LOW BACK PAIN AMONG INDUSTRIAL WORKERS

Occupational health studies on prevalence, incidence, and associations with work and lifestyle in I.R. Iran

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This thesis presents the results from a prospective industrial population cohort study on epidemiology and risk factors for low back pain (LBP) in Iran. The four papers in the thesis were based on a cross-sectional survey and one-year follow-up of 18,000 employees in the automotive industry. The main goals of this thesis were: 1) to identify prevalence and incidence of LBP, and 2) to identify work-related exposures and lifestyle factors related to LBP.

In paper I, the study group consisted of all 18,000 employees working in the automotive industry. In this cross-sectional study, the majority of the study population were young males (<30 years), and the one-year prevalence of self-reported LBP was 21 % (20 % males and 27 % females). The self-reported prevalence rate of absence due to LBP was 5 % per annum.

In paper II, the study population was the same as in study I, and we followed them for one year. All new episodes of disabling LBP lead to medically certified sickness absence being registered. During the one-year follow-up, the incidence of disabling LBP was 2.1 % and the recurrence rate was 2.9 %. The incidence rate of disabling LBP among employees who rejected our invitation to participate at baseline was 3.9 %. A history of previous low back pain significantly increased the risk of a new episode of disabling low back pain. In our study, there is a higher prevalence of LBP in women than in men. However, LBP incidence and recurrence are more frequent in male employees. Men in this study were mostly unskilled workers with physically demanding tasks, while women were office workers with more sedentary tasks.

In paper III, the study population was a cohort of 4500 randomly and strategically selected employees from the automotive industry. The aim was to study the effect of psychosocial exposures on disabling LBP. The results showed that high demands, low control, job strain, low job satisfaction and low job appreciation are associated with both LBP prevalence and incidence of disabling LBP. This prospective study suggests the aetiological role of job strain for LBP. From the prevention point of view, our findings suggest that a reduction in exposure to adverse psychosocial workplace factors may lower the risk of LBP.

In paper IV, the study group was the same as in study III (n=4500), and the aim was to study the effect of cigarette smoking as one important lifestyle factor on the occurrence of disabling LBP. The highest prevalence and incidence rate was found in unskilled workers. With increasing age and work experience, the number of employees who smoked increased. Smokers experienced higher pain intensity and had a higher rate of surgery due to LBP. Sleeping problems and negative impact of LBP were greater in smokers than in non-smokers. The results showed that there is a positive significant association between LBP and current smoking. Current smoking increased both LBP prevalence and the incidence of disabling LBP. Smokers experienced three times the number of new episodes of disabling LBP compared with non-smokers.
In conclusion, incidence of LBP differs considerably between developed countries and developing countries. Psychosocial risk factors at the workplace are associated with LBP. Lifestyle factors such as cigarette smoking will increase the risk of getting LBP.

This study is one of the first longitudinal studies to include this number of participants with different job titles from a developing country that has attempted to test the suggested link between different physical, psychosocial and lifestyle factors and LBP. A better understanding of such key issues as the exposure panorama, causal pathway and dimension of the selected health problem is paramount for interventional health promotion programmes in the workplace. Our study results generate knowledge and open up possibilities for evidence-based intervention programmes. The fact that there was an extremely large number of study subjects with different job titles suggests that our results can be generalized, and may be of interest to similar occupational populations in developing and developed countries.

**Keywords:** Low back pain, epidemiology, occupational health, incidence, prevalence, psychosocial factors, physical load, demand, control, job satisfaction, strain, sickness absence, developing country, middle-income country.
LIST OF PUBLICATIONS

I. Low Back Pain among Iranian industrial workers

II. Incidence and Recurrence of Disabling Low Back Pain and Neck-Shoulder Pain

III. Effect of psychosocial factors on low back pain prevalence and incidence among industrial workers: Findings from a 1-year follow-up of the IKCO cohort study
     Mostafa Ghaffari, Akbar Alipour, Irene Jensen, Malin Josephson, Ali Ashgar Farshad and Eva Vingard. Submitted

IV. Cigarette Smoking and Low Back Pain
    Results from the IKCO cohort study
    Mostafa Ghaffari, Akbar Alipour, Irene Jensen, Malin Josephson, Ali Ashgar Farshad and Eva Vingard. Submitted
# CONTENTS

1 INTRODUCTION ................................................................. 1

2 BACKGROUND ........................................................................... 3

   2-1 Epidemiology ................................................................. 4

   2-2 Low Back Pain ............................................................... 4

   2-3 The Prevalence of Low Back Pain ........................................ 5

   2-4 The Incidence of Low Back Pain ........................................ 7

   2-5 Pain and Disability .......................................................... 8

   2-6 Sickness Absence ........................................................... 9

   2-7 Economic aspect of Low Back Pain ...................................... 10

3 RISK FACTORS ...................................................................... 13

   3-1 General Factors ............................................................. 14

       3-1-1 Age ....................................................................... 14

       3-1-2 Gender .................................................................. 15

       3-1-3 Anthropometry ....................................................... 15

       3-1-4 Physical activity ..................................................... 15

       3-1-5 Smoking .................................................................. 16

   3-2 Workplace Factors .......................................................... 16

       3-2-1 Physical risk factors .................................................. 17

           3-2-1-1 Manual Material Handling ................................. 17

           3-2-1-2 Bending and Twisting ........................................ 17

           3-2-1-3 Whole-Body Vibrations ...................................... 17

           3-2-1-4 Sitting Position ................................................. 18

       3-2-2 Psychosocial Risk Factors .......................................... 18

           3-2-2-1 Job Demands .................................................... 19

           3-2-2-2 Control at Work ................................................. 19

           3-2-2-3 Social Supports ................................................. 19

           3-2-2-4 Job Satisfactions ............................................... 19

           3-2-2-5 Finding of Reviews ............................................. 20

4 AIMS AND OBJECTIVES ....................................................... 21

   4-1 Overall Aim of Research .................................................. 22

   4-2 Study Objectives ............................................................. 22

   4-3 Specific Research Questions ............................................. 23

5 BRIEF DESCRIPTION OF IRAN ............................................... 25

   5-1 Iran ................................................................................ 26
LOW BACK PAIN AMONG INDUSTRIAL WORKERS
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBP</td>
<td>Low Back Pain</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Cooperation and Development</td>
</tr>
<tr>
<td>MSDs</td>
<td>Musculoskeletal Disorders</td>
</tr>
<tr>
<td>WBVs</td>
<td>Whole-Body Vibrations</td>
</tr>
<tr>
<td>SA</td>
<td>Sickness Absence</td>
</tr>
<tr>
<td>HSE</td>
<td>Health, Safety and Environment</td>
</tr>
<tr>
<td>NSP</td>
<td>Neck-Shoulder Pain</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>NMQ</td>
<td>Nordic Musculoskeletal Questionnaire</td>
</tr>
<tr>
<td>IKCO</td>
<td>Iran Khodro Industrial Group</td>
</tr>
<tr>
<td>GNP</td>
<td>Gross National Product</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
</tbody>
</table>
1 INTRODUCTION
1 INTRODUCTION

Low back pain (LBP) is an important public health, social and economic problem. It is a disorder with many possible aetiologies, occurring in different groups, and is also a common health condition in working populations. In the literature there are many different definitions of LBP, since low back pain is a symptom that cannot be easily validated by an external standard, the symptom being what a person reports (Waddell G 1998, Leboeuf-Yde C 1995, Loney PL 1999). Of the regional sites, pain occurring in the low back is the most commonly reported site of pain.

It has been estimated that up to 60-80 % of the population will, at some point in their lives, experience back pain (Cassidy et al 1998). Back pain leads to high costs for the individual, the workplace and society, because it is a frequent reason for medical care-seeking, with an estimated 6-7 % of the adult population annually consulting a general practitioner for their complaints, and one of the most commonly cited causes of sickness absence (Vingard E 2000, Croft PR 1998, Hansson E 2005).

