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Research paper

LOW BACK PAIN: A COMPARATIVE STUDY ON THE VALUE OF CORE TRAINING VS TRADITIONAL STRENGTHENING EXERCISES

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Abstract. This randomised controlled trial (RCT) employed a pre-test/post-test design to compare the effects of core training (Pilates method) and traditional back exercises on a population with low back pain (LBP). Therapeutic intervention related to the Pilates method has recently become popular, but there is little evidence to prove it works. In this study, 120 individuals with LBP were allocated to three different groups. Group A was the control group, Group B was given modified Pilates intervention and Group C received traditional back exercises. All three groups were given a posture re-education session and back-care advice. After the initial session, the control group had individual sessions on posture re-education. The other groups undertook a six-week course of either modified Pilates or general back exercise classes. The modified Pilates group was taught how to use the core muscles, incorporating stabilisation with increasing functional movements. The back exercise group did similar exercises without learning to specifically stabilise. The Oswestry Low Back Pain Disability Questionnaire (ODQ) and the Visual Analogue Scale (VAS) were used as measures for pain and functional disability. Post-test ODQ readings showed no significant difference for pain-related function whilst VAS readings revealed a significant improvement in pain levels in all three groups, with the control group showing the best scores. However, the six-month follow-up scores showed that only the modified Pilates group continued to improve. At this stage, the control group was beginning to regress and the back exercise group was almost back to baseline measures. It was therefore concluded that core stability exercises have better long-term effects than traditional back exercises.

Keywords Back pain, core stability, exercise, Pilates, posture

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1 Introduction

It has been reported that 60-80% of people in the Western hemisphere suffer from back pain at some time in their life (Long, BenDebba & Torgersen, 1996). Of these, 85% are classified as suffering from non-specific low back pain (NSLBP) (Krismer & van Tulder, 2007), which is the term coined due to a lack of diagnosis (Ferreira et al., 2007). Much research has been carried out on the effects of management of low back pain (LBP) (e.g. Liddle, Baxter & Gracey, 2003; Hayden et al., 2005). Klaber-Moffett et al. (1999) conducted a study on mechanical back pain, which is the term used to define pain caused by placing abnormal stress and strain on the muscles of the vertebral column. They evaluated the effects of exercise programmes on patients with LBP and concluded that exercise classes were clinically more effective than traditional general practitioner (GP) intervention.

Maher, Latimer and Refshauge (1999) undertook a major review of all randomised controlled trials (RCTs) investigating NSLBP over a span of more than 30 years. They found that structured exercise programmes that are intensive, supervised and involving the whole body, provide the best treatment for NSLBP in the sub-acute and chronic phases. Hanney, Kolber and Beekhuizen (2009) agreed that avoiding physical activity and adapting fear avoidance behavior increases risk for chronicity and that improved fitness decreases pain perception. In a survey of GP practice, Williams et al. (2010) found that primary care does not follow evidence-based guidelines and may contribute to the high costs of managing LBP.

In the past decade there has been a shift towards core stability training or segmental stabilisation training (Jull & Richardson, 2000). Whilst traditional exercises generally work to increase the "global" strength of the larger muscles responsible for movement, the "core stability" approach aims to improve the dynamic stability role of the "local" muscles (Richardson et al., 2002). Figure 1 shows how the local muscles work together, acting as a cylinder to provide segmental stabilisation to the spine. However, many reviews argue that although stability training is widely popular, there is still not enough strong evidence to prove that it works better than more traditional training in the rehabilitation process of LBP (e.g. Mannion et al., 2012; Ferreira et al., 2006). Norris (1995) describes muscular imbalance and "active instability" as major culprits in LBP, arguing that retraining quality of movement is essential to target muscle imbalance. This is corroborated by Vleeming et al. (1995), O'Sullivan et al. (1997), Jull and Richardson (2000) and Comerford and Mottram

(2001a). However, a systematic review by Macedo et al. (2009) reported that there was no evidence found to prove that motor control exercise is any better than manual therapy or other forms of exercise.

