ACTIVE STABILISATION TRAINING IN A GROUP EXERCISE CLASS: A PILOT STUDY

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A research report submitted to the Faculty of Medicine, Department of Physiotherapy, University of the Witwatersrand in partial fulfilment of the requirements of the degree Master of Science in Physiotherapy (Orthopaedics)

Johannesburg 1999

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

COMMITTEE FOR RESEARCH ON HUMAN SUBJECTS (MEDICAL)
Ref: R14/49 Jacobs

CLEARANCE CERTIFICATE PROTOCOL NUMBER M 960411

PROJECT A rehabilitation programme for dynamic stability of the lumbar spine and its effect on movement dysfunction

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DECISION OF THE COMMITTEE *

Approved unconditionally

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DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and ONE COPY returned to the Secretary at Room 10001, 10th Floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

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DECLARATION

I, Lorraine Eleanor Jacobs declare that this research report is my own work. It is being submitted for the degree M.Sc in Physiotherapy (Orthopaedics) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

9th day of November 1999.

In loving memory of my mother

Phyllis Mary Duffett

1916 - 1995

This study supports the use of a group class for active stabilisation training of the lumbar spine. The results justify the establishment of a randomised controlled study to provide more conclusive evidence.

ABSTRACT

ACTIVE STABILISATION TRAINING IN A GROUP EXERCISE CLASS : A PILOT STUDY

There is evidence that exercise is beneficial for patients who suffer from low back pain. Clinical observation suggests that there is often poor compliance with individual exercise programmes. Regular group exercise classes may improve patient compliance, and therefore good outcomes in these patients.

An observational study was performed on participants in a group exercise programme for the rehabilitation of lumbar stability. Six patients, 2 male and 4 female, aged 30-60, who had suffered more than two episodes of low back pain during the past two years agreed to participate in the study.

The holding capacity of transversus abdominus as an indicator of deep abdominal muscle function was measured. The subjects performed a self-assessment of pain, disability, handicap and well being. All these measurements were repeated on three occasions – before commencement of the exercise classes, after one month's participation and after three month's participation. A follow–up postal questionnaire was completed after one year.

All these measurements showed trends of improvement during the study.

This study supports the use of a group class for active stabilisation training of the lumbar spine. The results justify the establishment of a randomised controlled study to provide more conclusive evidence.

ACKNOWLEDGEMENTS

I wish to thank Margie Morrell for allowing me access to her exercise class participants.

I would also like to thank Leigh-Ann Hale and Tom Paulsen for acting as my supervisors.

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ABBREVIATIONS

Abd	Abduction
ADL	Activities of daily living
CLBP	Chronic low back pain
CSA	Cross sectional area
EMG	Electromyography
Erector sp	Erector spinae
Exc(s)	Exercise(s)
Ext	Extension
Fl	Flexion
Glut med	Gluteus medius
Glut max	Gluteus maximus
IAR	Instantaneous axis of rotation
IASP	International Association for the Study of Pain
ICIDH	International Classification of Impairment, Disability and Handicap
Lat Fl	Lateral flexion
LBP	Low back pain
m	Muscle
MAP	Muscle activation pattern
Mult	Multifidus
No	Number
NSAIDs	Non-steroidal anti-inflammatory drugs
NZ	Neutral zone
PAP	Personal activity profile
Quad lumb	Quadratus lumborum
Reps	Repetitions
R-M Q	Roland-Morris Questionnaire
ROM	Range of movement
SLR	Straight leg raise
Tr Abd	Transversus abdominus
US	Ultrasound
WHO	World Health Organisation

INTRODUCTION

It has been estimated that physiotherapists in an outpatient department spend up to 40% of their time treating patients with Low Back Pain (LBP)(Goldby, 1997). The Clinical Standards Advisory Group (United Kingdom) (1994) report on acute and recurrent low back problems in adults investigated the value of various physiotherapy techniques on LBP through a critical review of the literature. It was concluded that such types of interventions were frequently not substantiated. However several authors have shown that exercise has a valuable place in the management of chronic low back pain (CLBP), when appropriately administered (Johansson et al 1995, O'Sullivan, Twomey and Allison 1997, Richardson and Jull 1995, Schneider 1995).

Recent scientific studies have established a link between dysfunction in the local back muscles and back pain. Several researchers have demonstrated dysfunction in the multifidus muscle of back pain patients. Hides et al (1994) reported a significant reduction in segmental multifidus cross sectional area in patients with acute, first episode unilateral back pain. Biederman et al (1991) and Ranatanen et al (1993) have also shown abnormalities of the muscle fibres of multifidus. Dysfunction of the transversus abdominus muscle has also been shown in back pain patients (Hodges and Richardson, 1996a).

Richardson and Jull (1995) suggested that specific therapeutic exercise aimed at retraining the multifidus and transversus abdominus muscles may provide effective relief for chronic and recurrent low back pain sufferers.

Mannion et al (1999) showed in a randomised clinical trial comparing modern active physiotherapy, muscle reconditioning on training devices and low impact aerobics that although there were no significant differences in the patients' responses to these therapies the direct costs associated with the administration of modern physiotherapy and muscle reconditioning were far greater than the costs associated with the low impact exercise classes.

1.1 RESEARCH QUESTION

From a review of the literature it would appear that active stabilisation training has an important role to play in the management of the patient with chronic or recurrent low back pain. The majority of these studies refer to rehabilitation on an individual basis. This is not always a cost-effective solution. It was therefore decided to investigate a rehabilitation programme for active stabilisation training which takes the form of a group exercise class and to determine whether this approach is an effective way to manage recurrent LBP.

1.2 AIM OF RESEARCH

In order to show that a group exercise programme is an effective means of rehabilitating lumbar stability the research undertaken had the following aim:

to determine in this pilot study whether any long-term benefits are obtained from participation in a group exercise class directed at the active stabilisation training, thus warranting a randomised control study.

Beattie (1996) suggests that if it can be shown that a treatment approach has favourable long term outcomes on a series of patients then a randomised clinical trial is then warranted to compare this treatment approach with a present "standard of care" approach. A randomised clinical trial can then produce experimental evidence of the efficacy of this treatment approach compared to another.

The assessment of patients included in this study included outcome measures that reflected the nature of the subject's pain and degree of disablement as well as a clinical measurement of the subject's deep abdominal muscle function.

1.3 THE NULL HYPOTHESIS

The null hypothesis is thus:

In a group of patients attending group exercise classes directed at active stabilisation training there will be:

- no change in the deep abdominal muscle function of the subject.
- no reduction in pain and disability experienced by the patient.

2. REVIEW OF THE LITERATURE

Low Back Pain (LBP) is widely recognised as one of the most serious and escalating health disorders afflicting the Western world, incorporating large proportions of the population and costing a great deal in lost productivity and health related expenditure (Davis and Eichhorn, 1963). It is estimated that 80% of the population will suffer at least one disabling episode of low back pain during their lives, and at any one time as much as 35% of the population will be suffering from backache of some sort (Frymoyer and Cats- Baril, 1991). Studies of acute low back pain indicate a 90% rate of recurrence of symptoms, with 62% of cases recurring within a year (Hirschon et al, 1969). This high rate of recurrence presents a challenge to the clinician.

Sahrmann (1997) speculates that repetitive faulty movement and the subsequent accumulative microtrauma may be the source of much musculoskeletal pain, and that faulty movement may be the cause and not solely the result of pathology. Thus the need to re-educate faulty movement patterns and muscle recruitment is paramount in the rehabilitation of musculoskeletal dysfunction.

The nature of neuromusculoskeletal control and subsequent spinal dysfunction is multifactorial. Increasingly the issues of recruitment and timing of onset of the deep stabilising abdominal muscles, rather than strength, is seen as essential for the correct functioning of specific joint complexes. It would appear that this more centrally controlled component of stabilisation appears to play a key role in the dysfunctional state within LBP subjects. (Hodges and Richardson, 1997).

2.1 FUNCTIONAL ANATOMY OF THE LUMBAR MOTION SEGMENT

The lumbar vertebral column consists of five separate vertebrae, separated from one another by an intervertebral disc. Two adjacent vertebrae with their disc and ligaments form a spinal motion segment. The vertebrae articulate with one another anteriorly at the anterior intervertebral joint, and posteriorly at the zygopohyseal joints (Bogduk and Twomey, 1991).

A lumbar vertebra may be divided into three functional components. These are

- the vertebral body anteriorly
- the pedicles
- the posterior elements consisting of the laminae, the spinous process and the articular processes which form the zygopohyseal joints.

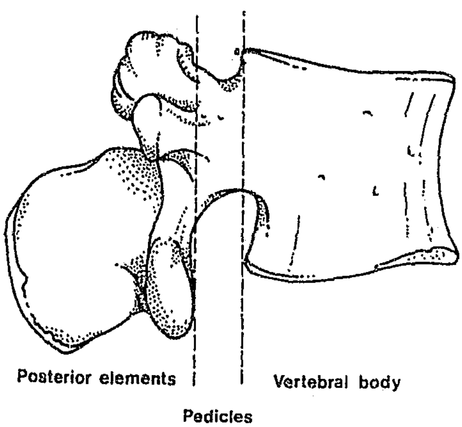

Fig 2.1 The division of a lumbar vertebra into its three functional components (Bogduk and Twomey, 1991).

The anterior vertebral body performs the function of longitudinal load bearing, via its flat superior and inferior surfaces. It is not however designed to provide stability in any other direction. (Bogduk and Twomey 1991)

The posterior elements form an irregular mass of bone, adapted to receiving forces from different directions. The inferior articular processes lock into the superior articular processes of the vertebra below, forming synovial joints whose principal function is to provide a locking mechanism that resists forward sliding and twisting of the vertebral bodies (Bogduk and Twomey 1991).

The spinous, transverse, accessory and mamilliary processes provide areas for muscle attachments. Every muscle (except Iliopsoas and the crura of the diaphragm) acting on the lumbar vertebral column is attached to the posterior elements. The pedicles transmit forces from the posterior elements to the vertebral bodies (Bogduk and Twomey (1991).

2.2 THE CONCEPT OF THE NEUTRAL ZONE

Panjabi et al (1989) proposed the concept of the neutral zone (NZ) as an indicator of spinal instability. The neutral zone is the amount of vertebral displacement that occurs early in range without a significant increase in load on the vertebral column. This zone therefore represents the amount of vertebral movement that is not restrained by "stiffness" of the collagen tissues around the joint. Stiffness is the ratio of the force applied to a structure and the motion that results. A structure is then relatively less stiff if a given load produces a greater displacement (Pope and Panjabi, 1985).

The total range of movement (ROM) of a spinal motion segment may be divided into two parts, the neutral zone and the elastic zone. The elastic zone is nearer to the end of the range of movement, where substantial resistance to movement by the capsule and ligament structures is encountered. The stabilising system of the spine must limit the excursion of spinal motion segments and maintain the proper ratio of neutral to elastic zone motion.

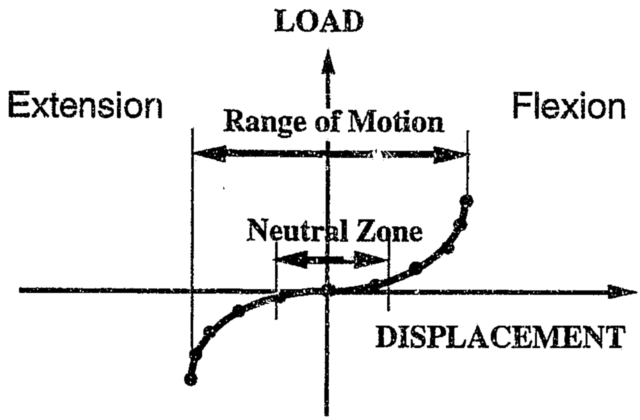

Fig 2.2 A load-displacement curve for the lumbar spine according to Panjabi (1995)

Panjabi et al (1989) found that the neutral zone of lumbar functional spinal units increased with increasing injury to restraining structures. As restraints are damaged the segment displaces further before any resistance to motion is encountered (the elastic zone).

Using these concepts Panjabi (1995) suggests the following definition of <u>clinical instability</u> as a significant decrease in the capacity of the spine to maintain the intervertebral neutral zone within physiological limits so there is no neurological dysfunction, no major deformity and no incapacitating pain.

Thus, if the restraints of a vertebral segment are weakened, then the segment will displace further before resistance is encountered to control the motion, and the segment may displace beyond its normal range.

2.3 STABILITY OF THE LUMBAR SPINE

The joints of the body are designed to permit motion between two bones. The direction and range of movement of individual joints is governed by the shape of the articular surfaces of the bones, and by the soft tissue structures around the joint, including the joint capsule, ligaments and muscles. These soft tissue structures act as a restraint by resisting distorting forces and limiting excess joint displacement.

