# Prescription of activity for low back pain: What works?

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This paper provides evidence-based guidelines for the prescription of activity in the management of non-specific low back pain (NSLBP). The 62 clinical trials published between 1966 and 1997, identified by a search of the Medline and Cinahl databases, were reviewed to provide the basis for the guidelines. The available evidence suggests that physiotherapists should advise patients with acute and sub-acute NSLBP to avoid bed rest and to return to normal activity using time rather than pain as the guide to activity resumption. While structured exercise programs have not been shown to provide a benefit for acute NSLBP, there is strong evidence to support their use for patients with sub-acute and chronic NSLBP and in the prevention of NSLBP. **[Maher C, Latimer J and Refshauge K (1999): Prescription of activity for low back pain: What works? *Australian Journal of Physiotherapy* 45: 121-132]**

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## Introduction

One question we are often asked by medical colleagues and patients alike is "Does *exercise* work for low back pain?" In answering this question, we prefer to broaden the topic to "does *activity prescription* work for low back pain" because prescription of a formal exercise program is only one of the ways physiotherapists advise about activity levels when managing patients with non-specific low back pain (NSLBP). Often, the treating physiotherapist may provide advice as simple as avoiding bed rest, encouraging a return to normal activity or discouraging fear of movement. Use of the term "activity prescription" encompasses both this simple advice and formal exercise programs. The aim of this paper is to provide evidence-based guidelines for the prescription of activity from a review of the available clinical trials.

To ascertain the value of activity prescription we have reviewed those clinical trials which have evaluated the effect of bed rest, advice to alter activity levels and exercise for NSLBP. Non-specific low back pain is the diagnosis given for back pain in which no pathological or structural cause can be established (approximately 85 per cent of all low back pain). The use of this label presumes that an examination of the patient has been undertaken to rule out specific pathologies such as infection, metastatic disease or arthritis (ie red flag conditions). This paper provides information regarding the type and dosage of activity that has been shown to be useful for different NSLBP presentations. In addition, the activity guidelines presented presume that the patient with NSLBP does not have other comorbid conditions such as diabetes or heart disease.

To locate relevant clinical trials, a computer-aided search was undertaken of the Medline and Cinahl databases for the period 1966-1997, using a search strategy modelled on that of the Cochrane Collaboration Back Review Group (van Tulder et al 1997a). Trials were included if they were randomised controlled trials (RCTs) and published in peer-reviewed journals. The reference lists of the located papers were also searched for additional RCTs and on one occasion the authors of a located RCT were contacted to ascertain if they had subsequently published long term results of their RCT. Finally, the authors asked their colleagues if they knew of any additional trials. Using this strategy, a total of 62 randomised controlled clinical trials were located (Table 1). Since the effect of activity might depend on the phase of NSLBP, the studies were classified according to whether they investigated acute, sub-acute or chronic NSLBP. The 10 studies that did not distinguish between the phases of NSLBP (mixed strata) and the five trials that studied patients with specific pathology have not been considered further.

When considering the outcome measures in each trial, we have emphasised outcomes that sample domains that are relevant to the patient and society:

**Table 1.** Summary of trials investigating activity prescription for NSLBP.

The number of trials that have investigated prescription of exercise or activity for non-specific low back pain (NSLBP) are presented with the corresponding reference number as denoted in the list. Because several papers have reported on a single trial, there are more references than trials. Trials have investigated: acute, sub-acute and chronic NSLBP, a mixed strata (stages of chronicity not separated) of patients, the efficacy in prevention of NSLBP, and in the treatment of patients with specific pathologies.

| Problem | Reference | No of trials |
|---|---|---|
| Acute NSLBP (duration < 6weeks) | (Dettori et al 1995, Faas et al 1993, Farrell and Twomey 1982, Fordyce et al 1986, Gilbert et al 1985, Hides et al 1996, Lindequist et al 1984, Linton et al 1993, Malmivaara et al 1995, Philips et al 1991, Rupert et al 1985, Stankovic and Johnell 1990, Stankovic and Johnell 1995, Szpalski and Hayez 1992, Waterworth and Hunter 1985, Wiesel et al 1980, Wilkinson 1995, Zylbergold and Piper 1981) | 17 |
| Sub-acute NSLBP (duration 6 weeks - 3 months) | (Indahl et al 1995, Lindstrom et al 1992a, Lindstrom et al 1992b,) | 2 |
| Chronic NSLBP (duration > 3 months) | (Alaranta et al 1994, Bendix et al 1995, Bendix et al 1996, Bendix et al 1997, Bentsen et al 1997, Buswell 1982, Callaghan 1994, Deyo et al 1990, Elnaggar et al 1991, Frost et al 1995, Hansen et al 1993, Johannsen et al 1995, Kendall and Jenkins 1968, Manniche et al 1988, Manniche et al 1991, Manniche et al 1993a, Nicholas et al 1992, Reilly et al 1989, Risch et al 1993, Rose et al 1997, Spratt et al 1993, Timm 1994, Turner and Clancy 1988, White 1966) | 23 |
| Prevention of NSLBP | (Donchin et al 1990, Gundewall et al 1993, Kellett et al 1991, Linton et al 1989, Linton and Bradley 1992, Ljunggren et al. 1997) | 5 |
| Mixed or unspecified duration of NSLBP | (Davies et al 1979, Delitto et al 1993, Deyo et al 1986, Erhard et al 1994, Evans et al 1987, Kuukkanen and Malkia 1996, Lidstrom and Zachrisson 1970, Martin et al 1980, Postacchini et al 1988, Sachs et al 1994) | 10 |
| Specific pathology | (Coomes 1961, Manniche et al 1993b, Nwuga 1982, Nwuga and Nwuga 1985, O'Sullivan et al 1997) | 5 |
| **Total** | | **62** |

pain/symptoms, function, well-being, disability and satisfaction with care (Deyo et al 1998).

## The role of exercise in the management of acute non-specific low back pain (less than six weeks duration)

Seventeen randomised controlled trials (see Table 1) were identified that investigated the effect of activity prescription on acute NSLBP, that is, NSLBP of less than 6 weeks duration. None of the nine RCTs that evaluated structured exercise programs were able to demonstrate that the exercises evaluated were more effective than the control treatment (Dettori et al 1995, Faas et al 1993, Farrell and Twomey 1982, Gilbert et al 1985, Hides et al 1996, Lindequist et al 1984, Malmivaara et al 1995, Waterworth and Hunter 1985, Zylbergold and Piper 1981). The exercise programs included extension exercises, flexion exercises, isometric abdominal exercises, iliopsoas stretches, isometric multifidus contraction in co-contraction with the deep abdominal muscles and range of motion exercises.

