Ten Risk Factors for Low-Back Pain

By Blake McGowan, CPE
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Blake McGowan, Managing Consultant and Ergonomics Engineer for Humantech, helps companies implement and sustain effective workplace ergonomic initiatives. With over 15 years of experience, Blake has helped his clients achieve best-in-class results that improve human performance, increase productivity, enhance product quality, and reduce injury and illness rates/costs. His clients include British Petroleum, Coca-Cola, General Electric, Georgia-Pacific, Ingersoll-Rand, John Deere, Johnson Matthey, and Procter and Gamble.

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About this E-book

This e-book was created for you if you are responsible for the health and safety of your associates in the workplace. I hope this information helps you make better decisions to address workplace illnesses and injuries and implement an effective low-back pain prevention program.

About 80 percent of adults will experience low-back pain at some point in their lives. In this e-book, I focus on why and how low-back pain occurs. I examine ten risk factors, both occupational and non-occupational, and offer some suggestions on how to address each of the risk factors. I hope you will have an “aha moment” or two as you read.

But let’s not stop there. I invite your comments, questions, and reactions to this e-book on Humantech’s blog, The 30-Inch View. And if you enjoy what you read, please feel free to share it with your colleagues and co-workers.
Introduction

As a kid, most of my free time involved sports. I enjoyed all sports. As a Canadian, though, I spent a lot of time playing ice hockey—competitive, travel ice hockey. So it’s hard to believe that a decision I made three decades ago may have set the foundation for this short book. While playing hockey in Sweden, I decided to retire from it. I was exhausted. I no longer enjoyed the singular pursuit of ice hockey. More importantly, two new passions captured my attention.

First, it was basketball. At that time, it was the historic end of the Magic Johnson and Larry Bird rivalry (due to Bird’s debilitating low-back pain), and the start of the Michael Jordan dynasty. Basketball was fresh and exciting. I loved to watch it, and play it too. And I played all the time.

Second, I developed an interest in science. At that time, my hockey coach’s son became a sports physician. I was fascinated by his profession. I learned this field of study was called Kinesiology (the science of human movement). I wanted to learn more about the physiological, mechanical, and psychological mechanisms that governed movement, performance, and injury. At that point, I knew it was what I wanted to study at university.

Preparing for that goal took time and effort. I was pursuing something never accomplished in my family before—an undergraduate degree. To afford university, I needed a job that paid well. Those jobs usually involved manual labor, otherwise known as manual material handling. So I found a job that required lifting, lowering, pushing, pulling, and carrying. It was physically demanding work.

At the time, I didn't realize the occupational risks associated with my job. I did experience some occasional, short-term muscle and joint discomfort, but I never experienced an injury or musculoskeletal disorder (MSD). It wasn't until years later, while pursuing my undergraduate degree in Kinesiology and my master’s degree in Biomechanics, that I started to understand the risks of low-back pain during manual material handling.
I had a chance to work with some of the leaders in the field of spine biomechanics and injury prevention, specifically Dr. Jack Callaghan and Dr. Stuart McGill. They taught me the fundamentals of spine/injury biomechanics. I learned how the lower back functions, the basic mechanisms of low-back pain, and strategies to prevent injury. I learned there are many risk factors for low-back pain, including health, lifestyle, fitness, age, and gender, as well as psychological and occupational factors.

About 80 percent of adults will experience low-back pain at some point in their lives. To date, I am still part of the lucky 20 percent, and as I enter my fifth decade of life, I am committed to keeping it that way. Professionally, a big part of my job is understanding the risks associated with manual material handling and trying to minimize the incidence of low-back pain. Personally, health and fitness is still important to me. I enjoy a new sport now—rowing. It is a graceful sport, yet physically demanding. It's associated with a high incidence of low-back pain, if the risk factors are not managed properly.

In this e-book, I hope to share what I have learned over the years. I hope this information helps you make better decisions and implement an effective low-back pain prevention program. I really enjoyed writing this book. I found that a lot of the important research on this topic was awarded the Volvo Award in Clinical Sciences. Coincidentally, it's an award given by a multinational manufacturing company located in Sweden—the same country where I made my decision to retire from ice hockey three decades ago.
Why is low-back pain such a serious issue?