In the vertebral column, movements between lumbar vertebra occur in a three dimensional manner. These motions are restrained by compression forces through the posterior joints, and by tensile stresses in the joint capsule and the annulus of the intervertebral disc. Muscle action also resists vertebral displacement when a load is applied (Panjabi et al, 1989). There is a complex interaction between the osteoligamentous static joint components (the passive subsystem) and dynamic muscular control (the active subsystem). This interaction is continually adjusted by the neural control system (Panjabi 1995), represented as follows:

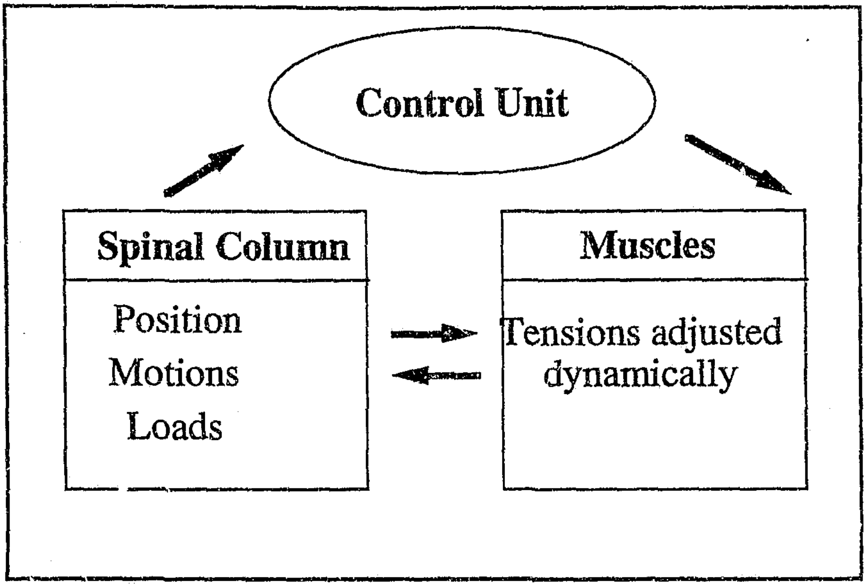

Fig 2.3: The spinal stabilising system consists of three inter-related subsystems (Panjabi, 1995)

2.3.1The Passive subsystem

The passive subsystem consists primarily of the vertebral bodies, zygopophyseal joints and joint capsules, spinal ligaments and passive tension from the musculotendinous units (Panjabi 1995). The passive subsystem plays its most important stabilising role in the elastic zone (ie near the end of the range of movement.)(Panjabi et al 1982). The relative contributions of these structures to segmental stability have been investigated by serially cutting the structures (Haher et al 1994, Sharma et al 1995) and through mathematical modeling experiments (Panjabi et al 1982, McGill 1988).

The posterior ligaments of the spine along with the zygopohyseal joints and joint capsules and the intervertebral discs are the most important stabilising structure when the spine moves into flexion (McGill 1988). End range extension is stabilised primarily by the anterior longitudinal ligament, the anterior aspect of the annulus fibrosis and the zygopophyseal joints (Haher 1994, Sharma 1995). Rotational movements of the lumbar spine are stabilised mostly by the intervertebral discs and the zygopohyseal joints (Gracovetsky et al 1985). Lateral flexion movements have not been studied extensively, but it appears that the intertransverse ligaments may play an important role.

It is thought that these structures may also function as force transducers in the neutral zone, sensing changes in position and providing feedback to the neural control subsystem (Panjabi 1982, Jiang et al 1995). Evidence for this role is provided by anatomical observation of afferent nerve fibres capable of conveying proprioceptive information in most of the structures of the passive subsystem, including the intervertebral discs, the zygopophyseal joints capsules, and the interspinous and supraspinous ligaments (Indahl et al 1997, Jiang et al 1995). Injury to the passive subsystem may have important implications for spinal stability. Intervertebral disc degeneration or disruption of the posterior ligaments of the spine may increase the size of the neutral zone, increasing the demands on the active and neural control subsystems to avoid the development of segmental instability (Panjabi 1989).

2.3.2 The Active subsystem

The active subsystem of the spinal stabilising system consists of the spinal muscles and tendons. The active and neural control systems are primarily responsible for spinal stability in the neutral zone, where passive resistance to movement is minimal. Biomechanical studies have shown that the spinal column with its musculature removed is incapable of carrying normal physiological loads (Panjabi et al 1989). Kong et al (1996) developed a model of muscle dysfunction in the lumbar spine. Muscle dysfunction destabilised the lumbar spine, and reduced the role of the facet joints in transmitting load, and shifted the load to the discs and ligaments. They postulate that trunk and lumbar spine muscle insufficiency can render the spine vulnerable to overload and injury.

Multifidus is the largest and most medial of the lumbar muscles and is situated close to the zygopophyseal joints (Macintosh and Bogduk, 1986). It consists of a repeating series of fascicles that radiate from each of the lumbar spinous processes. These fascicles are arranged in overlapping groups so that each lumbar vertebra gives rise to one of these groups. At each segmental level a fascicle arises from the base and caudolateral edge of the spinous process, and several fascicles arise by means of a common tendon from the caudal tip of the spinous process. The fascicles of each group diverge caudally to assume separate attachments to mamilliary processes, the iliac crest and the sacrum. Some of the deeper fibres attach to the capsule of the zygopophyseal joint, to protect the joint capsule from being caught inside the joint during the movements executed by multifidus. The medial branch of the dorsal ramus that issues from below a vertebra innervates all the fascicles arising from the spinous process of the same vertebra. Thus the nerve of that segment innervates the muscles that act on a vertebral segment (Gray's Anatomy, 1993).

As a result of its close relationship to the zygopophyseal joint multifidus can act as a stabiliser of the lumbar spine. Recent in vitro, biomechanical studies have shown that the lumbar multifidus is able to provide segmental stiffness and control motion in the neutral zone. (Goel et al 1993, Panjabi et al 1989, Wilke et al 1995). Biomechanical studies have provided evidence of the importance of multifidus in spinal stability. Wilke et al (1995) showed that when compared with other muscles in close proximity to L4-L5 multifidus contributed two-thirds of the increased stiffness imparted by the contraction of the muscles. Seven human lumbo-sacral spines were tested in a spine tester that allowed simulation of muscle forces. It was found that muscle action generally decreased the range of motion and the neutral zone of the motion segments. The total neutral zone for flexion and extension was decreased by 83%. The multifidus muscle group had the strongest influence. The localised stabilising effect of multifidus has also been confirmed in animal research (Kaigle et al 1995).

There is evidence between multifidus dysfunction and poor functional outcome and recurrence of LBP after disc surgery. (Rantanen et al 1993, Sihvonen et al 1993). Rantanen et al (1993) allocated eighteen patients to a positive or negative outcome group on the basis of functional outcome. Results of multifidus biopsies of the eight patients with poor outcome showed muscle atrophy and an increase in frequency of pathological changes in the multifidus, especially moth-eaten type I fibres. In the positive outcome group of ten patients the type I pathological changes were decreased. Functional recovery following disc surgery was associated with curtailment of structural abnormalities in the multifidus muscle. Sihoven et al (1993) proposed that poor functional outcome in thirteen patients was secondary to loss of functional muscle support, disturbed segmental mobility and increased mechanical strain and disability.

Hides et al (1994) demonstrated localised segmental dysfunction of multifidus after a first episode of acute unilateral low back pain. Ultrasound imaging was used to examine the effect of LBP on the size of the lumbar multifidus muscle. Bilateral scans were performed on 26 patients with acute unilateral LBP and 51 normal subjects. The cross sectional area (CSA) was measured. Marked asymmetry ipsilateral to the side of the pain, and confined to the vertebral level of the pain was seen. It is proposed that this phenomenon is a result of pain and localised reflex inhibition of the muscle.

Transversus abdominus lies deep to the internal oblique muscle, arising from the lateral third of the inguinal ligament, anterior two-thirds of the inner lip of the iliac crest, thoraco-lumbar fascia between the iliac crest and the 12th rib, the inner surfaces of the posterior aspect of the lower six ribs, interdigitating with the diaphragm, and via an aponeurosis from the lateral aspect of the middle layer of the thoraco-lumbar fascia. It runs circumferentially to insert on the rectus sheath. The posterior layer of the thoraco-lumbar fascia fuses with the middle layer of the thoraco-lumbar fascia and with transversus abdominus and provides an indirect attachment for the transversus abdominus to the lumbar spinous processes (Grays Anatomy, 1993).

The deep transverse fibres of the transversus abdominus have been shown to work almost continually during lumbar movement (Cresswell 1992) and thus have an important role in lumbar spine stabilisation.

When a limb is moved, equal and opposite forces to those producing the movement are imposed on the body. It is essential that contractions of the muscles of the trunk are co-ordinated with limb movement to protect the spine from injury. Transversus abdominus has been shown to be active prior to limb movement in the performance of both upper and lower limb movements (Hodges and Richardson, 1996a, Hodges and Richardson 1997).

The contribution of transversus abdominus to spinal stabilisation was evaluated in subjects with and without low back pain using an experimental model to identify co-ordination of the trunk muscles in response to a disturbance of the spine produced by arm movement (Hodges and Richardson 1996a). Fifteen subjects with LBP and 15 matched control subjects performed rapid shoulder flexion, abduction and extension, while standing, in response to a visual stimulus.

Electromyographic activity of the abdominal muscles, lumbar multifidus, and the contralateral deltoid was evaluated using fine wire electrodes. In the control subjects movement in each direction resulted in a contraction of trunk muscles before or shortly after the deltoid. The transversus abdominus was invariably the first muscle active and was not influenced by movement direction. Contraction of transversus abdominus was significantly delayed in patients with LBP with all movements. It was concluded that the delayed contraction of transversus abdominus indicated a deficit of motor control, and is hypothesised to contribute to inefficient muscular stabilisation of the spine.

A second study (Hodges and Richardson, 1997) was performed to evaluate the response of lumbar multifidus and abdominal muscles to leg movement. However only subjects with no LBP were examined by means of fine wire and surface electrodes which recorded activity of selected trunk muscles and the prime movers for hip flexion, abduction and extension during hip movements in each of these directions. Once again transversus abdominus was the first muscle active, and its reaction time was consistent across all three movement directions. These findings suggest that the neural control system normally anticipates the need for stabilisation against the reactive forces of limb movement.

2.3.3 The neural control subsystem

Sensory feedback including proprioception from the passive osteoligamentous and dynamic muscle systems should provide information for co-ordination via the neural control centres (Panjabi, 1995). However Brumagne et al (2000) showed in their study conducted on 23 patients with LBP and 21 control subjects that patients with LBP have a less refined position sense than healthy individuals. Other studies have demonstrated increased postural sway (Nies and Sinnott 1991) and slower reaction times in patients with LBP when compared to subjects without LBP (Luoto et al 1996). Nies and Sinnot (1991) studied the balance responses of a group of

25 healthy subjects compared to 20 LBP sufferers, using computerised force plate stabilometry. The LBP sufferers showed significantly greater postural sway and were more likely to fulcrum around the hip and back to maintain uprightness in challenging balance tasks. The healthy subjects tended to fulcrum around the ankle during these tasks.

Luoto et al (1996) conducted a study on reaction times of upper and lower limbs, and postural stability using sixty-one healthy control volunteers and ninety-nine patients with low back pain. The subjects were not matched. They found that patients with low back pain had significantly slower reaction times than healthy volunteers. They also found impaired postural control among women with low back pain. Both of these measures improved after participation in a functional restoration back rehabilitation programme. The programme was not described.

If proper functioning of the neural control system is not restored following an injury the potential for re-injury may be increased (Gardner-Morse and Stokes 1998).

2.4 MEASUREMENT OF ACTIVE POSITIONAL STABILITY OF THE LUMBAR SPINE.

Numerous clinical findings are proposed to be diagnostic of lumbar segmental instability. Radiological criteria of vertebral displacement during flexion and extension have been established to identify patients requiring surgical fixation. Jull et al (1993) developed a clinical method of measurement of active positional stability of the lumbar spine on the application of a standardised sagittal load with a unilateral bias to test rotary control, and used this method to detect a lack of active muscle stabilisation. This laboratory test resulted in the development of the pressure biofeedback, which will be described in detail in Chapter 3. Cairns, Harrison and Wright (2000) have shown that this is a useful tool to act as an indicator of deep muscle dysfunction.

2.5 OTHER STUDIES

Previous studies have shown the beneficial effects of rehabilitation programmes aimed at improving dynamic lumbar stability. The studies reviewed here were chosen on the basis of their contribution to knowledge in the following areas:

- Individual active stabilisation training and co-ordination
- Independent versus supervised interventions
- Individual versus group interventions
- Group preventative back workout programme

Table 2.1 summarises some of the features of these studies.

