment outcomes who was blinded to the randomization and other outcome measures. The number of participants which failed to continue this trial till the end is not mentioned. All the participants' outcomes were analyzed by the groups to which they originally belonged. The data of both groups was collected in similar manner. Statistical analysis was done calculating relative gain with the treatment. ANOVA One Way was used for inter-group and intra-group comparisons. Binomial test was used for transversus abdominis activation. Significance was set at p value < 0.001. This study assumed 80% power to detect 30% improvement in pain on visual analogue scale, with a standard deviation of 2 points and a significance level of 5%. All variables were significantly improved with treatment in segmental stabilization group ($P<0.001$). Contraction of the transversus abdominis was improved by 48.3%. Also in superficial strengthening all variables were improved ($P<0.001$) but with minimum outcomes compared to segmental stabilization group. Nevertheless, transversus abdominis had negative gains (worsening -5.1%). When intra-group comparisons were done, the segmental stabilization yielded significantly higher gains in all variables compared to superficial strengthening group ($P<0.001$). This study concluded that both techniques lessened pain and reduced disability. However, segmental stabilization but not superficial strengthening improved transversus abdominis activation. Thus, segmental stabilization is superior to superficial strengthening for all variables. The negative aspect of this study was there were no immediate and long term follow-up examinations. Also bio-psychological factors were not taken into consideration while doing this study. Further relevant research would be beneficial as this study failed to provide sufficient sample size.

4) Randomized controlled trial of specific spinal stabilization exercises and conventional physiotherapy for recurrent low back pain – Cairns et al, 2006.

The trial aims to evaluate the effect of adding specific spinal stabilization exercises to conventional physical therapy for patients with recurrent low back pain. The population studied was 97 patients between age 18-60 years following normal referral from general practitioner, consultant or back pain physical therapy clinic. The primary outcome measure was back-related functional disability at 12-months and the secondary outcome measure was pain intensity. Disability was assessed by Roland Morris Disability Questionnaire and pain intensity was estimated by McGill Pain Questionnaire. This study is aimed to find out the efficacy of specific spinal stabilization exercises, thus randomized controlled trial is suitable for this study. Adaptive Stratified randomization was used for two groups: 'conventional physical therapy group' and 'conventional physical therapy plus specific spinal stabilization exercises group.' There were 47 patients in spinal stabilization group and 50 patients in conventional physical therapy group attempting balance in each group. It is a single blinded trial with participants blinded to their allocation of treatment group. Though double blinding is not possible in this study, it could not exclude the possibility of 'observer bias.' No information is given concerning assessor blinding. All participants were not followed up in each study group and there was loss-to-follow up at 6 month and 12 month. At the end, the number of participants which completed trial was 33 in the spinal stabilization group and 35 in the conventional treatment group. However, the participants in both groups were followed up and data was collected in an identical manner from both groups. This trial achieved 89% power to detect a 3-point difference on the Roland Morris Disability Questionnaire between the groups at 12 months which is less in relation to estimated value. The results are presented in a statistical method with total of 68 patients (70%) provided 12-month follow-up data. The statistical data was

represented as mean difference in scores. All analyses were undertaken using Analysis of Covariance (ANCOVA) to examine difference in mean change scores. Both groups showed improved physical functioning, reduced pain intensity, and an improvement in the physical component of quality of life. Mean change in physical functioning was -5.1 (-6.3 to -3.9) for the specific spinal stabilization exercises group and -5.4 (-6.5 to -4.2) for the conventional physical therapy group. No statistically significant differences between the two groups were shown for any of the outcomes measured, at any time. Thus, this study fails to prove its clinical influence due to inadequate sample size and insignificant results.

5) Comparison of general exercise, motor control exercise and spinal manipulative therapy for chronic low back pain: a randomized trial – Ferreira et al, 2006 (a).

This paper aims to compare effects of general exercise, motor control exercise and manipulative therapy on functional and perceived effect of intervention in patients with chronic back pain. The outcome measures were patient-specific function and global perceived effect after 8 weeks. These outcomes were also measured at 6 and 12 months. There were 240 participants with non-specific chronic low back pain. The study protocol was registered with the Australian Clinical trials Registry and approved by the Ethics Committees of the University of Sydney. Participants were allocated equally to all three groups with 80 participants in each group. Block randomization was used to allocate the groups. The physiotherapist to whom all participants reported their outcomes was blinded to allocation. There is no additional information provided about the participants and staff blinding. At 8 week follow up, there were 93% (n=74) participants in general exercise group, 91% (n=73) in motor control group and 96% (n=77) in spinal manipulation group. At 6 month follow up, the percentage of participants in all groups declined to 89% (n=71), 85% (n=68) and 90% (n=72) respectively. The numbers of participants at 12 month follow up were respectively 73 (91%), 65 (81%) and 73 (91%). All

the data was collected with respect to the group allocation. However, power analysis is not mentioned in the study. The results are specified in statistical method. In the short term, the groups receiving motor control exercises or spinal manipulative therapy improved more than the group receiving general exercise. At 8 weeks, the motor control exercise group had better function with CI = 2.9 (0.9 to 4.8) and p = 0.004. For global perceived effect, confidence interval was 1.7 (0.9 to 2.4) with p value < 0.001. Thus there was better effect of motor control exercise than did the general exercise. Likewise the spinal manipulative therapy group had better function with CI = 2.3 (0.4 to 4.2) and p = 0.016. Also, spinal manipulative therapy was found to be better in global perceived effect than did the general exercise. The confidence interval was 1.2 (0.4 to 2.0) with p = 0.004. There was little difference between the motor control exercise and spinal manipulative therapy groups (for function: p = 0.643; for perceived effect of therapy: p = 0.151). Similar but slightly smaller and statistically non-significant effects were seen in the secondary outcomes at 8 weeks. There were no apparent differences between groups in either primary or secondary variables at 6 or 12 months. However, the confidence interval for function in spinal manipulation group was wide (CI: 0.4 to 4.2), which suggests that more data should be collected to confirm its validity. Though patient specific function (PSFS) and global perceived effect were primary outcomes, pain intensity of these participants is not taken into account in this study which is a potential limitation. Moreover, there is no information provided about the power calculation which precludes commenting anything concerning its validity in clinical practice.