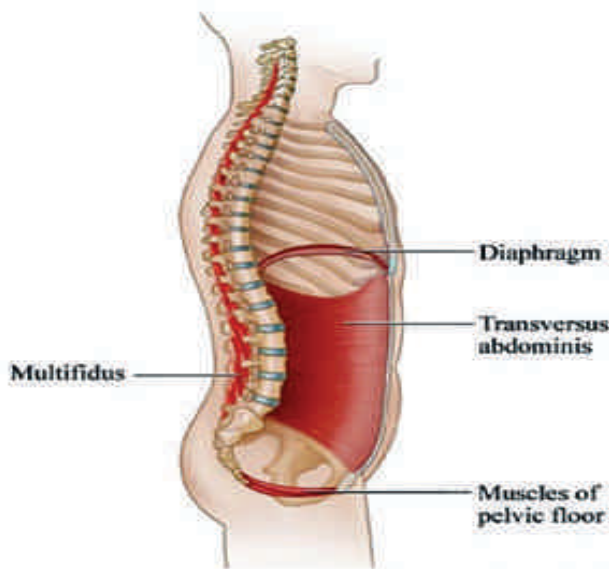


Figure 1: Muscular segmental stabilisation to the spine (City Edge Physio Sydney Physiotherapy, 2014).

Panjabi (1992) described the stabilising system of the spine as being made up of three components, termed the active (muscular), passive (ligamentous) and neural (control) subsystems, which intercommunicate harmoniously to provide stabilisation by controlling intervertebral movement. He defined the neutral zone as the range of “intervertebral motion in which there is minimal internal resistance for spinal motion to be produced” (p.394). The neutral zone can be abnormally increased due to laxity in the passive joint restraints or due to lack of dynamic muscular control (Panjabi, 1992).

In 2003, Panjabi looked at load distribution during movement in the spinal column and concluded that the spine is flexible with low loads and stiffens with increasing load. The analogy of a ball in a bowl was employed to aid visualisation of the load displacement curve. The ball moves easily within the neutral zone (base of bowl) but requires greater effort to move in the outer regions of the movement (steeper sides of the bowl). The shape of the bowl indicates spinal stability: the deeper the bowl, the more stable is the spine. This compares well with the biomechanical work carried out by Granata and Wilson (2001) who concluded that co-contraction of muscles is necessary to achieve stability in the spine, but specific neuromuscular control is required to maintain stability in asymmetric lifting postures. In such postures, the spinal load is increased significantly and the risk of overload injuries is higher.

A considerable amount of research has been carried out on the mechanism of the spinal stabilising system. Electromyography (EMG) testing and ultrasound scanning have shown that the local stabilisers, mainly Transversus Abdominis (TrA), the deep fibres of Lumbar Multifidus and lately also a small portion of Psoas Major, have a specific stabilising role on the spine (Hodges, 1999; Richardson et al., 2002; Standaert, Weinsten & Rumpeltes, 2008). Cresswell (1992) observed intra-abdominal pressure (IAP) during dynamic trunk loading and concluded that TrA contributes to the general mechanism of trunk stabilisation

rather than producing torque. He also concluded that TrA is controlled independently of the other abdominal muscles and should be re-educated more specifically, as sufferers of LBP lose timing and cross-sectional area of both Multifidus and TrA, which have been found to work in synchrony (Wallwork et al., 2009; Jansen et al., 2010). These must be re-educated to work as postural (tonic) muscles, which contract submaximally prior to and during movement and have been found to work optimally in neutral postures (Mew, 2009).

In the presence of LBP, the function of the stabilising muscles is impaired (Hodges 1999; Urquhart et al., 2005). This impairment can be related to alterations in timing or a decreased cross-sectional area (Comerford and Mottram, 2001b; Jansen et al., 2010) which, in turn, may be due to reflex inhibition caused by pain (Dickx et al., 2010). Danneels et al. (2002) compared EMG results of Multifidus and Iliocostalis Lumborum in healthy participants and patients with LBP. They concluded that back pain patients have a decreased ability to recruit Multifidus voluntarily. Although EMG was normal during low load stabilisation exercises, a low EMG result was reported during high load strength exercises. This may have been due to pain, pain avoidance or deconditioning of the muscle.

Improvement in pain and function has been reported with exercise interventions based on the inward movement of the lower abdominal wall (Hides, Richardson & Jull, 1996; O’Sullivan et al., 1997). Urquhart et al. (2005) carried out several EMG tests on TrA and concluded that the best position for independent contraction of TrA is in supine. Through the use of ultrasound screening, Mew (2009) found that TrA thickness improves more when trained in a good standing posture, which is more functional (Reeve & Dille, 2009).

Pilates exercises are considered to be a good rehabilitation tool for core strengthening and spinal stability (Akuthota & Nadler, 2004). Comerford and Mottram (2001b) demonstrated that the principles of proprioceptive facilitation and overflow, as practised in Pilates, are utilised to re-educate dysfunctional movement. Although Pilates is a popular tool in rehabilitation of back pain, few quality studies have been done to compare its effectiveness compared to more traditional exercises.