AUTHOR, DATE	SUBJECTS	TYPE OF STUDY	PURPOSE	VARIABLES MEASURED	INSTRUMENTATION	INTERVENTION	RESULTS
INDIVIDUAL STUDIES							
Hides et al 1996	Acute LBP First episode Unilateral pain n=39	Prospective controlled trial Observers blinded to group allocation	Evaluate effectiveness of specific localised exercise therapy on muscle recovery	Pain	McGill Q, VAS, Analgesics	1. medical treatment 2. medical treatment and specific exercise therapy	Both groups: ↓ pain, disability ↑ ROM Group 2 showed rapid and more complete muscle recovery than Group 1
				Disability	R-M Q		
				ROM Fl, Ext, Lat fl	Ripstein Goniometers		
				Habitual activity	Questionnaire		
				Bilateral measurements of multifidus CSA	Real time US imaging		
O'Sullivan, Twomey and Allison 1997	Spondylolysis Spondyiolisthesis n = 44	Randomised controlled trial , test –retest design	Evaluate the effect of stabilising exercises on CLBP	Pain		1. specific retraining abdominal muscles and multifidus	↓Pain ↑Functional mobility, ROM, abdominal muscles activation
				Functional mobility			
				ROM Lx, Hips		2. aerobic exercises and sit-ups	no significant changes
				Abd muscle recruitment patterns			

TABLE 2.1 SUMMARY OF OTHER STUDIES

AUTHOR, DATE	SUBJECTS	TYPE OF STUDY	PURPOSE	VARIABLES MEASURED	INSTRUMENTATION	INTERVENTION	RESULTS
Schneider 1995	patients with history of recurrent episodes of "instability" n=15	Single group of subjects – Observational, no controls	To evaluate the effect of specific exercises on episodes of lumbar instability	Frequency of occurrences		Two exercises 1. supine fl 2. isometric oblique abd excs	All subjects remained free of typical episodes at 12 and 18 months
				Location of IAR	Radiological tracings		
Johansson and Lindberg 1995	1. 35 year male, L5 spondylolisthesis 2. 40 year female 3. 18 year female gymnast n=3	3 single case studies Experimental multiple baseline design No control group	The clinical evaluation of the effect of a rehabilitation programme for lumbar stabilisation for patients with CLBP	pain	DIBS Scale	Supervised stabilisation programme	↓ pain, improvement in MAPs and muscle endurance.
				ROM lateral fl	Fingertip distance from lateral joint space knee		
				ROM hip ext	goniometer		
				spinal lateral fl	goniometer		
				MAP hip ext	Adapted from Janda and Jull (1987), best of three measures		
				MAP hip abd			
				MAP curl up			
				Endurance abdominals, hip ext and resisted excs	No of reps with control of lumbar spine position		
				Post pattern	Relationship of anatomical reference points in the sagittal and frontal planes		
				Pain free standing time	Stopwatch - minutes		
Johannsen, Remvig, Kruger 1995	patients admitted to hospital with LBP duration of 1yr ages 18 – 65 n=40	Random allocation, stratified for sex, age, duration of symptoms, x-rays - unblinded observers	To evaluate whether co-ordination is as important as spinal mobility and back strength in the rehab of CLBP	Isokinetic muscle strength	Kin-Com system	1. endurance training	1. ↓ pain, and ↑ strength
				ROM – Fl, Ext, Lat Fl			
				Pain	5 point scale		
				Disability		2. co-ordination training	2. ↓ pain, with no ↑ strength
				Drug consumption			
				Well being	3 point scale		

TABLE 2.1 SUMMARY OF OTHER STUDIES

AUTHOR, DATE	SUBJECTS	TYPE OF STUDY	PURPOSE	VARIABLES MEASURED	INSTRUMENTATION	INTERVENTION	RESULTS
Reilly K et al 1989	patients with CLBP n=40	Randomised controlled trial	To evaluate changes in physiological parameters in a group of patients with CLBP assigned to supervised and independent training programmes	Aerobic fitness		Pre-designed exercise programme with supervision	Significant improvement in aerobic fitness and strength, decreases in pain and body fat – supervision increases compliance and success
				Strength			
				Body fat		Pre-designed exercise programme without supervision	
				Pain	VAS		
GROUP STUDIES							
Mannion, Muntener, Taimela and Dvorak 1999	patients with CLBP n=148	Randomised clinical trial, observers blinded	To examine the relative efficacy of three active therapies for CLBP	Lumbar mobility	CA 600 Spine Motion Analyzer	• modern active physiotherapy • muscle reconditioning on training devices • low impact aerobics	Significant reductions in pain intensity, frequency, disability, FABQ in all 3 groups.
				Pain	VAS Pain drawing		
				Disability	Roland Morris Q		
				Psychosocial factors	Fear, Avoidance Beliefs Q		
Bardin 1997	Participation in a spinal rehabilitation programme CLBP>2 years duration	Pilot study Single case study	To evaluate the accuracy of outcome measures in the measurement of a spinal rehabilitation programme	Pain	VAS pain thermometer Wong Baker faces	Spinal rehabilitation programme consisting on supervised exercise and lectures on back care	The four subjective parameters showed significant improvement
				Disability	Roland Morris Q		
				Handicap	Personal activity profile		
				Distress	WHO distress scale		
				Physical measures (objective)	SLR Stability testing Ability to isolate tr abd and multifidus		

TABLE 2.1 SUMMARY OF OTHER STUDIES

Frost et al 1998	patients with CLBP referred to the Physiotherapy dept of an Orthopaedic hospital n=81	Single blind randomised controlled trial with 2yr follow-up by postal questionnaire	To evaluate the long term effect of a supervised fitness programme on patients with CLBP	Effect of CLBP on daily activity	Oswestry LBP disability index	Group aerobic exc class with home programme, advice	7.7% reduction in Oswestry LBP index
						Home programme and advice	2.4% reduction in Oswestry LBP index
Gudenall et al 1993	Nurses employed at a hospital	Prospective randomised control trial	To evaluate the benefit of an on-site back workout programme for hospital employees	Sick leave	Days of sick leave as a result of low back pain	Back care exercises performed for 20 minutes at the beginning of the working day	One person off sick as result of LBP (total 28 days)
						No intervention	12 people off sick for a total of 155 days on 17 separate occasions

TABLE 2.1 SUMMARY OF OTHER STUDIES

2.5.1 INDIVIDUAL INTERVENTIONS

Hides et al (1996) performed a study to measure the recovery of multifidus in acute first episode low back pain. This study was based on a previous study (Hides et al, 1994) which showed (using ultrasound imaging) rapid multifidus atrophy ipsilateral to the location of pain after a first episode of acute or sub-acute unilateral LBP. A prospective controlled trial was undertaken to document the natural course of lumbar multifidus recovery, and to evaluate the effectiveness of specific localised exercise therapy on muscle recovery.

Forty-one patients were recruited from an accident and emergency department. The subjects were randomly assigned to a control group (medical management) or an experimental group (specific exercise therapy). Two independent examiners who were blinded to group allocation performed assessments.

The following assessments were used:

- Pain - McGill pain questionnaire, visual analogue scale, pain diary including use of analgesics
- Disability - Roland Morris Disability Index
- Range of lumbar motion - flexion, extension and lateral flexion were measured using oil-filled Ripstein goniometers.
- Habitual activity questionnaire to determine premorbid activity levels in the areas of work, sport and leisure.
- Bilateral measurements of multifidus cross sectional area (CSA) using real time ultrasound imaging

Patients in group 1 received medical treatment consisting of advice on bed rest and prescription of analgesics or NSAIDs only. Patients in group 2 received medical treatment as well as specific localised exercise therapy. This involved the facilitation of an active, isometric multifidus contraction in co-contraction with the deep abdominal muscles with the spine in a neutral position in standing, based on the approach of Richardson and Jull (1995). Using real-time ultrasound imaging to ensure that the inhibited multifidus was activated specifically enhanced the exercise.

All patients were assessed initially to provide baseline data, and reassessed weekly for four weeks and again at ten weeks. The groups were shown to be comparable in terms of their characteristics and their compliance to treatment. Pain, disability and range of movement decreased significantly in both groups within four weeks, and there were no significant differences between the groups.

Ultrasound imaging showed however that muscle recovery was more rapid and more complete in the group of patients who had received the specific exercise therapy. Analysis of the variance revealed that the total muscle recovery and the weekly muscle recovery differed significantly between the groups.

Correlation analyses for both groups showed that pain correlated with disability, and that pain and disability decreased simultaneously in both groups. However the results of assessments of the patients from group 1 showed that this reduction in pain and disability was not correlated with muscle recovery. Measurements of multifidus CSA at ten weeks were not significantly different from the measurements made at four weeks for either group.

It was concluded that multifidus recovery from inhibition associated with first episode acute low back pain does not occur automatically with the resolution of pain and disability. Even when the functional levels of activity returned to normal muscle size did not return to normal. Hides suggests that this may be one factor that contributes the high recurrence of LBP.

This study is important as it highlights the fact that although the patient appears to have made a full recovery from the initial episode of low back pain in terms of pain and functional ability, he still carries a hidden disability. This study is applicable specifically to patients with acute LBP.

This study was a controlled trial, performed systematically. The observers were blinded to group allocation, reducing error. The inclusion and exclusion criteria were clearly stated. The variables measured were appropriate to the group and the condition measured.

Although it is stated that this is a clinical trial, access to ultrasound imaging facilities and the interpretation of these scans in general physiotherapy practice is extremely limited, both for assessment and feedback purposes. These factors would make it difficult to replicate the study on a large scale. However, in this instance, where multifidus is a deep muscle, not visible to the naked eye and not easily palpated in isolation from the other erector spinae muscles, or reached with the application of EMG electrodes, (all of which would be indirect measurements), real time ultrasound imaging is an extremely useful tool for direct measurement of muscle size. The assumption is made that muscle size correlates with muscle strength. This study creates an awareness of the importance of rehabilitation of multifidus.

O'Sullivan, Twomey and Allison (1997) studied the effects of stabilising exercises on patients suffering from chronic LBP with the radiological diagnosis of spondylolysis or spondylolisthesis. Forty two CLBP patients with an average duration of symptoms of three and a half years entered the study. Prior to intervention testing was carried out to determine average pain intensity levels, functional mobility levels, sagittal range of movement of the lumbar spine and hips and abdominal muscle recruitment patterns. They were randomly assigned to two treatment groups.

The first group underwent a ten week programme, directed on a weekly basis by a physiotherapist. This involved the specific training of the anterolateral abdominal muscles and the lumbar multifidus proximal to the pars defect. The activation of these muscles was incorporated into static postures and functional tasks, with a view to providing a dynamic corset for the lumbar spine during activities of daily living.

The second group underwent treatment over the same period as directed by their treating practitioner. This involved predominantly regular general aerobic exercise and "sit-up" exercises.

Prior to the intervention there was no statistically significant difference between the two groups on the basis of the measures used. Results of the trial showed that the specific exercise group showed a statistically significant reduction in average pain intensity levels, increase in functional mobility levels, increases in range or movement in standing and an increase in the activation the anterolateral abdominal muscles relative to rectus abdominus. The control group showed no significant change on these parameters. At a three month follow-up, the *improvement in the* specific exercise group was maintained. The second group again showed no change.

The results of this study are limited in their application as all the subjects had the radiological diagnosis of spondylolysis or spondylolisthesis, which is a specific form of lumbar instability.

Schneider (1995) investigated the effect of specific exercises on episodes of lumbar instability. He selected a group of 15 patients previously treated by himself. Inclusion was based on history. Four factors were considered by the author to be specific for lumbar instability:

- a minimum frequency of two episodes per year for three years
- each episode is triggered by a relatively trivial, unguarded spinal movement
- a relatively rapid recovery within 10 days
- an inability to return to full physical activity between episodes

Two exercises were prescribed to address the factors associated with instability ie flexion in supine lying, designed to address the abnormal location of the instantaneous axis of rotation (IAR) which the author suggests is a factor in instability, and activation of the oblique abdominal muscles. The exercises were described in detail. Each case was reviewed after 12 and 18 months. In every case the subject remained free from the typical episodes of loss of mobility.

However as the study was observational, without controls it cannot prove that the exercises were effective. However there was a significant reduction in the frequency of episodes, and therefore the exercises cannot be excluded as a possible benefit. It also can not be shown which of the two exercises was more beneficial. The author concluded that these exercises were effective in reducing the frequency of episodes.

Johansson and Lindberg (1995) analysed the results of three single case studies using a multiple baseline design, and concluded that stabilisation training was effective for those subjects with moderate chronic low back pain, who did not perceive themselves as disabled. Each patient was assessed individually, and an exercise programme was prescribed. This programme is designed to permit individual adjustment of exercises within a standardised structure, and takes 3-12 months to complete on an outpatient basis. Three subjects with CLBP were included in the study: a 35 year old male with a L5 spondylolisthesis, a 40 year old female and an 18 year old female gymnast. The dependent variables for the study were chosen from the physiotherapy diagnosis, and there were different variables for each subject.

The data were collected 4 times during pre-treatment phase, then at each subsequent visit. The following variables were measured, where it was considered appropriate:

- pain intensity using the DIBS (duration, intensity, behaviour scale)
- spinal lateral bending ROM measured by fingertip distance from lateral joint space of the knee
- Hip extension ROM measured with a goniometer
- Prone knee flexion ROM measured with a goniometer
- Muscle activation patterns - hip extension, abduction and curl-up with straight legs adapted from Janda and Jull (1987). The best of three measures was used
- number of repetitions with control of lumbar spine position - measure of endurance for abdominal, hip extensor and resisted exercises
- postural pattern measured by the relationship of anatomical reference points in the sagittal and frontal planes
- pain-free standing time measured with a stopwatch.

The data were collected by three physiotherapists. Inter- and intratester reliability was established before the study commenced. Graphs were drawn indicating baseline measures and sequence of interventions designed to improve the subject's limitations.

The authors concluded that the results suggest that stabilisation training was effective for those subjects with CLBP who did not perceive themselves as disabled. They suggest that the use of a multiple baseline design made it possible to address the process and result without invalidating the authenticity of treatment. They also suggest that future studies should incorporate measures to evaluate behavioural changes in patients undergoing stabilisation training.

