Low Back Pain in Construction Workers

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Introduction

This document is a summary of an extensive review conducted into low back pain (LBP) in construction workers. The construction industry constitutes a substantial part of the workforce of most developed countries. In Australia, up to 15% of the male workforce, and around 3% of the female workforce, is employed in construction and related trades (Australian Bureau of Statistics). 88% of Australian construction workers are male. The incidence of LBP in construction workers was found to be 50% higher than for all other industries [6].

This review contains many findings that it is hoped will assist in efforts to decrease low back injuries in construction workers. It emphasises the importance of training and preventative interventions. For workers new to the trade, the following findings are of particular relevance:

- Younger workers are often more prone to low back injury (LBI) due to endurance factors, inefficient work strategies, and postural influences.
- Workers who develop LBP often have ‘poor movement strategies’ that make them vulnerable to injury
- Evidence shows younger and inexperienced workers may be more ‘trainable’ in correct lifting and handling techniques, as they can be targeted before bad habits and injuries become established.

Injury mechanisms are analysed, and it is proposed that most attention in the industry needs to be focused on the effects of sustained and repetitive bending, and stresses due to lifting and lowering. The research shows that standard advice and instruction on lifting and handling techniques is often inadequate and incorrect. This article challenges the widely promoted advice to “bend the knees and not the back”.

One of the recommended preventative interventions is the correct prescription of exercise. While pre-work stretching programmes are becoming more popular in the workplace, most are still based on out-dated & ineffective principles. Alternatives are recommended. There is also a brief discussion of possible future directions in injury prevention.

Contents

Causes and Types of Low Back Injuries

Injury Mechanisms & Risk Factors

While a precipitating 'event' may often be described as a cause of LBP, it is important to be aware that most back injuries do not occur due to a single event. In the majority of cases, repeated or sustained positions and activities over many hours, day after day, make the spine more prone to injury [27,41,71].

General Risk Factors

Work Related Factors

Risk factors for low back injury (LBI) include frequent and sustained bending and twisting, static postures, sedentary occupations, lifting, rapid bending or twisting, excessive force or speed of movement, awkward postures, pushing and pulling, repetitive work, high work intensity, exposure to whole body vibration, and balance loss when the back is under load [1,4,6,17,40,41,50,51,53,60,71,73,80,86]. Injury may also result from sudden, unexpected movements or extra loading, or loads that move unpredictably [31,83,84]. Up to 12% of injuries have been attributed to a sudden loading event [83]. High volumes of spinal loading in a mid to end range bent positions is a particular risk factor in industry [17,18,23,67,81]. Maintaining or adopting a twisted spinal posture was found to be problematic if conducted for any greater than 10% of the work day [59]. Working while in pain was ranked highly by workers as a contributing factor [50]. In apprentice construction workers, 36% of injuries were related to either prolonged static positions or bending / twisting movements [85]. Careers involving driving a motor vehicle or machine excavator were also reported as high risk [97,130].

Individual Risk Factors

These include:

- Lumbar spine muscle endurance. A lack of endurance was shown to be a risk factor for first-time back injury [13,14,57,76,97,118].
- Sedentary habits and lack of physical activity levels outside of work were shown to increase the risk of developing LBP [57]. There is mounting evidence that lack of flexibility, inefficient postures and poor movement techniques may contribute to LBP [18,23,67,18,57,89,91,94,129]. There is research evidence that static postures (such as sitting) influence how the person moves during dynamic tasks like lifting [87,97].
- Other individual factors which may have an effect on LBP development include general health, personality, psychological factors, beliefs, societal and cultural influences, and language [41].

Time Factors

The back is particularly vulnerable during the first one to two hours after rising from bed. This is mainly due to increased hydrostatic disc pressure and stiffness [1,2,38,71]. Bending stresses in the morning can be up to 300% greater in the discs [71,112], and 80% greater in the ligaments, compared to later in the day [71].