International surveys of low back pain report a point prevalence of 15-30 %, and a 1-month prevalence of between 19 and 43 % (Nachemson A 2000). Most epidemiological data concerning low back pain are related to developed (high-income) and industrialized countries with high income, and there is little information about low back pain in the general or working population in developing (low and middle-income) countries. This lack of research leaves a profound gap in what is known about low back pain in a large part of the world, where the bulk of the world’s working population resides (Volinn E 1997).

Thus, additional epidemiological data on prevalence and incidence of occupational low back pain in a country with a young population and a huge labour force is very important for health promotion programmes in workplace. The main focus of the present thesis is to create a clear picture of the magnitude of the problem in terms of low back pain prevalence and incidence, and to identify work-related and lifestyle risk factors for low back pain among an industrial population. This kind of knowledge is important for different levels, from patients to employers, health professionals in occupational and clinical settings and finally for public health policy makers. Awareness of work-related factors is important for primary and secondary prevention, since it is easier to adjust work-related factors than individual ones.
2 BACKGROUND
LOW BACK PAIN AMONG INDUSTRIAL WORKERS

2 BACKGROUND

Because of the lack of validated external standards for LBP, the study of the epidemiology of low back pain is a nebulous field; even though human beings have suffered from backache throughout recorded history.

2-1 Epidemiology

Epidemiology is defined as the study of the distribution and determinants of disease in the population, and the application of this study to prevent and control health problems (von Korff 1988). In the case of low back pain, epidemiology investigates how its frequency varies by age, gender, location and occupation, and how the frequency changes overtime. Epidemiology provides a better understanding of the natural history of low back pain, which is important and essential for the rational planning of health care programmes, public health policy-makers and also provides a standard to which the efficacy of various treatments may be verified. Low back pain epidemiology also provides the link between pain and the individual or external factors, which in a sense allows risk factors to be identified, controlled and minimized. The main tasks in epidemiological research are to quantify the occurrence of disease, detect and measure exposures and finally estimate the effects of exposures (Rothman KJ 2002). Prevalence and incidence are the two basic concepts of epidemiology. Incidence is defined as the rate at which healthy people develop a new symptom or disease over a specified period of time, which is dependent solely on the rate at which the disease occurs. However, in contrast to incidence, prevalence is a measure of the number of people in the population who have a symptom or disease at a particular point of time.

2-2 Low back pain

There are no generally accepted classification criteria that outline the low back area in which to identify an episode of low back pain. Pain occurring in the low back can be attributed to a number of anatomical structures, including muscles, ligaments, facet joints, blood vessels and spinal nerve roots (Deyo 1992). As small proportion of cases of back pain (only 10 %) can be attributed to an underlying cause (Croft 1995). Although serious spinal diagnoses are rare, as many as 40 % of patients with low back pain worry that they may become crippled or that they have a serious disease (Waddell 1998). Pain and disability are subjective personal experiences, and cannot be measured objectively. By definition, pain is an unpleasant and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (International Association for the Study of Pain, 1979).

In the face of a lack of objective findings associated with the occurrence of back pain, most research has relied on self-reported symptoms, and this has led, in turn, to a diverse range of classification criteria being employed (Dionne 1999). Often, a simple sentence such as “Have you ever been troubled with pain in your back?” has been used, while others have enquired about pain, aches or stiffness in the lower back (Svensson 1989). The problem with this approach is that the response, whether positive or
negative, is highly dependent on the individual’s perception of pain and the definition of the low back area. Therefore in epidemiological studies of musculoskeletal pain, it is essential to define the anatomical region. Anderson (1977) suggested that the lower back be defined as lying between the lower costal margins and the gluteal folds. With this definition in mind, a manikin for musculoskeletal pain (figure1) has been developed, which outlines this anatomical area, and which has been commonly used in different studies of low back pain occurrence (Papageorgiou 1995).

Figure 1- Preshaded manikins used to define pain at (A) low back; (B) shoulder; (C) forearm; and (D) knee.

2-3 The prevalence of low back pain

Most studies in the literature talk about prevalence, which is the percentage of people in a known population who have the symptom during a specified period of time. Point prevalence is the percentage of those who have pain on the day of the interview or when filling in the questionnaire. One-week, one-month or one-year prevalence is the percentage of those who have had pain at some time in the past week, month or in the past year. Lifetime prevalence is the percentage of those who can remember pain at some time in their lives. Many international surveys of low back pain have reported a point prevalence of 15 % to 30 %, a one-month prevalence of between 19 % and 43 %, and a lifetime prevalence of about 60 % to 84 % (table1).
<table>
<thead>
<tr>
<th>Study (Ref.)</th>
<th>Country</th>
<th>Design</th>
<th>Sample</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghaffari et al 2006</td>
<td>Iran</td>
<td>Cross-sectional</td>
<td>14,000 industrial workers</td>
<td>Questionnaire survey</td>
<td>- 1-year prevalence 20% for Men 27% for Women - 1-week prevalence 8% - Absenteeism 5%</td>
</tr>
<tr>
<td>Linton et al 1998</td>
<td>Sweden</td>
<td>Population-based mailed survey</td>
<td>2300 persons</td>
<td>Questionnaire</td>
<td>- 1-year prevalence 63% for Men 69% for Women Absenteeism 19%</td>
</tr>
<tr>
<td>Papageorgiou et al 1995</td>
<td>United Kingdom</td>
<td>Population-based cross-sectional survey</td>
<td>7669 adults</td>
<td>Questionnaire</td>
<td>1-month prevalence 35% for Men 42% for Women</td>
</tr>
<tr>
<td>Carey et al 1996</td>
<td>USA</td>
<td>Telephone interview</td>
<td>4437 adults</td>
<td>Interview</td>
<td>Functionally limiting LBP: &lt;60 yr 8.5% &gt;60 yr 5%</td>
</tr>
<tr>
<td>Hillman et al 1996</td>
<td>United Kingdom</td>
<td>Cross-sectional survey</td>
<td>3184 adults</td>
<td>Questionnaire</td>
<td>- Point prevalence 19% - 12-month prevalence 39% Absenteeism 6.4%</td>
</tr>
<tr>
<td>Guo et al 2004</td>
<td>Taiwan</td>
<td>Nationwide survey</td>
<td>22,475 workers</td>
<td>Questionnaire</td>
<td>- 1-year prevalence 18.3% for Men 19.7% for Women</td>
</tr>
<tr>
<td>Oksuz et al 2006</td>
<td>Turkey</td>
<td>Community-based survey</td>
<td>7000</td>
<td>Questionnaire</td>
<td>- Life-time prevalence 44% - 12-month prevalence 34% - Point prevalence 19.7%</td>
</tr>
<tr>
<td>Cassidy et al 1998</td>
<td>Canada</td>
<td>Population-based cross-sectional</td>
<td>2184 inhabitants</td>
<td>Questionnaire</td>
<td>- Life-time prevalence 84.9% - 6-month prevalence 48.9% - Point prevalence 28.4%</td>
</tr>
<tr>
<td>Urwin et al 1998</td>
<td>United Kingdom</td>
<td>Population survey</td>
<td>6000 adults</td>
<td>Questionnaire</td>
<td>- 1-month prevalence 23%</td>
</tr>
</tbody>
</table>
2-4 The incidence of low back pain

Incidence concerns the onset/occurrence of a disease episode in a population that is initially free from the disease. All these individuals should be potentially at risk of contracting the disease during a defined period of time. There are two specific measures of incidence; incidence rate and incidence proportion. Incidence rate is the number of cases of specific outcome or disease in relation to the size of the study base, i.e., the total time during which the individuals in the study population are at risk of getting the disease (Ahlbom 1993).

Incidence proportion measures the proportion of people who become diseased within a given period of time, and is calculated by dividing the number of subjects who develop the disease during this given period of time by the number of individuals in the population without the disease at the beginning of the period, after excluding the dropouts (Rothman 2002). This quantity is often called the cumulative incidence.

While the prevalence of low back pain has been investigated in numerous cross-sectional studies (Leboeuf-Yde C 1995), there are very few cohort studies that describe its incidence and course in a general adult population. In one systematic literature review, Hestbeak L, noted too much heterogeneity of study populations and low back pain outcomes to undertake a meta-analysis of the reviewed studies (Hestbeak L 2003). For example, the incidence of low back pain episodes varied from 14 % to 93 % annually.