This study shows the value of a set of clinical measurements that can easily be incorporated into practice, and used on an ongoing basis during the course of treatment. An advantage of using such measures is that the patient is also able to assess the effects of treatment, which acts as a motivating factor. Furthermore it allows the physiotherapist to modify and progress exercises as goals are reached. Ongoing assessment is the basis of sound clinical practice. The study was an extremely small study.

Johannsen, Remvig and Kryger (1995) investigated whether co-ordination is as important as spinal mobility and back strength in the rehabilitation of chronic LBP patients. The study compared the effects of intensive training of muscle endurance with muscle training, including co-ordination in chronic low back pain patients. They proposed that the training of co-ordination and proprioception of patients with LBP in as many different movements as possible, with a limited and controlled load, may assist the development of smooth movement, which might decrease the risk of locally harmful forces.

The sample consisted of forty patients with LBP for more than 1 year, aged between 18-65 years and who were employed. These patients were assigned into two groups, randomised by stratification for sex, age, and duration of symptoms, and x-rays. Group 1 was subjected to endurance training, and group 2 to co-ordination training. Both groups were trained in groups of up to 10 patients for one hour twice a week during a three month period. However, not all the exercises are described in detail. The same two unblinded observers on entry into the programme evaluated the subjects, at three months and at six months.

The following variables were measured:

- isokinetic muscle strength using the Kin-Com trunk testing system
- spinal mobility - lateral flexion, flexion and extension
- back pain - at the time of evaluation and average back pain during the past week - subjective on a 5 point scale
- disability - subjective
- drug consumption
- well-being on a three point scale 1=good, 3=bad -subjective

However, although strength was measured, no measure of co-ordination was included.

The following non -parametric tests were applied to the data

- Willcoxon-Pratt to analyse changes in scores within groups
- Mann-Whitney test to analyse differences between groups
- Spearman correlation

There was a significant difference in the levels of pain between the group of subjects that dropped out compared to the group of subjects that finished the programme. Seventy nine percent of patients with less than 120 days sick leave completed programme whilst only 42% of patients with more than 120 days sick leave completed programme. After 3 months of training both training groups showed significant improvement in pain score, mobility and disability, drug consumption - no difference was found between groups. Isokinetic back extension strength improved in the endurance trained group, otherwise there was no significant change in isokinetic strength within or between groups. Correlation analysis between the subjective parameters (pain, disability) showed significant negative correlation with the objective parameters (mobility score, back extension strength).

The group that completed the strength training programme showed a significant decrease in LBP, with significant improvement in back extensor strength. There was however also a significant improvement in LBP in the co-ordination training group without a concomitant increase in back extensor strength. There was no measure of co-ordination improvement so the other case could not be proved - ie improvement in co-ordination could not be measured. The observers were also not blinded to group allocation.

2.5.2 GROUP INTERVENTIONS

Mannion, Muntener, Taimela and Dvorak (1999) performed a randomised clinical trial to examine the relative efficacy of three active therapies for CLBP. The aim was to identify the most successful method of treatment to target the specific needs of the patient with CLBP and the budget of the healthcare provider.

One hundred and forty eight patients with CLBP were randomised to one of the following treatments, which they attended twice a week for three months:

- Modern active physiotherapy involving half-hour individual sessions focussed on improving the functional capacity of the patient, ergonomic advice and exercises.

- Muscle reconditioning on training devices ie the David back clinic programme using controlled progressive exercises carried out on training devices within the patients pain-free range of motion. The patients attended in groups of two to three, and each session lasted 1 hour.
- Low impact aerobics. The patients in this group attended small group exercise classes (12 patients maximum per class), lasting an hour, including aerobic and muscle stretching exercises.

The inclusion criteria were:

Younger than 65 years, more than 3 months continual or recurrent episodes of LBP, with or without referred pain of a non-radicular nature, serious enough to cause absence from work or warrant medical attention, ability and willingness to travel independently to hospital, ability to perform the planned outcome tests.

The exclusion criteria included:

Constant or severe pain, non-mechanical LBP, pregnancy, previous spinal surgery, current nerve root entrapment accompanied by severe nerve root deficit, spinal cord compression, tumours, severe structural deformity, severe instability, osteoporosis, fresh fractures, inflammatory disease of the spine, spinal infection, severe vascular or metabolic diseases, acute infection, lack of co-operation.

The following outcomes were measured pre- and post-therapy and at a six month follow –up:

Pre- and post-therapy measurements of objective measurements of lumbar range of movement were performed, and questionnaires were administered about self-rated pain and disability, and psychosocial factors. Similar questionnaires were administered 6 months after therapy.

The main findings of the study showed that the three types of treatments administered to the CLBP patients – individual active physiotherapy, muscle strengthening/co-ordination using training devices and group aerobic/stretching exercises proved to be equally efficacious in their ability to reduce pain intensity, pain frequency and disability in tasks of daily living immediately after therapy. Moreover the effects observed were well-maintained, sometimes even improved over the following six-months follow-up period, with the exception of the disability in the physiotherapy group, which regressed back towards it pre-therapy value.

The authors suggest that these results are due to some sort of "central effect".

The authors went on to compare the socio-economic implications in terms of costs for the three treatment regimes, concluding that the cost ratio of the three types of treatment is 3.9: 3: 1., and as such the introduction of aerobics classes has the potential to save millions attributable to the direct costs of treating LBP.

This study was performed on a large group of patients, who were randomly assigned to one of three types of therapy. The patients were blinded to the expected outcome of the trial. There was a dropout rate of 10%. The results of the study are compared by the authors to previously published data, specifically studies performed on the David Back Clinic approach, as well as the study performed by Frost et al (1995), showing similar effect sizes.

(effect size is defined as (postmean - premean/pre SD)

Bardin (1997b) established that a spinal rehabilitation programme consisting of back care lectures and group therapeutic exercises based on the principles of muscle balancing, neural mobilisation and posture re-education was found effective by patients. Data were collected through questionnaires given to random sub-groups. A total of 56 patients were recruited during a period of ten months. It was stated that the mean pain rating of the group prior to commencement of the intervention on a scale of 0 – 10 was 3.96, and the mean disability score based on the Roland-Morris questionnaire was 8/24. No post-intervention scores were given. Ninety-eight percent of the patients rated the lectures as informative and helpful – it was not stated what how this was rated.

A pilot study (Bardin 1997a) was also performed on a single participant in this spinal rehabilitation programme in order to evaluate the accuracy of outcome measures in the measurement of this programme. The following subjective measurements were used, based on the World Health Organisation (WHO) classification of impairment, disability, handicap and distress:

- Pain – VAS, pain thermometer, Wong Baker faces
- Disability - Roland Morris Questionnnaire
- Handicap - Personal activity profile compiled by the author which tested four areas of interaction with the environment
- Distress - WHO 6 point distress scale

The following objective measures were also used:

- Straight leg Raise test (SLR)

according to age, the absence or presence of LBP, degree of pain and job position. They were randomised into training and control groups. The training group was instructed on back care exercises by a physiotherapist, which they performed for 20 minutes at the start of their working day. There was no intervention in the control group. After 13 months it was found that in the group performing exercises only one person had been off sick as a result of LBP, for a total of 28 days. In the control group 12 people had been of sick for a total of 155 days on 17 separate occasions. This resulted in a cost efficiency saving of 1.3 days for one hour of physiotherapy.

The Clinical Standards Advisory Group (1994) report on back pain encourages the early mobility and exercise of patients with low back pain. The studies reviewed above provide evidence:

- for the effectiveness of stabilisation training in reducing pain and disability
- for the effectiveness of stabilisation training in reducing recurrences
- that specific retraining of the abdominal muscles and multifidus is more effective than general aerobic exercises and sit-ups
- that group exercise classes with back education are more effective than back education classes alone
- that supervised exercise classes increase compliance and success

It would appear from this evidence that there is a role for supervised exercise programmes incorporating active stabilisation training in the management of LBP patients.

Active stabilisation training needs to address the following factors:

- The patient is unlikely to be able to isolate transversus abdominus (Hodges, 1996b), and there is wasting and inhibition of multifidus (Hides 1994).
- The CLBP patient has been shown to have poor proprioceptive feedback mechanisms (Hurley, 1997), as well as balance and co-ordination impairments (Nies and Sinnott, 1991).
- The CLBP patient has also developed compensatory mechanisms of tight overactive muscles (eg rectus abdominus and psoas), and weak inhibited muscles (eg gluteus maximus and medius) (Janda and Jull, 1987). There may also be disturbances of the timing and synchronisation of the movement patterns of the lumbar spine and hip (Sahrman, 1997, Janda and Jull, 1987).
- High speed repetitive movements have been shown to inhibit stabilising muscles (Richardson and Bullock, 1986). No exercise should cause pain as this has been shown to inhibit the stabilisers (Richardson and Jull, 1995).

The following exercise sequence is proposed (Richardson and Jull 1995) for the restoration of active lumbar stabilisation.

- The re-education of the co-contraction of transversus abdominus and multifidus muscles is taught in various positions using facilitation techniques where necessary. Ideally these techniques should be taught individually.

- Load is then imposed on the trunk in various starting positions. This load may take the form of adding limb movements and / or resistance while the lumbar spine is stabilised in neutral. Patients are then taught to exercise within their pain free range of motion eg by changing position with the lumbar spine stabilised. Proprioception and balance re-education is added by using unstable surfaces such as balls, rollers and wobble boards.

3. METHODS

In order to investigate the applicability of this evidence a pilot study was conducted in a private practice, with the intention that if the results were positive a larger trial would be warranted in a number of practices (Beattie 1996) from a cross-section of socio-economic backgrounds. The results of such a study could then be presented to healthcare funders to motivate remuneration for this form of treatment and to persuade more patients as to the benefits of attending exercise classes. In the clinical context of this study it was decided that the measuring instruments for the above variables had to be inexpensive, easy to apply and not require sophisticated equipment. The instruments must also be easy to use and time-efficient to encourage their application. The instruments chosen should be relevant to the setting, condition and participants. The instruments chosen must also show, together with validity and reliability, a responsiveness to change.

3.1 DESIGN OF STUDY

A pilot study was performed on a small group of patients attending group exercise classes for active stabilisation training, in order to determine the ease of application of the measuring instruments, as well as the responsiveness of these instruments to change.

The participants in the study were measured three times during a three month period, and completed a questionnaire a year after commencing the classes.

3.2 SELECTION OF PARTICIPANTS

A practice was selected, after an in-depth interview, whose classes are based on the principles outlined in the previous chapter. Regular classes are run throughout the week at times that are convenient for a large cross-section of people. The physiotherapist running these classes agreed to participate in the study. All new participants in the classes were assessed according to her normal procedure. All patients meeting the inclusion criteria below were requested to participate in the study.

3.3 INCLUSION CRITERIA

The subjects, of either gender and aged between 30 - 60 years old, had to be willing to attend classes two times per week for a three month period. They had to have suffered more than two episodes of low back pain during the past two years. Low back pain was defined as pain in the lumbo-sacral region, with or without referral into the buttock and or posterior thigh in a non-dermatomal distribution.

3.4 EXCLUSION CRITERIA

The following were regarded as exclusion factors:

1. an acute episode of low back pain at the time of selection.
2. any neurological deficit
3. a straight leg raise test of less than 60°
4. continuous use of non-steroidal anti-inflammatory drugs (NSAIDs)
5. Previous spinal surgery
6. A radiological diagnosis of spondylolysis or spondylolisthesis

7. Constant pain indicating an inflammatory disease or malignancy

8. Severe pain of more than 8/10 on a visual analogue scale

9. Pregnancy

3.5 PROCEDURE

The subjects were assessed before participation in the study according to the principles described by Maitland (1990) by the physiotherapist who conducts the exercise classes, according to her normal procedure. A record was kept of any X-ray and/or MRI scan results. The patient was taught how to isolate and contract transversus abdominus at this stage according to the principles outlined by Richardson and Jull, (1995) as described previously. Patients meeting the inclusion criteria were asked if they would like to participate in the study. If the subject agreed they were requested to read the information for participants (appendix 1) and written consent was obtained.

The group exercise classes selected for the study followed all of the principles outlined in the previous chapter. The exercises were performed in various starting positions with the lumbar spine stabilised in neutral. Loads were imposed on the trunk by adding limb movements and resistance. The patients were also taught to exercise within their pain free range of motion by changing position with the lumbar spine stabilised. Proprioception and balance re-education was added by performing the exercises on unstable surfaces eg wobble boards, balls and rollers.

The exercises were performed under close supervision of the physiotherapist. The participants were encouraged to wear close-fitting clothes so that body positions and movements could be easily seen and corrected if necessary. Music was used to keep the classes interesting. The content of the exercise classes varied from day to day to maintain the participant's interest, but the principles of active lumbar stabilisation were followed closely. There were fewer than twelve participants in each class.

3.6 ASSESSMENT AND QUESTIONNAIRES

On entry into the study all of the subjects completed a standardised form (Appendix 2), after which the holding capacity of transversus abdominus was measured by the Researcher. They underwent the same procedure after one month of participation, and again after three months of participation in the exercise classes. A year after they had begun the exercise classes they completed a postal questionnaire consisting of the standardised form, as well as some additional open-ended questions.