The control treatments in the exercise RCTs included: NSAIDS (Waterworth and Hunter 1985), encouraging normal activity (Gilbert et al 1985, Malmivaara et al 1995), spinal manipulative therapy (Farrell and Twomey 1982, Waterworth and Hunter 1985, Zylbergold and Piper 1981), medical care that did not include exercise (Hides et al 1996, Faas et al 1993), bed rest (Malmivaara et al 1995), placebo (Faas et al 1993), no treatment (Dettori et al 1995) and less intense exercise (Lindequist et al 1984). None of the exercise RCTs were able to demonstrate

a benefit of exercise over these control treatments, in improving patient relevant outcomes such as the patient's present symptoms, their function or mobility, or decreasing recurrence rate. Interestingly, one study found that advising patients to exercise and return to normal activity provided worse results than just encouraging the subjects to return to normal activity (Malmivaara et al 1995). For example, at 3-month follow-up, the exercise group had taken 2.5 more days of sick leave (95 per cent CI 0.2 to 4.9) than the normal activity group.

A good example of these trials is the trial of Faas et al (1993) in which 473 subjects were randomised to either usual physician care, placebo ultrasound or exercise therapy, with outcome assessed over the following 12 months. The subjects in the exercise group performed a set of eight exercises including mobility exercises, iliopsoas stretches, pelvic flexion and isometric abdominal exercises with each subject receiving individual instruction from a physiotherapist for 20 minutes twice a week for five weeks. To enhance exercise compliance, subjects received an audiotape and book that contained instructions for exercise and a written compliance contract was made with each patient. While the analysis revealed that the exercise group had better results than the usual physician care group on a few of the outcome comparisons, more often there was no difference between the exercise and physician care groups and importantly, there were no outcome comparisons that favoured the exercise group over the placebo group. For example, the duration of the pain episode was 58 days for exercise *vs* 54 days for placebo; duration of recurrences 45 days in the exercise group *vs* 41 days for placebo; recurrence rate 70 per cent *vs* 66 per cent; pain reduction at one month 19mm for both groups; pain reduction at three months 24mm *vs* 22mm; pain reduction at 12 months 26mm for both groups.

Hides and colleagues (1996) evaluated a very different form of exercise therapy for acute low back pain, with 39 subjects randomised to medical management or specific localised exercise therapy, however, unlike the Faas et al (1993) study, there was no placebo control group. The subjects in the exercise group received therapeutic exercise designed to facilitate isometric multifidus contraction in co-contraction with the deep abdominal muscles, with real-time ultrasound imaging used to ensure that the multifidus was activated specifically. The authors reported no statistically significant between-group differences for measures of pain, disability or range of motion and because the recovery curves for pain and disability are parallel, with the between-group differences always less than the measurement error of the instrument, there would also appear to be no clinically meaningful difference between the groups. In contrast with the lack of effect on these clinical outcomes the authors reported that restoration of symmetry of multifidus cross-sectional area (CSA) was more rapid and complete in the exercise group. For example, at four-week follow-up, multifidus CSA in the exercise group was symmetrical whereas the control group had a 15-20 per cent difference between sides. The relevance of this effect is unclear, however the data from the study suggest that restoration of symmetry of multifidus CSA is unrelated to measures of pain, disability or range of motion in the four weeks following an acute episode. While the authors argue that restoration of multifidus CSA symmetry could reduce predisposition to future injury or recurrence, it needs to be remembered that even if this were the case, the exercise, as administered in this trial, required access to ultrasound imaging facilities not typically available in physiotherapy clinics.

It is unlikely that the absence of effect seen in all studies can be attributed to poor trial quality or low statistical power. At least two of the RCTs (Faas et al 1993, Malmivaara et al 1995) have been rated as being of high quality in two systematic reviews (Faas 1996, van Tulder et al 1997b). For example, Malmivaara et al's trial had blind assessment, only 13 per cent of the 186 subjects were lost to follow-up, clinically relevant outcomes were studied and the authors used an appropriate intention to treat analysis. Similarly, the failure to demonstrate a benefit for exercise cannot be attributed to low statistical power because two of the trials had 80 per cent power to detect an effect size as small as one third of a standard deviation. More importantly, in two of the trials there was actually a trend for exercise to produce worse results than the control treatment: placebo treatment for the Faas et al trial (1993) and no treatment for the Gilbert et al trial (1985). Lastly, as mentioned earlier, Malmivaara (Malmivaara et al 1995) found that exercise therapy gave worse results than encouragement to resume ordinary activity.

While low statistical power and low trial quality are not reasonable explanations for the lack of effect in the nine RCTs of exercise for acute NSLBP, the type of exercises administered in each trial is. Within each of the nine exercise RCTs, the same package of

exercises was administered to each patient in the exercise group, ie the therapists did not tailor the exercise to the individual clinical presentation of the patient. It is conceivable that exercise programs need to be tailored to the specific needs of each patient with acute NSLBP, to be effective. This is a hypothesis that is worth investigating in future clinical trials.

The only clinical trial that may be considered to be exercise that noted improvement in clinically relevant outcomes evaluated McKenzie therapy, however in this trial, the patients received postural correction and postural/ergonomic instructions in addition to exercise. This trial found that McKenzie therapy was more effective than a back school program, ie group education sessions about relevant anatomy, and sitting and lifting postures (Stankovic and Johnell 1990 and 1995) The benefits of McKenzie therapy included decreased sick leave, decreased recurrence of pain and pain intensity, and increased range of motion (Stankovic and Johnell 1990) with the reduction in sick leave and pain recurrence still evident at five-year follow up (Stankovic and Johnell 1995). The benefits of McKenzie therapy were quite substantial, for example the average amount of sick leave taken in the first six weeks was 11.9 days in the McKenzie group compared with 21.6 days in the back school group.

