

## The current evidence for the effectiveness of exercise in low back pain

Kim, Tae-Yoon., P.T., Ph.D.  
Department of Physical Therapy, Kwang-ju health college  
Jung, Sung-Woog., P.T., M.A.

### 요통에 대한 운동치료 효과의 최근 연구에 따른 증거

\*광주보건대학 물리치료과

\* 김 태 윤  
정 성 옥

#### < 국문초록 >

컴퓨터를 이용하여 MEDLINE, AMED, CINAHL과 Cochrane Library를 검색하여 요통환자를 위한 다양한 형태의 운동치료 효과에 대해서 발표된 연구 보고서 중 1991년부터 2001년 사이에 영문으로 출판된 보고서를 중심으로 본 연구에 합당한 주제를 충족시키는 연구 보고서 40편을 선택하였다. 수집된 자료를 통하여 요통 관리의 운동치료 효과에 대하여 연구하였으며 일반적인 요통환자들만을 대상으로 급성, 아급성, 만성단계로 구분하였다.

실험논문은 수정된 rating system을 이용하여 논문의 질 수준과 연구결과를 측정하였으며 고찰 논문과 관찰 연구는 grading system을 사용하여 주요 연구 결과를 측정하였다.

본 연구의 결과는 운동치료가 통증감소와 기능 향상에 효과적임이 증명되었고, 총괄적으로 타당도를 지지하는 정도는 중등도에 해당되었다. 연구보고서들을 scale system을 통해서 세부적으로 분석했을 때, 상급의 연구 방법론적 질을 충족시켰다. 결과에 따르면 급성, 아급성과 만성요통에 대한 운동치료가 효과적이었다라는 확실한 증거를 나타냈다.

본 연구의 결론은 요통환자에 대한 운동치료는 효과적으로 입증되었으며, 특별히 만성요통환자의 경우에 더욱 더 효과적인 것으로 나타났다. 이러한 결론을 더욱 지지하기 위해서는 더 많은 고질의 연구 논문들이 이루어져야 할 것이다.

## I. Introduction

Low Back Pain (LBP) is the most common and expensive health problem in Western industrialised countries. It affects 80% of people at some stage during their lives. Although the literature suggests that LBP is commonly characterised as a self-limiting and benign problem tending to improve spontaneously

overtime, a large variety of therapeutic interventions are available for its management (van Tulder et al 2000). Physiotherapy is frequently employed in the management of LBP. Despite considerable growth in knowledge and technology, the management of LBP remains controversial.

Various therapeutic interventions including mobilisation, manipulation, exercises,

electrotherapy, hydrotherapy and self-education programmes are available for the treatment of LBP. Bed rest and analgesics used to be prescribed by most physicians for the management of LBP. However, current research suggests bed rest does not affect the natural history of LBP, excepting a brief duration of rest immediately after the onset of acute LBP (Deyo et al 1986). Hence physiotherapists often advise patients with LBP to avoid bed rest and encourage them to return to normal activity. In addition to this, appropriately designed exercises and physical movement programs are frequently prescribed for patients with LBP (Maher et al 1999). While many exercise programs for LBP patients have traditionally purposed to increase strength, endurance, fitness and functional capacity, recent research has emphasised the importance of motor control of muscle systems (Maher et al 1999, Walker et al 1993). Although anecdotal evidence suggests exercise is effective in the treatment of LBP, higher levels of scientific evidence have reported conflicting conclusions.

Today evidence-based practice is considered to be highly important amongst both health professions and patients. The physiotherapy profession must reflect this climate by basing its treatment practices on sound scientific principles which are validated by rigorous research (Ritchie 1999). To ascertain the effectiveness of exercise in LBP, the following topic was addressed in this review:

#### **The current evidence for the effectiveness of exercise in low back pain**

This reviews evaluated the evidence available for the effectiveness of exercise in the management of LBP by:

- a) assessing the methodological quality of the studies
- b) grading the level of evidence on a scoring system.

Therefore, the aims of this review were to:

identify the quality of evidence available in the research articles selected regarding any type of therapeutic exercise intervention in acute, subacute and chronic LBP and determine the effectiveness of exercise in the management of LBP.

This review presents current published studies (1991-2001) of various research design types, regarding the effectiveness of exercise for LBP. Only studies investigating non-specific LBP were included to avoid confusion, because most cases of LBP show a lack of a plausible pathophysiologic or pathoanatomic explanation. All studies in this review were evaluated by critical appraisal.

## **II . Method**

### **1. The definition of terms**

The individual terms in this research topic were defined in order to create the appropriate search plan.

Current evidence refers to any published studies that prove or disprove the effectiveness of exercise for low back pain in the last decade.

Effectiveness is defined as a specific result or a specific influence which determines whether an intervention works in subjects to whom it has been offered.

Exercise is defined as the therapeutic intervention of physical exertion for improvement of physical dysfunction or health.

Low back pain is defined as an ache, pain or discomfort in the lumbar area, irrespective of whether it extends from there to one or both legs.

### **2. Search strategy**

#### **1) Create the search plan**

The topic contained three main searchable concepts, including effectiveness, exercise and low back pain (Table 2.1).