2 Method

2.1 Participants

One hundred and twenty participants were recruited over a six-month period. Referrals were made to the Physiotherapy Outpatients Department at St Luke’s Hospital, Malta via the Orthopaedic Outpatients Department at Mater Dei Hospital or directly from the participants’ GP. Physiotherapists working in the back-care unit within the Physiotherapy Department at St. Luke’s Hospital assessed all patients referred for NSLBP. Approval to carry out the study was obtained from the Research Ethics Committee of the Faculty of Health Sciences, University of Malta, the Manager of Physiotherapy Services and all referring orthopaedic and medical staff. Each participant was given an informative letter explaining the purpose of the study. Informed consent was obtained from the patients prior to random assignment to the treatment groups. Ethically, all patients were given valid treatment and were reassured that confidentiality was guaranteed.

56% of the participants were females and 44% were males. While 21% of all participants were aged between 16 and 35 years, 38% were between the ages of 36 and 50 years and 41% were aged 51-65 years. The participants’ age distribution within groups following random assignment is shown in Table 1.

Table 1. Age distribution within groups following the randomisation process.

Age	Group A	Group B	Group C
16-35 years	10	7	1
36-50 years	7	15	10
51-65 years	17	8	10

Table 2 lists the entry and exclusion criteria for participant selection.

Table 2. Criteria for participant recruitment.

Entry Criteria	Exclusion Criteria
18-65 years	Acute pain
6 weeks with LBP (VAS)* score > 3cm	Neurological dysfunction
	Recent surgery or childbirth

*The Visual Analogue Scale (VAS) is described in Section 2.4 (Data collection)

2.2 Procedure

The study consisted of two parts. The primary study was a pre-test/post-test control group design with simple randomisation administered upon entry to the study. Participants were randomly assigned to Group A (posture re-education), Group B (core stability exercises) or Group C (traditional back exercises) by administrative staff who were not involved in the study. The second part of the study was a follow-up reassessment of the outcome measures after a six-month period.

2.3 Interventions

Participants were assessed individually by two senior musculoskeletal physiotherapists and baseline measures taken on their first visit to the department. Each participant was taught how to correct posture during the first session. All participants received back-care and ergonomic advice which was suited to their individual needs. The two intervention groups were given a written Home Exercise Programme (HEP).

Group A participants were reviewed individually and followed a postural re-education programme, which consisted of advice and practice of posture re-alignment during sitting, standing and daily active functions. Group B attended Core Stability classes which teach how to co-ordinate ‘core’ muscle activity with costal breathing and graded ‘flowing’ movement. The exercises are a modification of the original Pilates exercises. The HEP consisted of three modified Pilates Level 1 exercises (Withers & Stanko, 2004), as presented in Figure 2. The aim of the Abdominal Preparation (A) is to teach deep neck flexor co-contraction and shoulder stabilisation. In Hip Twist Level 1 (B), the aim is to teach hip dissociation while maintaining neutral spine. In Breaststroke Preparation (C), the aim is to teach neutral spine in prone position. In all three exercises, one had to pair the movements with breathing control and TrA and Multifidus co-contraction.

Group C attended traditional back exercise classes. The HEP consisted of three traditional back exercises as illustrated in Figure 3. The Curl Up (A) aims at strengthening the abdominal muscles, the Knee Hug (B) releases tension from the lower back and gluteal muscles and the Spine Twist (C) gently mobilises the spine to release neural tension, and stretches tight structures. All groups attended over a period of six weeks and classes were taught at the Physiotherapy Department, St Luke’s Hospital. The participants were advised to carry out their HEP once daily.

2.4 Data Collection

The outcome measures used in this study were the Oswestry Disability Questionnaire (ODQ) (Fairbank et al., 1980) and the Visual Analogue Scale (VAS) (Boonstra et al., 2008), both of which were scored by all participants who completed the six-week course. The ODQ is used to score disability induced by LBP