6) Trunk muscle stabilization training plus general exercise versus general exercise only: randomized controlled trial of patients with recurrent low back pain – Koumantakis et al, 2005.

This paper focused on trunk muscle stabilization training and general exercise. The purpose of this trial was to examine the usefulness of the addition of specific stabilization exercises to a general back and abdominal muscle exercise by comparing it with general exercise only. The outcome measures were pain, disability and cognitive status of the subjects. McGill pain questionnaire was used to measure pain intensity. Disability was estimated by Roland Morris disability Questionnaire. Cognitive status was assessed by Pain Self-Efficacy Questionnaire, Tampa Scale of Kinesiophobia and Pain Locus of Control Scale. Fifty five patients with recurrent non-specific low back pain participated in this trial. There is no mention about the informed consents from the patients and ethical approval of the study. All patients were randomly divided into two groups by computer randomization. Randomization codes were kept in sealed envelopes with consecutive numbering. The research physical therapist who was in charge of the study and who performed the outcome assessments of subjects and data analyses was unaware of the group allocation throughout the study. Patients were also kept unaware of the theoretical bases of each of the exercise regimens. However, the clinical physical therapist who administered the exercise program could not be masked to group allocation. All the participants were not followed up from each group due to loss-to-follow-up at 2 and 5 months. Thus the final data after intervention was collected from only 38 subjects. Nevertheless, analysis of the data was done according to the groups assigned to the subjects. All the data was represented statistically and various statistical tools were used for data analysis such as analysis of covariance (ANCOVA) and Mann-Whitney U Test. Normality of distribution for all data collected was analyzed with the Kolmogorov-Smirnov test. Reliability of tools was described which was found to be high. Thus, data assessed is quite reliable and valid. Power analysis of this study revealed that power of 80% was achieved to detect a 2.5-point between-group difference in the scores of Rolland Morris Disability Questionnaire as it was the primary outcome of the study. The results are expressed in statistical method in term of medians and interquartile ranges. The level of significance was set at $P = 0.05$ for all

comparison. At 2 months follow up, for the Rolland Morris Disability questionnaire, there was a statistically significant between-group difference immediately following exercise (mean difference = 2.55, P = 0.027) in favor of the general exercise only group. But this difference failed to present at the 3 months follow up. No between-group differences were present for any other outcomes at any time with values; median = 23.50, interquqrtile ranges = 20.00 - 24.00 for stabilization-enhanced exercise group and median = 22.00, interquqrtile ranges = 15.00 – 24.00 for general exercise only group. Thus, this study identified that stabilization exercises do not appear to provide additional benefit along with the general exercise to patients with sub-acute or chronic low back pain without spinal instability. However, due to insignificant sample size, further studies regarding this topic would be recommended for its generalization.

7) Motor control exercises, sling exercises and general exercises for patients with chronic low back pain: a randomized controlled trial with 1-year follow-up – Fladmark et al, 2010.

The aim of this study was to compare supervised low-load motor control exercises and supervised high-load sling exercises with general exercises in the early phase of rehabilitation for patients with chronic low back pain. The primary outcome measure was pain after treatment and at a 1-year follow-up. Secondary outcome measures were self-reported activity limitation, clinically examined function and fear-avoidance beliefs after intervention. Pain intensity was measured by Numerical Pain Rating Scale whereas; self-reported activity limitation and clinically examined function were assessed by Oswestry Disability Questionnaire and Fingertip-to-floor Test respectively. Baseline scores were reported prior to intervention. There were 109 participants with chronic non-specific low back pain recruited from general practitioners and physical therapists at a large local hospital in Norway. Subjects

were divided in three groups by computationally generated randomization. Written informed consent was given by all participants before randomization. No information about blinding of participants, assessor or clinical therapist is reported in the study. All the participants were not followed up from each group as there was loss to follow up after intervention and at 1 year. However, analysis of data was performed with all subjects; which may bias the findings of the result. There is no mention regarding power calculation. Statistical analysis was carried out using statistical package for social sciences (SPSS) and NPSS scales. The level for statistical significance was set at $P \leq 0.05$. The post-intervention showed no significant differences among groups with respect to pain or any other outcome measures. Mean group differences for pain reduction after treatment and after 1 year were 0.3(-0.7 to 1.3) and 0.4 (-0.7 to 1.4) for motor control exercises versus sling exercises, 0.7 (-0.6 to 2.0) and 0.3 (-0.8 to 1.4) for sling exercises versus general exercises, and 1.0 (--0.1 to 2.0) and 0.7 (-0.3 to 1.7) for motor control exercises versus general exercises. This research concluded that there were no significant group differences in pain, disability, trunk flexibility or fear avoidance beliefs after eight weeks of motor control exercises, sling exercises and general exercises in patients with chronic non-specific low back pain. Nonetheless, they also identified that confidence intervals for improved outcome spanned clinically important differences in favor of the motor control exercise intervention compared with general exercise intervention. But, due to lack of information concerning power analysis, the findings of this trial cannot be generalized.