So, what is the big deal with the lower back? Why does it deserve so much attention, and even this e-book? To help answer these questions, let’s start with the big picture and place low-back pain in the context of business and other public health and safety concerns.

First, big business understands that focusing on health and safety is good business. Companies that deploy comprehensive health and safety initiatives experience significant reductions in health care costs, increases in productivity, and enhanced worker performance. Furthermore, companies with a strong commitment to positive health and safety cultures have outperformed their competition in the stock market by 5% per year. Overall, healthier workers and safer workplaces are a competitive financial advantage.

Second, low-back pain is a prevalent and serious public health problem. To better understand how big a problem workplace safety issues and, in particular, low-back pain, are, let’s first understand the prevalence of common health issues in the general population. As a society, there are several chronic diseases—heart disease, stroke, cancer, diabetes, obesity, and arthritis—that are costly and preventable. They require our full attention. As of 2012, about half of all U.S. adults (or 117 million) had one or more chronic health conditions. Of those, heart disease and cancer account for nearly 48% of all deaths. There are also several (non-fatal) prominent chronic diseases that cause serious disability, the most notable being arthritis. Presently, 53 million adults are diagnosed with arthritis, and more than 22 million have difficulties with common activities because of it.

We can all agree that these are serious health conditions. They require proper medical and professional help. These common diseases and disabilities are likely beyond the responsibility of the typical workplace safety professional, but they will help us put workplace safety issues into proper context. The most common (non-fatal) chronic health and safety illness/injury associated with the workplace is low-back pain.

Globally, the lifetime prevalence of low-back pain is reported to be as high as 84%. Based on the U.S. adult population, approximately 34 million people experience low-back pain at any one point in time, which is about 31% of the population. Annually, there are also over 8 million new occurrences of low-back pain in the U.S. adult population. More than half (4.6 million) are reported as a back-muscle strain, while just under half (4.1 million) are described as disc degeneration, herniation, or rupture. Overall, the prevalence of low-back pain is not too far from the most commonly occurring fatal and non-fatal chronic health concerns in society.
So, what is low-back pain? It has been described as a somewhat non-specific irritation or problem associated with the muscles, tendons, nerves, joints, or discs in the lower-back region. This is a pretty general statement and it indicates how challenging it can be to understand low-back pain. Usually it is described as one of the following three conditions:

- **Muscle sprain or strain** – caused by overstretching or tearing ligaments, or tears in tendon or muscle

- **Intervertebral disc degeneration** – deterioration and loss of mechanical integrity and cushioning ability of the disc

- **Herniated or ruptured disc** – compression and bulging outward (herniation) or rupturing of the intervertebral disc

All three conditions make normal movements and activities painful to perform. The pain is usually described as a severe, stabbing/shooting pain or a dull, aching sensation.

In the workplace, about 2% (500,000 people) of the U.S. adult workforce claim occupational low-back injuries on an annual basis. Based on OSHA's Safety Pay Program calculator, the average direct costs (insurance premiums or medical/rehabilitation costs) for a muscle sprain or strain injury range between $28,866 and $33,258. For herniated or ruptured discs, the average direct costs range between $22,548 and $76,430. There are also indirect costs associated with these injuries and illnesses, like additional wages to maintain production, administrative costs to manage claims, training costs for replacement workers, reductions in productivity, and repair costs, among others. These indirect costs account for 1.1 times the direct costs, significantly increasing the overall costs of these injuries.

So, what is the primary cause of low-back pain in the workplace? According to the Liberty Mutual 2014 Workplace Safety Index (based on data from 2012), the leading cause of serious, non-fatal workplace injuries is overexertion. Overexertion injuries include incidents that are related to lifting, pushing, pulling, holding, carrying, or throwing. These are injuries associated with manual material handling activities. The most recent data shows that a quarter of all workplace injuries are related to manual material handling. These injuries account for $15.1 billion in direct costs per year, and at 1.1 the direct costs, an additional $16.6 billion in indirect costs.

What is all of this data telling us? It is evidence that low-back pain is pervasive and costly, especially to businesses when low-back pain is diagnosed as work-related. It’s also telling us that, if we don’t already, we must understand what can cause low-back pain and aim to mitigate the risks whenever possible.
What are the mechanisms for low-back pain and injury?