Results from various studies on incidence of low back pain are difficult to compare, often because of differences in the definition of outcome, period of recall, study population and length of follow-up period. A complicating factor in low back pain research is the fact that onset and duration of low back pain episodes are difficult to measure. For example, if the time of onset of low back pain is not clearly defined, it is very difficult to distinguish between incidence and recurrence (Burdorf A 1999).

The annual incidence of back pain in the general population is estimated at between 10 % and 15 % (Anderson GBJ 1999). In a population-based prospective cohort study in Canada the cumulative incidence of low back pain was 18.6 % (Cassidy 2005). In a three-year follow-up study among scaffolders, Elders reported that the annual incidence of low back pain varied between 20 % and 28% (Elders 2004).

In general practice in England, the annual cumulative consultation rate because of low back pain among adults was 6.4 % (Croft P.R 1998). In a general working population in Sweden aged 20-59 years, approximately 5 % sought care because of a new low back pain episode during a three-year period (Vingard E 2002).
LOW BACK PAIN AMONG INDUSTRIAL WORKERS

In this study about low back pain among scaffolders, during the three-year follow-up study, 34 % of the population had been on sick leave for at least one episode of low back pain (Elders LA 2003). In one study in the USA, the incidence of new absence for back pain was 5.6 % (Watson 1998).

<table>
<thead>
<tr>
<th>Study (Ref.)</th>
<th>Country</th>
<th>Design</th>
<th>Sample</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghaffari et al 2006</td>
<td>Iran</td>
<td>Prospective cohort</td>
<td>4500 industrial workers</td>
<td>Questionnaire and sickness absence registration</td>
<td>1-year incidence of disabling LBP 2.1 %</td>
</tr>
<tr>
<td>Hillman et al 1996</td>
<td>United Kingdom</td>
<td>Two-stage cross-sectional survey</td>
<td>3184 adults</td>
<td>Questionnaire</td>
<td>Annual incidence 4.7 % Absenteeism 6.4 %</td>
</tr>
<tr>
<td>Linton et al 1998</td>
<td>Sweden</td>
<td>Population-based mailed survey</td>
<td>2300 persons</td>
<td>Questionnaire</td>
<td>1-year Absenteeism 19 %</td>
</tr>
<tr>
<td>Cassidy et al 2005</td>
<td>Canada</td>
<td>Population-based prospective cohort</td>
<td>2184 adults</td>
<td>Questionnaire</td>
<td>1-year incidence self-reported LBP 18.6 %</td>
</tr>
</tbody>
</table>

2-5 Pain and disability

Pain is the main symptom in LBP. Pain itself does not meet the definition of impairment or abnormality, but if activity aggravates pain and the individual avoids or reduces his/her activities, then pain may lead to disability. Non-specific low back pain seems to be mainly a matter of disturbed function or painful musculoskeletal dysfunction. Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (International Association for the Study of Pain 1979). Pain is a symptom, not a clinical sign, a diagnosis or a disease. It is not possible to assess pain directly. Assessment always depends on how the individual thinks and feels about it and communicates it. Disability, conversely, means disturbed function and restricted activity. The most comprehensive definition is by the World Health Organization (WHO): “A disability is any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being” (WHO 1980). Disability due to back pain involves both physical dysfunction and illness behaviour. Behaviour always involves motor and physiological activity, and physiological processes always have behavioural expressions (Nachemson 2000).
2-6 Sickness absence
Sickness is defined (Alexanderson 1995) as the role a person is given or assumes in a cultural context, normally when having an illness and/or disease. It often implies exemption from social duties, such as work. Sick leave is better understood as interplay between the individual’s health versus the social insurance system; levels of benefits; type of work; flexibility at work by lowered working capacity; attitudes towards work; and other medical, social and psychosocial factors (Alexanderson K 1998, Bergstrom G 2006, Johansson G 2000, Kristensen T 1991, Marmot M 1995).

Low back disorders constitute one of the most common diagnosis behind long-term sickness absence and disability pension in Sweden and other western countries (Nachemson 2000). Even though back disorders are a common cause of sickness absence, not all back pain leads to sick leave. Linton found that 15 % of a studied population reported having taken time off work due to low back pain, although they had not used sick-leave days. In addition, many occupations involve job tasks that even an employee suffering from back pain can perform, at least to some extent, and in such cases it is not always necessary to take sick leave.

An alternative dimension of sickness absence (SA) when ill is sickness presenteeism, meaning that the individual attends work despite illness. By definition, sickness presenteeism means continuing to work despite impaired work capacity due to disease, and like sickness absenteeism it is multifactorial (Vingard E 2004). Reported one-year prevalence of sickness presenteeism has been 53 % (Aronsson G 2005). More common causes for sickness presenteeism are low levels of sickness benefits, that there is nobody else to perform the work tasks, and loyalty towards colleagues.

Impaired work ability due to disease or injury

Yes

"Sickness Presence"

"Sickness Absence"

At Work

Shirking/Insurance abuse

No

Absence from work

Yes

Figure 2- Model of basic dimensions in the sick-leave process (source Gunnel Hensing)
LOW BACK PAIN AMONG INDUSTRIAL WORKERS

Most European Union countries report different rates of increase in sick leave attributed to back disorders (Nyman 2002). Within the EU, Sweden and the Netherlands have the highest sick-leave rates for back disorders. However, the increase has been greater in Sweden in the past five years (Hansson and Jensen 2004). In a study by Elders, about low back pain among scaffolders in the Netherlands, during the three-year follow-up period, 34% of the population had been on sick leave for at least one episode of low back pain (Elders LA 2003).

2-7 Economic aspects of Low back pain

Low back pain has a major impact on society in most western countries. The incidence and prevalence of low back pain are considerable. Payments for health care as well as for sick leave and work disability are enormous. The consequences of low back pain are not restricted to the patient, but are also felt by many other sectors, such as the family, health care providers, employers and society as a whole.

The economic burden of a particular disease on society is measurable in terms of direct costs and indirect costs. Direct costs include utilization of health care (primary care, outpatient care, inpatient care, institutional care and medications) and patient and family costs, such as out-of-pocket costs, paid and unpaid help and travel costs. Indirect costs refer to the value of production lost to society due to illness-related absence from (paid and unpaid) work and days of inactivity. Musculoskeletal disorders appear to be one of the most expensive disease categories. The total cost of back pain, which accounts for more than half of all musculoskeletal incapacity, is estimated at 1-2 % of the GNP (Norlund and Waddell 2000). A tentative comparison among three European reports on back pain indicated high utilization of visits to an outpatient physician in the United Kingdom, high utilization of inpatient care in the Netherlands, and high utilization of sickness benefit absence in Sweden. However, the cost structure was similar: about 10 % direct costs and 90 % indirect costs (Norlund and Waddell 2000).

Table 3- Cost of back pain in US dollars in the United Kingdom, Sweden and the Netherlands* (Source Goossens 2002)

<table>
<thead>
<tr>
<th>Cost categories</th>
<th>United Kingdom</th>
<th>Sweden</th>
<th>The Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost in million US$ (% of total)</td>
<td>Cost per inhabitant</td>
<td>Cost in million US$ (% of total)</td>
</tr>
<tr>
<td>Direct Costs</td>
<td>385 (11.5)</td>
<td>7</td>
<td>213 (8)</td>
</tr>
<tr>
<td>Indirect Costs</td>
<td>2948 (88.5)</td>
<td>113</td>
<td>2262 (92)</td>
</tr>
<tr>
<td>Total Costs</td>
<td>3333 (100)</td>
<td>120</td>
<td>2475 (100)</td>
</tr>
</tbody>
</table>

* The costs estimated by each study were converted to US$ for the same base year, i.e.1991, by using OECD currency, and were divided per inhabitant according to demographic statistics from the OECD (OECD, 1996).
Fordyce (1995) and Waddell (1998) introduced the pain-disability paradox; on the one hand there is no evidence that the incidence and prevalence of back pain has changed in the past 40 years. On the other hand, however, there has been a major increase in the societal and economic impact of musculoskeletal pain. In all western countries, the number of persons who have become legally categorized as disabled due to low back pain has increased dramatically (Einerhand 1995; Waddell 1998). According to experts, this increase in low back pain sickness absence and invalidity benefits may be explained by different factors such as social, economic and demographic factors, rather than because of the back pain itself (Waddell 1998).