After studying all these articles selected for the present study, it was found that there were variations with regards to the factors affecting the treatment. These variations were with respect to age groups, inclusion and exclusion criteria of the participants, and their baseline parameters such as duration of low back pain, physical functioning, and the follow up period which varied from 6 weeks to 3 years. Moreover, intervention strategies, the frequency and duration of treatment sessions and the additional treatments added were also different. There

were also variations concerning primary and secondary outcomes. Furthermore, in regards to the ethnic group of population; participants included in the studies were from different regions of the world such as Brazil, Australia, Norway and UK. However, these studies researched some common features in relation to the outcome measures assessed. Thus, these common features will form the basis for the emergent themes which will be discussed in the next chapter.

5.5. Summary of the Selected Articles:

Table 7: Summary of Selected Studies

Author and year	Aim	No. of Participants	Outcome measures	Treatment	Conclusion
Costa et al	To investigate the efficacy of motor control exercise for people with chronic low back pain	154	Pain intensity, activity, patient's global impression of recovery	Gr1- Motor control exercise, gr2- placebo treatment	Motor control exercise produced short-term improvements in global impression and recovery and activity but not pain.
Hides et al	To report a specific exercise intervention's long-term effects on recurrence rates in low back pain patients	39	Pain, disability, range of motion, multifidus muscle cross-sectional area	Gr1- medical management, gr2- medical management plus motor control exercises	Specific stabilization exercises and medical management are more effective than medical management alone.
Franca et al	To contrast the efficacy of segmental stabilization and strengthening of abdominal and trunk muscles in chronic low back pain	30	Pain, functional disability, transsversus abdominis muscle activation capacity	Gr1- specific stabilization exercise, gr2- strengthening exercises	Segmental stabilization is superior to superficial strengthening for all variables.
Cairns et al	To evaluate the effect of adding specific spinal stabilization	97	Functional disability, pain	Gr1- specific stabilization exercise, gr2-	No additional benefit of adding specific

	exercises to conventional physiotherapy for recurrent low back pain			low load high repetition muscle activity	stabilization exercise to conventional physiotherapy.
Ferreira et al	To compare the effects of general exercise, motor control exercise and manipulative therapy	240	Physical function, perceived effect of intervention	Gr1- general exercise, gr2- motor control exercise, gr3- manipulative therapy	Motor control exercise and spinal manipulative therapy produced better short term effects than general exercise.
Koumantakis et al	To examine the usefulness of addition of specific stabilization exercises to a general back and abdominal muscle exercise for low back pain	55	Pain, disability, cognitive status	Gr1- specific stabilization exercise, gr2- general back and abdominal exercise	Specific stabilization exercise does not provide additional benefit to patients with low back pain.
Fladmark et al	To study the compared outcomes after motor control exercise, sling exercise and general exercise in low back pain	109	Pain, self-reported activity limitation, clinically examined function and fear-avoidance beliefs	Gr1- motor control exercise, gr2- sling exercise, gr3- general exercise	Motor control exercise, sling exercise and general exercise were found to be equally effective.

CHAPTER 6

ANALYSIS

6.1. Introduction:

The aim behind this chapter is to analyze the articles obtained by following a methodological approach and analyzing them using carefully thought themes. Burls (2009) states that critical appraisal or analysis is a process by which research evidence is systematically analyzed to find out the validity of the results and the relevance of the results to help take a decision. The articles are grouped according to the interventions an outcome measures found in each article. Sub-groups should be formed from the results obtained after analysis of the themes. Different studies have different outcome measures and analysis is based on these outcomes. Different groups have to be made because each study comprises of different outcome measures, it also makes it easier to analyze the different themes. Classifying the studies into different sub groups will give a better knowledge and understanding of the effectiveness of motor control exercises and conventional therapy on low back pain and the outcomes of the different studies. The themes that were created after careful study of the various articles regarding effectiveness of motor control exercises and conventional physical therapy in chronic non-specific low back pain are included in Table 8 (Mind MAP analysis table 8):

6.2. List of The Themes:

- Theme 1: Effect of motor control exercises and conventional therapy on pain intensity
- Theme 2: Effect of motor control exercises and conventional therapy on physical function

- Theme 3: Effect of motor control exercises and conventional therapy on multifidus and/or tranversus abdominis muscles.

Table 8: Summary of Analysis

Authors	Theme 1	Theme 2	Theme 3
Costa et al	✓	✓	
Hides et al		✓	✓
Franca et al	✓	✓	✓
Cairns et al	✓	✓	
Ferreira et al		✓	
Koumantakis et al	✓	✓	
Fladmark et al	✓	✓	

1) Theme 1: Effect of motor control exercise and conventional therapy on pain intensity

The studies found under this theme are Costa et al (2009), Franca et al (2010), Cairns et al (2006), Koumantakis et al (2005) and Fladmark et al (2010).

The study conducted by Costa et al (2009) focuses to find out the efficacy of motor control exercises for people with chronic low back pain. The outcome areas were pain intensity, activity and patient's global impression of recovery. Pain intensity was measured by Patient-Specific Functional Scale. Participants in each group received 12 half-hour treatments over an