The trials also provide consistent evidence that structured exercise programs are less effective than spinal manipulative therapy (SMT) for acute NSLBP. In one of the three trials that examined this issue (Farrell and Twomey 1982) the SMT group recovered significantly faster than the exercise group. In the other two trials (Waterworth and Hunter 1985, Zylbergold and Piper 1981), although the trend was similar, it did not reach statistical significance. Spinal manipulative therapy has been recommended for the treatment of acute low back pain in three recent clinical practice guidelines (ACC and National Health Committee 1997, Bigos et al 1994, Waddell et al 1996) with research studies showing it is effective, providing better results than placebo or alternate treatments such as shortwave diathermy, ultrasound, infrared radiation and analgesia (Shekelle et al 1992).

There has been a recent emphasis on advising patients with acute low back pain to avoid bed rest, return to normal activity as quickly as possible, and not to be fearful of movement (Waddell et al 1996). A paper commonly cited to support the early activity approach is that of Deyo et al (1986) who found better results with two days of bed rest compared with seven days. Unfortunately the study sample was not confined to acute low back pain patients and included patients with chronic low back pain (10 per cent). Similarly, another study cited to support this approach (Indahl et al 1995) actually studied subjects with sub-acute low back pain

There are seven RCTs (Gilbert et al 1985, Linton et al 1993, Malmivaara et al 1995, Rupert et al 1985, Szpalski and Hayez 1992, Wiesel et al 1980, Wilkinson 1995) that provide evidence on the efficacy of bed rest in the treatment of acute low back pain. All but one of the studies (Wiesel et al 1980) provide evidence against the use of bed rest. Szpalski and Hayez (1992) found that three days of bed rest produced the same improvement in pain and trunk strength as did seven days of bed rest, a result that has been used to support the prescription of a limited period of bed rest. However, four studies provide results that argue against even a brief period of bed rest. Gilbert et al (1985) found that four days of bed rest gave worse results than encouraging normal activity immediately, while both Malmivaara et al (1995) and Wilkinson (1995) found that two days of bed rest also gave worse results than encouraging normal activity. Rupert et al (1985) found that bed rest was less effective than manipulation and no different from sham manipulation. Finally, Linton et al (1993) found that an early activation package that included the reinforcement of healthy behaviours and encouragement to maintain daily activities gave a better result than a traditional treatment approach that included prescription of sick leave and rest. Subjects in the early activation group were eight times less likely to develop chronic pain.

When the results of the trials of bed rest for acute low back pain are considered together with Deyo et al's (1986) trial that considered subjects with both acute and chronic pain, a dose response relationship is evident such that the longer a subject spends in bed, the worse the result. This suggests that, in general, bed rest is harmful and that the longer the duration of bed rest the worse the result will be. The only paper to report a benefit for bed rest over normal activity (Wiesel et al 1980) studied a group of army recruits who developed back pain during basic combat training. The study noted that bed rest reduced work loss by 50 per cent and pain by 60 per cent compared with immediate ambulation. Because only one study has investigated the use of rest for the treatment of

LBP in young military recruits it is unclear whether Weisel and colleagues' finding should be attributed to chance or is the result of selecting a sub-group of acute NSLBP patients who truly respond differently to bed rest than the general population.

In combination with encouraging an early return to normal activity, it has become popular to advocate that activity levels should be incremented according to time rather than allowing pain to be the guide. The issue of whether pain or time should be used as the guide to progress activity levels has been studied in two trials (Fordyce et al 1986, Philips et al 1991). Both studies found no difference at short term follow-up, however Fordyce et al (1986) followed his subjects for a year and noted that at 12 months, the group who followed the traditional "let pain be your guide" approach had worse results in terms of health care utilisation, impairment and pain. Fordyce's result is consistent with three recent prospective studies that have demonstrated that high fear-avoidance beliefs are predictive of poor outcome in patients with acute NSLBP (Burton et al 1995, Klenerman et al 1995, Rose et al 1995).

The early activation approach has recently been promoted in the Australian media as an alternative to treatment with SMT (Sweet 1998), however to date no study has compared the two approaches and so it is premature to advocate one over the other.

The evidence from RCTs on activity prescription suggests that physiotherapists should advise their patients with acute NSLBP to avoid bed rest and to return to normal activity using time rather than pain as the guide to activity resumption. If the therapist wishes, this advice could be complemented with the provision of manipulative therapy or McKenzie therapy. The structured exercise programs that have been evaluated to date have not been shown to provide a benefit for patients with acute NSLBP.

## The role of exercise in the management of sub-acute non-specific low back pain (six weeks to three months duration)

Two clinical trials have examined the efficacy of activity prescription for sub-acute NSLBP, ie pain of six weeks to three months duration (Indahl et al 1995, Lindstrom et al 1992a and 1992b). Both trials were well conducted, eg Indahl and colleagues recruited 975 subjects with only 5 per cent of subjects approached declining to participate in the study and no subjects dropping out of the study. Information on sick leave taken by subjects in the follow-up year was obtained from the National Insurance Office and these data were analysed using an appropriate statistical model. The findings of both studies clearly demonstrate that, for patients with sub-acute NSLBP who remain off work at six weeks, there still exists a good chance for a successful return to full pre-injury duties. For example in Lindstrom et al's study (1992a and 1992b) exercise increased the proportion of subjects who were at work from 0 per cent at baseline to 80 per cent on completion of the program. However, for patients with chronic low back pain, the return to work rates are less impressive with exercise treatment, for example Bendix et al (1996) reported that an exercise program similar to Lindstrom's increased the number of subjects who were ready for work from 39 per cent at baseline to 58 per cent on completion of the program. Hence the aim of prescribing activity for patients with sub-acute NSLBP is to reduce the risk of becoming chronically disabled by increasing activity at the sub-acute stage.

Interestingly, the two trials that studied sub-acute NSLBP used different approaches to the prescription of activity. Lindstrom and colleagues (Lindstrom et al 1992a and 1992b) used a graded exercise program in addition to physician care. Physician care included advice, sick listing with rest and analgesics. The graded exercise program was closely supervised by a physiotherapist who measured each patient's functional capacity and then designed an individual, sub-maximal, gradually increased exercise program to improve the patient's level of function. During the program, the physiotherapist provided positive reinforcement when the patient completed each quota of exercise or improved their ability to perform daily tasks and ignored complaints of pain or disability and displays of pain behaviour.