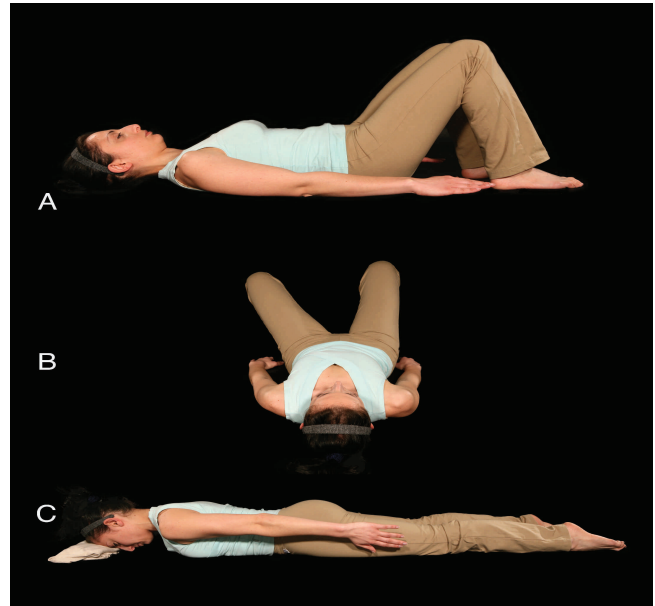


Figure 2: The HEP of three modified Pilates Level 1 exercises (Group B).

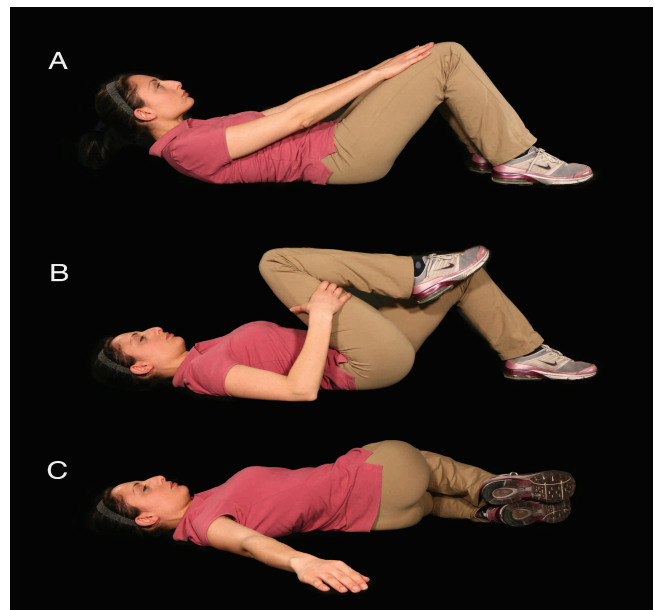


Figure 3: The HEP of three traditional back exercises (Group C).

and has been translated into many languages, including Maltese (Sant’Angelo, 2000). It is a validated tool that is designed to assess a patient’s level of function or disability, providing quantitative data that are suitable for quality assurance and research purposes (Beattie & Maher 1997; Kopec, 2000; Stratford, Riddle & Binkley, 2001; Vianin, 2008). The VAS scale is a valid and reliable tool to rate pain intensities along a 10cm line. The patient is asked to put a mark along this line to reflect the intensity of the pain. The score is measured from the zero anchor to the patient’s line (Williamson & Hoggart, 2005).

The Kolmogorov-Smirnov test indicated that the scores ob-

tained for the three individual groups had a non-normal distribution. The Kruskal-Wallis test was therefore used to compare the mean scores obtained for the three independent groups.

2.5 Results

A total of 120 participants were eligible to take part in this study. These were divided equally to three pre-defined groups of 40 participants in each group, of whom 33 completed the postural programme, 32 completed the Pilates programme and 24 completed the traditional back class programme. For statistical analysis, the data were grouped in such a manner that no intervention group could be recognised.

Paired sample t-tests were used to test for significant differences in measures obtained before and after the programme. The VAS readings indicated a significant difference at the 1% level ($p = 0.003$) between the three groups, while the ODQ readings showed no significant difference ($p = 0.123$). Results showed an improvement across all groups in pain and disability scores, as illustrated in Figures 4 and 5 respectively. In Group A, the average VAS was 6.02cm upon entry to the programme and 2.42cm upon discharge. The average individual change was a decrease of 3.6cm (<60%). The average ODQ score was 43% before treatment and 35% after treatment (<12%). Six months later, average scores were 3.87cm for the VAS and 36% for the ODQ. The average VAS score for Group B was 6.19cm upon entry to the programme and 4.44cm upon discharge, with a decrease of 1.75cm on average (<28%). ODQ results showed that the average disability measure pre-intervention was 47%, versus 43% upon completion of the programme (<4%). Six months later, average scores stood at 4.07cm and 35.4% for the VAS and ODQ respectively. Group C results showed the average VAS to be 5.35cm upon entry and 4.08cm upon discharge. The average individual change was a decrease of 1.27cm (<24%). The average ODQ for the back exercise program was 39% versus 33% (<6%). Six months post-intervention, average scores were 5.07cm (VAS) and 39.92% (ODQ).