Age

Younger workers. There are certain factors that make younger workers more prone to LBI. It has been found that during repeated bending and lifting tasks, a younger or inexperienced worker will adopt a posture involving greater flexion, placing the spine in a more vulnerable position [16,81]. In addition, younger workers tended to lack the adaptation strategies used by older workers which help to 'share the load' and minimise stress under different lifting tasks [16]. There is evidence that younger workers have reduced low back muscle endurance compared to older workers [16].

Older workers. There is a gradual reduction in spinal range of motions after 30 years of age for males and 40 years for females [61]. This increase in stiffness, as well as complex biochemical changes within the spinal tissues, has led some authors to speculate that increasing age is a risk factor for LBI in the workforce [16,85,86,92,117,121]. It was found that an injury in an older worker was more likely to be severe, to lead to greater time off work, and be more costly to manage [16].

Sustained Bending

While lifting is usually cited as the main cause of LBI in manual workers, this assumption may ignore significant risk factors preceding the lifting injury. Sustained and repetitive bending is often the major precipitating factor to LBI. Through progressive weakening of supportive tissues, and potential for increased disc pathology, excessive bending creates a back that is vulnerable to injury in a range of even innocuous situations. Hazards associated with working bent forward are regularly quoted in the literature [4,26,59,81]. Lifting with a bent back after repeated or sustained bending will be particularly risky [121]. Working in extreme flexion was problematic if repeated for any more than 5% of the day [59].

Lifting and Lowering

Lifting has consistently been reported as the major cause of LBI [8,56,119,121]. Lifting and bending was said to account for 33% [8] to 60% [31] of all work related LBP. 50% of acute back injuries were thought to be related to excessive or incorrect lifting [41]. Overall, 80% of all lifting-related injuries were LBIs [31,56]. More specifically, lifting while twisting or bent sideways is a significant risk factor [26,50]. Reaching further than 25cm to lift was also described as an important risk factor [6], as was any lifting from the ground [108]. One study found 52% of manual materials handling activities involved lowering of weights [65], and it has been suggested this could be an equal or greater risk factor to lifting [31].

Pushing & Pulling

Due to ergonomic changes in industry, a lot of bending tasks are being replaced by pushing and pulling tasks, which may account for 50% of manual handling activities [67]. Up to 20% of industry LBP may be related to pushing or pulling manoeuvres [67].

Types of Injuries in Construction Workers

General Low Back Injuries

Structures that are prone to injury in the lumbar spine include bones, joints, muscles, ligaments, and the intervertebral discs (see more on disc injury below). Bones are most vulnerable from compressive and extension loads [4,15,60,71]. Joints are most vulnerable from extension bending and twisting [1,4,15,60]. Ligaments are particularly vulnerable in flexion and rotation [4].

Disc Injuries

Disc injuries are thought to be the most significant spinal tissue injury resulting from bending and lifting-related causes [30,71,72]. The main types of disc injury are:

- An annular sprain or tear.
- More substantial progressive or sudden injury to the fibres of the annulus, resulting in disc *herniation or prolapse*.
- A compression injury, with or without spinal flexion, resulting in damage to the *vertebral endplate*.

Disc injuries are known to result from activities that involve repeated or sustained bending [2,4,30,45,71], particularly when under a compressive or twisting load [1,4,71,72]. When the back is bent forward, the support from the bony joints is lessened, making the disc particularly vulnerable to side bending and twisting motions [1,4,17,60,80]. The fibres of the disc are much less tolerant to load in this position [80], a reason most herniations occur *posterolaterally* [4]. If a large load is carried, even a small amount of bending can lead to injury [1]. Repetitive full bending forwards-and-backward is also a potential risk factor [3,11,21].