MONTH													
assessment of participants before participation in the classes, inclusion and exclusion criteria, informed consent	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	1	2		3									4
	Duration of study												Postal questionnaire

Fig 3.1 Timeline of events during study

The following variables were measured

3.6.1. Holding capacity of Transversus Abdominus

The ability of the stability synergists, transversus abdominus and multifidus to maintain a 10 x 10 second contractions at a low load was measured. Clinically it has been proposed that a person should be able to perform 10 repetitions of a 10 second holding contraction of these supporting muscles without difficulty (Richardson and Jull 1995). The score out of 10 was the number of contractions (without substitution) the subject could hold in the correct position. If the subject complained of fatigue or pain or was unable to hold the tonic contraction without substitution the test was stopped.

A Pressure Biofeedback Unit (PBU) (Chattanooga, Australia Pty Ltd) (Jull et al, 1993) was used to monitor any changes in lumbo- pelvic alignment during movement. A PBU consists of an inflatable cushion connected to a pressure gauge calibrated in mmHg. The cushion is inflated to a baseline pressure, to fit the space between the lumbar curve and exercise surface.

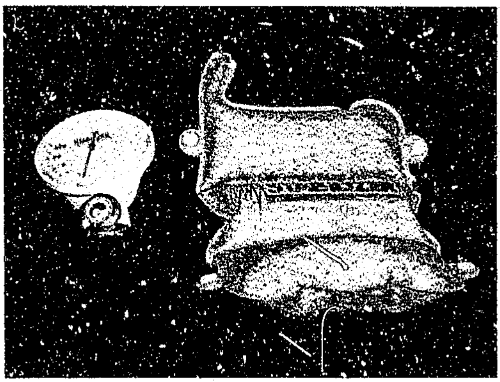

Fig 3.2: A Pressure Bio-feedback unit

Transversus abdominus and multifidus were measured in prone using a pressure biofeedback. The PBU was placed under the lower abdomen, the lower edge in line with the anterior superior iliac spine, and inflated to 70mmHg. The patient was asked to draw the lower stomach gently off the pressure bio-feedback unit and hold the position. Richardson and Jull (1995) suggest that the pressure should decrease by approximately 6-8mmHg up to a maximum of 10mmHg in the holding position. The simultaneous contraction of multifidus was palpated close to the spine in the lower lumbar area.

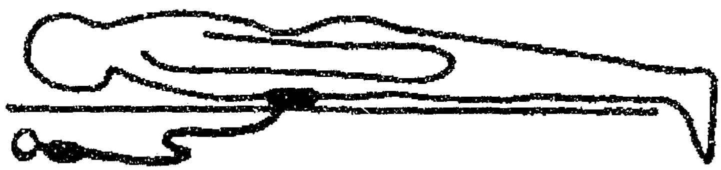

Fig 3.3: Position for testing the holding capacity of transversus abdominus

If any of the following signs of substitution were noted the test was stopped. The score given was the number of contractions performed before substitution took place:

- Sucking in the upper abdomen by holding a deep breath – there will be a drop in pressure of 1 –2 mm Hg
- Abnormal bracing of the external obliques – the movement of the rib cage can be observed, and a pressure increase of 1- 2 mmHg. (Richardson and Jull 1995)

3.6.2 PAIN

A pain body chart on which the subject filled in the area(s) of his pain, together with a description of that pain (eg burning, throbbing, ache) was selected. This is a qualitative measure that allows the subject and the researcher to visualise the subject's pain, and therefore assists in communication.

A visual-analogue pain scale (VAS) (Von Korff, Deyo et al 1993) was selected as a quantitative measure of the subject's pain. Different forms of the VAS were used in a number of the studies discussed earlier. It was decided to use a triple visual analogue scale (Appendix 2 a) for this study as it rates the subject's pain over a period of time, It was felt that this would be more appropriate as the subjects who fulfill the inclusion criteria of this study have chronic or recurrent low back pain.

The subject was requested to rate his pain out of 10, (with 0 = no pain, and 10 = the worst pain that he can imagine) on three scales. The first scale rated the intensity of the subject's present pain. The second scale rated the intensity of the average pain the subject has felt during the past week. The third scale rated the intensity of the worst pain felt by the subject in the past month. An average of the three scores was taken. This average is biased towards the worst case experienced by the subject (as one of the scores is based on the "worst pain") and would give a good indication of improvement. Jensen et al (1999) compared the validity and reliability of several measures of pain intensity for chronic pain, and concluded that composite pain scales showed greater reliability than individual scales with relatively small sample sizes. A VAS has shown good repeatability (Van Korff, Deyo et al 1993, Jensen et al 1999).

3.6.3 FUNCTIONAL ABILITY

The Roland Morris Questionnaire (Appendix 2 b) was used in a number of the studies discussed previously to measure disability. (Roland, Morris 1983). This questionnaire consists of a list of 24 items that the subject marked with respect to his condition as it felt on the day. Scores range from 0 to 24, covering a range of no complaint to extreme disability. A higher score indicates greater disability. This questionnaire has been shown to act as a discriminating outcome measure in low back pain, and has shown good short-term repeatability (Deyo, 1986).

3.6.4 HANDICAP

Bardin (1997a) developed a Personal Activity profile (PAP) (appendix 2 c) for a single case study on outcome measurements in spinal rehabilitation. The PAP is a set of four visual analogue scales, which test four areas of interaction with the environment:

- personal care eg dressing yourself, washing hair, getting into and out of the bath etc
- social interaction and family life
- sports, hobbies and recreation. The subjects were also requested to comment on any adjustments that they had made as a result of their condition, or whether they had discontinued any sports or hobbies.
- The subject stated their occupation and described their work. They were then asked to rate the extent to which their work was affected by their pain or disability or condition. The scale was 0 = not affected at all, to 10 = very severely affected or major adaptations required.

Although its validity and reliability have not been established, it was decided to use this profile as it is easy to understand, and tests a wide range of daily activities. The exercise classes tested by Bardin were similar in structure to those in this study. Bardin's study is also South African, and it was felt that it would be useful to test the reliability of the PAP on a larger group of subjects.

3.6.5 DISTRESS

The 6-point scale of distress (appendix 2 d) as developed by the World Health Organisation (Enderby and Kew, 1995) was used to evaluate the effect of the subject's LBP on his emotional well-being. This scale consists of a set of six statements ranging from "my condition does not affect me emotionally at all" (score = 0) to "I feel my condition is so severe and disabling that my life is not worth living. Suicidal thoughts have crossed my mind" (score = 5). The subject is requested to mark the statement that best applies to him on the day of the assessment.

3.6.6 FOLLOW – UP QUESTIONNAIRE AT 12 MONTHS

A questionnaire was posted to all subjects one year after commencement of the exercise programme. This consisted of a number of open-ended questions concerning the exercise classes, in order to assess the subject's current status, as well as to measure their level of satisfaction with the classes. (Appendix 3)

They were also requested to complete a subjective questionnaire similar to the one completed on the previous three occasions. (Appendix 2).

To summarise:

Patients about to commence group exercise classes for active stabilisation training were requested to participate in this study. Their ability to hold a sustained contraction of transversus abdominus, as well as their levels of pain, disability, handicap and distress were measured before starting these classes. The same measurements were repeated at 1 month, 3 months and 12 months.

4. RESULTS

Over a nine-month period seven patients agreed to participate. One withdrew from the study after the first assessment, due to medical reasons.

4.1 PATIENT PROFILE

A profile of the subjects as assessed before participation in the classes appears below:

Subject	A	B	C	D	E	F
Gender	F	F	F	F	M	M
Occupation	housewife	teacher	librarian	housewife	company director	company director
Age	60	58	46	36	37	30
Area of pain	central, L>R, bilateral referral to knee	central	central, L>R, referral post L knee	central, L>R	central, patches of pain at hips, knees and ankles	central, radiating into both buttocks
Nature	burning shooting	deep ache	severe ache	intermittent throb, ache	stabbing	ache
Aggravates	forward leaning, sitting, driving, kicking ball	flexion, standing	sit ->stand, forward leaning, standing, driving	awkward or sudden movements, shopping, walking uphill	flexion, prolonged standing	sitting, leaning forward
Eases		rest		lying, hugging knees	lying with hip and knee flexion	stretching into flexion
24 hr pattern	worse am	worse by the end of the day	worse am, end of day	worse by end of day	worse by end of day	worse am
ROM	moderately limited	slightly limited	good	good	moderately limited, tight hamstrings	moved with caution
Activities	gardening, hiking	tennis, embroidery	hiking swimming	spinning	golf	tennis, gym
X-rays/CT scan	none	degeneration of L4/5, L5/S1 facet joints bilaterally	mild lumbar scoliosis convex to R, advanced L4/5, L5/S1 disc degeneration with degenerative changes of the posterior facet joints	central herniation of L4/5, L5/S1 discs with paravertebral degeneration	disc herniation with early degenerative changes L4/5, L5/S1	disc protrusion with early degeneration of L4/5, L5/S1

Table 4.1 Summary of the characteristics of the subjects

4.2 INDIVIDUAL SCORES OBTAINED FROM THE FIRST THREE MONTHS OF THE STUDY AND THE FOLLOW - UP QUESTIONNAIRE AT 12 MONTHS

The raw data obtained are listed below:

Subject	Session	Pain	RMQ	PAP	WHO	Tr Abd
Score out of		*10*	*24*	*10*	*6*	*10*
A	1	7.3	11	2.6	4	2
	2	3.6	3	2	1	5
	3	0	0	0	0	10
	C	0	0	0	0	
B	1	5.6	9	3	2	10
	2	4.2	6	1.7	0	8
	3	1.6	3	0.3	0	10
	l year	1.33	7	2.25	0	
C	1	6.3	6	7.2	2	5
	2	7.3	12	5.7	2	5
	3	7.3	8	3	1	10
	l year	5.6	4	1.7	2	
D	1	3.3	6	4	2	5
	2	1.6	4	0.6	0	10
	3	0.6	4	3	1	10
	l year	1	4	1	0	
E	1	5	13	4.5	3	7
	2	6.6	14	3	2	10
	3	4	7	2	1	10
	l year	4	11	2.75	2	
F	1	6	11	3.5	1	8
	2	5.3	12	2	0	10
	3	3.3	7	3.25	0	10
	l year	2	10	3.75	0.5	

Table 4.2 individual scores obtained from the first three months of the study and the follow - up questionnaire at 12 months

4.2 ANALYSIS OF THE TRENDS OF THE RESULTS OBTAINED IN THE STUDY

The mean scores and standard deviations were calculated for each category of measurement.

	At entry into programme		1 month		3 month		I year follow-up	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pain	5.58	1.36	4.77	2.09	2.8	2.69	2.32	2.09
Roland Morris Q	9.33	2.88	8.5	4.72	4.83	3.06	5.5	3.73
Personal Activity Profile	4.13	1.65	2.5	1.75	1.93	1.44	1.91	1.32
WHO distress scale	2.33	1.03	0.83	0.98	0.5	0.55	0.75	0.99
Transversus Abdominus	6.17	2.79	8	2.45	10	0	No measurement taken	

Table 4.3 Mean scores and standard deviations of the scores for each period

The data were grouped and Page's *L* trend test (Hicks 1995) (Appendix 4) was used to determine whether there was a significant trend in the results of each individual variable over time.

Page's *L* trend test is a non parametric test used for a same-subject design, when the data is ordinal or interval / ratio, when there are three or more conditions ie in this case one group of subjects being tested on three different occasions. This test is an extension of the Friedman test. The Page's *L* trend test is used when the experimenter has predicted a trend in the results. As there is a specific direction to the results the hypothesis is one-tailed. When calculating Page's *L* trend test a value *L* is obtained which is looked up in the probability tables associated with Page's test to see whether this value represents a specific trend in the results. The ranking may be found in Appendix 5.

The following results were obtained from Page's *L* trend test:

	Mean score At entry into prog-ramme	**Mean score At one month**	**Mean score At three months**	**Mean score at one year follow up**	**SIGNIFICANCE ACCORD-ING TO PAGE'S *L*-TREND TEST**
Pain	5.58	4.77	2.80	2.32	$p<0.001$ $L=173.5$, $N=6$, $C=4$
Roland Morris Question-naire	9.3	8.5	4.8	5 5	$p<0.01$ $L=168$, $N=6$, $C=4$
Personal Activity Profile	4.13	2.50	1.93	1.91	$p<0.05$ $L=165.5$, $N=6$, $C=4$
WHO 6 point distress scale	2.33	0.83	0.5	0.75	$p<0.05$ $L=163.3$, $N=6$, $C=4$
Trans-versus Abdominus	4.83	7.67	10	Not measured	$p<0.05$ $L=80$, $N=6$, $C=3$

Table 4.4 - Mean scores obtained and significance according to Page's *L* trend test

p = the probability ie the likelihood that random error is producing the results in the study

L = the value obtained from the formula (Appendix 4). For L to be significant at a particular probability level it should be equal to or larger than the critical values associated with the C and N of the study

N = number of subjects

C= number of conditions

4.3.1 PAIN

This decreased from a mean score of 5.58/10 (range 5 – 7.3) to 2.65/10 (range 0 – 6). Using Page's L trend test the results were found to be significant at $p < 0.001$ for a one-tailed hypothesis. This suggests that there is a significant trend in the reduction of pain in all subjects.