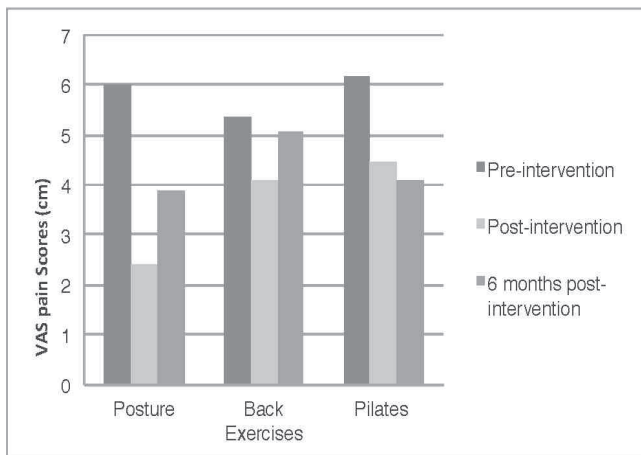


Figure 4: Pain scores obtained pre-intervention, post-intervention and six months post-intervention using the (VAS).

Although Group A showed the best improvement in scores initially, Group B scores continued to improve over time, with patients doing equally as well as participants in Group A after six months. Participants in Group C initially improved but had regressed close to pre-intervention levels after six months. Age-related pre- and post-test differences were interesting. As shown in Figure 6, the 16-35-year-old age group improved by 70% on VAS scores and by 23% on ODQ scores. The 36-50-year-olds scored an average of 24% improvement on the VAS and 9% on the ODQ

while the 51-65-year-olds improved by 35% and 16% on the VAS and ODQ respectively.

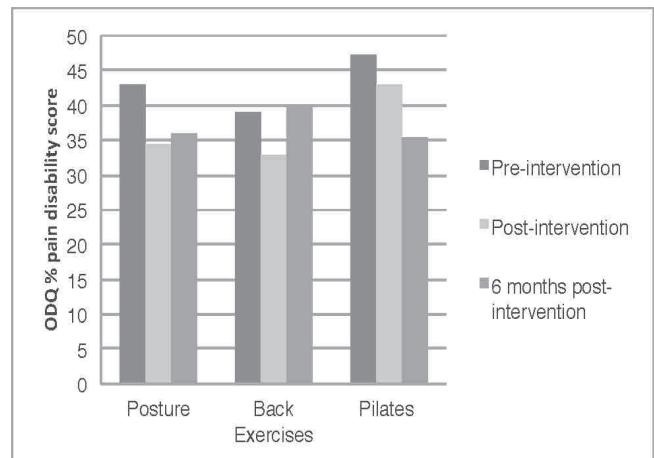


Figure 5: Percentage pain disability scores obtained pre-intervention, post-intervention and 6 months post-intervention using the ODQ.

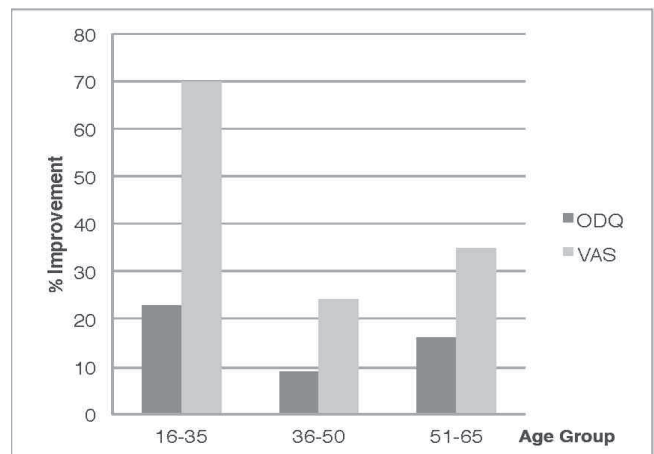


Figure 6: Percentage improvement measured by the ODQ and VAS across age groups.

3 Discussion

The aim of this RCT was to compare the effect of core training and traditional back exercises on a population with LBP. A pre-test/post-test design was implemented over a period of six weeks. Outcome measures consisted of ODQ and VAS scores. Six months after programme completion, a follow-up re-assessment of the outcome measures was carried out.