Indahl and colleagues (1995) did not structure or closely supervise an exercise program, rather advice was given by physiotherapists to exercise and return to normal activity. The physiotherapists also discouraged patients from focusing on sickness behaviours or being fearful of the pain or of activity, an approach similar to that used by Lindstrom et al (1992a and 1992b). In addition, subjects were not closely monitored by a physiotherapist, but were simply reviewed on two occasions (at three months and one year). This approach was compared with conventional medical care as practised by doctors in

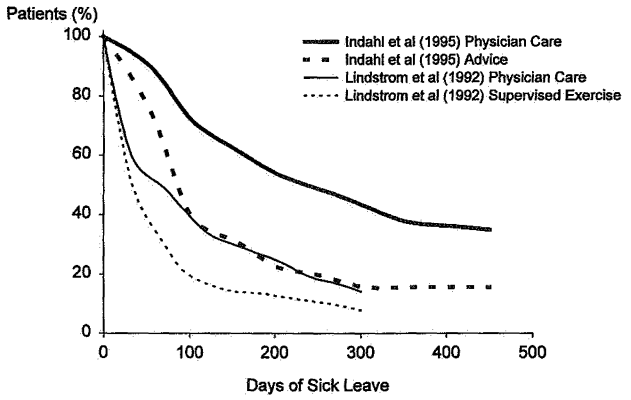


**Figure 1.** Comparison of advice and exercise for patients with sub-acute low back pain. Rate of return to work measured by days of sick leave after provision of advice (Indahl et al 1995: Norway) and a supervised exercise program (Lindstrom et al 1995: Sweden) compared with usual physician care in those countries respectively. Both interventions appear to be more beneficial than usual physician care, although advice provided in Norway appears to have similar outcomes to physician care in Sweden.

Norway. Consistent with the results of Lindstrom et al (1992a and 1992b) the group receiving advice and prescribed early return to normal activity by the physiotherapist required significantly less sick leave than the group undergoing Norwegian conventional medical care. It is interesting that Indahl et al consider the group who received advice and were prescribed an early return to normal activity as "untampered" (as used in the title of their study). It is for this reason that the results of Indahl et al (1995) have often been misinterpreted as support for the assertion that patients with sub-acute low back pain require no intervention. Indahl's good results required some intervention though it is probably less than many physiotherapists provide.

Both studies (Indahl et al 1995, Lindstrom et al 1992a and 1992b) found that activity prescription halved sick leave rates compared with subjects who received usual medical care with Lindstrom and colleagues (1992a and 1992b) also noting a reduced rate of recurrence of NSLBP in the activity group (48 per cent *vs* 79 per cent) in the second follow-up year. In the Indhal et al (1995) study 60 per cent of the control group were still on sick leave 200 days after the onset of their pain, whereas only 30 per cent of the activity group were still on sick leave. In the Lindstrom study (Lindstrom et al 1992a and 1992b) 42 per cent of the control group were still on sick leave 12 weeks after treatment commenced compared with 20 per cent of the activity group, with the activity group on average returning to work 5.1 weeks earlier than the control group.

Taken together, the studies reviewed here suggest that an early return to normal activity is important to reduce disability and reduce time lost from work from sub-acute NSLBP. To compare the efficacy of the two activity prescription approaches, the rates of return to work from both trials are superimposed in Figure 1. While a direct comparison of the results between the two studies needs to be viewed with caution, it appears that the subjects who received Lindstrom's (1992a and 1992b) graded exercise program achieved a higher return to work rate at an earlier point in time than the subjects who received Indahl et al's (1995) advice. This impression would need to be directly tested in a future RCT.

## The role of exercise in the management of chronic low back pain (duration of more than three months)

Chronic NSLBP (ie pain of more than three months duration), by its nature, is resistant to treatments that are successful in the management of acute or sub-acute NSLBP. However, all 23 randomised controlled trials that investigated the effect of exercise for chronic NSLBP (Table 1) provide evidence to support the use of exercise. Seventeen trials, described in 19 different papers, compared one form of exercise to another (Bendix et al 1995, Bendix et al 1997, Bentsen et al 1997, Buswell 1982, Callaghan 1994, Elnaggar et al 1991, Hansen et al 1993, Johannsen et al 1995, Kendall and Jenkins 1968, Manniche et al 1988, Manniche et al 1991, Manniche et al 1993a, Nicholas et al 1992, Reilly et al 1989, Rose et al 1997, Spratt et al 1993, Timm 1994, Turner and Clancy 1988, White 1966); five RCTs had a no treatment control (Bendix et al 1996, Deyo et al 1990, Risch et al 1993, Timm 1994, Turner and Clancy 1988); one RCT had a placebo control (Hansen et al 1993); one RCT had a conventional back school control (Frost et al 1995); one had hot pack, ultrasound and TENS as the control (Timm 1994); one RCT compared exercise with manipulative therapy (Timm 1994); one RCT compared exercise with passive physical therapy (Alaranta et al 1994); and one RCT compared

**Table 2.** Guide-lines for activity prescription for NSLBP

The activity that has been shown to be effective for various conditions is summarised for acute, sub-acute and chronic NSLBP, and for the prevention of NSLBP. There is strong evidence that bed rest should be avoided, and that return to normal activity should form a part of every management program. Intensive whole body exercises should be prescribed for patients with sub-acute or chronic NSLBP.

| Problem | Recommendation |
|---|---|
| Acute<br>(pain< 6/52) | 1. Advice<br>• Encourage normal activity<br>• Progress activity by time not pain<br>• Discourage fear of pain and activity<br>• Avoid bed rest<br>2. Spinal manipulative therapy<br>3. McKenzie therapy |
| Subacute<br>(pain 6/52-3/12) | 1. Supervised exercise program<br>• Individual, sub-maximal, gradually increased exercise program to improve the patient's level of function using an operant conditioning approach to encourage 'well' behaviours and discourage 'pain' behaviours<br>2. Advice<br>• Explain benign nature of NSLBP and reassure patient that light activity will not damage their back but will instead enhance recovery.<br>• Encourage patient to mobilise their spine by light activity and to set their own goals for exercise, encourage gradual return to normal activity.<br>• Encourage patient not to focus on pain, be fearful of NSLBP or be over-cautious |
| Chronic<br>(pain > 3/12) | 1. Supervised exercise program<br>• Whole body intensive exercise program<br>• Quotas of exercise<br>• Time and function, not pain contingent<br>• Discourage pain behaviours and reward well behaviours<br>2. Functional restoration program<br>• Comprehensive fitness program<br>• Work simulation, work hardening<br>• Recreational activities eg games, swimming<br>• Psychological pain management<br>• Job acquisition skills |
| Prevention | 1. Group fitness classes<br>• Supervised whole body exercise program including a range of exercises designed to warm up, improve mobility, strengthen muscles and improve cardiovascular fitness. Finish class with 5-10 minutes of relaxation.<br>• Commitment to do the same at home at least once per week. |

exercise with mild abdominal exercise, hot pack and massage (Manniche et al 1988, Manniche et al 1991). The only trials with non-significant findings were four of the 17 RCTs that compared one form of exercise to another (Buswell 1982, Johannsen et al 1995, Rose et al 1997, White 1966).