**Table 2.1 Three main search concepts**

Concept 1	Concept 2	Concept 3
effectiveness	exercise	low back pain

For each concept, synonyms or other related words were listed to minimise the possibility of missing studies with different concepts but having the same purpose (Table 2.2)

**Table 2.2 Key concepts used in search**

Concept 1	Concept 2	Concept 3
*effectiveness	*exercise/exercises	*low back pain
*efficacy	training	low back dysfunction
effect/effects	activation/activity	backache
efficiency	strengthening	low back
outcome	stretching	low back disorder
result/results	stability	
influence/influences	mobility	
	*exercise therapy physiotherapy	
	physical therapy	

2) Search methods

Searches were performed for any published studies reporting the effectiveness of any form of exercise therapy for low back pain. Computerised databases of MEDLINE, AMED, CINAHL and the Cochrane Library were searched to identify published studies concerning exercise for low back pain.

Any type of study relevant to the topic published in English during time period from August 1991 to August 2001, was included. Meta-analysis/systematic reviews (SRs) of experimental studies, literature reviews (LRs), randomised controlled trials (RCTs), controlled clinical trials (CCTs), other experimental trials (OETs), and observational studies (OSs) were all study designs included in the review.

The concepts from the definition of search terms (with or without other related words) were applied as the keywords to each individual database.

3) Study selection

All the results from each individual database search were reviewed by reading the titles and abstracts of the listed articles and so their potential relevance to the research topic was determined.

A study based on the definition of terms described previously was included if the following criteria were met:

1. It involved either meta-analysis/systematic/literature review articles, any type of experimental trials including RCTs, CCTs and OETs, or observational studies, aiming to determine the effectiveness of exercise therapy for low back pain.
2. The intervention in the study included specific back exercises such as stretching/strengthening exercises, dynamic/static back muscle exercises, isometric/mobilising exercises, flexion/extension exercises, McKenzie back exercises, and hydrotherapy/fitness exercises

as the treatment regimen.

3. Only patients with non-specific low back pain including acute, subacute and chronic stages were included.
4. The article was published in English between the period from August 1991 to August 2001.
5. It investigated any comparable conservative type of intervention used with exercise therapy.

### 3. Critical appraisal

In order to evaluate the methodological quality of the studies that were selected, five scale systems were used in this review:

- a) Physiotherapy Evidence Database (PEDro) scale
- b) Modified Crombie scale
- c) Modified Greenhalgh scale

### 4. Assessment of methodological quality and outcome measures

All eligible papers were scored according to the methodological criteria described previously in this paper. As the basis for critical appraisal of the studies, the PEDro scale checklists designed for assessing the methodological quality of randomised and non-randomised studies was used (Table 2.3). The Modified Crombie scale checklists were used to evaluate the methodological quality of review articles (Table 2.4). The appraising of observational studies was performed via the Modified Greenhalgh scale checklists (Table 2.5). One reviewer assessed the methodological quality of the studies. However, the main objective of the analysis was to evaluate the methodological quality of papers used in this review.

The included studies were rated to be relevant if at least one of the following outcome measures was used: pain intensity (visual analogue scale or

numerical rating scale), overall improvement (self reported or observed), specific functional status (Roland Morris questionnaire, Oswestry questionnaire), physical assessment (range of motion, spinal flexibility, degree of straight leg raising or muscle strength), impact on employment (days of sick leave, return to work), medication use, mobility and general fitness. Each individual study was classed as having positive or negative outcomes according to the outcome measures, however any studies that showed ambiguous outcomes were classified as having no evidence.

A trial was judged positive if it reported that therapeutic exercise had a statistically significant beneficial effect in one or more outcome measures, and negative if it reported no statistically significant benefit of exercise for LBP. In the case of experimental studies, if a study scored 6 points or more on the PEDro scale, it was ranked as high quality, and if a study scored five points or less, then it was considered as low quality. A review article was ranked as high quality if it scored eight points or more on the Modified Crombie scale, and it was considered as low quality if it scored seven points or less on the scale. An observational study was considered to be of high quality if it scored 6 points or more on the Modified Greenhalgh scale, however if a study scored 5 points or less, it was considered as low quality.

### 5. Levels of evidence

The hierarchy of scientific research design types used in this review was as follows: 1. Meta-analysis and systematic review of RCTs, 2. Individual RCTs, 3. Non-randomised controlled experimental trials, 4. Observational studies.

Conclusions on the effectiveness of exercise for LBP obtained from experimental trials were based on the strength of the scientific evidence. These levels of evidence were determined according to a rating system, which consisted of four levels of

evidence based on the quality and the outcome of the studies (van Tulder et al 1997).

- 1) Strong evidence multiple (two or more) high quality trials reporting generally consistent findings
- 2) Moderate evidence multiple low quality trials or one high quality and one or more low quality trials producing generally consistent findings
- 3) Limited evidence only one trial (high or low quality) existed or the findings of existing trials were inconsistent
- 4) No evidence no relevant studies or ambiguous outcomes of any studies

To judge the strength of evidence presented in review articles, a modified grading system was constructed. It consisted of three grades of evidence based on the quality and the outcome of the studies.

- Grade I : strong evidence at least one high quality meta-analysis, or systematic reviews with consistent findings
- Grade II : moderate evidence one or more low quality meta-analyses, systematic reviews, or two or more high quality literature reviews with consistent findings
- Grade III : limited evidence one high quality literature review, or two or more low quality literature reviews with consistent findings
- Grade IV : no evidence only one low quality literature review with consistent findings

Observational studies are relegated to the lowest grade of the evidence. Therefore, in this article, two high quality observational studies or more were considered to be grade III level of evidence, otherwise a single observational study was considered to provide no evidence.