The million-dollar question: How does low-back pain occur? Even though tremendous amounts of investments have been made to better understand the mechanisms of low-back pain, the underlying answer has remained elusive. Don't get me wrong; significant progress has been made, but our understanding is still far from providing a definitive answer and solution for pain sufferers.

Let’s start with the basics. The human spine is made up of 33 vertebrae (or bones) separated by intervertebral discs (or shock absorbers). The vertebrae provide stability, while the discs allow for flexibility and movement. Each disc is made of strong rubber-like tissues, with a fibrous outer part and a softer jelly-like middle part. I’ve always described them as a deep-fried jelly donut, with a hard candy coating.

The spinal column houses and protects the spinal cord, which contains the nerves from the brain. The nerves from the spinal cord exit between the vertebrae and extend to various muscles in the body. Between each vertebra, strong ligaments connect adjacent vertebrae to provide support and strength. In addition, several muscles surround and attach to the spine.

There are many potential causes of low-back pain, but the most common cause is degeneration of the intervertebral disc. As the severity of the degeneration increases, so does low-back pain. The pain can be categorized as either indirect or direct.
Indirect pain

As the intervertebral disc begins to degenerate, there are several alterations that occur in neighboring structures that cause indirect pain. The mechanisms for indirect pain can be further categorized into functional or anatomical alterations.

- **Functional alterations** typically occur during the early, or mild, period of intervertebral disc degeneration, when the spine structure becomes less stable, resulting in pain. With more laxity in the spine, the muscles and ligaments surrounding it must take on more responsibility to stabilize it. This additional responsibility may lead to muscle spasms, muscle strains, or ligament strains that result in pain.

- **Anatomical alterations** are categorized into two common types that lead to pain: the narrowing of the spinal canal or vertebrae (stenosis), and a disc prolapse, commonly known as a slipped disc or a herniated disc. Disc prolapse is the most common disc alteration, occurring in almost 25% of all cases. Most prolapses occur in the lower back.

During a disc prolapse (left), part of the jelly-like middle of the intervertebral disc bulges (or herniates) through a weakness in the strong fibrous outer part of the disc. The bulging disc may cause radiating pain (or sciatica) to the extremities. This irritation is caused by inflammation or compression of the spinal nerves and blood supply. In addition to pain in the extremities, there may also be localized back pain.

With more severe disc degeneration, stenosis may occur, which narrows the gaps between vertebrae and causes compression of nerve roots. Vertebrae may also move forward or backward, causing additional compression on the nerve, all resulting in low-back pain.
Direct pain

Direct pain occurs when changes in the spine allow nerve extensions to penetrate the spine. Pain that is caused by the disc itself, not the neighboring structures, is more complex to understand. The mechanisms for direct pain include inflammation and tear alterations.

- **Inflammation alterations** occur during early disc degeneration, when there are subtle changes to the strong, fibrous outer part of the disc and the jelly-like middle part, primarily due to inflammation. The chemical byproducts of the inflammatory response reach the small nerves in the strong fibrous outer part of the disc and trigger pain.

- **Tear alterations** occur with moderate to advanced disc degeneration, when there are thickening and scarring of the jelly-like middle part of the disc. In addition, the strong fibrous outer part becomes disorganized, brittle, and weaker, leading to tears. Micro-tears propagate and cause cracks that can penetrate the strong fibrous outer part without causing disc prolapse. Unlike healthy discs, these degenerated discs can promote an environment into which nerves and blood supply can grow, and the discs become sensitive to pain.

So, what does this tell us? First, the spine is an extremely complex structure. And second, understanding the mechanisms for low-back pain is complicated and the pain is sometimes difficult to diagnose. However, as safety professionals, there are some things we can do to address and reduce low-back pain; there are risk factors that show a strong association with low-back pain, and understanding and addressing them is the key.
What are the key risk factors for low-back pain?

As safety professionals, we can add value to our business by addressing the risk factors associated with low-back pain. However, this is not as easy as it sounds. The risk factors can be difficult to discern. Many factors interrelate in the workplace. The relationship between occupational risk factors and low-back pain is somewhat unclear for two specific reasons: it is difficult to accurately quantify exposure, and exposure to several occupational risk factors often occurs at the same time. However, there are ten common risk factors that show a strong association with low-back pain. The first five can be described as occupational, and the last five are considered non-occupational.