Several studies investigated the type and dose of exercise that had the greatest efficacy and some interesting features emerged from these studies. It was found that programs were more effective if the program was intensive (Bendix et al 1995, Bendix et al 1997, Callaghan 1994, Manniche et al 1991) and supervised (Frost et al 1995, Reilly et al 1989), however the results were similar if patients were supervised in small groups or individually (Rose et al 1997). While some programs ran for up to six months (Reilly et al 1989) good results were achieved in programs as short as four (Frost et al 1995) or six weeks (Bendix et al 1997). Two studies found that exercise programs were more effective if they included cognitive-behavioural treatment (Nicholas et al 1992, Turner and Clancy 1988). Almost invariably, the studies used whole body exercise (not just exercises for the spine). These findings challenge a recent text that advocates specific stabilisation exercises directed to individual spinal muscles in preference to general exercise (Richardson et al 1999). To date there has been no head-to-head comparison of the two approaches and no trial of specific stabilisation exercise has studied chronic NSLBP, so the approach should be regarded as untested for this patient group. There is one trial that has evaluated specific stabilisation exercise for chronic low back pain patients with a radiologic diagnosis of spondylolysis or spondylolisthesis (O'Sullivan et al 1997) and this trial found that this form of exercise was more effective than physician care.

Many of the effective programs used a quota system to prescribe the dose of exercise and pain behaviours were not rewarded with attention (Alaranta et al 1994, Frost et al 1995, Nicholas et al 1992, Rose et al 1997, Turner and Clancy 1988). That is, patients were instructed to complete quotas of exercises, rather than being instructed to "let pain be your guide". In fact, pain behaviours were discouraged and well behaviours rewarded, an approach similar to that taken by Lindstrom et al (1992a and 1992b) for sub-acute NSLBP. The quota was therefore prescribed, and increased, based on length of time in the program and the patient's functional capacity rather than according to reduction in pain. Since education of most clinicians places great emphasis on closely attending to a patient's pain and illness behaviours, it is often difficult to ignore pain behaviours. However, such well-intentioned attention to pain may in fact be counter-productive when managing patients with sub-acute and chronic NSLBP, because it reinforces illness behaviours and may result in greater disability.

A more expensive option for the management of chronic low back pain is the multidisciplinary functional restoration program (Gatchell et al 1992). Functional restoration is usually reserved for injured workers with chronic, entrenched disability and involves the formal assessment and management of the physical, psychological and social barriers to return to work. The programs are intensive, for example, Bendix and colleagues (1995, 1996 and 1997) modified the functional restoration program, requiring the subject to participate in physical, ergonomic and psychological training for 39 hours per week for three successive weeks, after which the program is then reduced to six hours per week for three weeks. The program includes aerobics, weight training, work simulation, work hardening, stretching, recreational activities eg games, swimming, relaxation, psychological pain management and a modified back school. Interestingly, Bendix et al (1995, 1996 and 1997) incorporated the development of skills in job acquisition into their successful functional restoration program (eg writing resumes, job application, matching skills to job - Table 2). Functional restoration is clearly more than an exercise program, and it may be the combination of elements that is responsible for the outcomes.

While these programs have become popular, particularly in the USA, there have been only four true randomised controlled trials (Alaranta et al 1994, Bendix et al 1995, Bendix et al 1996, Bendix et al 1997, Rose et al 1997). Earlier studies (eg Mayer et al 1987) used subjects who were denied access to the programs as controls and this practice is likely to produce a substantial bias. In contrast, the more recent studies have avoided this bias, and have strong designs. For example two studies have observer blinding (Bendix et al 1995, Bendix et al 1996, Bendix et al 1997) and all four have clinically important outcomes, less than 20 per cent drop-out rates and an appropriate intention to treat analysis.

These trial features mean that the studies provide robust estimates of the efficacy of functional restoration.

Bendix and colleagues demonstrated that their modified functional restoration program produced better results than a no treatment control group (Bendix et al 1996) or less intensive programs (four hours per week instead of 39) of either physical training and back school or physical training and psychological pain management (Bendix et al 1995, Bendix et al 1997). In these studies the patients who received functional restoration had better results in terms of pain, disability, sick leave, health care contact, and work readiness than the comparison groups. For example at four-month follow-up, Bendix (Bendix et al 1996) found that 64 per cent of the functional restoration group had returned to work *vs* 28 per cent in the control group and the group median days of sick leave was 10 days in the functional restoration group compared with 122 days in the control group.

In summary, there seems to be strong evidence to support the use of supervised, whole body, intensive exercise for patients with chronic NSLBP. Multidisciplinary functional restoration programs should be considered for patients with entrenched disability that prevents return to work. The control treatments that were found to be less effective than exercise include massage, heat, TENS and manipulative therapy.

## The role of exercise in the prevention of NSLBP

Exercise is currently one of the few methods for successfully preventing NSLBP. Five randomised controlled trials of exercise for the prevention of NSLBP have been conducted, all of which reported beneficial effects of exercise programs in workers (Donchin et al 1990, Gundewall et al 1993, Kellett et al 1991, Linton et al 1989, Linton and Bradley 1992) and a general population (Ljunggren et al 1997).

The four workplace studies (Donchin et al 1990, Gundewall et al 1993, Kellett et al 1991, Linton et al 1989, Linton and Bradley 1992) recruited subjects who were currently working, and followed up the workers for at least one year to assess the effect of exercise on the subsequent development of NSLBP. This group was compared with a no treatment control group and, in Donchin's study, a back school group was also included. In all studies, the subjects exercised in a group of their peers and performed whole body exercise rather than simply spinal exercise. The programs ranged from a brief, intensive, five-week residential program (Linton et al 1989, Linton and Bradley 1992) where the subjects were involved in activity for at least four hours per day, to weekly or bi-weekly programs that continued for 3-18 months (Donchin et al 1990, Gundewall et al 1993, Kellett et al 1991).