8-week period. The means effect on pain was 0.9 points (CI: -0.001 to 1.8) measured on 11-point scale. Thus, from this study, it can be stated that there was no significant improvement in pain intensity after motor control exercise intervention. Another research by Franca et al (2010) performed a comparative study between segmental stabilization and muscular strengthening in chronic low back pain. The outcome measures were pain, functional disability and activity of transversus abdominis muscle. Pain intensity was estimated by Visual Analogical Scale in this trial. The interventions were conducted over 6 weeks, twice per week, each session lasting 30 minutes. This study suggests that both segmental stabilization and strengthening exercises effectively reduce pain with $p < 0.001$. Thus, there was no additional benefit of motor control exercises over strengthening exercises for pain intensity in chronic low back pain. Furthermore, Cairns et al (2006) conducted a trial to evaluate the effect of adding specific spinal stabilization exercises to conventional physical therapy for patients with recurrent low back pain. In this study, the secondary outcome measure was pain. Patients received a maximum of 12 treatments over 12 weeks. The comparison of baseline scores with the post-treatment scores was done. Final follow up results for pain indicated a reduction in both groups for current i.e. visual analog scale and usual i.e. numerical pain rating scale levels. No between group differences were shown for either the VAS or numerical rating scale. Thus, this study does not support the use of specific stabilization training over conventional physical therapy for pain management in patients with recurrent low back pain. Also, Koumantakis et al (2005) performed a comparative study to identify the effects of addition of specific stabilization exercises plus general exercises by comparing it with general exercises alone in patients with low back pain. The important outcomes of this trial were pain, disability and cognitive status of patients. In this study, pain was estimated by McGill Pain Questionnaire. The frequency of intervention given for both groups was twice per week for 8 weeks. It is mentioned in the study that for the pain, the results were similar for both groups and not significant ($p > 0.05$). But, details of this result are not provided limiting to compare the

confidence intervals of both groups for their clinical application. This research proves that Stabilization exercises do not appear to provide additional benefit in relation to the pain intensity for patients with sub-acute or chronic low back pain. Moreover, Fladmark et al (2010) performed a study to compare motor control exercises and sling exercises with general exercises in the early phase of rehabilitation for patients with chronic low back pain. The participants in all treatment groups attended treatment once a week for 8 weeks. In this trial, pain intensity was measured by numerical pain rating scale. Mean current pain group differences after intervention, adjusted for baseline score, were 0.3 (-0.7 to 1.3) in the motor control exercise group compared with the sling exercise group, 0.7 (-0.6 to 2.0) in the sling exercise group compared with the general exercise group, and 1.0 (-0.1 to 2.0) in the motor control exercise group compared with the general exercise group. P value for overall significant group difference (P = 0.19). Thus, this study also identified that there was no significant group difference for the pain intensity between motor control exercise, sling exercise and general exercise in patients with chronic low back pain.

After careful observation of these studies, it was found that the assessment tools used in each study were different with different reliability scores (e.g. Visual Analogical Scale or McGill Pain Questionnaire). Moreover, the duration of intervention given was variable in all trials such as in the study performed by Cairns et al; the period of treatment was 12 weeks while Franca et al provided it for 6 weeks duration. In general, there was no significant effect of specific stabilization exercises in comparison with other forms of physical therapy interventions such as strengthening exercises, sling exercises or general exercises for pain management in patients with chronic low back pain.

2) **Theme 2: Effect of motor control exercises and conventional therapy on physical function**

Following studies were found under this theme – Costa et al (2009), Hides et al (2001), Franca et al (2010), Cairns et al (2006), Ferreira et al (2006a), Koumantakis et al (2005) and Fladmark et al (2010).

Costa et al (2009) conducted a study with the purpose to investigate the efficacy of motor control exercises for people with chronic low back pain. Patient-Specific functional Scale on 11-point scale was used to assess the physical functioning of the participants. Participants from both groups gained 12 half-hour treatments over an 8-week period. The mean effect of motor control exercise on activity that is physical function of the participants was 1.1 points with CI = 0.3 to 1.8. Thus the result of this study suggested that there was significant improvement in physical function after motor control exercise in chronic low back pain patients which was maintained at 6- and 12-month follow-ups. Another trial done by Hides et al (2001) focused on long term effects of specific stabilizing exercises on recurrence rates in acute, first-episode low back pain patients. In this study, physical function was assessed by Rolland Morris Disability questionnaire. The intervention period was 4 weeks and patients from the specific exercise group were seen twice per week in this period. It was observed that there was complete reduction in pain intensity and disability in 90% of patients. Also, functional outcome was improved after intervention though statistical figures for the physical function are not mentioned. Furthermore in 2010, Franca et al conducted a study to contrast the efficacy of two exercise programs; segmental stabilization and strengthening of abdominal and trunk muscles. The main outcomes were pain, functional disability and activation of transversus abdominis muscle. The physical function was assessed by Oswestry Disability questionnaire. Both exercise interventions were given for 6 weeks, twice per week, each session lasting 30

minutes. In this study, it is found out that segmental stabilization exercises significantly ($p < 0.001$) improved physical function of all participants. However, physical function was also improved by superficial strengthening. Thus, both treatments were effective in decreasing functional impairment. Another study was performed by Cairns et al (2006). The main aim of this study was to find out effect of adding specific spinal stabilization exercises to conventional physical therapy in chronic low back pain patients. Physical function of the participants was assessed by Roland Morris Disability Questionnaire. The treatment session was lasted for 12 weeks with frequency once in each week. The mean difference in scores for physical function was -5.1 (-6.3 to -3.9) for stabilization treatment and -5.4 (-6.5 to -4.2) for conventional treatment. Thus in this study, it is observed that for patients with nonspecific, recurrent LBP, for the outcome physical function; no additional benefit is gained from spinal stabilization exercise over a package of advice, general active exercise and manual therapy. However, Ferreira et al (2006a) conducted a randomized controlled trial to compare effects of general exercise, motor control exercise and manipulative therapy. The primary outcomes of this study were to find out the effect of these exercises on function and perceived effect of intervention. The physical function of the patients was measured by patient specific function scale (PSFS) on the scale of 3 to 30. Participants attended for up to 12 treatment sessions over an 8 weeks period. In the study, it was observed that at 8 weeks, the motor control exercise group had better physical function ($p = 0.004$) than did the general exercise group. Thus, according to this study, motor control exercise produces slightly better short-term function and perceptions of effect than general exercise. While, Koumantakis et al (2005) conducted a comparative study to find out the effect of trunk muscle stabilization training plus general exercises versus general exercises only in patients with recurrent low back pain. The primary outcomes of this study were pain, disability and cognitive status of the participants. The disability was assessed by Roland Morris Disability Questionnaire. The frequency of intervention given for both groups was twice per week for 8 weeks. There was a statistically significant between-group difference