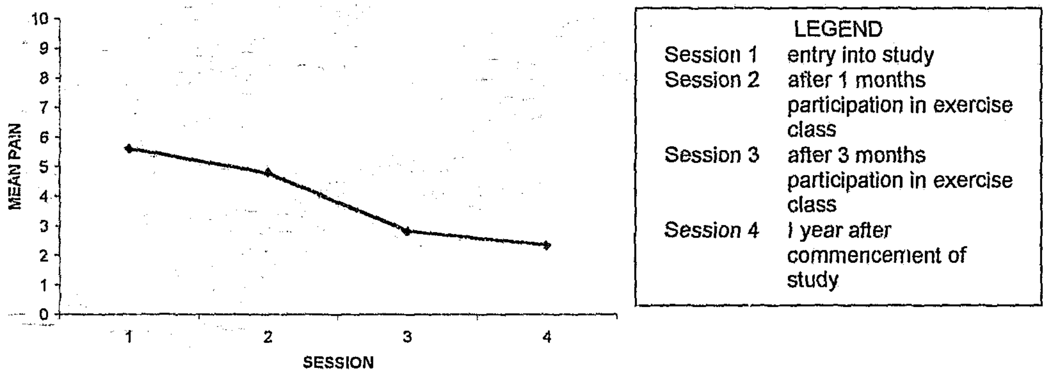

Fig 4.1: Mean change in pain scores measured with the triple visual analogue scale.

4.3.2 DISABILITY - ROLAND MORRIS QUESTIONNAIRE

This decreased from a mean score of 9.3/24 (range 6 - 13) to 4.8/24 (range 0 - 8). Using Page's *L* trend test the results were found to be significant at $p < 0.01$ for a one-tailed hypothesis. This suggests that there is a significant trend with respect to the improvement of function in all subjects. Stratford et al (1996) suggest that for a 90% confidence level or greater subjects need to show a change of 4 points. The average total change in this study was 4.5 points.

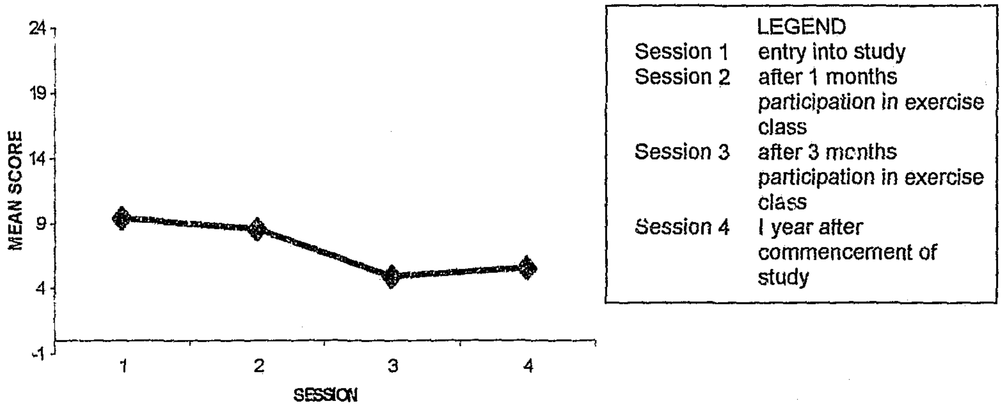

Fig 4. 2: Mean change in disability scores obtained from the Roland-Morris questionnaire

4.3.3 PERSONAL ACTIVITY PROFILE

This decreased from a mean score of 4.13/10 (range 2.6 - 7.2) to 1.93/10 (range 0 - 3). Using Page's *L* trend test the results were found to be significant at $p < 0.05$ for a one-tailed hypothesis. Inspection of the individual items showed that all patients were able to work, and their greatest area of perceived handicap was in terms of sport, hobbies and recreation.

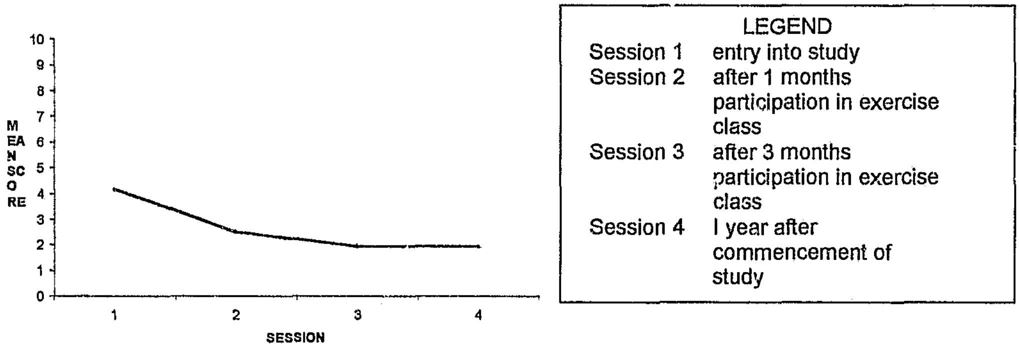

Fig 4. 3: Mean handicap scores obtained from the Personal Activity Profile

4.3.4 WELL-BEING ACCORDING TO THE WORLD HEALTH ORGANISATION 6-POINT DISTRESS SCALE

This decreased from a mean score of 2.33/6 (range 1 – 4) to 0.5/6 (range 0 - 1). Using Page's L trend test the results were found to be significant at $p < 0.05$ for a one-tailed hypothesis. This suggests that there is a significant trend with respect to the improvement of the effect of the subjects' pain on their well being.

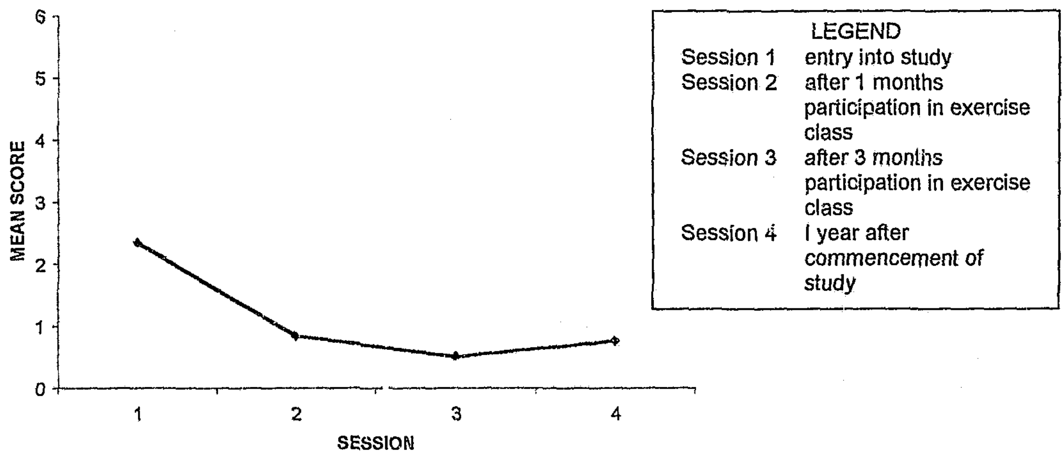

Fig 4. 4: Change in mean score for Well Being According To The World Health Organisation 6-Point Distress Scale

4.3.5 HOLDING CAPACITY OF TRANSVERSUS ABDOMINUS

This improved from a mean score of 4.83/10 (range 2 - 6) to 10/10 (range 10). Using Page's *L* trend test the results were found to be significant at $p < 0.05$ for a one-tailed hypothesis. This suggests that there is a significant trend with respect to the improvement of the holding capacity of Transversus Abdominus in all subjects at the end of three months. All subjects were able to hold ten 10 second contractions by the end of three month's participation in a group programme for active stabilisation training.

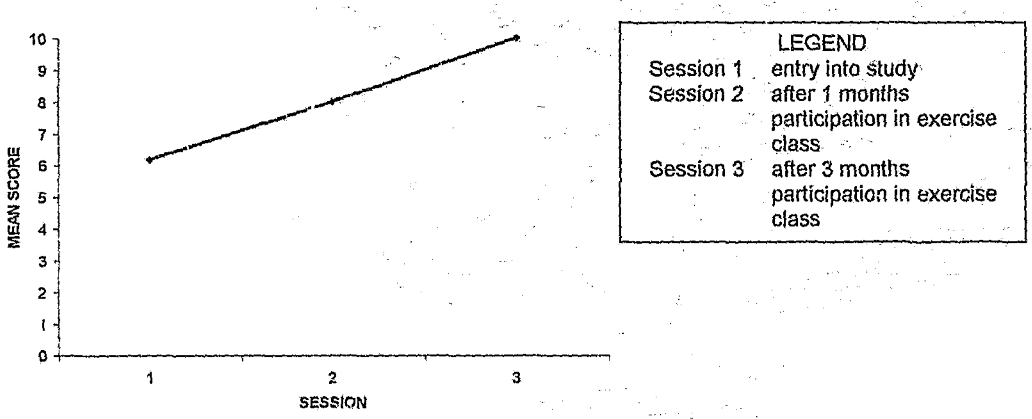

Fig 4.5: Holding Capacity of Transversus Abdominus

4. 4 FOLLOW – UP QUESTIONNAIRE AFTER 1 YEAR

All six subjects returned the follow-up questionnaire (appendix 3) posted to them after a year's participation in the exercise classes. All of the subjects were still attending classes, three once a week and three twice a week. They all found the classes beneficial and enjoyable. The three younger participants had not returned to any activities that they had discontinued because of their LBP. Two subjects had experienced an acute episode of LBP, and two stated that they suffered from occasional low back ache.

They all completed the subjective questionnaire.

The results of the follow-up questionnaire appear in the following table:

	A	B	C	D	E	F
Attendance	1x/week	1x/week	2x/week	1x/week	2x/week	2x/week
Beneficial	yes	yes	yes	Yes	yes	yes
Enjoyable	yes	yes	yes	Yes	yes	yes
Returned to activities	yes	returned to walking and swimming, not to tennis and golf	walking on treadmill, can stand for longer periods	no	no	no
Medication	no	no	occasional Mobic	no	occasional panado	occasional Feldene
Recurrence of episodes	no	no, sometimes LBP at end of day	no occasional LBP - ache	one episode, had not needed any medication	One episode	occasional episodes of low backache
Other comments		one of the benefits of the classes is the individual attention given to each participant's problem.	improvement in balance and large muscle co-ordination.	classes had taught her to be aware of her body and its limitations. Physical benefits of stretching and strength-ening.	if he missed classes he felt worse, and also continued with home exercises. He found the sharing of information about his condition beneficial.	certain exercises aggravated his pain, others were too easy. Overall he feels that he has benefited from the exercise classes.
Pain	0	1.3	5.6	1	4	2
Disability	0	7	4	4	11	10
Handicap	0	2.25	1.7	1	2.75	3.75
Well-being	0	0	2	0	2	0.5

Table 4.5 Summary of the results of Follow up Questionnaire at 12 Months

To summarise:

Six subjects attending a group exercise class for active stabilisation training consented to participate in this study. At the end of a 12-month period they showed significant improvements in their ability to sustain control of transversus abdominus, as well as a significant reduction in their pain, disability, handicap and level of distress.

5. DISCUSSION

The aim of this pilot study was to determine whether a group exercise class is an effective method of active stabilisation training in the chronic low back pain patient. The subjects' ability to maintain ten 10 second contractions of transversus abdominus was used as a measurement of active lumbar stability. The subject's own perception of his or her problem were measured ie pain, disability, handicap and distress, in order to determine the effect of the intervention on the subject.

The subjects were assessed on four different occasions – before commencement of exercise classes, after participating in exercise classes for one month, after three months and after twelve months. As all the subjects had continued with the exercise classes it was impossible to determine whether the positive effects of the classes would have been sustained even if the classes had been terminated.

This study has shown a significant trend ($p < 0.05$) in the improvement of the subjects' ability to hold ten 10 second contractions of transversus abdominus as a measure lumbar stabilisation mechanism. The study has also shown a significant trend ($p \leq 0,05$) in the subjective improvement of pain, disability, handicap and distress.

All the participants stated in at the end of a twelve month period that they had found the exercise classes enjoyable and beneficial. They went on to make individual comments such as:

- One of the benefits of the classes is the *individual attention given to each* participant's problems.

- There has been an improvement in my balance and large muscle co-ordination.
- Classes have taught me to be aware of my body and its limitations. There are also the physical benefits of stretching and strengthening.
- If I miss classes I feel worse. I find the sharing of information about my condition beneficial.
- Overall I feel that I have benefited from the exercise classes.

There is no control group in this study. As a result it cannot be proved that the exercises are effective. The outcomes in this study however fail to disprove that the group exercise classes are effective. The subjects showed significant changes in a number of variables, therefore the group exercise classes could not be excluded as a possible benefit. If there had been no change the exercise classes would be excluded as a source of benefit.