Non-Back Related Injuries

Analysis of injuries to areas other than the lower back is beyond the scope of this review. Briefly, after LBI the next most common areas of the body to be injured in construction workers were the shoulders, neck, knees, wrists / hands, and elbows [6,25,50,52,85,120]. In some cases neck pain or injury resulted in higher health care costs and absenteeism than LBP [50]. Some important factors leading to injury include:

Shoulder and Neck

Working overhead, or looking upwards [26,86].

Knees

Kneeling and crouching [6,26]. This includes repetitive squat-lifting (see the section on lifting, below).

Wrists / Hands

Twisting, gripping, poorly designed tools and handles, and vibration forces [6,40.41].

Epidemiology of LBP

LBP in the General Population

The lifetime prevalence of LBP is consistently reported as being 80% [31,103,119]. It affects around 10% of the worlds' population at any point in time [114]. LBP is the most common reason for activity limitation in those under 45 years of age [31,41,70]. It is the primary health problem affecting quality of life [41]. The incidence of LBP continues to rise [31,92]. Over the past 10 years in the US, while the percentage of disability has decreased for circulatory disorders (11.8% to 9.6%) and respiratory conditions (3.6% to 3.1%) it has increased for MSK injuries (20.6% to 25.4%) [132]. Currently, LBP is the third most frequent cause of disability behind arthritis and heart disease [31].

LBP in Construction

While the lifetime incidence of LBP is reported at 80% for the general population, it was reported as 90% in construction [97]. In US construction in 1999, the incidence of LBI was said to be 50% higher than for all other industries [6]. In US manual handling jobs, 80% of work injuries were to the low back [31,65]. In injury surveys, 70% of workers reported LBP [6], 60% to 66% had suffered from LBP in the previous 12 months [41,50], and over 30% had experienced LBP during the previous week [50] In apprentice workers, 54.4% reported injuries to the low back, for which 16.8% had consulted a physician, and 7.3% had missed work days during the previous year [85].

Prevention & Management

Workplace Training

Surveys have indicated that up to 91% of workers want information and training on health and safety, the nature of injury, lifting and handling methods, exercise programmes, and they also want better access to health services at the workplace [41,51,130].

Education

Back Care Principles

There is a great deal of advice that can be given to workers to assist them in preventing and managing LBP:

- Workers should be advised to look out for warning signs of damage, including 'spasms' in the lower back muscles [113], and aches and pains that don't settle, particularly after a nights' rest [6].
- Exercises and postural changes throughout the day can minimise and partially reverse the stresses imposed on the back [73,41,99]. In one study, mini-breaks were found to significantly reduce MSK discomfort levels [73].
- Because it is known that spinal tissues can take several hours to recover after prolonged bending, this has implications for job design [71]. Variation and regular change of position is recommended.
- Advice to avoid unduly loading the back at times when it is known to be vulnerable, such as the first part of the morning, after a long drive, or after repeated or sustained bending [71,112].

Advice on How to Manage Back Injuries

Workers should be given advice on how to manage their back if an injury occurs. Injuries can often be prevented from becoming serious if processes are put in place when symptoms are still mild [86]. After acute injury, correct management over the first few days is often critical, and can help to prevent an injury becoming chronic. As the mechanics of lumbar spine injury are extremely complex, workers with LBP often need a great deal of guidance and monitoring [86].

Training

Training to improve skills, along with health and safety, is often cursory or entirely lacking in the construction industry. In US bricklayers, only 11% of surveyed workers had undergone apprentice training [50,51], and only 14% of these felt the training was adequate for the job [51]. Others reported training techniques were not applicable to what they did at work [130]. While 69% of surveyed construction companies in the US provided a lifting education programme [26], studies have shown that skills and safety procedures taught during training are rarely carried through to the workplace [24,30,70,76,130], and that the goals of training are often not achieved [9,30,44,70,76,103,121]. This could be for a number of reasons, including: a) questionable methods of training [24,30,44,70,121], such as basing manual handling training on teaching the squat lift [24]; b) difficulty breaking pre-established methods and habits [24,70]; c) fast pace of the worksite [24]; or d) the benefits of training for one task are not transferrable to other tasks [30,43].