**Figure 3- Trends in UK sickness and invalidity benefits for back pain**
(Source Waddell 1998)
LOW BACK PAIN AMONG INDUSTRIAL WORKERS
3 RISK FACTORS
3- RISK FACTORS

3-1 General factors

Low back pain is a multifactorial disorder with many possible aetiologies. Therefore, the determination of risk factors becomes a difficult task. Many epidemiological studies have focused on risk factors for low back pain, attempting to analyse occupational, non-occupational, and psychosocial factors (Waddell G 1996, Heliövaara M 1991, Barnekow-Bergkvist 1998, Viikari-Juntura E 1998, Vingard& Nachemson 2000). The role of the workplace in the causality of low back pain is extremely important because the greatest potential for low back pain prevention exists in the workplace. It is difficult to determine the relationship between occupational factors and low back pain because:

1- Low back pain is not easily defined.
2- Low back pain is very common in the general population.
3- Sickness absence due to LBP is influenced by social factors and the insurance system.

Three different groups of potential risk factors have been identified:
A- Individual and lifestyle factors such as age, gender, weight, smoking, physical activity.
B- Biomechanical and physical factors such as heavy physical load, lifting, twisted postures, vibration, sitting and working with hands under knee level.
C- Psychosocial factors such as job demands, control, support and job satisfaction.

Individual and lifestyle factors

3-1-1 Age

Aging is an evolutionary and dynamic process that results in degenerative changes, not only in the intervertebral discs, but also in ligaments and bones (Buckwalter JA 1995). Low back pain affects men and women in their best productive years, with the peak frequency of symptoms occurring in the age range of 30-55 (Shelerud RA 2006). In his study, Leboeuf confirmed that LBP prevalence is significant as early as age 12 to 14 in both sexes.

Klein and colleagues, who analysed workers’ compensation claims from 26 states, studied the scope of LBP in the workforce. Compensation claims peaked in the 20 to 24 year old age group for men, and 30 to 34 year old age group for women (Klein BP 1984). A review of studies that evaluated pain in the elderly suggests that complaints of pain are more prevalent, varying from 44 % to 84 %, in contrast to the general population, in which pain complaints are reported in 14 % to 29 % of the population (Bressler HB 1999).
Gender differences in the prevalence of LBP are frequently observed, but might differ in degree from country to country. The 1988 National Health Survey in the USA reported a higher prevalence of back pain in male workers (Guo HR 1994, 2004), and a study on LBP in Japan showed that the incidence in male workers was about four times greater than in female workers (Kuwashima A 1997). In a French study, LBP occurred more often and was more severe among women (Alcouffe J 1999).

In a representative prevalence study in Germany, seven-day back pain prevalence was significantly higher for women (Schneider S 2006). In a recent review by Schneider, seven out of twelve studies demonstrated significantly higher pain prevalence for women (Schneider S 2005). In addition, some back pain reported by women in epidemiological studies may also be associated with menstruation, and with pregnancy. It has also been shown that a sciatica diagnosis, which may affect 2% of the population with LBP, was seen more frequently in men than women (5.3 % vs 3.7 %) and operations for disc herniation are performed about 1.5 to three times more often in men than in women (Heliövaara M 1989, Heliövaara M 1987). Workers’ compensation claims are more common in men than in women (Unruh AM 1996).

Epidemiological studies generally indicate no strong correlation between body height, weight and LBP (Sheferud RA 2006). In a systematic review of epidemiological literature by Leboeuf-Yde on body weight and LBP, 32 % of all the studies report a statistically significant positive weak association between body weight and LBP (Leboeuf-Yde C 2000). Obesity influences normal body mechanisms by making it more difficult to sit, stand and walk, and increases the time required to recover from an injury. In obese people the spine must support a larger amount of fat, which may increase the pressure on discs and other structures. Obesity in relation to herniated lumbar intervertebral discs showed conflicting results (Han TS 1997, Böstman OM 1993).

Physical inactivity may result in diminished muscle strength or muscle endurance, reduced bone mineral content, and poor flexibility and coordination, which could all contribute to back pain. The prospective study of strength and fitness as related to back injuries among firefighters performed by Cady et al is one of the most widely cited studies supporting the beneficial affects of fitness with respect to LBP (Cady LD 1979). Positive effects of leisure-time activities in relation to LBP have been reported in some studies (Herreby M 1997, Videman T 1995, Leino PI 1993), but no such effects have been reported in others (Barnekow-Bergkvist 1998, Kujula 1996, Saraste & Hultman 1987).
3-1-5 Smoking

Smoking is suggested to be associated with LBP (Leboeuf-Yde C 1999, Ernst E 1993, Frank A 1993, Scott SC 1999). According to the results from a systematic review by Goldberg, there are at least 40 published epidemiological articles, most of them from developed countries, which have reported on a possible link between smoking cigarettes and non-specific back pain and related back disorders. There seems to be a perception that the data not only exhibit a positive association but also support a causal interpretation (Goldberg MS 2000).

Different mechanisms are suggested that could link smoking with LBP. Gyntelberg suggested two mechanisms; aortic atherosclerosis may cause LBP, and chronic bronchitis may induce LBP because of the repeated increase of spinal pressure due to coughing. Since then the cardiovascular theory has evoked much interest, although the information relating to the cardiovascular hypothesis is confusing (Gyntelberg F 1974). There are different studies that are in agreement with this theory, and other studies that disagree or are equivocal (Landsbergis P 1994, Kaupilla LI 1993, Kaupilla LI 1994). Other plausible mechanisms that have been suggested to explain the association are:

- smoking diminishes bone mineral content, resulting in osteoporosis and micro-fractures of the trabeculae of the vertebral bodies (Daniell HW 1976, Hopper JL 1994, Nguyen TV 1994).
- smoking impairs fibrinolysis and promotes fibrin deposition and scar formation, leading to chronic inflammation and back pain (Jayson MIV 1984, Pountin GD 1987).
- smoking reduces blood flow to the vertebral body, adversely affecting the metabolic balance of the discs, thereby accelerating degenerative processes and making the spine more susceptible to mechanical deformities and injury (Heliövaara M 1995, Heliövaara M 1991, Hambly MF 1992, Holm S 1988). More prospective studies are needed to investigate a possible link between smoking and LBP.

3-2 Workplace factors

Many potentially causal and associated factors at the workplace have been discussed, from heavy work to psychosocial strain (Vingard E 2000, Burdorf A 1997). Analyses of potential occupational risk factors for low back pain usually take into account either physical factors only, or psychosocial factors only. Less often, both types of factors have been simultaneously studied and analysed (Vingard E 2000, Heliövaara 1991, Leino & Hänninen 1995, Wickstrom G 1998) and even less frequently, non-occupational and lifestyle factors have been studied in parallel with work-related conditions (Vingard E 2000, Josephson 1999).

Typically, studies investigating occupational risk factors for low back pain have tended to have more focus on work-related mechanical and physical risk factors, with many
using job title as a proxy measure of physical workload. On the other hand, measurement of quantitative exposure provides more accurate and reliable information about actual activities performed. More recently, work-related psychosocial factors have also been considered as risk factors for LBP (Hoogendoorn 2000, Bongers 1993, Linton SJ 2001, Davis KG 2000). It has been hypothesized that psychosocial factors may be related to increased stress and subsequent adverse health outcomes, as a result of various organizational and social factors at the workplace (Karasek RA 1990).