The applicability of this study is limited by the small size of the sample. It showed that over a period of time the instruments used to measure pain (The triple visual analogue scale) and disability (the Roland Morris Questionnaire) were sensitive enough to measure the changes resulting from participation in a group exercise class. The validity and reliability of these measures has been determined elsewhere (Von Korf et al 1993, Deyo 1986) and these measures were used frequently in other studies (Hides et al 1996, O'Sullivan et al 1997, Reilly et al 1989). The pain body chart did not appear to be reliable in all subjects – although the subjects were asked to draw their pain as it was on the day some of the subjects appeared to have a fixed image of the "quality" of their pain and persevered with this, even though the "quantity" of their pain (measured by the

VAS) had changed. The validity and reliability of the Personal Activity Profile has not been proved. This test appeared to lack content validity as it was dependent on how the subject felt about a "handicap" on a specific day eg if it did not bother the subject on a some days that he could not play golf he rated the effect of his pain on his activities of daily living as low. On another day if the same factor affected him emotionally he may have given it a higher score. It was also felt that the WHO distress scale was not sensitive enough to measure subtle changes in the subjects emotional wellbeing.

All of these questionnaires were easy to apply, inexpensive and time efficient in a private practice setting. However the reliability of the measurements, in particular the outcomes questionnaires, across different cultures and languages would have to be determined if they were to be used across different cultural groups.

The test used to measure the change in lumbar stability using a pressure bio-feedback has shown concurrent validity. (Hodges, Richardson and Jull (1996b). Cairns, Harrison and Wright (2000) have shown in a trial on 45 subjects that the PBU is a useful measurement tool to act as an indicator of deep abdominal function, using the prone test.

The applicability of this study is limited in that it was performed in a private practice in Johannesburg. A characteristic of the group as a whole were that they were all already seeking help for their problem, which may also affect the outcome. The participants who volunteered all had a high level of education and socio-economic status. Keel et al (1998) found that most successful patients who participated in an integrative group treatment programme had a higher level of education. The report on back pain in the workplace released by the International Association for the Study of Pain (1996) suggests that a lower monthly wage almost doubles the risk of chronicity of low back pain. The implication is thus that the subjects in this study would tend to have a better result than a group of subjects from a lower socio-economic background.

Eales (1998) suggests that psychosocial factors are predictive of acceptance of self responsibility, including knowledge of the chronic nature of the disease as well as of the modification of the risk factors, a certain income, education and satisfaction with the outcomes as the most important determinants of acceptance of self responsibility. She suggests that this acceptance of self-responsibility is a significant factor in improvement in the quality of life in patients suffering from chronic disease. Although this study was performed on subjects with cardio-vascular disease the results could be extrapolated to other chronic diseases.

5.1 COMPARISON OF STUDY WITH PREVIOUSLY PUBLISHED STUDIES

The results of this study were compared to other studies using a formula for effect size = (pre-test mean- post-test mean) / pre-test standard deviation. (This could only be performed on studies that reported these values).

	PAIN Effect size	DISABILITY Effect Size
This study	2.04	1.56
Mannion (1999) All subjects	0.56	0.28
Mannion (1999) aerobics only	0.77	0.30
O'Sullivan (1997) (specific exercise group.)	1.67	0.93
Frost (1998) Aerobics group	0.71	0.62

Table 5.1 Comparison of the effect size across studies

In general the effect sizes for pain and disability were higher than the other studies examined, but this could also be as a result of the small sample size.

The subjects in this study reported two occurrences during the follow up period of twelve months ie a recurrence rate of 30%. The results of this study support the results obtained by O'Sullivan et al (1997) and Schneider (1995). However all of these studies look at a recurrence rate over a longer period of time.

The results of this study also compare well to Johannsson and Lindberg (1995) who reported improvements in pain, muscular activation patterns and muscle endurance at one year after completion of a lumbar stabilisation training programme.

From discussion with the subjects it was observed that attending exercise classes was seen by some of the participants as an alternative to surgery. Spinal surgery was perceived as having a limited rate of success. A general anaesthetic was considered potentially dangerous and the cost of time off work too great, as well as the cost of surgery. The price of failure can then be considered high, encouraging self-responsibility and compliance. Their expectation of outcomes was realistic and they expressed satisfaction even though they still had a degree of pain. They had accepted self-responsibility, which is an important factor in the outcome of chronic disease (Eales 1998).

Studies have shown that muscle function of transversus abdominus and multifidus is altered in low back pain syndromes, and recovery of this muscle function is not spontaneous after injury (Hodges et al, 1996a, Hides et al, 1996). It would appear that the participation in this group exercise programme resulted in a significant improvement in the subject's ability to maintain a contraction of transversus abdominus as a measurement of deep abdominal muscle function.

5.2 POSSIBLE MECHANISMS FOR EFFECTS

Wall (1989) suggests that movement strongly influences central inhibitory control systems. Good quality of movement may therefore be a method of mobilising descending inhibitory control circuits of the central nervous system. Controlled movement with lumbar stabilisation as used during these exercise classes may assist in normalising movement patterns hence reducing the perception of pain.

Mannion et al (1999) found in their study of three types of treatment – modern active physiotherapy, muscle strengthening/co-ordination using training devices and group aerobic/stretching classes that all three were equally efficacious in their ability to reduce pain intensity, pain frequency and disability in activities of daily living. These effects they attributed to some "central" effect (not described in any greater detail).

In CLBP there may also be a loss of sensory afferent information from damaged proprioceptors (Byl and Sinnot 1991, Luoto et al 1996). The success of such a programme may be due in part to increasing normal proprioceptive input when the segment is stabilised.

Waddell (1987) recommends that the role of the patient needs to change from a negative philosophy of rest and being a passive participant of treatment to a more positive active role of sharing the responsibility for the restoration of function. The patients in this study are still attending the group classes a year later. This suggests that they have accepted responsibility for their own well being, and that the exercise classes have become a way of life. A group exercise programme fits in well with the therapeutic model for the restoration of function by encouraging patient participation and locus of control (Watson, 1996).

Participation in a group exercise class enhances compliance. The exercises are performed under close supervision of a physiotherapist. Reilly (1989) suggests supervision increases the chance of complianc… d …ccess of an exercise programme. A wide variety of exercises were performed, with emphasis on the maintenance of lumbar stability during performance of the exercise. There is an element of fun in a class, together with subtle competition which encourages the participant to perform. Frost et al (1998) reported that at a 2-year follow up chronic low back pain patients who had participated in a supervised exercise programme had statistically significant differences in their disability scores compared to a group who were given home exercises only.

De Rosa and Porterfield (1992) suggest that the most important objective for patients with recurring or chronic low back pain is the enhancement of neuromuscular performance. One of the subjects reported that her balance and large muscle co-ordination had improved as well.

5.3 RELEVANCE OF THIS STUDY

In South Africa at present there is a move by managed health care groups supported by insurance companies towards the establishment of high - tech rehabilitation centres (SanlamHealth – report, 1997). Encouraging participation in group exercise classes under the right circumstances may be a low cost alternative. However these companies will demand evidence to show the effectiveness and value-for-money of any clinical intervention.

The clinical trial performed by Mannion et al (1999) emphasises the cost effectiveness of the group aerobic / stretching class versus individual physiotherapy treatment and the muscle strengthening / co-ordination using training devices which all showed similar outcomes.

Gudenall et al (1983) showed a cost efficiency saving of 1.3 day's sick leave per hour of physiotherapy as a result of an ongoing exercise regime in the prevention of LBP.

In the changing field of health care with its emphasis on primary health care and cost effectiveness this is a challenge that needs to be addressed. There will be increasing employer involvement in the promotion of wellness of their employees. This may well be an opportunity for patients to have access to physiotherapy in an occupational health setting. A group class approach is a resource efficient means of reaching a large group of patients who may not otherwise have access to management of their low back pain.

Physiotherapists need to be encouraged to provide this service. At present there is little incentive for this. The minimum space needed for a gym area is 8m X 4m at a monthly rental of approximately R40/m^2 in an urban area, ie R1280/month. In order to break even on her rental only she needs to hold a minimum of 10 classes of six participants per class. However, if she were to spend those 10 hours treating patients (needing no additional space) she would earn R2000. An interesting dilemma requiring an integrative solution if the needs of the patient are to be served.

5.4 CLINICAL APPLICATION OF STUDY

The subjects appeared to enjoy the process of assessment, looking forward to measuring the changes in their results. As well as being a tool for assessing the effectiveness of the programme, ongoing appropriate assessment is an essential tool for goal setting. Periodic re-evaluation of the patient's progress and documentation of improvement can help to maintain his motivation. Communicating these results to the patient, his referring doctor and his health care funder may help in planning future treatment needs for the patient.

Records of the measurements obtained in this study were kept using Microsoft Excel. Graphs can be produced easily with this programme, facilitating interpretation by the physiotherapist and the patient. Clinically, gaps in the patient's abilities can be identified, progress can be seen at a glance, and goals can be set.

Using subject B as a example:

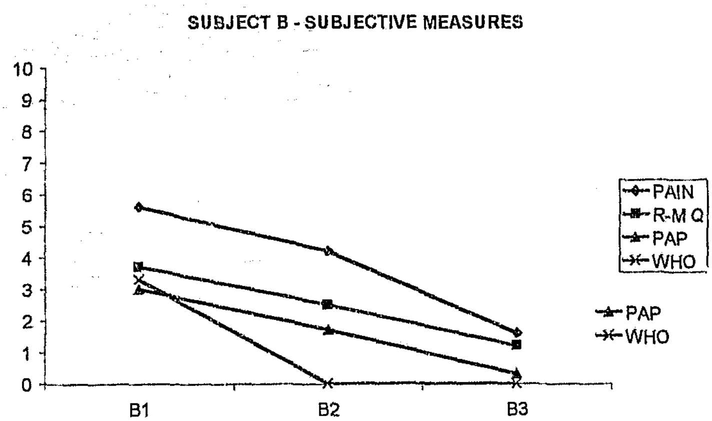

Fig 5.3 – Subject B – change in scores (expressed as an index) over a period of 3 months.

A decreasing score, with a perfect score tending towards 0 indicated improvement in the subjective measurements.

Using such graphs facilitates the interpretation of results by lay people (eg patients, funders) and also reduces the use of jargon, which may lead to misinterpretation of results by other disciplines.

5.4 RECOMMENDATIONS FOR A RANDOMISED CONTROLLED TRIAL BASED ON THIS PILOT STUDY

The results of this study are encouraging in supporting the clinical application of a group exercise class based on the principles of the active stabilisation training. They also justify the establishment of a randomised controlled study to examine the effects of group exercise classes to improve lumbar stability in chronic low back pain patients. This study would require a larger, more heterogeneous group.

The tests used were easy to apply clinically, and could be integrated into practice on a regular basis. They were shown to be suitable for use as a component of a postal questionnaire. They could therefore be used in a randomised controlled study to measure the effectiveness of a rehabilitation programme, as well as in clinical practice for motivating the patient throughout the process of the active stabilisation training. However the evaluation of the quality of pain and the personal activity profile will need further refinement.

The question to be addressed by such a trial would be: is the intervention as described in this study (active stabilisation training) better than another intervention eg general aerobic exercise or no intervention. Patients would be included on the basis of the inclusion and exclusion criteria described in this study and randomised to one of the three interventions. In order to obtain a homogenous study population Mannion et al (1999) recruited their subjects through a newspaper advertisement. Another method would be to recruit subjects already seeking help via their general practitioners. All subjects would have to be English literate if the questionnaires as described here were to be used. The size of the sample would have to be in the magnitude of 60 patients per group (depending on the confidence limits and the confidence interval) (Hicks 1995). It would be impossible to blind the subjects to the intervention, however the observer would be blinded to the group allocation of the subjects. The measurements used in this study could be applied, but it is suggested that the following could also be included:

- McGill pain questionnaire (Melzack, 1975) which includes descriptions of the quality of the subjects' pain in terms of sensory components, affective components and evaluative components. This would help to counteract the effect of the perseverance of the subject with the pain body chart as discussed above.
- the Fear Avoidance Beliefs questionnaire (Waddelll et al 1993) to measure fear avoidance beliefs related to work and physical activity.

It is suggested that the intervention be for a period of three months. The subjects would be measured prior to the intervention, and then monthly during the intervention. After three months the intervention would be discontinued. Subjects could then be followed up 12 months later by means of a postal questionnaire.

To summarise:

Participants in a group exercise class based on the current understanding of the principles of the restoration of active stabilisation training were measured over a period of three months. Over this period they showed improvement in their ability to control transversus abdominus as a measurement of their ability to stabilise the lumbar spine. They also showed improvement in their pain intensity, disability in their tasks of daily living and well being.

The study is limited in that it was performed over a three-month period on a small sample of patients. These patients had a moderate level of pain, which did not interfere with their capacity to work. The subjects had a high level of education and socio-economic status.

6. CONCLUSION.

A group of six patients attending exercise classes were measured over a period of three months. During this period their ability to contract Transversus Abdominus as a measure of deep abdominal muscle function improved so that they were able to sustain ten 10 second holds of this muscle without substitution of other muscle groups.

During this period their levels of pain, disability, handicap and distress also improved. These improvements were maintained at a follow-up one year after commencement of the exercise classes.

The null hypothesis ie

In a group of patients attending group exercise classes directed at active stabilisation training there will be:

- no change in the deep abdominal muscle function of the subject
- no reduction in pain and disability experienced by the patient

was thus disproved.