### III . Results

#### 1. Study selection

The MEDLINE, AMED, CINAHL and Cochrane Library databases identified a total number of forty-seven articles. After reviewing the information presented in the abstract of these studies, forty articles were found to be eligible for review according to the inclusion criteria. Seven articles were excluded due to one or more of following reasons:

- 1) Those articles demonstrated respectable opinion or anecdotal reports (Konlian 1999, Manniche 1996, Stevans and Hall 1998)
- 2) The selected subject groups had complaints of specific LBP (OSullivan 1997, Timm 1994)
- 3) Exercise therapy was addressed in the paper but was not used as the intervention for the study (Ito et al 1996)
- 4) Complex physiotherapy intervention was used in the study and thus not able to selectively investigate the effectiveness of exercises for LBP (Zigenfus 2000)

Two studies by Lindstrom et al (1992) reported on the same trial. However, in this review, both studies were considered to be separate papers because those articles focused and addressed different outcomes, although the methodology of the intervention was the same.

#### 2. Study characteristics

Study characteristics of the forty included articles are summarised in Table 3.1. Reporting language could be English only and publication dates extended from 1991 to 2001. Studies were categorized by the research design types as clinical trials (CTs), review articles (RAs), and observational studies (OSs). The selected forty articles in this review contained thirty-one CTs consisting of twenty-eight RTCs, and three CCTs, four RAs consisting of two systematic reviews and two literature reviews, and five OSs consisting of two cohort studies, one case-control study and two case series.

**Table 3.1 Study characteristics**

Characteristics	Clinical trials	Review articles	Observational studies
Number of studies	31	4	5
Research design			
RCTs	28		
CCTs	3		
Meta-analysis		0	
Systematic review		2	
Literature review		2	0
Cross-sectional			2
Cohort			1
Case-control series			2

### 3. Patients characteristics

Patients with LBP involved in the studies were categorized by pathological states as acute, subacute and chronic stages. The study set included 4869 patients with LBP, distributed between CTs (n=3070) and OSs (n=1799). The 4869 LBP patients were composed of 932 (19 %) acute LBP patients only, 24 (0%) combined acute or subacute LBP patients, 157 (3%) subacute LBP patients only, 187 (4%) combined subacute or chronic LBP patients, and 3569 (71 %) chronic LBP only. In addition to this, there were 145 (3%) healthy subjects used as a control group involved in two CCTs. Therefore, a total of 5014

subjects were involved the selected studies of this review (excepting RAs). Demographic features of patients in the included studies are displayed in Table 3.2. Figure 3.1 demonstrates the distribution of patients suffering the different stages of LBP. Five RCTs with acute LBP compared exercise with other types of interventions, including manipulation, usual care, placebo ultrasound, and bed rest (Dettori et al 1995, Erhard et al 1994, Faas et al 1993, Malmivaara et al 1995, Stankovic and Johnell 1995). Twenty-six studies concerning chronic LBP, (18 RCTs, 3 CCTs and 5 Oss), compared exercise with other interventions such as massage, heat pack, usual care, and back care education.

**Table 3.2 Patients characteristics**

Characteristics	Clinical trials (RCTs/CCTs)	Observational studies (Cohort/Case-control/Case series)
Number of patients	3070 (2842/228)	1799 (537/1259/3)
Stages of LBP		
Acute	932(932/0)	0
Combined acute/subacute	24(24/0)	0
Subacute	157(157/0)	0
Subacute	187(0/187)	0
Combined subacute/chronic	1770(1542/228)	1799(537/1259/3)

Chronic		
Number of Healthy subjects	145 (0/145)	0
Number of Studies	31(28/3)	5(2/1/2)
Acute	5(5/0)	0
Combined acute/subacute	1(1/0)	0
Subacute	3(3/0)	0
Subacute	1(1/0)	0
Combined subacute/chronic	21(18/3)	5(2/1/2)
Chronic		

Three RCTs were identified that studied the effectiveness of exercise in patients with subacute LBP (Lindstrom et al 1992, Lindstrom et al 1992, Chok et al 1999). Only one RCT studied the effectiveness of exercise in patients with either

acute or subacute LBP (Delitto et al 1993). There was one other RCT identified that studied the effectiveness of exercise in patients with either subacute or chronic LBP (Moffett et al 1999).

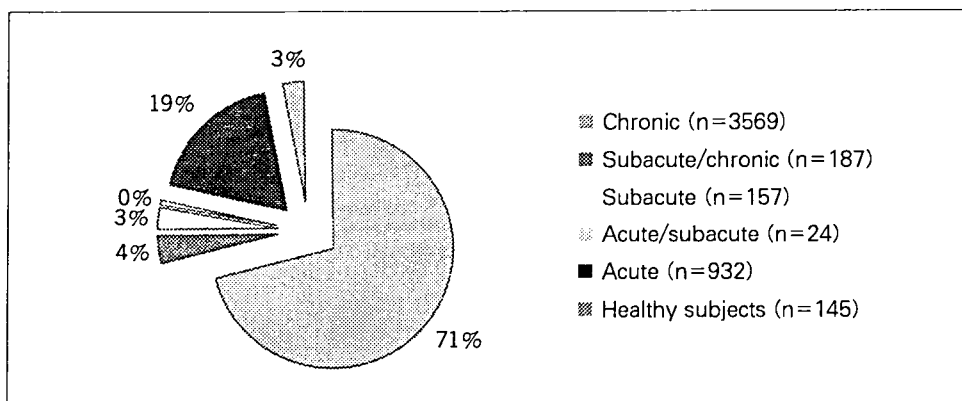


Figure 3.1 Distribution of subjects according to different pathological stages in the selected studies