for functional outcome immediately following exercise (mean difference = 2.55, *P* = .027) in favor of the general exercise– only group, but this difference was no longer present at the 3-month follow-up. Both groups improved immediately following intervention (*P* = .001) and these improvements were maintained 3 months later for all outcome measures when assessed individually. Thus, results of this study indicated that general exercises have more impact on physical function in patients with recurrent low back pain than trunk muscle stabilization training plus general exercises. Moreover, Fladmark et al (2010) performed a trial on motor control exercises, sling exercises and general exercises for patients with chronic low back pain. The primary outcome measure was pain. The secondary outcome measures were self-reported activity limitation, clinically examined function and fear-avoidance beliefs after intervention. All the participants received their corresponding interventions once in a week for eight weeks. The activity limitation was assessed by Oswestry Disability Index. Mean adjusted group differences in activity limitation score after intervention were 0.6 (-4.3 to 5.4) in the motor control exercise group compared with the sling exercise group, 3.0 (-2.4 to 8.5) in the sling exercise group compared with the general exercise group and 3.6 (-0.5 to 7.6) in motor control exercise group compared with the general exercise group. P value was 0.21 for overall group difference. This study concluded that there were no significant group differences in physical disability after eight weeks of motor control exercises, sling exercises, and general exercises in patients with chronic nonspecific low back pain. However, confidence intervals for improved physical function outcome spanned clinically important differences in favor of the motor control exercise intervention compared with the general exercise intervention.

Thus from the above discussion, it is clear that motor control exercises alone or in addition to other forms of conventional physical therapy were effective to improve physical function in patients with chronic low back pain though in few studies such as Hides et al (2001), results were not that significant. However, goal of achieving advantage from motor control exercises

for the effective functional outcome was accomplished up to some extent. Although, there were variations with respect to measurement scales and time span of treatment, it can be observed that grossly there was positive effect of motor control exercises in treating physical function for chronic low back pain patients.

3) **Theme 3: Effect of motor control exercises and conventional therapy on multifidus and/or tranversus abdominis muscles.**

The studies which were found under this theme are Hides et al (2001) and Franca et al (2010).

The main outcome measures in the study performed by Hides et al (2001) were pain, disability, range of motion and multifidus muscle cross-sectional area. For ultrasound imaging data concerning multifidus muscle cross-sectional area, the percentage difference between the painful and non-painful side was calculated for each vertebral level measured. Analysis of muscle recovery was conducted using the data from the most affected vertebral level. The intervention given for both groups was for 4 weeks and patients from the specific exercise group were seen twice per week in this period. In the control group, multifidus muscle at the most affected vertebral level remained 16.8% ± 9.3% less at 4 weeks and 14% ± 6.3% less at ten weeks. Muscle recovery was more rapid and more complete in patients in group 2 who received specific and localized exercises ($p = 0.0001$). Also, at the 10-week follow-up examination, patients in group 1 still exhibited significantly decreased multifidus muscle size though they resumed normal levels of activity, and the difference between groups was still significant ($p = 0.0001$). The results from this study showed that subjects with acute, first-episode of low back pain who received specific exercise therapy in addition to medical management and resumption of normal activity experienced more rapid and improin loved

recovery of multifidus muscle in long-term also than subjects who received only medical management and resumed normal activity. Furthermore, Franca et al (2010) conducted a comparative study to contrast the efficacy of two exercise programs, segmental stabilization and strengthening of abdominal and trunk muscles. The important outcomes of this study were pain, functional disability and activation of transversus abdominis muscle in chronic low back pain patients. Pressure biofeedback unit (PBU) was used to assess muscle activation capacity of patients. The interventions were conducted over 6 week, twice per week, each session lasting 30 minutes. The results of this study showed that contraction of the tranversus abdominis muscle was improved by 48.3% in segmental stabilization group. However, in superficial strengthening group, transversus abdominis muscle had negative gains (worsening -5.1%, $p = 0.99$). Both techniques lessened pain and reduced disability. Thus, this study found out that segmental stabilization is superior to superficial strengthening as superficial strengthening does not improve transversus abdominis muscle activation capacity.

Hence, motor control exercises unambiguously improve multifidus muscle and / or tranversus abdominis muscle activation capacity. No other forms of treatments were seemed to be effective in improving the ability of these trunk muscles. However, specific stabilization exercises significantly ameliorated cross-sectional area of these muscles regardless of the duration of treatment provided.

Thus, from the above discussion, it is evident that motor control exercises in conjunction with the conventional physical therapy are beneficial for trunk muscles activation, functional outcome and up to some extent for pain intensity. More discussion from the literature concerning its significance will be presented in the next chapter.

CHAPTER 7

DISCUSSION

7.1. Introduction:

With the purpose of finding the evidence to support this study, it is very important to consider the thematic analysis to describe the research question relating to different themes of the studies which were explained in the analysis chapter (Table 8: summary of analysis). In the discussion of the themes, it was identified that physical function and trunk muscle activation were seemed to be improved by the use of motor control exercises and conventional physical therapy though effective output concerning pain intensity was debatable. Thus, in this chapter, these findings will be enlightened by looking at other relevant evidences from the literature.