3-2-1 Physical risk factors

3-2-1-1 Manual material Handling

Manual handling of materials comprises carrying and/or lifting burdens, as well as pushing and pulling objects. It has a relation between time and force. Many studies have found a relationship between manual handling, mainly lifting and handling of patients in health care workers, and reports of LBP (Vingard 2000, Burdorf A 1997, Shelerud RA 2006).

3-2-1-2 Bending and twisting

Flexion or lateral bending of the trunk and bending and rotation of the trunk are considered potential risk factors for low back pain. Many occupations especially in production lines involve awkward postures for different time periods. Most of the studies show an association between forward bending and/or twisting, and low back pain (Vingard E 2000, Liira JP 1990, Punnett L 1991, Bovenzi M 1994).

3-2-1-3 Whole-body vibrations

Whole-body vibrations (WBVs) are mechanical energy oscillations that are transferred to the body. This usually happens through a seat or a platform. The most common exposed occupational groups are truck and automobile drivers, ship pilots and aircraft personnel. Laboratory studies have shown that WBVs can cause fatigue of para-spinal muscles and ligaments, lumbar disc flattening, disc fiber strain, intradiscal pressure increase, disc herniation, and micro-fractures in the vertebral end plate (Wilder DJ 1996). Whole-body vibration has been reported to be associated with LBP. Systematic reviews showed that whole-body vibration is associated with an increased risk of low back pain, sciatica and lumbar intervertebral disc disorders (Vingard E 200, Bovenzi 1999, Burdorf A 1997).

3-2-1-4 Sitting position

In a systematic review, Hartvigsen concluded that having a sedentary job might have a protective or neutral effect in relation to LBP, whereas having a heavy physical job constitutes a significant risk factor. Furthermore, they found that the extensive recent
epidemiological literature does not support the popular opinion that sitting-while-at-work is associated with LBP (Hartvigsen J 2000).

3-2-2 Psychosocial risk factors

In more recent years, psychosocial characteristics of work have been investigated as potential risk factors for LBP (Bongers PM 1993). In a systematic review of literature by Hoogendoorn WE in 2000, different explanations for the association between psychosocial work characteristics and musculoskeletal symptoms have been suggested:

Psychosocial work characteristics can directly influence the biomechanical load through changes in posture, movement and exerted forces (Bongers PM 1993, Sauter SL 1996, Theorell T 1996).

Psychosocial factors may trigger physiological mechanisms, such as increased muscle tension or increased hormonal excretions that may in the long-term lead to organic changes and the development or intensification of musculoskeletal symptoms, or may influence pain perception and thus increase symptoms. Psychosocial factors may change the ability of an individual to cope with an illness, which, in turn, could influence the reporting of musculoskeletal symptoms. The association may well be confounded by the effect of physical factors at work (Bongers PM 1993, Sauter SL 1996, Theorell T 1996, Lundberg U 1999).

In research into the relationship between psychological workload and well-being, the Job Demand-Control model developed by Karasek in 1979 has frequently been used (Karasek RA 1979). The main assumption in this model is that psychological stress reactions in the workplace can chiefly be explained by high job demands and low job decision latitude. A combination of these two job characteristics is assumed to have a stronger effect on health and well-being than either of the two separately (Karasek RA 1990). Johnson and Hall in 1988 extended the model with a third dimension, into the Job Demand-Control-Support model. This model predicts that a combination of high job demands, low job decision latitude and low social support from colleagues and superiors has the most negative consequences on employee health (Johnson J, 1988).

3-2-2-1 Job demands

Job demands are defined as all those occurrences, circumstances, and conditions in the workplace that require the individual to act or respond. The physical environment poses job demands (e.g. lifting of heavy things). There are different types of demands on workers: the increasing amount of work, time pressure, irregular work, high work pace, or repetitive and monotonous work, the need for quick decisions, often on complex matters, the need for maximum attention, and precision, for acquiring new skills and updated qualifications, as well as demands inherent in social interaction with customers or clients.
3-2-2-2 Control at work

The concept of control in working life studies has been used to refer to the subject’s objective or perceived freedom or possibility to exercise control, regulate, direct, and make decisions about her or his work. In work psychology, the concept of control relates to both autonomy and participation in planning and decision-making. Autonomy refers to the extent to which individual workers can structure and control how and when they should do their particular tasks. Participation or participative decision-making refers to the extent that workers are given opportunities to control or influence their job environment. Control may act as a buffer of job demands, and improvement in control may improve the perceived quality of the work environment (Ganster 1989, Frese M 1989). However, control may also provide workers with opportunities to reduce work demands.

3-2-2-3 Social support

Social support refers to resources provided by significant others for the individual. Social support may consequently be defined as a transactional process dependent on the characteristics of both the provider and the recipient. There is some conceptual confusion about what constitutes social support at work, and there are many contradictory findings on the roles of such support in reducing distress and strain. Most studies show positive associations between social support and health. However, a number of studies show no effects, minor effects or negative associations between support and well-being (Howard JH 1986). In a review study in 1993, Bongers found that poor social support at work was associated with reported incidence of back pain.

3-2-2-4 Job satisfaction

The concept of job satisfaction has been used both as a global indicator of an employee’s satisfaction with his or her job and as a specific multifaceted indicator of attitudes towards sources of satisfaction at work (Spector PE 1997).

3-2-2-5 Findings of reviews

Seven reviews examine the evidence for psychosocial factors at work as risk factors for back pain in recent years (Bernard BP 1997, Bongers PM 1993, Burdorf A 1997, Davis KG 2000, Hoogendoorn WE 2000, Vingard E 2000). Bongers concluded that there is evidence that monotonous work or poor work content and poor support by colleagues are risk factors for back pain (Bongers PM 1993). Burdorf and Sorock concluded that job dissatisfaction and monotonous work were important factors (Burdorf A 1997). The results of Bernard showed that there was evidence for intensified workload being a risk
factor, and limited evidence for low job control and job dissatisfaction (Bernard BP 1997). The results of Hoogendoorn showed that there was strong evidence for a positive effect of low social support in the workplace and low job satisfaction (Hoogendoorn WE 2000). Davis concluded that job satisfaction and job stress are more consistently and more strongly associated with the development of LBP than are psychosocial work characteristics themselves (Davis KG 2000). Vingard found weak associations between certain psychosocial factors and LBP, but the dose and exposure time needed to give a health effect could not be concluded. A comparison of the results of these reviews on psychosocial factors showed that although there was evidence for the effect of some psychosocial work characteristics in all reviews, the results were rather heterogeneous.
AIMS AND OBJECTIVES
LOW BACK PAIN AMONG INDUSTRIAL WORKERS

4-1 Overall aim of the research

In order to generate knowledge about the epidemiology of low back pain in Iran, we conducted this study among an Iranian industrial population. The main goals of this thesis were:

1) to identify prevalence and incidence of LBP in an industrial population
2) to identify work-related exposures and lifestyle factors related to LBP.

4-2 Study objectives

Study I: To determine the prevalence of LBP in Iranian industrial workers and how it varies with demographic factors, job title, and gender.

To determine work exposure differences between occupational groups.

Study II: To assess incidence and recurrence of disabling low back (LBP) and neck-shoulder pain (NSP) in an industrial population, and to investigate the association with sex and job title during follow-up.

Study III: To study and determine the influence of psychosocial factors at work on LBP.

Study IV: To study and determine the influence of smoking on LBP.
4-3 Specific research questions:

♦ What is the prevalence proportion for low back pain among an Iranian industrial population? (Paper I)

♦ What is the incidence proportion for low back pain among an Iranian industrial population over a one-year follow-up period? (Paper II)

♦ What are the associations between LBP and physical factors at work? (Paper I)

♦ Are work-related psychosocial exposures of importance for the onset of low back pain? (Paper III)

♦ What is the association between smoking and low back pain? (Paper IV)
5 Brief descriptions of the Islamic Republic of Iran

5-1 Iran

Iran located in the Middle East, is a vast country covering an area of 1,648,195 sq km and sharing boarders with Pakistan and Afghanistan in the east, Azerbaijan, Turkmenistan and Armenia in the north and the Persian Gulf in the south. The country has access to both the Caspian Sea in the north, and the Persian Gulf and Oman Sea in the south.