A typical example of a program is that of Kellett et al (1991). The employees exercised to music once a week for 30 minutes during work hours and also agreed to exercise at home at least once per week for 30 minutes. The supervised exercise program included a range of exercises designed to warm up, improve mobility, strengthen muscles and improve cardiovascular fitness. Following the exercise program, the subjects performed 5-10 minutes of relaxation.

All studies consistently demonstrated a reduced number of episodes of NSLBP in the exercise group, with two studies (Kellett et al 1991, Linton et al 1989, Linton and Bradley 1992) also noting reduced sick leave due to NSLBP. In addition Donchin et al (1990) found that the back school intervention was no more effective than no treatment in reducing future episodes of NSLBP, and Gundewall et al (1993) found that the training group lost a total of 28 work days in the 13 month follow up period whereas the control group lost 155 work days. Gundewall et al (1993) also demonstrated the cost effectiveness of such programs, because each hour spent by the physiotherapist supervising the exercises resulted in 1.3 work days gained.

Considered together, the studies provide convincing evidence that workplace exercise can reduce the incidence of NSLBP and work loss due to NSLBP. This is an important finding because a recent well conducted RCT (Daltroy et al 1997) found that workplace modification and an educational program was ineffective in preventing NSLBP. Whether the positive effects of exercise can be generalised outside the workplace is unclear because the only non-worker study (Ljunggren et al 1997) did not have a no-treatment control group. However, given the other health benefits that have been documented for regular exercise, it would not seem unreasonable to encourage patients to consider undertaking a regular exercise program.

## Conclusions

The studies reviewed here provide evidence that an early return to normal activity is important in the management of all NSLBP. However, in the acute phase, more structured exercise programs appear to confer no benefit; effective treatment options include spinal manipulative therapy or a McKenzie program. In the sub-acute and chronic phases of NSLBP, structured exercise programs that are intensive, supervised, involve the whole body and are prescribed according to a quota system provide the best results. Whole body exercise in the workplace also prevents the occurrence of NSLBP. Finally, it is important to note that bed rest is usually not required for NSLBP, and may actually increase disability.

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## References

Accident Rehabilitation and Compensation Insurance Corporation (ACC) and the National Health Committee (1997): New Zealand Acute Low Back Pain Guide. Wellington: ACC.

Alaranta H, Rytokoski U, Rissanen A, Talo S, Ronnemaa T, Puukka P, Karppi S L, Videman T, Kallio V and Slatis P (1994): Intensive physical and psychosocial training program for patients with chronic low back pain. A controlled clinical trial. *Spine* 19: 1339-1349.

Bendix A, Bendix T, Lund C, Kirkbak S and Ostenfeld S (1997): Comparison of three intensive programs for chronic low back pain patients: a prospective, randomized, observer-blinded study with one year follow-up. *Scandinavian Journal of Rehabilitation Medicine* 29: 81-89.

Bendix A, Bendix T, Ostenfeld S, Bush E and Andersen A (1995): Active treatment programs for patients with chronic low back pain: a prospective, randomised, observer-blinded study. *European Spine Journal* 4: 148-152.

Bendix A, Bendix T, Vaegter K, Lund C, Frolund L and Holm L (1996): Multidisciplinary intensive treatment for chronic low back pain: a randomized, prospective study. *Cleveland Clinic Journal of Medicine* 63: 62-69.

Bentsen H, Lindgarde F and Manthorpe R (1997): The effect of dynamic strength back exercise and/or home training program in 57-year-old women with chronic low back pain. Result of a prospective randomized study with a 3-year follow-up period. *Spine* 22: 1494-1500.

Bigos S, Bowyer O, Braen G et al (1994). Acute low back problems in adults. Clinical Practice Guideline No. 14, Agency for Health Care Policy and Research, USA.

Burton A, Tilotson M, Main C and Hollis S (1995): Psychosocial predictors of outcome in acute and sub-acute low back trouble. *Spine* 20: 723-728.

Buswell J (1982): Low backpain: a comparison of two treatment programmes. *New Zealand Journal of Physiotherapy* 10: 243-247.

Callaghan M (1994): Evaluation of a back rehabilitation group for chronic low back pain in an outpatient setting. *Physiotherapy* 80: 677-681.

Coomes E (1961): A comparison between epidural anaesthesia and bed rest in sciatica. *British Medical Journal* 264: 20-24.

Daltroy LH, Iversen MD, Larson MG, Lew R, Wright E, Ryan J, Zwerling C, Fossel AH and Liang MH (1997): A controlled trial of an educational program to prevent low back injuries. *New England Journal of Medicine* 337: 322-328.

Davies J, Gibson T and Tester L (1979): The value of exercise in the treatment of low back pain. *Rheumatology and Rehabilitation* 18: 243-247.

Delitto A, Cibulka M, Erhard R, Bowling R and Tenhula J (1993): Evidence for use of an extension-mobilisation category in acute low back syndrome: a prescriptive validation pilot study. *Physical Therapy* 73: 216-228.

Dettori JR, Bullock SH, Sutlive TG, Franklin RJ and Patience T (1995): The effects of spinal flexion and extension exercises and their associated postures in patients with acute low back pain. *Spine* 20: 2303-2312.

Deyo R, Diehl A and Rosenthal M (1986): How many days of bed rest for acute low back pain? A randomized clinical trial. *New England Journal of Medicine* 315: 1064-1070.

Deyo R, Walsh N, Martin D, Schoenfeld L and Ramamurthy S (1990): A controlled trial of transcutaneous electrical nerve stimulation (TENS) and exercise for chronic low back pain. *New England Journal of Medicine* 322: 1627-1634.

Deyo R, Battie M, Beurskens A, Bombadier C, Croft P, Koes B, Malmivaara A, Roland M, Von Korff M, Waddell G (1998): Outcome measures for low back pain research. A proposal for standardized use. *Spine* 23: 2003-2013.

Donchin M, Woolf O, Kaplan L and Floman Y (1990): Secondary prevention of low-back pain. A clinical trial. *Spine* 15: 1317-1320.