7.2 General Discussion Based on Evidences:

Through the discussion of the themes it was observed that motor control exercise when added with the conventional treatment is beneficial in patients with chronic low back pain. This is supported in the systematic review by Maher et al (2009) which shows that motor control exercises are superior to minimal intervention and confers benefit when added to another therapy for pain relief at both short and long term follow ups and disability at long term follow ups. In a different study by Rackwits et al (2006), it was identified that specific stabilization exercises are more effective than the treatment by general practitioner. However, they also added that when compared to other forms of physical therapy management for low back pain, these exercises were not found to be beneficial. Costa et al (2009) provided evidence that motor control exercises were better than placebo in patients with chronic low back pain. Most

of the effects observed in the short term were maintained at 6 and 12 month follow-up, but the magnitude of the effects was small in population, who has aspects associated with poor outcome. Thus, their results suggested that this intervention should be considered for patients with chronic low back pain in order to improve activity and global impression of recovery and to improve pain intensity in long term follow ups but not in short term. Nevertheless, a study conducted by Cairns et al (2006) showed that for patients with non-specific, recurrent low back pain, without evidence of psychological distress, no additional benefit from spinal stabilization exercises was observed when compared to general active exercises and manual therapy.

7.2. Discussion Based on the Themes:

After careful consideration of all literature evidences, it was reported that motor control exercises along with the conventional physical therapy were seemed to be effective. Strong evidences were found to support the use of these exercises in improving lumbar multifidus and transversus abdominis muscle activation. Although, there were some literature sources which stated no use of adding these exercises in traditional treatment for the outcome pain intensity, grossly these exercises were found to be beneficial in treating pain intensity considering all evidences together. Similarly for the functional outcome, very few evidences reported insignificant results. Thus inclusively, motor control exercises in conjunction with conventional physical therapy were seemed to be effective for all three outcomes considered.

7.3 - 1) Lumbar Multifidus and / or Transversus Abdominis Activation:

Lumbar multifidus and transversus abominis muscles play an important role in the genesis of low back pain. Richardson et al (2002) found that weak and abnormal contractions of

tranversus abdominis muscle affects sacroiliac joint which produces the symptoms of low back pain. These findings were substantiated in the study by Hodges (1999) which stated that compared with healthy control, chronic low back pain subjects exhibit over activation of the more superficial muscles of the trunk and under activation of the inter-segmental ones. Inter-segmental muscles are responsible for providing segmental stability and direct control over the position of lumbar segments. Also, in 1999 (b), Hodges and Richardson reported that contraction of the transversus abdominis and the lumbar multifidus, which normally occurs in preparation for subsequent movement of the extremities of the body in any direction has shown to be delayed or attenuated in those with low back pain. Interestingly, these findings were found to be improved in the study by Hides et al (2001). In this study, it was observed that multifidus muscle recovery was more rapid and more complete with the specific stabilization exercises and medical management when compared with medical management alone. Similar findings were identified in the study by Franca et al (2010). These authors found that after implication of segmental stabilization exercises, contraction of the transversus abdominis muscle was improved as compared to the prior observations. Also, there was no effect of superficial strengthening exercises on transversus abdominis contraction. Similar findings were observed by Hides et al (2008), who suggested that a staged stabilization program, including voluntary contraction of the multifidus, transversus abdominis, and pelvic floor muscles and movement training, was commensurate with an increase in multifidus muscle cross-sectional area and restoration of between-side symmetry. The results of this study concluded that specific stabilization retraining resulted in an improvement in multifidus muscle cross-sectional area and this was concomitant with a decrease in pain. Furthermore, O'Sullivan (2000) added into this account that an individual motor learning exercise approach designed to enhance optimal segmental spinal control for patients with lumbar segmental instability is a logical management strategy for this condition. He strongly recommended the

use of specific spinal stabilization exercises in patients with lumbar segmental instability with low back pain. However, he also suggested further clinical trials to confirm these findings.

7.3 - 2) Pain Intensity:

Motor control exercises have an impact on pain intensity in chronic low back pain. This finding was supported by O'Sullivan (2000) who showed that specific stabilizing exercises reduced low back pain associated with lumbar segmental instability. Also, in a systematic review conducted by Maher et al (2009), it is stated that motor control exercises when added to other forms of treatment are beneficial in reducing pain intensity in individual with low back pain. However, they also recommended the emphasis on evaluating issues such as dosage parameters, feedback approaches, and effects in defined subgroups in future trials. Moreover, Hides et al (2008) found that specific stabilization training improves multifidus muscle cross-sectional area. It is also effective in decreasing low back pain associated with altered multifidus muscle activity. Similar results were found in the study by Franca et al (2010) which showed that segmental stabilization exercises improved pain intensity in patients with chronic low back pain. However, long term effects are not taken into account in this study. Nevertheless, a randomized trial by Cairns et al (2006) has different findings concluding that spinal stabilization exercises have no additional effect when added to the conventional physical tharapy for patients with recurrent low back pain. Failure of the follow up of patients according to the groups allocated was the limitation of this study. Thus the result of this study cannot be considered as valid. While in 2009, Costa et al identified that motor control exercises produced short-term improvements in global impression of recovery and activity but there was no significant effect on pain intensity as compared to the placebo group. Another trial by Koumantakis (2005) concluded that general exercises alone produced better effect in patients with recurrent low back pain than trunk muscle stabilization training plus general exercise. Kasai (2006) in his review suggested that segmental stabilization exercises produce

significant long term effect on low back pain and prevents its recurrence. The results of this review stated that these exercises are more beneficial than general strengthening exercises in reducing low back pain. Also, Ferreira et al (2006b) in their systematic review identified the importance of using specific stabilization exercises in spinal and pelvic pain than general physical therapy program. Also, in a case report by Filho et al (2008), it is noticed that specific stabilization exercises have long term effect on chronic low back pain. There was an important decrease in pain and disability which was kept after a long period and the recovery of lumbar lordosis was able to be observed in MRI after the treatment. Nevertheless, a study conducted by Fladmark (2010) proved that all three interventions that is, motor control exercises, sling exercises and general exercises were equally effective in reducing pain in chronic low back pain.