Table 3.3 Exercise intervention characteristics

Characteristics	Clinical trials (RCTs/CCTs)	Observational studies (Cohort/Case-control/Case series)
Number of studies	31 (28/3)	5 (2/1/2)
Type of exercises		
Stretching/strengthening exercises	3(2/1)	0
Dynamic/static back muscle stabilising exercises	2(2/0)	1(0/0/1)
Isometric/mobilising exercises	1(1/0)	0
Flexion/extension exercises (McKenzie back/Williams exercises)	7(7/0)	0
Hydrotherapy exercise	1(1/0)	0
Fitness exercise	3(3/0)	0
Endurance exercise	2(2/0)	0
Combined exercise/ combined physiotherapy exercise program	12(10/2)	4(2/1/1)

#### 4. Exercise intervention characteristics

Exercise intervention characteristics are displayed in Table 3.3. The exercise interventions mainly used included stretching/strengthening exercises, dynamic/static back muscle stabilising exercises, isometric/mobilising exercises, flexion/extension exercises, McKenzie back exercises, and hydro/fitness exercises.

However, only one study reported on hydrotherapy as an exercise intervention, and one other used mobilising exercises (Malmivaara et al 1995, Soukup et al 1999).

#### 5. Methodological quality

##### 1) Clinical trials

Individual CTs were scored by the PEDro scale and categorised as either high and low quality. Table 3.4 displays the detailed PEDro scores of thirty-one CTs.

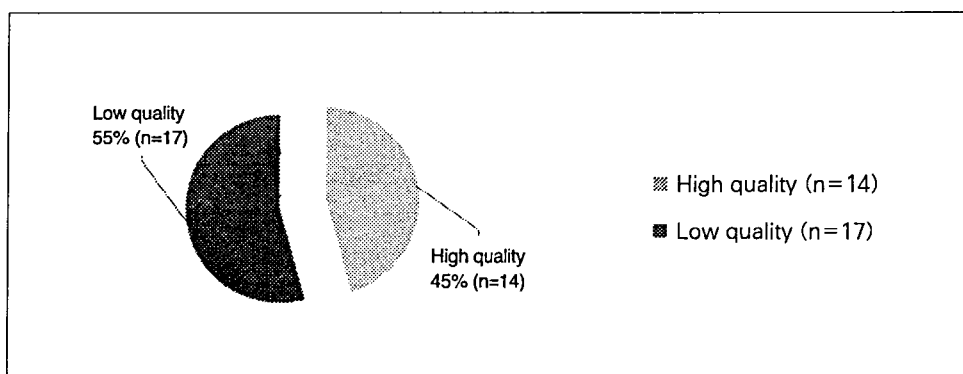
The assessment of quality in thirty-one CTs showed a broad spectrum of PEDro scores ranging from one to eight points. On the basis of analysis of the scores, fourteen (45%) CTs scored six points or more, indicating studies of high methodological quality. On the other hand, seventeen (55%) studies of thirty-one CTs scored five points or less, displaying low methodological quality. Figure 3.2 depicts the distribution of the methodological quality of thirty-one CTs.

**Table 3.4 Quality assessments of clinical trials (RCTs and CCTs) on the effectiveness of exercise for LBP (PEDro score)**

Authors	1	2	3	4	5	6	7	8	9	10	11	Total score
Bentsen et al (1997)	1	1	0	0	0	0	0	1	0	1	0	3/10
Chok et al (1999)	1	1	0	1	0	0	0	0	0	1	1	4/10
Danneels et al (2001)	1	1	1	0	0	0	0	1	0	0	1	4/10
Delitto et al (1993)	0	1	0	1	0	0	0	0	0	1	1	4/10
Dettori et al (1995)	1	1	0	1	1	0	0	1	0	1	1	6/10
Elnaggar et al (1991)	0	1	0	1	0	0	0	0	0	1	1	4/10
Erhard et al (1994)	1	1	0	1	0	0	0	1	0	1	1	5/10
Faas et al (1993)	1	1	1	1	1	1	0	0	1	1	1	8/10
Friedrich et al (1998)	1	1	0	1	1	0	0	0	0	1	1	5/10
Frost et al (1995)	1	1	0	1	1	0	0	1	1	1	1	7/10
Frost et al (1998)	1	1	1	1	1	0	0	0	1	1	1	7/10
Hansen et al (1992)	1	1	0	1	1	0	0	0	0	1	0	4/10
Johannsen et al (1995)	1	1	0	1	0	0	0	1	1	1	1	6/10
Kankaanpaa et al (1999)	1	1	1	1	0	0	0	0	0	1	1	5/10
Kaser et al (2001)	1	1	0	1	1	0	0	1	1	1	1	7/10
Lindstrom et al (1992)	1	1	0	1	1	0	0	1	0	1	1	6/10
Lindstrom et al (1992)	1	1	0	1	1	0	0	1	0	1	1	6/10
Ljunggren et al (1997)	1	1	1	1	0	0	0	0	0	1	1	5/10
Malmivaara et al (1995)	1	1	1	1	1	0	0	1	0	1	1	7/10
Mannion et al (1999)	1	1	0	1	1	0	0	1	1	1	1	7/10
Mannion et al (2001)	1	1	0	1	1	0	0	1	1	1	1	7/10
McIlveen and Robertson(1998)	1	1	0	0	0	0	0	0	0	1	0	2/10