Elnaggar I, Nordin M, Sheikhzadeh A, Parnianpour M and Kahanovitz N (1991): Effects of spinal flexion and extension exercises on low-back pain and spinal mobility in chronic mechanical low back pain patients. *Spine* 16: 967-972.

Erhard RE, Delitto A and Cibulka M (1994): Relative effectiveness of an extension program and a combined program of manipulation and flexion and extension exercises in patients with acute low back syndrome. *Physical Therapy* 74: 1093-1100.

Evans C, Gilbert J, Taylor W and Hildebrand A (1987): A randomized controlled trial of flexion exercise, education, and bed rest for patients with acute low back pain. *Physiotherapy Canada* 39: 96-100.

Faas A (1996): Exercises: which ones are worth trying, for which patients, and when? *Spine* 21: 2874-2879.

Faas A, Chavannes A, van Eijk J and Gubbels J (1993): A randomized, placebo-controlled trial of exercise therapy in patients with acute low back pain. *Spine* 18: 1388-1395.

Farrell JP and Twomey LT (1982): Acute low back pain: comparison of two conservative treatment approaches. *Medical Journal of Australia* 1: 160-164.

Fordyce W, Brockway J, Bergman J and Spengler D (1986): Acute back pain: a control-group comparison of behavioral vs traditional management methods. *Journal of Behavioral Medicine* 9: 127-141.

Frost H, Klaber-Moffett J, Moser J and Fairbank J (1995): Randomised controlled trial for evaluation of fitness programme for patients with chronic low back pain. *British Medical Journal* 310: 151-154.

Gatchell R, Mayer T, Hazard R, Rainville J and Mooney V (1992): Editorial: Functional restoration. Pitfalls in evaluating efficacy. *Spine* 17: 988-995.

Gilbert J, Taylor D, Hildebrand A and Evans C (1985): Clinical trial of common treatments for low back pain in family practice. *British Medical Journal* 291: 791-794.

Gundewall B, Liljeqvist M and Hansson T (1993): Primary prevention of back symptoms and absence from work. A prospective randomised study among hospital employees. *Spine* 18: 587-594.

Hansen F, Bendix T, Skov P, Jensen C, Kristensen J, Krohn L and Schioeler H (1993): Intensive, dynamic back-muscle exercises, conventional physiotherapy, or placebo-control treatment of low-back pain. *Spine* 18: 98-108.

Hides J, Richardson C and Jull G (1996): Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. *Spine* 21: 2763-2769.

Indahl A, Velund L and Reikeraas O (1995): Good prognosis for low back pain when left untampered. A randomised clinical trial. *Spine* 20: 473-477.

Johannsen F, Remvig L, Kryger P, Beck P, Warming S, Lybeck K and Larsen L (1995): Exercises for chronic low back pain: a clinical trial. *Journal of Orthopaedic and Sports Physical Therapy* 22: 52-59.

Kellett K, Kellett D and Nordholm L (1991): Effects of an exercise program on sick leave due to back pain. *Physical Therapy* 71: 283-293.

Kendall P and Jenkins J (1968): Exercises for backache: a double-blind controlled trial. *Physiotherapy* 54: 154-157.

Klenerman L, Slade P, Stanley I, Pennie B, Reily J, Atchison L, Troup J and Rose M (1995): The prediction of chronicity in patients with an acute attack of low back pain in a general practice setting. *Spine* 20: 478-484.

Kuukkanen T and Malkia E (1996): Muscular performance after a 3 month progressive physical exercise program and 9 month follow-up in subjects with low back pain. A controlled study. *Scandinavian Journal of Medicine Science and Sports* 6: 112-121.

Lidstrom A and Zachrisson M (1970): Physical Therapy on low back pain and sciatica. *Scandinavian Journal of Rehabilitation Medicine* 2: 37-42.

Lindequist S, Lundberg B, Wikmark R, Bergstad B, Loof G and Ottermark A (1984): Information and regime at low back pain. *Scandinavian Journal of Rehabilitation Medicine* 16: 113-116.

Lindstrom I, Ohlund C, Eek C, Wallin L, Petersen L and Nachemsen A (1992a): Mobility, strength, and fitness after a graded activity program for patients with sub-acute low back pain. A randomized prospective clinical study with a behavioural therapy approach. *Spine* 17: 641-652.

Lindstrom I, Ohlund C, Eek C, Wallin L, Peterson L, Fordyce W and Nachemson A (1992b): The effect of graded activity on patients with sub-acute low back pain: a randomised prospective clinical study with an operant-conditioning behavioural approach. *Physical Therapy* 72: 279-293.

Linton S and Bradley L (1992): An 18 month follow-up of a secondary prevention program for back pain: Help and hindrance factors related to outcome maintenance. *Clinical Journal of Pain* 8: 227-236.

Linton S, Bradley L, Jensen I, Spangfort E and Sundell L (1989): The secondary prevention of low back pain: a controlled study with follow-up. *Pain* 36: 197-207.

Linton S, Hellsing A and Andersson D (1993): A controlled study of the effects of an early intervention on acute musculoskeletal pain problems. *Pain* 54: 353-359.

Ljunggren A, Weber H, Kogstad O, Thom E and Kirkesola G (1997): Effect of exercise on sick leave due to low back pain. A randomised, comparative, long-term study. *Spine* 22: 1610-1617.

Malmivaara A, Hakkinen U, Aro T, Heinrichs M, Koskenniemi L, Kuosma E, Lappi S, Paoloheimo R, Servo C, Vaaranen V and Hernberg S (1995): The treatment of acute low back pain. Bed rest, exercise or normal activity? *New England Journal of Medicine* 332: 351-355.

Manniche C, Hesselsoe G, Bentzen L, Christensen I and Lundberg E (1988): Clinical trial of intensive muscle training for chronic low back pain. *Lancet* 2: 1473-1476.

Manniche C, Lundberg E, Christensen I, Bentzen L and Hesseloe G (1991): Intensive dynamic back exercise for chronic low back pain: a clinical trial. *Pain* 47: 53-56.

Manniche C, Asmussen K, Lauritsen B, Vinterburg H, Karbo H, Abildstrup S, Fischer-Nielson K, Krebs R and Ibsen K (1993a): Intensive dynamic back exercises with or without hyperextension in chronic back pain after surgery for lumbar disc protrusion. A clinical trial. *Spine* 18: 560-567.