7.3 - 3) Physical Function / Functional Outcome:

Chronic low back pain eventually leads to physical disability of an individual which is improved by motor control exercises. This statement is supported in the trial conducted by Ferreira et al (2006a) which concluded that motor control exercises produce slightly function and perception of effect than general exercise nut not better medium or long term effects, in patients with chronic non-specific low back pain. The similar findings were observed for the spinal manipulative therapy group in this study. Also in 2010, Franca et al identified that motor control exercises were effective in decreasing functional impairment but not more effective than the control group. While Kasai (2006) in his review recommended the use of specific spinal exercises over general strengthening exercises to reduce physical disability in patients with chronic low back pain. Furthermore, Ferreira et al (2006b), in their systematic review suggested that spinal stabilization exercises are more effective than general physical therapy for both pain and functional disability. However, they also added that these exercises seemed to be effective only in chronic low back pain and not in acute low back pain. However, Hides et

al (2001) found that for improving functional outcome, specific stabilizing exercises have no benefit over medical management and resumption of normal activity as both groups produced equal significant effects. While, Costa et al (2009) in their trial reported that motor control exercises improved activity and patient's global impression of recovery as compared to the placebo group. These effects were maintained at the 6 and 12-month follow up examinations. Cairns et al (2006) identified motor control exercises and conventional physical therapy as effective as conventional physical therapy alone for pain intensity and physical functioning in patients with recurrent low back pain. However, in a prospective study by Luomajoki et al (2010), it is observed that disability improved significantly following specific individual exercise programs, performed with physiotherapeutic intervention. Also, Filho et al (2008) in their case report concluded that motor control exercises are effective in decreasing physical disability in chronic low back pain. While, Koumantakis (2005) suggested that there was no significant benefit of trunk muscle stabilization training plus general exercises over general exercises alone. Also, Fladmark (2010) identified that there was no significant difference between the groups; motor control exercises, sling exercises and general exercises for the outcome disability. However, they also added that clinically important additive effects of motor control exercises cannot be excluded.

Overall, it is observed that motor control exercises should be added to other forms of physical therapy such as general strengthening exercises for achieving maximum benefit from all outcome measures. These exercises were seemed to be effective in improving postural control through activation of transversus abdominis and lumbar multifidus muscles. However, in the future studies, adequate sample size, consideration of all important outcomes and bio-psychological factors should also be taken in an account and frequent follow ups should be considered for early interventions.

7.4. An Overview of the Research:

The above stated discussions and variability of the results helps to identify the significant factors that will determine the efficacy of motor control exercises in individuals with chronic low back pain. It is not only pain intensity but also the functional disability and cross sectional area along with the activation of tranversus abdominis muscle and lumbar multifidus muscle which improve with the application of motor control exercises. In addition to this, conventional physical therapy should also be used in conjunction with the specific stabilization exercises to achieve better outcome in all variables such as quality of life, range of motion. These variables help in comparison of results in different settings of different studies. Moreover, it is understood that in a particular study, different settings and results can affect the main outcome. So it is very important to use the most appropriate treatment modalities to treat patients with chronic low back pain. The selected studies show that allocation of patients and choosing the variables is more important to investigate the effectiveness of the study. Selection of the subjective and objective outcomes is necessary to know which approach is more effective for the patient.

Power analysis is another important factor in the validity of the study. However, from seven discussed studies, two studies did not mention about their power calculation. Thus the results of those studies cannot be generalized to any population and further research should be needed to substantiate their findings. Considering all above factors, it is noticeable that these findings have direct influence on different practices. The health care professionals should consider the patients and find most suitable treatment for such patients. It is necessary to take into account of some factors like social and economic background, work status and psychological factors before implementing the treatment. The patients should have flexible treatment session and timing and duration of treatment. The physician or surgeon should give full details of treatment to patients to get more beneficial results. Thus the selection of patients

and the selection of treatment are important factors to achieve significant results. It is necessary to educate the patient on treatment methods, progression and adverse effects. So that patients can avoid fear about the implementation of intervention and achieve confidence on their treatment to report better outcome results.

From the above discussion, it can be concluded that doing any research study, it is necessary for the health care professionals to look for the proper resources and health care settings to carry out the research for better outcome.

7.5. Limitations of the Research:

Limitations are very important to be considered while conducting research. There were number of limitations which author came across while conducting this literature review. Specific protocol for the use of motor control exercises is not determined yet. Thus all studies may have followed their own protocol for its intervention which can be an important factor in influencing the findings of all selected studies. A potential limitation was inclusion and exclusion criteria which were set to limit the search to only published articles available after year 2000 to keep the study based on more recent evidences. Thus, the other relevant articles which were not published or were published before year 2000 could not be included in the study. The key words and phrases to identify the literature may have the chances of bias so that the relevant material may not have been searched for different search words. To search the articles, English language was used limiting the inclusion of other relevant articles from different languages. There are more studies available in this area with different methodology which are relevant to the current study, but as the main focus of this study was to find out an efficacy of a specific treatment in comparison with the other, only RCTs were used to answer the question and thus limiting the present study from the available information from other study designs.