1. Manual material handling

Manual material handling has the strongest association with low-back pain. Whether the task is a single, maximum exertion or a frequent, submaximal exertion, lifting, lowering, pushing, pulling, and carrying are strongly associated with low-back pain. Common manual material handling tasks associated with low-back pain include palletizing products, unloading ingredients into hoppers, and loading products into machines, among others.

According to the National Institute for Occupational Health and Safety (NIOSH), lifting is the most frequent cause of low-back pain. Rates of low-back pain are as high as eight times greater during heavy lifting jobs compared to sedentary occupations. Excessive lifting further raises the rates and severity of injury. The strongest association between lifting and low-back pain is for lifting items weighing more than 50 lb.

What can you do? Quantify the level of risk associated with manual material handling in your workplace. The NIOSH Lifting Equation can help you determine the acceptability of any lifting or lowering task. The Snook & Ciriello Tables can help you determine the risk associated with pushing, pulling, and carrying. These tools will allow you to create a prioritized list of risky manual material handling tasks, as well as map your “hot spots” throughout the workplace.
2. Heavy physical work

There is a strong association between occupations involving heavy physical work and low-back pain. Health care workers—including nursing aides, orderlies, and attendants—have the highest rates of injuries in industry. Their rates are more than seven times greater than the average for all industries. Rates for other occupations involving heavy physical work, such as construction laborers, trades workers, and freight, stock and material movers, are also very high. These injuries are due, in large part, to overexertion. Sprains and strains are the most often reported types of injuries, and the lower back is the most affected body region.

What can you do? In occupations that require heavy physical work, the best approach is to provide employees with the proper equipment (for example, patient handling devices) and procedures to minimize the risk. Clear expectations and procedures let workers know what is available and when and how to use it.
3. Awkward postures

Awkward postures, such as bending, reaching, and twisting, are associated with all musculoskeletal disorders, even low-back pain. The rate and severity of low-back pain increase with magnitude and frequency of awkward postures. When exposed to a combination of awkward postures, the rates and severity of low-back pain increase further.

What can you do? The best approach is to apply valid ergonomic guidelines to the workplace design. Data on proper heights, reaches, and clearances is readily available. Ideally, engineers and designers should understand and apply these guidelines early in the design phase, when it is most efficient and cost effective to do so. Once the workplace is implemented and operating, modifications can be costly and time consuming to make. However, it is still fairly easy at this point to use “Find It - Fix it” methods to identify improvement opportunities.

4. Static work postures

Working in primarily one posture, such as prolonged sitting, is associated with low-back pain. Delivery drivers, forklift drivers, control room operators, and office employees regularly experience static sitting. Studies show that adults sit, on average, between ten and fifteen hours a day; eight to nine of those hours are most likely spent sitting behind a desk at work. Sitting too much, also known as “sitting disease,” is associated with major health problems such as cardiovascular disease, Type II diabetes, obesity, and cancer, as well as low-back pain.

What can you do? The best approach is to promote movement in the design of the workplace. For example, in the office environment, design in reasons for employees to move throughout the day; centralize waste receptacles, design for a single copy room per floor, implement procedures to allow food only in the cafeteria, and design meeting spaces for standing.
5. Whole-body vibration

Several types of jobs expose workers to whole-body vibration, such as driving trucks, busses, cars, or farm equipment, or operating heavy construction equipment, forklifts, or airplanes. Exposure to whole-body vibration increases the risk of low-back pain and sciatica. The risk for those exposed to this type of vibration is about 1.5 times greater than the risk for the general working population.

What can you do? First, understand the frequency and magnitude of the problem in your workplace by measuring whole-body vibration. This may be somewhat difficult to do, as it requires expertise and some expensive equipment. But, after measurement, you will have a clear idea what jobs/tasks exceed guidelines for whole-body vibration. The countermeasures to reduce vibration are industry-specific. They may involve dampening mechanisms or new equipment to minimize the risks.

6. History

The single best non-occupational predictor of low-back pain is a prior history of it. A history of low-back pain doubles the risk of future pain. It is believed that those with prior low-back pain tend to reduce physical activity, which may, in turn, reduce back strength and endurance and lead to a future incidence of pain.