Iran is divided into 28 provinces, which are further broken down into smaller administrative areas (districts). The main cities are Tehran (capital city), Esfahan, Mashhad, Shiraz and Tabriz. According to the last census in 2006, the total reported population was about 70,000,000. Recently, because of increasing immigration from rural to urban areas, the proportion of inhabitants in rural areas has decreased to 40% of the total population. The population growth rate had a significant rise after 1978 up to 3.5% during 1979 to 1983. Then it was suppressed and controlled by some effective health policies and decreased to 1.5 in 1999. Therefore the main part of the population now includes young people under 20 years of age, a labour force for the future. Life expectancy in Iran is 72 years for men and 73.5 years for women.
Iran has a young population, half of the inhabitants being less than 25 years of age. The labour market in Iran is characterized by a workforce transition, a high unemployment rate and an incomplete social insurance system. During the last 20 years the workforce in Iran has undergone major changes: from being uneducated - even illiterate - or with a low level of education and male-dominated, to being more and more educated or highly educated, and with an increasing female participation. This transition from a developing country to a more developed state in respect of industrialization creates new situations, exposures and challenges that may affect workers’ health.

Figure 4- Population pyramid in Iran and Sweden
5-2 The health system in Iran

The Primary Health Care (PHC) system in Iran has spent a significant part of its potential resources on prevention of communicable diseases such as ARI (acute respiratory infection diseases), CDD (chronic diarrhoea diseases) and also expansion of immunization programmes (EPI) during the 1980s and 1990s. These programmes have helped to decrease mortality rates among children under the age of 5 years during the past twenty years.

Health houses in rural areas form the structure of the primary health care system in Iran. There are more than 15,000 health houses over the country today. Two people trained as Behvarz (health worker in a rural area) work at each health house. The number of Behvarz depends on the population covered by the health house and can vary between two or four. However, there is usually a man and woman, and the average population covered by one health house is 2000 people. Behvarz are trained for two years. From the implementation of occupational health services in the PHC network, Behvarz have some training in occupational health and deliver these services to the workers in the areas covered.

A rural health centre, supervising four to six health houses, is usually located in the biggest village. A general physician works in the health centre full time, and he/she is responsible for each activity in the health centre and the health houses it covers. Urban health centres are the same type of centres in urban areas. At district level there is a main health centre where there is an office for collecting data and analysing them. A university of medical sciences monitors the activities of health centres at district levels. There are 39 medical universities in Iran. All universities of medical sciences work under the supervision of the Ministry of Health and Medical Education.

5-3 The occupational health system in Iran

The main duties of occupational health in Iran are to improve the health condition of the work environment, working life and well-being and welfare status of workers. Based on the existing laws in Iran, the following bodies are responsible for occupational health and safety of workers:

* The Ministry of Labour and social Affairs (Occupational Safety Inspection Department) is basically responsible for occupational environment safety.

* The Ministry of Health & Medical Education (General Department of Environmental and Occupational Health) is responsible for policy and decision-making processes, assessment, evaluation, control of hazardous factors and occupational diseases and poisoning prevention, provision and inspection of workers’ health and workplaces.
* The Social Security Organization (Occupational Medicine Office and Health Services) is responsible for medical examination, workplace compensation and workers’ health.

By integration of occupational health services in primary health care networks, all of the capacities and capabilities that exist within the PHC network are utilized through the community health-workers (Behvarz) and district and provincial health centers. The main purpose of this plan was to develop and promote the quantity and quality of occupational health service provision for workforces in the small-scale industries in urban and rural areas.

For expansion and development of health and welfare services for industries and factories, the provision of PHC through establishment of ‘‘Workers’ Health houses’’ was initiated and implemented in 1987. This project has been implemented in the workshops and factories where there are between 50 to 500 workers, and the responsible person in the workplace is called co-health-worker (Behdasht –Yare –Kar). For workplaces within the range of 20-49 workers the Behgar project was implemented in cooperation with the employers. In this project one of the workers is chosen to take care of occupational health at the workplaces, after passing a three-week training course.

In factories with more than 500 employees, the employers should establish a work health centre at their workshop. In this centre, a general physician, who has been passed at least 25 hours occupational medicine training courses, must provide all of the occupational health services to the workers, with the assistance of an expert and a technician of occupational health and other necessary experts. At this time, however, the main focus of these centres is curative cervices, and they do not pay sufficient attention to occupational health and preventive activities. For this reason, despite the fact that many factories with more than 500 employees establish these centres, there are many occupational health problems in the factories.

5.4 Social security and insurance system in Iran

Under the constitution of the Islamic Republic of Iran, article 29, one can infer the following definition: social security is a comprehensive system which supports and protects each Iranian individual against any expected or unexpected social, financial or natural events, e.g. unemployment, retirement, illness, death, lack of guardian, poverty, reductions or cuts in revenue, physical and mental disabilities and social injuries. This system is to be directed and run in accordance with the people's income and the government's legal duties, by utilizing the people's participation and adopting suitable policies such as extending coverage of social insurances, health care services, relief and rescue services and organizing subsidies. The above-mentioned comprehensive system has not been fully established yet, but some part of it, such as social insurances and non-insurance support, are being offered to some part of the people.
5-4-1 Social Insurance Services

The most important services, which are offered to the insured people, are:
- Health care services to secure health care costs during illness or injuries by accidents.
- Social security benefits, such as pregnancy support, compensation for injuries, pensions for partial and total disabilities, pensions for retirement and orphan, unemployment benefits and compensation of income during illness.

5-4-2 Responsible and active organizations who govern insurance sector
- Social security organization.
- Civil retirement foundation.
- Health care services insurance organization.
- Armed force retirement and insurance foundations.
- Other retirement and insurance foundations dependent to ministries and organizations (15 foundations including, Iranian central insurance, the oil industry and dependent companies, Constructiveness strife, telecommunication, the Iranian steel company, the municipality of Tehran, Iran air, the copper company, the shipping and harbors administration, radio and TV, banks etc.)

In most of these organizations government has a major role; therefore, the government is the main policy-maker in social insurance activities.

<table>
<thead>
<tr>
<th>Year</th>
<th>Health care insurance</th>
<th>Employed covered by insurance</th>
<th>Pensioners</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>13,289,000</td>
<td>2,694,000</td>
<td>684,000</td>
</tr>
<tr>
<td>1988</td>
<td>15,847,000</td>
<td>3,127,000</td>
<td>843,000</td>
</tr>
<tr>
<td>1989</td>
<td>20,017,000</td>
<td>3,724,000</td>
<td>888,900</td>
</tr>
<tr>
<td>1993</td>
<td>32,250,000</td>
<td>5,266,000</td>
<td>1,138,200</td>
</tr>
<tr>
<td>1994</td>
<td>34,550,000</td>
<td>6,150,000</td>
<td>1,188,200</td>
</tr>
<tr>
<td>1998</td>
<td>55,453,000</td>
<td>11,090,000</td>
<td>1,650,000</td>
</tr>
</tbody>
</table>
5-5 Iran Khodro Industrial Group

Iran Khodro Company (IKCO) is the largest vehicle manufacturer in Iran and also in Eastern Mediterranean region. IKCO was established in 1962 for the production of buses and then continued by producing minibuses and different types of passenger vehicles. IKCO is owned by the state and the private interests and currently has 25,000 employees. There is a special centre for occupational health and medicine facilities in IKCO, with different specialist in the field of occupational hygiene, safety, medicine, psychology, and occupational nursing. There is an occupational laboratory for measuring the occupational physical and chemical hazards, and also all of the para-clinical facilities such as radiography, audiometry, and medical laboratory. A physical examination of all employees is performed annually, and for some special job title with special hazards, two or three times a year.
Pictures from IKCO Work Environment
Pictures from IKCO working Environment
MATERIAL AND METHODS
6 MATERIAL AND METHODS

The thesis is based on the IKCO cohort study. The IKCO study consists of a baseline cross-sectional study and a follow-up study of two cohorts of industrial workers.