Moffett et al (1999)	1	1	1	1	0	0	0	1	1	1	1	7/10
OSullivan et al (1998)	1	1	1	1	1	0	0	1	0	1	1	7/10
Risch et al (1993)	0	1	1	0	0	0	0	0	0	1	1	4/10
Soukup et al (1999)	1	1	0	1	0	0	0	1	0	1	1	5/10
Stankovic and Johnell (1995)	0	1	0	0	0	0	0	1	0	1	0	3/10
Tortensen et al (1998)	1	1	0	1	1	0	0	0	1	1	1	6/10
Kuukkanen and Malkia (2000)	1	0	0	1	0	0	0	0	0	1	1	3/10
Leinonen et al (2000)	1	0	0	1	0	0	0	0	0	1	1	3/10
Takemasa et al (1995)	1	0	0	1	0	0	0	0	0	0	0	1/10



**Figure 3. 2 Distribution (%) of the methodological quality of 31 CTs**

The fourteen studies rated as high quality were all RCTs while none of three CCTs indicated studies of high quality.

### 2) Review articles

The two systematic reviews and one literature review included in this review were ranked as

high methodological quality, scoring more than eight points on the Modified Crombie scale. However, one literature review scored five points, showing low methodological quality. Table 3.5 displays the detailed scores of the four RAs on the Modified Crombie.

**Table 3.5 Quality assessments of review articles on the effectiveness of exercise for LBP (The Modified Crombie score)**

Authors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total score
Scheer et al (1997)	1	1	1	1	0	1	1	1	0	1	1	0	1	1	1	12/15
Van Tulder et al (2000)	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	13/15
Ljunggren (1996)	1	0	0	1	0	0	0	0	0	0	1	1	0	0	1	5/15
Campello et al (1996)	1	0	1	1	0	0	0	1	0	1	1	1	1	1	1	10/15

### 3) Observational studies

The detailed scores of the five OSs on the Modified Greenhalgh scale are displayed in Table 3.6. Four OSs were considered to be high quality studies, scoring eight, eight, seven and six points

on the Modified Greenhalgh scale respectively. However, there was one case series which scored four points and was thus considered to be a low quality study.

**Table 3.6 Quality assessments of observational studies on the effectiveness exercise for LBP (The Modified Greenhalgh score)**

Authors	1	2	3	4	5	6	7	8	9	10	Total score
Leggett et al (1999)	1	1	1	0	1	1	0	1	1	1	8/10
Taimela et al (2000)	1	1	1	0	1	1	0	1	1	1	8/10
Van der Velde (2000)	1	1	1	0	0	1	0	1	1	1	7/10
Deutsch (1996)	1	1	0	0	0	1	0	1	1	1	6/10
McDonald and Lundgren (1999)	1	0	1	0	0	1	0	1	0	0	4/10

## 6. Outcome

### 1) Clinical trials

Appendix 1 displays a summary of thirty-one CTs, detailing methods, interventions and findings reported by the studies. The main results from each study were extracted according to what I considered to be the most relevant outcome measures, including: pain intensity (visual analogue scale or numerical rating scale), overall improvement (self reported or observed), specific functional status (Roland Morris questionnaire, Oswestry questionnaire), physical assessment (range of motion, spinal flexibility, degree of

straight leg raising or muscle strength), impact on employment (days of sick leave, return to work), medication use, mobility and general fitness.

Twenty-four CTs, twelve of high quality and twelve of low quality, reported positive results regarding the effectiveness of some types of exercise for some stages of LBP (Table 3.7). Conversely, seven CTs, including two of high quality and five of low quality reported negative results (Table 3.7). Therefore, according to the rating system described early in this review, there is strong evidence that exercise is effective in some stages of LBP. The results of CTs in different stages of LBP are illustrated in Figure 3.3.

**Table 3.7 Outcomes of CTs**

Characteristics	Positive (effective) (RCTs/CCTs)	Negative (ineffective) (RCTs/CCTs)
Number of studies	24 (21/3)	7 (7/0)
Stages of LBP		
Acute	4(4/0)	1(1/0)
Combined	1(1/0)	0
acute/subacute	2(2/0)	1(1/0)
Subacute	1(1/0)	0
Combined	16(13/3)	5(5/0)
subacute/chronic		
Chronic		
Quality of studies		
High	12(12/0)	2(2/0)
Acute	3(3/0)	0
0		0
Combined	2(2/0)	0
acute/subacute Subacute	1(1/0)	0

Combined	6(6/0)	2(2/0)
subacute/chronic	12(9/3)	5(5/0)
Low	1(1/0)	1(1/0)
Acute	1(1/0)	0
	0	1(1/0)
Combined	0	0
acute/subacute	10(7/3)	3(3/0)
Subacute		
Combined		
subacute/chronic		
Chronic		

### Acute LBP

Of twenty-four CTs that reported positive results, four CTs involving acute LBP patients demonstrated positive results for exercise. There was only one low quality CT investigating acute LBP which reported negative results. Three of four CTs that reported positive outcomes in acute LBP patients were ranked as high quality. Therefore, there is strong evidence that exercise is effective for acute LBP.

### Subacute LBP

Two high quality CTs involving subacute LBP patients reported positive results with exercise, whereas one low quality study reported negative outcomes. Therefore, there is strong evidence that exercise is a useful intervention for subacute LBP.