What can you do? Conduct a comprehensive low-back pain history survey with current and future employees. Once you identify the employees at higher risk, you can implement administrative and engineering controls to minimize the risk of occupational risk factors for low-back pain.
7. Smoking
There is a causal link between smoking and low-back pain. Smoking reduces oxygen supply to discs and the level of oxygen in the blood due to the effects of nicotine constricting the arteries. Because of the reduced blood flow, smokers experience more severe back pain and lower functional capabilities than non-smokers.

8. Obesity
Obesity is a serious health concern. Between 2009 and 2010, more than one-third of U.S. adults (about 78 million people) were obese. Obesity is defined as having a body mass index (BMI) $\geq 30$ kg/m$^2$. Studies have shown that the prevalence of low-back pain is significantly associated with BMI. As BMI increases, so does the prevalence and risk of low-back pain. Those individuals considered to be obese are at the highest risk.

What can you do? Conduct a survey for health concerns, such as obesity (and smoking), to identify the employees at higher risk. Programs that help us understand the health consequences of obesity, as well as the benefits of healthy food choices and exercise, can help minimize the risk of low-back pain.
9. Aging

In 2013, approximately 44 million people were 65 years old or older, accounting for about 14% of the U.S. population. Older workers (≥55 years) represented 19% of the U.S. workforce in 2009 and are the nation’s fastest growing segment of the working population. The prevalence of low-back pain in U.S. adults is highest for those 65 and older. In addition, the number of days away from work due to pain increases steadily with age.

What can you do? Understand where your most experienced and oldest employees work in the workplace. Make sure the manual material handling, force exertions, and postures are within normal guidelines. Then make efforts to accommodate the aging worker. As we age, we typically lose 1% of muscle strength per year after age 45. Be sure to apply proper force guidelines and provide equipment to reduce forceful exertions on the aging body.

10. Gender

In 2010, the proportion of adult men and women in the U.S. population was practically identical. Men and women make up 49.2% and 50.8% of the population, respectively. However, the prevalence of low-back pain is greatest in women. It seems to be a significant problem during pregnancy and often continues after delivery.

What can you do? Make sure the workplace is designed to allow movement throughout the day. Especially during pregnancy, women should incorporate more activity throughout the day to keep blood circulating and to help reduce some common pregnancy issues, including sciatica, varicose veins, blood clots, and swollen ankles. Increasing movement can be as simple as talking face-to-face with a coworker instead of using e-mail, getting a drink of water, or walking to the printer to retrieve a document.
What’s the “bottom line”?

Low-back pain is both a prevalent and costly issue in the workplace. Despite all of our best efforts, the exact mechanisms for low-back pain have yet to be uncovered, and the critical risk factors remain difficult to discern, as they are interrelated in the workplace. Nonetheless, as safety professionals, we still have a role to play. We must understand, quantify, and address these ten risk factors together to obtain a meaningful reduction in low-back pain in the workplace. There is no magic formula that dictates what percentage of your time, effort, or money should be applied to each risk factor, and there is no agreed-upon sequence of addressing them. I recommend addressing each risk factor in one comprehensive approach.

My experience also tells me that a problem is always easier to solve if it is measured and well defined. No matter if the problem is a single low-back issue at a particular work site, or a systemic, global low-back problem, the approach should be the same; define the gaps and understand your company’s aspirations to address the problem. Then you can establish goals and gain leadership support. Once you have implemented changes, it’s essential to conduct frequent reviews.

Here at Humantech, we’ve been known to describe most ergonomic improvements to the workplace as a “blinding flash of common sense.” When it comes to the back, many fixes fall into this category. Hopefully this e-book has shed some light on the complexities of the lower back. And the next time you go to pick up that heavy box, remember...you’ve only got one back for life. Take good care of it.
Additional Resources

For further reading on this topic, we’ve assembled these resources:

- Health and Safety Executive (UK) – Work and Back Pain
- Canadian Centre for Occupational Health and Safety – Back Injury Prevention
- National Institute of Neurological Disorders and Stroke – Low Back Pain Facts
- Humantech Blog - Ten Ways to Love Your Back

References