Pain and disability scores improved in all groups. At six weeks post-intervention, Group A showed the most significant improvements in both ODQ and VAS scores. However, results obtained after six months show that participants in Groups A and C had regressed to some extent. Group C scores had regressed close to pre-test levels. Group A scores were still much better than pre-intervention levels and were at par with Group B scores, which had continued to improve over the six months following the programme. Group A showed the highest percentage difference between six-week post-test VAS and ODQ scores. This group was

not provided with a HEP but participants were given four individual postural re-education sessions during the programme. Class/group therapy is still a new concept for managing physiotherapy patients in Malta, who may not expect to be given exercise as a means to manage their pain (Sacco, 2003). This may have introduced a bias in favour of Group A. Participants in Group B who had undergone the core stability programme had better VAS outcomes than those in Group C, who followed the traditional back classes. The opposite was true with the ODQ results at six weeks. These findings are comparable to those of similar research studies in which the effects of core stability exercises were investigated (Macedo et al., 2009). The evidence is inconclusive as to which type of exercise is best and actually leans towards incorporating any general exercise programme to improve function (Pool-Goudzwaard et al., 1998; Danneels et al., 2002; Standaert et al., 2008). However, scores taken after six months showed that participants who had learned core stability exercises continued to improve while those who only had postural re-education regressed slightly. This led to them having similar six-month results. O'Sullivan et al. (1997) found that reduction of pain and functional disability levels which were statistically significant were maintained at 30 months in participants who had undergone core stability rehabilitation.

It is noteworthy that the participants had been randomly assigned to three groups without considering that age differences could affect outcomes. The distribution of ages between groups appears to relate to the initial results and may have introduced a bias in favour of Group A as age-related differences were striking. The 16-35-year-old participants showed the greatest improvement, which finding could be due to several factors such as healing occurring faster in younger populations. For socio-cultural reasons, the youth are more body and movement aware in Malta (Sacco, 2003), so they assimilate exercises more easily. Also, they were more likely to be cases of first incidence of LBP, which would be easier to treat than recurrent episodes, or chronic LBP (Liddle et al., 2003).

The 36-50-year-old participants showed the least improvement. This may be because the patients in this age group are likely to have had the greatest physical demands due to their lifestyles at work and at home, and also the least time for their own well-being. The 51-65-year age group had a better outcome than their younger counterparts, which may reflect the fact that they had more time for themselves and so were more likely to implement their HEP. It would have been a good idea to record compliance to the HEP with a diary. Another factor contributing to the results obtained for the older groups may have been chronicity of pain. If pain persists for more than 12 weeks, or the individual suffers three or more LBP episodes in one year, the resumption of normal daily life becomes increasingly difficult due to the development of chronic pain (Balague et al., 2007; Liddle et al., 2003). As time passes, it becomes increasingly difficult for medical intervention to break down maladaptive behaviours (Arnau, Vallano & Lopez, 2006) and increased pain perception, which can impact heavily on psychological and physical function (Stroud et al., 2000). Psychosocial factors can be a bigger predictor of chronicity than biological or physical factors (Woby, Urmston & Watson, 2007).

Several weaknesses have been identified in this study. The comparative aspect of the investigation was aimed at testing the hypothesis that one type of exercise programme may be more beneficial than the other. While planning the study, it was not envisioned that the results would reflect that it may be more beneficial to give individual attention rather than treat in groups. It may have been more valid to give Group A postural awareness classes so as to have a better correlation between the groups. Age-related influences on outcomes had not been considered but appeared to affect scores. The inclusion criteria were left open, with variables such as lifestyle, previous therapies and participation in activities that could have heightened body awareness not taken into consid-

eration. These factors could have impacted the results.

The current study was based on physiological processes so it did not explore psychosocial aspects of back pain, which may have important implications. It would have been useful to collect qualitative data to better understand the effects of pain in this population. It is important to value the sociocultural factors that may have affected the participants' perceptions of their pain and treatment. The authors noted that although patients were stating that they felt much better, the ODQ scores did not reflect that whilst the VAS scores did. The study would have been more valuable had there been a larger population sample or a longer timeline.

4 Conclusion

The results of this study imply that core stability exercises have a better effect on improving pain and disability over a longer period than traditional back exercises. All participants were also given postural and ergonomic advice. Interestingly, the control group who had postural re-education did as well as the core stability group. Age was not considered to be a factor when allocating participants into groups. However, the younger age group showed marked improvement with posture re-education and exercise. These results are clinically significant. Further longitudinal studies in this area are called for, with a recommendation that participants are followed up for at least one year post-intervention in order to find out which approach has better long-term outcomes.

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