Studies on 'body mechanics' training, lifting techniques training, and manual handling instruction, are reported below. This training should address the body positions which place the back at greatest risk – sustained flexion, lifting / lowering, excessive reaching & twisting, and sudden maximal effort [70]. Body awareness includes making the worker conscious of injurious end-range spinal positions [97]. In a study of apprentice workers, a body mechanics instruction programme was found to be effective in the short-term [70]. In a study of adult manual workers, a 3 to 6 week lifting programme (using the 'semi-squat' technique – see below) was progressed to gradually more intense lifting, and to functional work tasks such as shovelling, mattocking, and digging [108]. The authors reported excellent results and no injuries among the 69 trainees [108]. Another study on lifting and handling training reported excellent results on improving strength, endurance, and lifting technique [69]. Body mechanics instruction needs to be situation dependent [69] and constantly updated.

Lifting and Handling

The literature on the 'correct' lifting technique is controversial [8,12,53,65]. The advice of 'bend the knees and keep the back straight' has been endorsed for at least 70 years [24,35]. In a recent study, 80% to 90% of experts in health and physical fitness promoted this advice, even though most had reservations about doing so [108]. What is interesting is that Davis et al questioned this advice 50 years ago[35], yet it is still the most common recommendation for lifting. Figure 5 shows a typical diagrammatic representation of this lift as recommended in industry[6]. This is known as the 'squat' or 'knee' lift, as opposed to the 'stoop' or 'back' lift where the knees are straight and the back bends. The advice on squat lifting is often provided with the disclaimer that this technique may only be effective with small, light loads [40]. In fact, squat lifting has been found to be impractical for the vast majority of lifting situations [8,9,31,37,56,79,107,108,121]. Clinical observation and research evidence shows that people bend their backs as much, or sometimes more, when squatting to lift [26,37,38,56,72,82]. In Figure 6A, excessive lumbar flexion is seen with a squat lift technique [82]. While most research on lifting style has focused on squat as opposed to stoop lifting, many experts are more likely to advocate the 'freestyle' or 'semi-squat' lifting method. This is a combination of the two techniques described above. If performed correctly, a semi-squat lift should ensure that neither the back nor knees bend excessively (Fig 6B). In reality, the lifting style adopted will depend on many factors that will vary between each situation and individual [12,15,44]. It may be unrealistic to teach a specific 'technique' [44,108] .

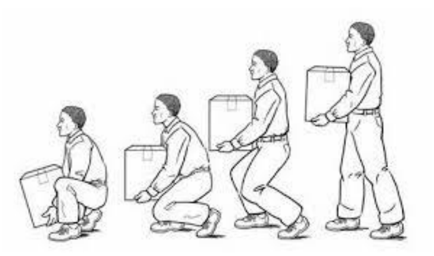

Fig. 5: The squat-lift. From. From *Simple Solutions – Ergonomics for Construction Workers, NIOSH* [6]

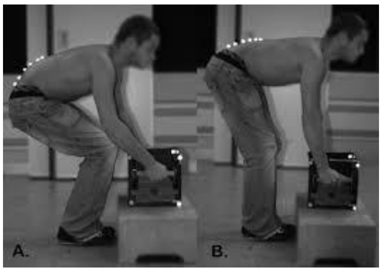

Fig. 6. Knee or squat lift (A) and a form of 'semi-squat' lift (B). With permission, *Mawston & Boocock 2012, NZ J Physio* [82]

Workplace Interventions

Pre-Work Exercise Programmes

Stretching

Stretching programmes have become increasingly popular in industry. In a 2012 study of US construction companies, 47% had introduced a pre-work stretching programme [26]. However there has been no evidence that stretching improves performance or helps to prevent injury. There is, however, overwhelming evidence that a dynamic or active warm-up is more appropriate and effective.