### Chronic LBP

Six high quality and ten low quality CTs investigating chronic LBP patients reported positive outcomes. However, there only were two high quality and three low quality CTs which showed negative results with exercise. Therefore, there is strong evidence that exercise is effective for chronic LBP.

Combined acute/subacute or combined subacute/chronic

One high quality RCT involving both subacute and chronic LBP patients reported positive outcomes with exercise, thus providing moderate evidence to support the effectiveness of exercise for LBP. One low quality RCT including both acute and subacute LBP patients also reported positive results with.

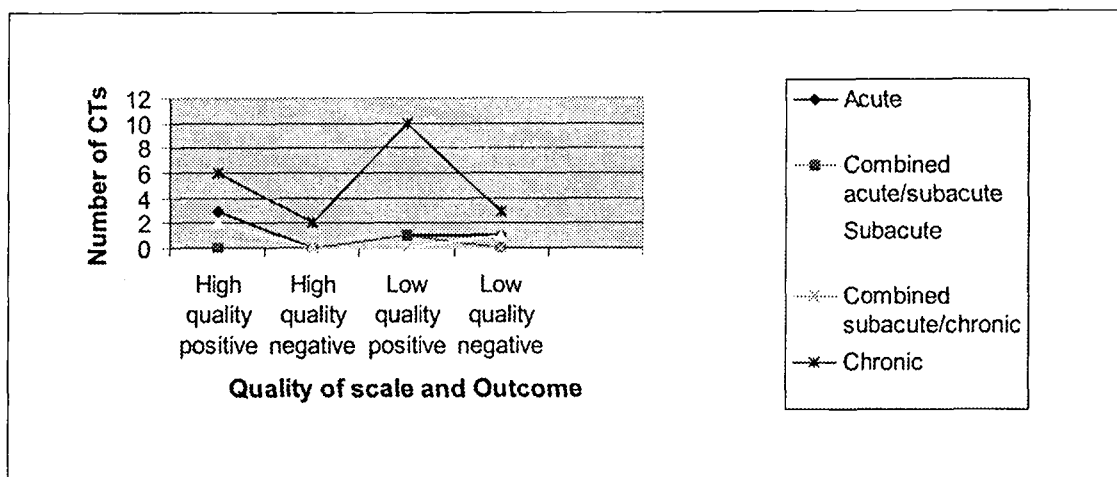


Figure 3.3 Distribution (number of studies) of outcome in CTs

## 2) Review articles

All selected RAs, three of high quality (two systematic review and one literature review) RAs and one of low quality concluded that exercise is effective for stage of LBP. Therefore, there is strong evidence that exercise is effective (Grade I evidence). Appendix 2 illustrates the main findings of the four RAs.

## 3) Observational studies

All five OSs reported positive outcomes for exercise in chronic LBP. The five OSs contained four high quality studies and one low quality study. However, because OSs are relegated to the lowest grade of the evidence, this finding adds limited evidence to support the effectiveness of exercise for LBP. Appendix 3 illustrates the method, outcome measures, and main findings of the selected OSs in this review.

# IV. Discussion

Forty articles containing thirty-one CTs, four Ras, and five OSs were included in this systematic review. This review shows that exercise is effective in reducing pain and improving function in patients with LBP. Overall, the number of validity items with a positive score was very moderate. Twenty-one (14 CTs, 3 RAs, 4OSs) studies met the high methodological quality requirements, based on critical appraisal with scale systems. According to the results, there was strong evidence to show that exercise is effective in acute, subacute, and chronic LBP.

## 1. Study limitations

Despite attempting to use the comprehensive search strategy for this review, publication bias is still possible, as small studies with the same purpose but reporting negative results may not have been submitted or accepted for publication.

Therefore, findings of this review must be interpreted in the light of the shortcomings of systematic reviews.

There were four other potential limitations which must be considered. Firstly, this review focused on selected clinical outcomes such as pain and functional status, ignoring data on psychological scales, which may also be associated with LBP. It is believed that clinically relevant outcomes should be used for judging exercise intervention for LBP.

Second'y, the assessment of methodological quality for selected studies of this review was arbitrary. The reviewer determined the points and the specific scales used to measure methodological quality. In addition to this, all selected studies were scored by one reviewer. These factors can introduce bias to the results and conclusions. In a recent systematic review on LBP, methodological quality assessment for each trial was performed by two assessors blinding each other (Van Tulder et al 2000). All scores from these two assessors had to agree. This can reduce possible bias and ensure reliability.

Thirdly, some published trials can be missed due to other keywords used, unclear abstracts and studies published in languages other than English.

Furthermore, some studies could not be indexed in the bibliographical databases used for the search strategy.

Fourthly, few of the selected studies(n=8) investigated acute(n=5) and sub-acute(n=3) LBP. Most studies researched chronic LBP. This small sample size may be detrimental to one of original aims in this review, which is to determine the effectiveness of exercise in the management of acute and subacute LBP.

## 2. Methodological quality

Of the forty-seven studies identified, forty

studies satisfied the inclusion criteria.

The quality of the forty studies selected for this review turned out to be almost equally distributed between low and high. The methodological quality in the studies of the most recent five years tends to be slightly improved compared to the quality of the studies performed from 1991 to 1995. However, therapists and assessors were not blinded in any of these studies, and subjects in only fourteen CTs of those studies were blinded.