6-1 Design

Study I: This study involved a cross-sectional, epidemiological analysis of LBP among Iranian industrial workers.

Study II: A prospective cohort study with one-year follow-up

Study III and IV: These two studies involved a prospective cohort of Iranian industrial workers.

Table 5- Characteristics of papers included in this thesis

<table>
<thead>
<tr>
<th></th>
<th>Paper I</th>
<th>Paper II</th>
<th>Paper III</th>
<th>Paper IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Cross-sectional</td>
<td>Prospective cohort with 1-year follow-up</td>
<td>Prospective cohort with 1-year follow-up</td>
<td>Prospective cohort with 1-year follow-up</td>
</tr>
<tr>
<td>Study population</td>
<td>18,000 industrial workers</td>
<td>18,000 industrial workers</td>
<td>4500 industrial workers</td>
<td>4500 industrial workers</td>
</tr>
<tr>
<td>Data Collection</td>
<td>Questionnaire</td>
<td>Registration system</td>
<td>Questionnaire and registration system</td>
<td>Questionnaire and registration system</td>
</tr>
<tr>
<td>Outcome</td>
<td>Self-reported LBP</td>
<td>Disabling LBP based on sickness absence registration</td>
<td>Self-reported LBP &amp; Disabling LBP based on sickness absence registration</td>
<td>Self-reported LBP &amp; Disabling LBP based on sickness absence registration</td>
</tr>
<tr>
<td>Exposure</td>
<td>Physical, psychosocial and life style factors</td>
<td>Sociodemographic factors</td>
<td>Physical and psychosocial factors</td>
<td>Smoking habit, physical and psychosocial factors</td>
</tr>
</tbody>
</table>
6-2 Subjects

Study I
All employees in one of the biggest car manufacturing industrial groups (IKCO) in Iran were chosen for this study. During 2003, IKCO had more than 18,000 full-time employees (17,300 men and 721 women) working in 14 main departments. The work titles were grouped into four main occupational categories: (1) unskilled workers, (2) skilled workers and technicians, (3) office workers, and (4) managers. Most employees at IKCO are young and only those who are absolutely fit are employed. According to IKCO regulation all new employees should pass complete medical examination and different laboratory exams before employment and only healthy people can be employed at IKCO.

Figure 5- Subject selection chart for study I

![Subject selection chart](chart.png)

Study II:
All employees at IKCO, working at 14 main departments and worksites, are included. The work titles are aggregated into four main occupational categories: unskilled workers, skilled workers and technicians, office workers and managers. All employees (18,031) were invited to participate in the baseline survey in 2003. Inclusion criteria for our cohort were working full-time at IKCO and completing the baseline questionnaire. For the incidence and recurrence analyses, 615 persons who retired or left the company during follow-up were excluded. Diagnoses related to
accidents (e.g. fractures) were not included, nor were rheumatological diseases or musculoskeletal pain associated with pregnancy.

Figure 6- Subject follow-up chart. All employees (18000) were invited to participate in the study in 2003. Employee with and without pain were recognized by questionnaire and followed until 2004 for one-year incidence. We plan to do another follow-up in 2007.

Study III and IV: All IKCO employees in Iran were chosen for this study. During 2003, IKCO had more than 18,000 full-time employees working in 14 main departments. Among them, 4500 randomly and strategically selected employees were invited to participate in the study. The strategically selections meant that due to few numbers all women working at IKCO in 2004 (n=521), and all managers (n=351) were included. In study III all persons employed that had been serving anytime in the war between Iran and Iraq (1980-1988) were excluded (n=664).

At IKCO, each site has a special committee for health, safety and environment issues (HSE committee). Their members are representatives from workers, technicians and employers. The head of the committee is the director of that workplace. The committee has regular weekly meetings and for each intervention or work environment programme related to HSE they give advice to the occupational health department.
In this project more than twenty committees were involved in meetings with the research group. The committee members helped to inform all workers and others involved about the project.

6-3 Data Collection

Study I
The prevalence of LBP, work exposures and lifestyle factors were recorded according to the standardized Nordic Questionnaire for analysis of musculoskeletal symptoms. The validity and reliability of this questionnaire has been investigated and approved in different studies and several languages, including Persian (Choobineh AR 2004, Kourinka I 1987). The questions about LBP during the last 12 months, during the last 7 days, and severe LBP that prevented subjects from working were phrased with dichotomized answer alternatives “yes” and “no”.

Questions about physical exposures (heavy lifting, repetitive work, sitting position, awkward working position), and psychosocial exposures (uninteresting work, monotonous work, organizational culture, support from superior, support from fellow workers, support in case of trouble at work, control at work, quantitative demand, qualitative demand, and anxiety about change) were asked, with dichotomised answers “yes” and “no” both for the present work situation and in previous work.

Demographic data and lifestyle factors (age, sex, education, weight, work experience, smoking, and exercise) were also collected.

In this study we used the following definitions for low back pain and prevalence. Low back pain was defined as a person who had trouble (ache, pain, discomfort) in the low back. A one-year prevalent case was defined as a subject who had had at least one episode of low back pain during the previous 12 months. A seven-day prevalent case was defined as a subject who had had at least one episode of low back pain during the past seven days. A one-year sickness absence prevalent case was defined as a subject who had been prevented from working because of low back pain. All 18,031 employees were included and given a questionnaire. All employees at IKCO were literate.

Study II:
Baseline data were collected with the standardized Nordic Questionnaire for analysis of musculoskeletal symptoms. The questions about low back and neck-shoulder pain were phrased as follows: Have you at any time during the last 12 months had trouble (aches, pain, discomfort) in the low back or neck-shoulder respectively? The dichotomized alternatives “yes” and “no” are used for answers. Demographic data including age, sex, education, job title and work experience, were also asked for. With this questionnaire, subjects free of low back pain and neck-shoulder pain during the 12 months preceding the baseline study were identified. The occupational health clinic at the factory followed the entire workforce for one year with regard to new episodes of LBP or NSP between 2003 and 2004. All episodes of LBP or NSP that lead to sick leave require a
medical certificate from a physician inside or outside of the factory, and are registered at the IKCO occupational health clinic. After a period of medically certified sick leave the employee needs to obtain permission to return to work from the occupational health clinic at the factory. Therefore the accuracy of detecting new episodes of LBP or NSP, which leads to sick leave in this study, was very high.

In this study, the following definitions were used. Low back pain (LBP) or neck-shoulder pain (NSP) was defined as trouble (aches, pain, discomfort) in the lower back or neck-shoulder respectively. Disabling LBP or NSP was defined LBP or NSP that leads to sick leave.  

*Prevalent case:* was defined as a subject who reported at least one episode of LBP or NSP during the previous 12 months at the baseline survey among 13,769 employees in 2003.

*Incident case:* was defined as a new episode of disabling LBP or NSP resulting in medically certified sick leave during the one-year follow-up, after a period of at least 12 months free of LBP or NSP respectively. The incident cases were collected between June 2003 and June 2004 with the help of the occupational health clinic registration system, from 10,907 employees who were free of LBP or NSP at the baseline.

*Recurrent case:* was defined as an episode of disabling LBP or NSP that leads to sick-leave in the one-year follow-up, subsequent to a previous year (baseline data) with complaints, from 2862 employees, who reported complaint at the baseline.

*Cumulative recurrence:* was defined as more than one episode of disabling LBP or NSP that leads to sick leave during the one-year follow-up.

*Recovered case:* was defined as a prevalent case at baseline and free of disabling LBP or NSP respectively during the one-year follow-up period.

**Figure 7- Subject selection chart for study II.** Among 13769 participants at the baseline questionnaire survey, we were defined the incidence and recurrence cases based on previous history of LBP.
Study III and IV:
Data were gathered by means of a self-reported questionnaire in 2004 and from register data on sickness absence in 2005. The questionnaire used (the MUSIC inventory) was designed to measure low back and neck-shoulder pain, as well as working life exposure, lifestyle factors, social exposures, co-morbidity, life events and psychosomatic complaints. The evolution of the questionnaire, as well as its reliability and validity, has been studied and published in Sweden (Hagberg M 1993). This questionnaire is the combination of questions and indices tested and approved in other studies (Torgen M 1997, Vingard E 2000, Wigaeus E 2001).