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APPENDICES

Appendix 1

INFORMATION FOR PARTICIPANTS

This practice is doing research on the effectiveness of rehabilitation programmes for patients who suffer recurrent episodes of low back pain.

We understand that you suffer from recurrent episodes of low back pain and would like you to participate in the study.

We will need to assess you monthly over a period of three months for various parameters such as pain, range of movement etc. You will be required to fill in a self assessment form and also undergo a physical assessment, and an electromyographic investigation (EMG). This is a non-invasive, pain-free examination to test muscles (similar to a heart ECG). This will take approximately fifteen minutes.

In addition you will be required to participate in an exercise class, twice weekly for a period of three months. You should not experience any pain or discomfort during or after these exercises.

The potential benefit of the research is a more effective exercise programme for low back pain sufferers with greater long term benefits such as fewer episodes of low back pain.

Participation in the study is voluntary and you are free to refuse to participate, or withdraw at any stage. Such refusal or discontinuance will not affect your treatment in any way. A signed copy of your consent form will be made available to you.

ASSESSMENT OF A LUMBAR REHABILITATION PROGRAMME

CONSENT FORM

I have fully explained the procedures to be used during this research, and have explained the purpose. I have asked whether or not any questions have arisen regarding the procedures and have answered the questions to the best of my ability.

Date_______________ Researcher _____________________________

I have been fully informed as to the procedures to be followed and have been given a description of the attendant discomforts, risks and benefits to be expected and the appropriate alternate procedures. In signing this consent form, I agree to this method of treatment and I understand that I am free to refuse to participate or withdraw my consent and discontinue my participation in the study at any time. I understand that if I have any questions at any time they will be answered.

Date _______________ Patient_________________________________

ASSESSMENT OF A LUMBAR REHABILITATION PROGRAMME

CONSENT FORM

I have fully explained the procedures to be used during this research, and have explained the purpose. I have asked whether or not any questions have arisen regarding the procedures and have answered the questions to the best of my ability.

Date_______________ Researcher _____________________________

I have been fully informed as to the procedures to be followed and have been given a description of the attendant discomforts, risks and benefits to be expected and the appropriate alternate procedures. In signing this consent form, I agree to this method of treatment and I understand that I am free to refuse to participate or withdraw my consent and discontinue my participation in the study at any time. I understand that if I have any questions at any time they will be answered.

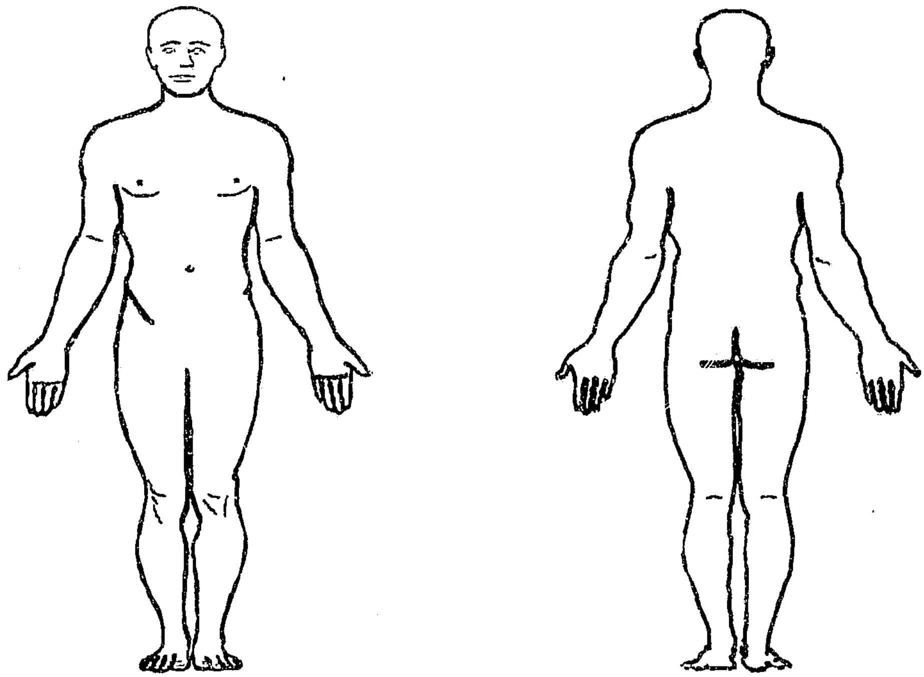
Date _______________ Patient_________________________________

Appendix 2 a

ASSESSMENT OF A LUMBAR REHABILITATION PROGRAMME

Name
Date

Pain chart:
Please mark on this chart your areas of pain and describe each area (eg ache, tingling, numbness, shooting, stabbing etc):



Mark your level of low back pain on the scales below:
(0 = no pain, 10 = extremely severe pain)

my low back pain right now

0 1 2 3 4 5 6 7 8 9 10

my average low back pain during the past week

0 1 2 3 4 5 6 7 8 9 10

my low back at its worst during the past month

0 1 2 3 4 5 6 7 8 9 10

Appendix 2 b

ROLAND MORRIS QUESTIONNAIRE

When your back is sore you may find it difficult to do some of the things you normally do. This list contains some sentences that people have used to describe themselves when they have back pain. When you read them you may find some stand out because they describe you today. As you read the list think of yourself today. When you read a sentence that describes you today, put a tick against it. If the sentence does not describe you then leave the space blank and go on to the next one. Remember only tick the one that describes you today.

- ☐ I stay at home most of the time because of my back.
- ☐ I change position frequently to try and get my back comfortable.
- ☐ I walk more slowly than usual because of my back.
- ☐ Because of my back I am not doing any of the jobs I usually do around the house.
- ☐ Because of my back I use a handrail to go upstairs.
- ☐ Because of my back I lie down to rest more often.
- ☐ Because of my back have to hold on to something to get out of an easy chair.
- ☐ Because of my back I try to get other people to do things for me.
- ☐ I get dressed more slowly than usual because of my back.
- ☐ I only stand for short times because of my back.
- ☐ Because of my back, I try not to bend or kneel down.
- ☐ I find it difficult to get out of a chair because of my back.
- ☐ My back is painful almost all of the time.
- ☐ I find it difficult to turn over in bed because of my back.
- ☐ My appetite is not very good because of my back.
- ☐ I have trouble putting on my socks or stockings because of the pain in my back.
- ☐ I only walk for short distances of my back pain.
- ☐ I sleep less well because of my back.
- ☐ Because of my back pain, I get dressed with help from someone else.
- ☐ I sit down for most of the day because of my back.
- ☐ I avoid heavy jobs around the house because of my back.
- ☐ Because of my back pain, I am more irritable and bad-tempered with people than usual.
- ☐ Because of my back, I go upstairs more slowly than usual.
- ☐ I stay in bed most of the time because of my back.

ASSESSMENT OF A LUMBAR REHABILITATION PROGRAMME

PERSONAL ACTIVITY PROFILE

Mark your level of performance on the scale 0-10 where
0 = no problem at all
10 = you cannot manage / your condition is very severely limiting your lifestyle or affecting your activities

1. PERSONAL CARE eg dressing yourself, washing hair, getting into and out of bath etc

0 1 2 3 4 5 6 7 8 9 10

2. SOCIAL INTERACTION AND FAMILY LIFE

0 1 2 3 4 5 6 7 8 9 10

3. SPORT, HOBBIES, RECREATION

0 1 2 3 4 5 6 7 8 9 10

Comment on adjustments / discontinuation of sports / hobbies etc

4. WORK
Occupation

Description of Work

Rate on this scale the extent to which your work has been affected by you pain / disability / condition
0 = not affected at al
10 = very severely affected / major adaptations required

0 1 2 3 4 5 6 7 8 9 10

ASSESSMENT OF A LUMBAR REHABILITATION PROGRAMME

Read the following sentences and tick only the block opposite the statement that describes you **today**

0. My disability does not affect me emotionally at all ☐

1. My pain affects me emotionally but I feel I can deal with it / cope with it by myself ☐

2. My pain causes me to become depressed occasionally ☐

3. My pain is constantly bothering me and I feel emotionally upset a lot of the time and my mood affects my performance at work and at home ☐

4. I am severely frustrated / depressed / irritable because of my condition and I feel I cannot cope on my own ☐

5. I feel that my condition is constantly so severe and disabling that life is not worth living. Suicidal thoughts have crossed my mind ☐

Appendix 3 – One year follow-up - letter to subjects

14 April 1999

Dear Ian

Thank you for participating in my study on Margie Morrell's exercise classes, last year. As a follow-up would it be possible for you to complete the following questions and fill in the enclosed questionnaire:

1. Are you still participating in exercise classes at Margie Morrell's Practice

   YES / NO

2. If yes, how often do you attend _____ X / week
3. Do you enjoy these classes YES / NO
4. Do you find them beneficial YES / NO
5. Have you returned to any activities that you had to give up because of your low back pain YES / NO
6. If yes, describe

   ____

   ____

7. How many acute episodes of low back pain have you had in the last 6 months

   ____

8. Do you need to take any medication for your low back pain? YES / NO
9. If yes, what medication do you take ______________________
10. How many per day ________
11. How frequently do you need this medication? ______________________

Is there anything else you would like to share with me about your participation in theses classes?

____

____

____

____

____

Would you be willing to come in to my rooms for a follow-up physical assessment? YES / NO

Please complete the enclosed questionnaire which is similar to the one you completed during the first part of the study.

Many thanks for participating in this part of the study. Please post me the replies in the stamped self-addressed envelope included.

Regards

Lorraine Jacobs

Calculating the Page's L trend test:

1. find the total sores for each condition.

2. Find the mean score for each condition.

3. Rank the scores for each subject, across the row, giving the rank of one to the lowest score, the rank 2 to the next lowest etc.

4. Add up the ranks for each condition.

5. Find the value of L from the formula

$$L = \Sigma (T_{c1} \times C) + \Sigma (T_{c2} \times C) + \Sigma (T_{c3} \times C)$$

Where Σ = the sum of any symbols that follow it

T_c = the total ranks for each condition

C= numbers allotted to the conditions from left to right ie 1,2,3

(T_c X C) = total of the ranks for each condition multiplied by the number assigned to the condition.

6. To look up the value of L in the probability tables the following values are required :

C = the number of conditions – in this study = 3 or 4

N = the number of subjects in the group = 6

<u>Appendix 5 - CALCULATING PAGE'S L TREND TEST</u>

Subject	Pain 4	Rank4	Pain 3	Rank 3	Pain 2	Rank2	Pain 1	Rank1
1	0	1.5	0	1.5	3.6	3	7.3	4
2	1.3	1	1.6	2	4.2	3	5.6	4
3	5.6	1	7.3	3.5	7.3	3.5	6.3	2
4	1	2	0.6	1	1.6	3	3.3	4
5	4	1.5	4	1.5	6.6	4	5	3
6	2	1	3.3	2	5.3	3	6	4
SUM	13.90	8	16.80	11.50	28.60	19.50	33.50	21.00
Ave	2.32		2.80		4.77		5.58	
L value	173.5							

Subject	RMQ 4	Rank4	RMQ 3	Rank 3	RMQ 2	Rank2	RMQ 1	Rank1
1	0	1.5	0	1.5	3	3	11	4
2	7	3	3	1	6	2	9	4
3	4	1	8	3	12	4	6	2
4	4	2	4	2	4	2	6	4
5	11	2	7	1	14	4	13	3
6	7	1.5	7	1.5	12	4	11	3
SUM	33.00	11	29.00	10.00	51.00	19.00	56.00	20.00
Ave	5.50		4.83		8.50		9.33	
L value	168							

Subject	PAP 4	Rank4	PAP 3	Rank 3	PAP 2	Rank2	PAP 1	Rank1
1	0	1.5	0	1.5	2	3	2.6	4
2	2.25	3	0.3	1	1.[illegible]	2	3	4
3	1.7	1	3	2	5.[illegible]	3	7.2	4
4	1	2	3	3	0.6	1	4	4
5	2.75	2	2	1	3	3	4.5	4
6	3.75	4	3.25	2	2	1	3.5	3
SUM	11.45	13.5	11.55	10.50	15	13.00	24.8	23.00
Ave	1.91		1.93		[illegible].50		4.13	
L value	**165.5**							

Subject	WHO 4	Rank4	WHO 3	Rank 3	WHO 2	Rank2	WHO 1	Rank1
1	0	1.5	0	1.5	1	3	4	4
2	0	2	0	2	0	2	2	4
3	2	2.67	1	1	2	2.67	2	2.67
4	0	1.5	1	3	0	1.5	2	4
5	2	2.5	1	1	2	2.5	3	4
6	0.5	3	0	1.5	0	1.5	1	4
SUM	4.5	13.17	3	10.00	5	13.17	14	22.67
Ave	0.75		0.50		0.83		2.33	
L value	**163.36**							

Subject	TA 1	Rank1	TA 2	Rank 2	TA 3	Rank3
1	2	1	5	2	10	3
2	10	2.5	8	1	10	2.5
3	5	1.5	5	1.5	10	3
4	5	1	10	2.5	10	2.5
5	7	1	10	2.5	10	2.5
6	8	1	10	2.5	10	2.5
SUM	37.00	8	48.00	12.00	60.00	16.00
Ave	6.17		8.00		10.00	
L value	**80**					