The pathological substratum of LBP is still not clear (Bouter et al 1998). This is probably the most significant difficulty in the scientific study of LBP. Indeed, most studies in this review showed some limitations concerning study design, definition of the sample, assessment exposure or outcome variables, or response rates that must be considered in terms of reliability of the results from the trials. RCTs are considered as the gold standard by which most clinical research is judged in evidence-based practice. Randomisation can help to keep experimental groups as similar as possible from the outset, together with other features of study design including blinding, sample size justification, appropriate outcome measures and statistical analysis. This means RCTs have the greatest potential to minimise bias. Nevertheless, most of the RCTs included in this review did not sufficiently outline how the randomisation procedure was performed. They only stated that the interventions were allocated randomly, which is not sufficient to ensure unbiased results. Perhaps another important fact is that bias and weak designs often cause trials to conclude that an intervention is effective. Of sixteen trials reporting positive results for chronic LBP, ten trials were ranked as low quality studies. A problem with scoring the quality of CTs with PEDro is the absence of criteria regarding sample size. A small sample size may introduce bias into the results. Future studies should be performed with:

- attention given to adequate randomisation, with proper description of the procedure
- sufficient size of the study population
- blinding of participants in the study
- adequate analysis and presentation of the data.

Methods of combining and reviewing data used in systematic reviews are an important means for assessing therapeutic intervention. The reviews must be conducted thoroughly and reliably. Systematic bias must be avoided to achieve a reliable systematic review. The most important part of the method process in a systematic review is the identification of all relevant trials. This will help to obtain statistically accurate results. Most reviewers showed that common limitations of systematic reviews are publication bias, search strategies using indexed databases and a cut-off point system on the methodological quality of selected studies (Scheer et al 1997, Van Tulder et al 2000). However, two systematic reviews used in this paper appeared to address all these possible factors well, thus minimising biases. They were both considered to be high quality studies and showed positive outcomes in the effectiveness of exercise for LBP, in particular during the chronic stage.

Observational studies are considered to be useful when research questions are associated with epidemiology such as diagnosis, prognosis and causation.

Observational studies are relegated to the lowest form of evidence in evidence-based medicine. Because observational studies can be difficult to design well, controlling bias will also be an intricate pitfall. Critical appraisal was performed to assess the validity of five observational studies used in this review.

Four of those were considered as high quality studies and only one ranked as low quality. There were two single case reports used in this review (Deutsch 1996, McDonald and Lundgren 1999).

The most powerful feature of case reports is the richness of information they can convey, which cannot possibly be expressed in CTs. For example, general information about the subjects condition, exercise intervention and the prognosis was delivered in great detail. However, this kind of study cannot be generalised to a larger population of patients in an uncontrolled and unsystematic manner.

### 3. Intervention

The most frequent exercise interventions used in the studies regarding chronic LBP selected in this review were combined physiotherapy exercise programs including stretching, strengthening, and mobilising exercises. Sixteen studies used such an exercise program for chronic LBP. Most of those studies indicated that the exercise is effective for chronic LBP patients. Three studies with acute LBP patients provided McKenzie back extension exercises as their intervention (Delitto et al 1993, Erhard et al 1994, Stankovic and Johnell 1995). Of these three studies, one study by Erhard et al (1994) reported that the group of subjects receiving manipulation combined with hand-heel rocking exercise displayed better outcomes than the McKenzie back extension group. However, because this study used an exercise intervention combined with another type of intervention, it is impossible to determine which form of intervention actually produced the beneficial effects. Dellitto et al (1993) and Lindstrom et al (1992) also used an exercise intervention combined with other interventions such as passive mobilisation and back school education, thus introducing biases. Other exercise interventions such as stretching/strengthening exercises, dynamic/static back muscle stabilising exercises, isometric/mobilising exercises, and hydro/fitness exercises were provided in a few studies (n=3).

Issues concerning motor control strategies in the management of LBP are frequently addressed by many LBP researchers in recent times (Jull and Richardson 2000, Stevans and Hail 1998). There are number of specific exercises developed and clinically used to increase motor control. They include

Pilates, Swiss gym ball exercises and Transverse Abdominal (TA) and multifidus stabilisation exercises. Because only a small number of studies have been performed investigating this kind of specific exercise the author of this review was not able to locate any data from the databases used in the search strategies. No studies performed with these interventions were included.

### 4. Effectiveness of exercise for LBP

The evidence for the effectiveness of exercise intervention in LBP was assessed using a rating and a grading system which took into account the number, methodological quality, and outcome of the selected studies. The findings from forty studies suggested that there is strong evidence for the effectiveness of exercise in the management of LBP. Of forty studies, two high quality systematic reviews have also drawn similar, but not identical conclusions, in terms of the effectiveness of exercise for LBP in different stages (Scheer et al 1997, Van Tulder et al 2000).

Van Tulder et al (2000), in their review of thirty-nine RCTs, concluded that there is conflicting evidence regarding the effectiveness of exercise for chronic LBP, but strong evidence that exercise is not effective for acute LBP. In this review, the results of sixteen studies investigating chronic LBP were homogeneous. Ten of these sixteen studies were low quality. Negative results were reported for chronic back pain in two high quality and three low quality CTs. This also indicates that there is strong evidence that

exercise is not effective for chronic LBP according to the rating system used in this review. However, all other types of studies, including sixteen CTs, five OSs and four RAs reported positive outcomes or conclusions for the effectiveness of exercise in chronic LBP. Therefore, the author of this review considers the result to be strong evidence for the efficacy of exercise in the management of chronic LBP.