It is possible that the electronic databases used in the present study have not shown all articles available as some of them were not accessible. Also all the included studies had different environment, culture, setting and population which can bias the results. In addition to this, the assessment tools (e.g. equipment, scales) used to measure the outcome measures were all different with variable reliability of the tools in all studies. Thus, it is difficult to derive a final conclusion. Furthermore, the research was imposed for the limitations only by the reviewer and it was not blind which may lead to bias during the study.

7.6. Considerations as a Researcher:

This study brings forward more questions for future research in order to clear the effectiveness of motor control exercises in conjunction with conventional treatment for chronic low back pain. These different studies provided different results in the researches for treating patients with chronic low back pain. So the researcher should improve the quality of the research. Moreover, in almost all studies adequate sample size was not achieved as mentioned in the power analysis and thus precluding their findings from clinical application.

Moreover, as a researcher, it was found that these exercises are effective in chronic low back pain for specific outcomes when given with adequate dosage. Thus, motor control exercises can be implemented in clinical practice as they are convenient for application with no cost and harm. So, use of this exercise should be promoted in practice areas to find out its efficacy and for further scope in its improvement in application. However, there should be specific protocol set to administer specific stabilization exercises on chronic low back pain patients.

Hence from the presented discussion, it was observed that motor control exercises in conjunction with conventional physical therapy were seemed to be effective for all considered

outcomes with the support from the literature evidences. However, there can be some limitation in this research with respect to inclusion / exclusion criteria or the databases, search terms used. Thus, the next chapter will present the conclusion concerning its effectiveness by considering the results, analysis and the relevant literature available. Also, there will be discussion on the recommendations for its further research and its clinical application.

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8.1. Introduction:

This chapter focuses on the conclusion of the findings of literature review relevant to this study. Also, recommendations will be suggested for the scope of further research in this field for an effective output, for the application of motor control exercises plus conventional physical therapy for chronic low back pain in the clinical practice and for its inclusion in academics to promote its administration.

8.2. Conclusion:

Literature review of the present study was conducted to find the evidence to support the effect of motor control exercises in conjunction with the conventional physical therapy in chronic low back pain and to answer the research question 'Are motor control exercises in conjunction with the conventional physical therapy effective in chronic non-specific low back pain?' The analysis was proved by available supportive literature that motor control exercises and conventional physical therapy are effective in chronic non-specific low back pain. The process of analysis included development of the research questions, forming criteria, search strategy, searching databases, title, abstract, full text screening, searching the data and articles manually, data extraction, quality assessment and data checking. Thus, after performing rigorous analysis, it is clear from the study motor control exercises and conventional physical

therapy are more effective in improving functional disability and activation of lumbar multifidus, transversus abdominis muscles along with their cross-sectional area associated with chronic low back pain as compared to the improvement in the pain intensity. However, it is difficult to determine what type of study has more impact on the treatment of the patients as well as which component is useful in treating the patients.

According to present study, it is found that power analysis was not mentioned in few trials which limit the generalization of results of those trials. In addition to this, the researcher has to be very careful in forming accurate measures like blinding, internal and external validity and outcome measures while conducting future research. It is vital important to explore which approach is appropriate to conduct the research.

It is clear that not all patients with chronic low back pain will be benefitted with the motor control exercises and conventional physical therapy. While treating the patients with chronic low back pain other factors such as chief complaints of patient, nature of low back pain (pathological, traumatic, etc.), patient's history, psychological factors and environmental factors must also be taken into account as these can affect the outcome. Thus, to consider all these factors, there is a need for further research on this subject to achieve a better understanding and outcome.

8.3. Recommendations:

8.3. - 1) For Further Research:

The findings of this study shows that motor control exercises in conjunction with the conventional physical therapy are effective in chronic non-specific low back pain, specifically at long-term follow up. However, there are very few studies available on combined effect of

motor control exercises and conventional physical therapy for chronic low back pain. Further research on this effect with adequate sample size would be beneficial to substantiate present findings. A specific protocol for the application of motor control exercises should be determined for the accuracy in the results. For a significant output concerning this field, baseline characteristics that is; pre-intervention scores should always be noted to identify the efficiency of the intervention. It would be useful if the study has provided the reliability of the assessment tools used. Sample size considered should be adequate to obtain the generalization of the results in the clinical practice. It is essential that the number of drop outs in the study is minimal as this is one of the potential factors in influencing the findings of the result. For assessing the methodological quality of the studies, future trials are needed. All important outcomes should be measured regardless of any forms of bias and should be followed up without fail. Also there is still scope for further research in relation with the different outcome measures considered such as effect of these exercises on lumbar range of motion or stiffness in chronic non-specific low back pain especially in long terms.

8.3. - 2) For Practice Implications:

Various studies proved that motor control exercises improve the lumbar multifidus and transversus abdominis muscle activation which play an important role in reduction of low back pain. Hence, patients with reduced functions of trunk muscles can effectively be treated by specific stabilization exercises and conventional physical therapy. Also, these exercises can be effective in lumbar segmental instability patients with associated low back pain or in the individuals with imbalanced postural control (e. g. low back pain in pregnancy). Also, according to some studies, these exercises were found to be beneficial in spinal / pelvic pain for which they can be used. Moreover, low back pain related disability can be managed with the combined effect of motor control exercises and traditional treatment.

8.3. - 3) For Education:

It would be beneficial if motor control exercises are included in academics which will lead to increase in awareness concerning this area. This will eventually accelerate the demand for its further scope and research. Also, maximum people can be benefitted by its individual or combined effect with conventional physical therapy for low back pain.

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