Manniche C, Skall H, Braendholt L, Christensen B, Ingerslev M, Jorgensen O, Larsen E, Lorentzen L, Nielsen C, Nielsen H and Windelin M (1993b): Clinical trial of postoperative dynamic back exercises after first lumbar discectomy. *Spine* 18: 92-97.

Martin P, Rose M, Nichols P, Russell P and Hughes J (1980): Physiotherapy exercises for low back pain: process and clinical outcome. *International Rehabilitation Medicine* 62: 176-179.

Mayer T, Gatchel R, Mayer H, Kishino N, Keeley J and Mooney V (1987): A prospective two-year study of functional restoration in industrial back injury. An objective assessment procedure. *Journal of the American Medical Association* 258: 1763-1767.

Nicholas M, Wilson P and Goyen J (1992): Comparison of cognitive-behavioural group treatment and an alternative non-psychological treatment for chronic low back pain. *Pain* 48: 339-347.

Nwuga G and Nwuga V (1985): Relative therapeutic efficacy of the Williams and McKenzie protocols in back pain management. *Physiotherapy Practice* 1: 99-105.

Nwuga V (1982): Relative therapeutic efficacy of vertebral manipulation and conventional treatment in back pain management. *American Journal of Physical Medicine and Rehabilitation* 61: 273-78.

O'Sullivan P, Twomey L and Allison G (1997): Evaluation of specific stabilizing exercise in the treatment of chronic low back pain with radiologic diagnosis of spondylolysis or spondylisthesis. *Spine* 22: 2959-2967.

Philips H, Grant L and Berkowitz J (1991): The prevention of chronic pain and disability: a preliminary investigation. *Behavioral Research Therapy* 29: 443-450.

Postacchini F, Faccini M and Palieri P (1988): Efficacy of various forms of conservative treatment in low back pain: a comparative study. *Neuro-Orthopaedics* 6: 28-35.

Reilly K, Lovejoy B, Williams R and Roth H (1989): Differences between a supervised and independent strength and conditioning program with chronic low back syndromes. *Journal of Occupational Medicine* 31: 547-550.

Richardson C, Jull G, Hodges P and Hides J (1999): Therapeutic Exercise for Spinal Segmental Stabilization in Low Back Pain. Edinburgh: Churchill Livingstone, pp.3-7.

Risch S, Norvell N, Pollock M, Risch E, Langer H, Fulton M, Graves J and Leggett S (1993): Lumbar strengthening in chronic low back pain patients. *Spine* 18: 232-238.

Rose M, Reilly J, Pennie B, Bowen-Jones K, Stanley I and Slade P (1997): Chronic low back pain rehabilitation programs. A study of the optimum duration of treatment and a comparison of group and individual therapy. *Spine* 22: 2246-2253.

Rose M, Reilly J, Slade P and Dewey M (1995): A comparative analysis of psychological and physical models of low back pain experience. *Physiotherapy* 81: 710-716.

Rupert R, Wagnon R, Thompson P and Exxeldin T (1985): Chiropractic adjustments: results of a controlled trial in Egypt. *ICA International Review of Chiropractic* : 58-60.

Sachs B, Ahmad S, LaCroix M, Olimpio D, Heath R, David J and Scala A (1994): Objective assessment for exercise treatment on the B-200 isostation as part of work tolerance rehabilitation. A random prospective blind evaluation with comparison control population. *Spine* 19: 49-52.

Shekelle P, Adams A, Chassin M, Hurwitz E and Brook R (1992): Spinal manipulation for low back pain. *Annals of Internal Medicine* 117: 590-598.

Spratt K, Weinstein J, Lehmann T, Woody J and Sayre H (1993): Efficacy of flexion and extension treatments incorporating braces for low-back pain patients with retro-displacements, spondylolisthesis, or normal sagittal translation. *Spine* 18: 1839-1849.

Stankovic R and Johnell O (1990): Conservative treatment of acute low-back pain. A prospective randomised trial: McKenzie method of treatment versus patient education in "Mini Back School". *Spine* 15: 120-123.

Stankovic R and Johnell O (1995): Conservative treatment of acute low back pain. A 5-year follow-up study of two methods of treatment. *Spine* 20: 469-472.

Sweet M (1998) Pain in your lower back? Get moving and cancel the chiropractor. *Sydney Morning Herald* 28th March, p. 1.

Szpalski M and Hayez J (1992): How many days of bed rest for acute low back pain? Objective assessment of trunk function. *European Spine Journal* 1: 29-31.

Timm K (1994): A randomized-controlled study of active and passive treatments for chronic low back pain following L5 laminectomy. *Journal of Orthopaedic and Sports Physical Therapy* 20: 276-286.

Turner J and Clancy S (1988): Comparison of operant behavioural and cognitive-behavioural group treatment for chronic low back pain. *Journal of Consulting and Clinical Psychology* 56: 261-266.

van Tulder M, Assendelft W, Koes B and Bouter L (1997a): Methods guidelines for systematic reviews in the Cochrane Collaboration back review group for spinal disorders. *Spine* 22: 2323-2330.

van Tulder M, Koes B and Bouter L (1997b): Conservative treatment of acute and chronic nonspecific low back pain. A systematic review of randomized controlled trials of the most common interventions. *Spine* 22: 2128-2156.

Waddell G, Feder G, McIntosh A, Lewis M and Hutchison A (1996): Low Back Pain Evidence Review. London: Royal College of General Practitioners.

Waterworth R and Hunter I (1985): An open study of diflunisal, conservative and manipulative therapy in the management of acute mechanical low back pain. *New Zealand Medical Journal* 98: 372-375.

White A (1966): Low back pain in men receiving workmen's compensation. *Canadian Medical Association Journal* 95: 50-56.

Wiesel S, Cuckler J, Deluca F, Jones F, Zeide M and Rothman R (1980): Acute low back pain. An objective analysis of conservative therapy. *Spine* 5: 324-330.

Wilkinson M (1995): Does 48 hours bed rest influence the outcome of acute low back pain? *British Journal of General Practice* 45: 481-484.

Zylbergold RS and Piper MC (1981): Lumbar disc disease: comparative analysis of physical therapy treatments. *Archives of Physical Medicine and Rehabilitation* 62: 176-79.