Five studies included in this review investigated the effectiveness of exercise intervention in the management of acute LBP. Four of these studies (3 high quality RCTs and 1 low quality RCT) reported positive results and only one low quality RCT reported negative results for the effectiveness of exercise in acute LBP. These findings suggest that there is strong evidence for a positive effect of exercise in acute LBP. Van Tuder et al (2000) in their review pointed out that only a small number of studies have been performed investigating the effect of exercise in patients with acute LBP, introducing potential bias. Studies selected in this review also demonstrated some limitations such as few types of exercise, small sample size and poor description of samples. The Physiotherapy Effectiveness Bulletin (1999) in the United Kingdom concluded that there is insufficient evidence regarding the effectiveness of exercise in the management of acute LBP.

Three studies investigating subacute LBP contained two high quality RCTs and one low quality RCT. The two high quality studies reported positive results for the effectiveness of exercise in subacute LBP. However, these two studies were actually the same trial, with two different outcome measures (Lindstrom et al 1992). Therefore, the evidence drawn from the results of these studies is considered as one RCT, and therefore insufficient.

Subacute LBP was often categorised under chronic LBP (Scheer et al 1997).

One high quality RCT combining subacute and chronic LBP patients reported positive results (Moffett et al 1999). In this particular study, Oxford fitness exercises were used and the results showed that there was significant improvement in pain and functional status at six weeks, six months and one-year follow-up compared with the control group. Another RCT selected in this review compared the McKenzie back extension exercise intervention with the Williams trunk flexion exercise in patients with acute or subacute LBP (Delitto et al 1993).

The results of this study reported that the mean functional status at baseline and after three and five days showed significantly more improvement in the McKenzie group than the comparison group. However, this study was considered as a low quality trial according to the PEDro score. There is insufficient evidence for the effectiveness of exercise in subacute LBP to judge whether exercise is beneficial in the management of subacute LBP. This interpretation is drawn from the results because only a small number of studies were used in this review, which possibly causes a bias of the results.

## V. Conclusion

### 1. Implication for physiotherapy practice

Evidence-based practice is a significant approach to health care practice, and is actively developed and promoted in current research. Best practice in physiotherapy occurs when therapists are aware of the evidence supporting clinical practice along with clinical knowledge and reasoning to implement interventions that are shown to be effective (Research committee of the Australian physiotherapy association and invited contributors 1999).

This review was undertaken to provide scientific

evidence for the effectiveness of therapeutic exercise in the management of LBP patients. Therapeutic back exercises are considered to be effective in some stage of LBP patients. In particular, exercise intervention is strongly recommended for patients with chronic LBP. Some specific types of back exercises such as McKenzie extension exercise have been shown to be effective for acute LBP patients. However, there is evidence that structured exercise programs are less effective than spinal manipulation therapy (Maher et al 1999). Maher et al (1999) in their review stated that an individual, sub-maximal, and gradual increased exercise program is recommended for subacute LBP. In one high quality trial undertaken to investigate this exercise intervention, the graded activity group showed a significant better outcome at 1-year follow-up following the initiation of the exercise intervention compared with the usual care group (Lindstrom et al 1992).

A question that still remains unanswered is what type of exercise intervention is the best in the different stages of LBP. Because this review did not address some current therapeutic exercise interventions (such as TA and multifidus stabilisation exercise, Pilates and motor control back exercises) which are frequently used in physiotherapy practice, this should be investigated in future research as more specific motor control back exercise data accrues.

## 2. Methodological issues associated with the quality of evidence

Critical appraisal is an important process to achieve the best evidence available in evidence-based clinical practice. To achieve the best evidence, therefore, critical appraisal skills are essential to assess the quality and interpret the method and results of the research. In systematic review, the interpretation of evidence is

frequently influenced by the quality of the research and the perspective of the reviewer. This review has some significant limitations in terms of critical appraisal. Since only one reviewer selected studies and assessed their methodological quality, the reliability of interpretation and scoring of the methodological quality of the included studies may not be acceptable. However, a large number of the CTs (55%) used in this review were identified as low quality.

Therefore, it is clear that more high quality research is needed to provide further insight into the effectiveness of exercise in the management of LBP.

The internal validity of studies can be improved by giving more attention to important methodological issues such as the randomisation procedure and its description, the blinding of appropriate outcome measurements and their statistical analysis.

## 3. What methodological issues in particular with LBP research need to be addressed in future research?

Based on data found in this review, there is strong evidence that exercise is effective in the management of LBP. As mentioned previously, study design has been moderately poor in many investigations into the effectiveness of exercise for LBP. Therefore, some issues identified in this review should be addressed in future research.

1. Many studies with positive outcomes are associated with low methodological quality. It is necessary to undertake more high quality trials to determine the effectiveness of exercise intervention.
2. There is a lack of a plausible pathophysiologic or pathoanatomic explanation for most LBP cases. It is important to be aware of the up-to-date diagnostic approach for LBP when performing the research.



3. High quality RCTs should describe the randomisation procedure.
4. Studies investigating specific recently developed exercise programs should be instigated to determine their effectiveness.
5. Most of the high-quality studies with positive findings pertain to chronic LBP. It is likely that well-designed, high quality future research on the effectiveness of exercise for chronic LBP will provide the best evidence for the physiotherapy clinic.

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