Job-Specific Dynamic Warm-up

Many, if not most sports, continue to incorporate a static stretching programme into their pre-match or pre-training warm-up. There is growing evidence that this is ineffective for injury prevention and performance [27,143,144,149,153]. Static stretching is also potentially harmful when used as part of a warm-up, as it has been shown to decrease performance & body 'preparedness' [135,138,149,153,154] . The best warm-up gets the body ready for what will be required during the activity to follow. This entails increasing the temperature of muscles and joints, enhancing muscle reaction time and the ability to generate power quickly, and well as 'waking-up' the nervous system. The best approach to achieving these requirements is a dynamic warm-up that prepares the mind and body for the strenuous demands to follow [149,153,154].

Future Directions

Musculoskeletal Screening

In professional sport, due to the strenuous nature of competition and high injury rates encountered, pre-season musculoskeletal screening is used extensively. The chief aim of this is to identify risk factors, and modify these to prevent injury. Arguably, workers in construction engage in more strenuous day to day activities than many professional sportspeople. In an ideal environment, new trainees in construction would be screened before they begin regular heavy work, to identify pertinent risk factors. Those particularly relevant include muscle endurance levels, flexibility through the back, hips and thighs, and analysis of postures and movement patterns adopted during bending, lifting and other manual tasks [23]. The author has undertaken a recent screening examination of novice construction trainees, and the results will be available in the near future.

After-Work Exercise for Injury Prevention

One construction training facility in Sydney is currently trialling and end-of-day strength and flexibility programme. This has been designed based on research, clinical experience of the author, and recent MSK screening results. Improved muscle strength and endurance are protective against LBI [13,14,23,33,46,57,76,118]. Exercise and stretching programmes have been found to be effective in improving flexibility and muscle endurance, both in workers and athletes [23,26,46,73,97]. For the type of sustained work and effort required by workers in construction, training in aerobic capacity, strength, power and endurance would be highly desirable [108]. This would incorporate training the 'core' to ensure the muscles of the trunk can control unwanted movement, while the muscles of the hips and thighs are trained to provide both mobility and power to movement [60]. Flexibility training may be particularly relevant for older workers, as after the fourth decade of life flexibility is known to progressively decrease with age [61,117].

Ergonomic Interventions

A comprehensive discussion of ergonomic interventions is beyond the scope of this review. This area has been studied widely. While early reports were encouraging, later results have been equivocal. In one systematic review, ergonomic interventions were not found to be any more effective than no intervention in preventing back and neck pain [39]. The results of ergonomic changes and interventions will obviously be dependent on many factors, and will vary greatly from site to site. Interventions in this area will continue to adapt as new knowledge, equipment and procedures become available.

Summary

This article summarises the findings of a review into low back pain in the construction industry. The prevalence of LBP in this sector is higher than in all other surveyed areas of the workforce. The mechanisms and risks relating to LBP were explored, and the main conclusions were:

- Individual risk factors can make certain workers more vulnerable to LBI compared to others. Training can help to modify some of these risk factors.
- There is evidence that developmental and experiential factors can influence the occurrence of LBP in young compared to older workers. Some factors make younger workers more vulnerable, however it is also theorised that these workers have a greater scope to respond favourably to training interventions.

- Lifting is widely reported as the major contributing factor to LBI. Sustained and repetitive flexion is also a significant contributing factor for many workers with LBP.
- It is recommended that further attention in industry be afforded to interventions such as skills and body mechanics training, lifting techniques training, and manual handling instruction.
- The advice to “bend the knees, not the back” is challenged.

An analysis was made of the evidence relating to workplace training interventions and prevention programmes. It is argued that such programmes have often failed to provide adequate or appropriate training. While there is still a lot of research needed in this area, improved knowledge of lifting techniques and efficient body mechanics factors can provide guidance to health workers, industry managers, and workers, to help them to continue to develop ever improving methods of injury prevention.

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