A Persian version of this questionnaire prepared by standard translation and back-translation method was tested for reliability and validity. Results provided evidence that the Persian version of the MUSIC inventory is a reliable and valid instrument to measure musculoskeletal pain and disorders, and work-related physical and psychosocial exposures as well as non-work-related factors.

In this study, the following definitions were used. LBP was defined as trouble (aches, pain, discomfort) in the lower back. Disabling LBP was defined as LBP that leads to sick leave for one day or more.

**Point prevalent case:** was defined as a subject who reported a current episode of LBP at the baseline survey among 4500 employees in 2004.

**Incident case:** was defined as a new episode of disabling LBP resulting in medically certified sick leave during the one-year follow-up. The incident cases were collected between Dec 2004 and Dec 2005 with the help of the occupational health clinic registration system.

**Definitions and measurement of exposures**
Psychosocial workplace factors were measured with reference scales on psychological demands (five items), decision latitude (six items), support (six items), job satisfaction (four items) and job appreciation (four items). Response categories for psychological demands, decision latitude and support items were on a four-point scale. Job satisfaction and job appreciation response categories were on a five-point scale. Psychological demands (range 4-20 points), decision latitude (range 4-24 points), support (range 4-24 points), job satisfaction (range 5-20 points) and job appreciation (range 5-20 points) scales were constructed by summing individual items. The internal consistencies of the scales were satisfactory.

We calculated job strain and iso-strain by median splits of the respective subscales. Job strain based on median split was assigned to those subjects who scored simultaneously above the median on the psychological demands and below the median on the decision latitude scale. If these subjects also scored below the median on the total support scale, they were assigned to iso-strain based on median split.
Smoking habits and sleeping problems were measured by a self-reported questionnaire. Physical exposures, such as sitting position, awkward working position, working with hands above shoulders or under knee level and carrying heavy objects, were measured by response categories on a five-point scale. The impact of LBP was measured by response categories on a four-point scale: no impact, temporary change or problems in the daily job task (lasting at least four weeks), changing jobs and finally disability pension.

6-4 Statistical analysis

Study I

Factors examined were: frequency distributions of responses, and cross-tabulations of demographic, physical, psychosocial and lifestyle factors with reported history of LBP in the last 12 months, absence due to LBP in the last year, and LBP in the past seven days. Group differences were statistically tested by the chi-square test, and P-values were derived from the chi-square test for trend, and the Pearson chi-square test. Odds ratio (OR) with 95% confidence interval was used to estimate the relationship between exposure and musculoskeletal symptoms, and multiple logistic regression analysis was used to study the influence of more than one variable on the outcome. Unadjusted OR calculations and multiple logistic regression analysis were carried out after excluding workers with less than 12 months of work experience. The occurrence of LBP in the previous year, and LBP-related absence, was chosen as an outcome variable for the risk analysis. The determinants consisted of variables representing the physical exposures, psychosocial exposures, lifestyle factors and individual data. All variables with significant OR, with 95% CI in bivariate analysis were, included in the multiple logistic regression analysis.

Study II:

Frequency distributions of responses, and cross-tabulations of demographic factors with reported history of low back and neck-shoulder pain in the last 12 months, were examined. Group differences were statistically tested by chi-square test. All statistical analyses were carried out using the SPSS program.

Study III:

Frequency distributions of responses, and cross-tabulations of demographic factors with reported history of LBP in the last 12 months, were examined. Group differences were statistically tested by chi-square test. Logistic regression methods were used to analyse the association between the risk factors and the outcome variable. The analysis was performed in three stages. Initially, univariate analysis was performed to establish the association between each
psychosocial risk factor and two outcomes (LBP prevalence at baseline and the incidence of disabling LBP at follow-up). Then the basic model was controlled in the first stage for age, and in the next stage for physical exposures. In the third and final stage three psychosocial risk factors were added and logistic regression was performed for this model. All statistical analyses were carried out using the SPSS program.

Study IV:

Frequency distributions of responses, and cross-tabulations of demographic factors with reported history of LBP in the last 12 months, were examined. Group differences were statistically tested by chi-square test. The association between cigarette smoking and LBP was analysed separately in two adjusted models. The first model was adjusted for age, sex and war participation. The second model was additionally adjusted for psychosocial exposures and physical workload. All statistical analyses were carried out using the SPSS program.
LOW BACK PAIN AMONG INDUSTRIAL WORKERS
7 RESULTS

7-1 Study participants

Papers I, II
The entire group of 18,031 employees at a car manufacturing company in Iran was included in these two studies. A total of 14,384 completed baseline questionnaires were collected, giving an overall response rate of 77.7%. From this cohort, 615 subjects (4.3%) retired or left the company during the one-year follow-up. The cohort of employees with complete data during the one-year follow-up was 13,769.

Figure 8- Subject selection chart for study I and II

18031 (Base line study population) → 3647 (non-respondents) → 14384 (respondents- study I) → 615 (no longer at the company or incomplete data) → 13,769 (total cohort for one-year follow-up in study II)

Papers III, IV:
During 2003, IKCO had more than 18,000 full-time employees. Among them, 4500 randomly and strategically selected were invited to the study. A total of 3838 completed baseline questionnaires were collected, giving an overall response rate of 85%. This cohort was followed for one year. From this cohort 664 subjects who had a history of war participation or disability were excluded from analysis in paper III. Therefore the cohort of employees with complete data during the one-year follow-up was 3174 in paper III and 3838 in paper IV.
**Figure 9- Subject selection chart for study III and IV**

- 18031 (Base line study population)
- Randomly and strategically selection
- 4500
- 662 (non-participants)
- 3838 (total cohort for one-year follow-up in study IV)
- 664 (history of war participation)
- 3174 (total cohort for one-year follow-up in study III)

**7-2 Prevalence of self-reported LBP and its association with physical, psychosocial and lifestyle factors (Paper I)**

Among the participants, 20.8% had suffered from LBP during the last twelve months, projecting to about 2866 cases. The prevalence in females was 6.7% higher than males. The majority of this study population is young male (under 30) and a small proportion of work force is female (4%). In unskilled workers; physical exposures, especially repetitive work is high, and in managers’ psychosocial exposures, especially high qualitative and quantitative demands are high. Most women are office workers, and awkward working positions and high qualitative demands are the most common physical and psychosocial exposures in this group.

The demographic characteristics and their association with LBP in employees are described in table 6. The associations between different job title and exposure is displayed in table 7 and in table 8 lifestyle, physical and psychosocial factors at work and their association with LBP are displayed.
Table 6- Demographic characteristics and their association with low back pain in employees, 2003 (n=13776)

<table>
<thead>
<tr>
<th>Study population</th>
<th>LBP in past 12 months %</th>
<th>LBP-related absence in last year %</th>
<th>LBP in past 7 days %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group (years)</td>
<td>No</td>
<td>%</td>
<td>% pos</td>
</tr>
<tr>
<td>Under 30</td>
<td>8105</td>
<td>60.2</td>
<td>19.8</td>
</tr>
<tr>
<td>31-50</td>
<td>4711</td>
<td>35</td>
<td>21.8</td>
</tr>
<tr>
<td>&gt;51</td>
<td>642</td>
<td>4.8</td>
<td>24</td>
</tr>
<tr>
<td>Sex</td>
<td>13171</td>
<td>95.9</td>
<td>20.5</td>
</tr>
<tr>
<td>Male</td>
<td>13171</td>
<td>95.9</td>
<td>20.5</td>
</tr>
<tr>
<td>Female</td>
<td>562</td>
<td>4.1</td>
<td>27.2</td>
</tr>
<tr>
<td>Job Title</td>
<td>1410</td>
<td>10.4</td>
<td>19.7</td>
</tr>
<tr>
<td>Manager</td>
<td>286</td>
<td>2.1</td>
<td>20.6</td>
</tr>
<tr>
<td>Office worker</td>
<td>1410</td>
<td>10.4</td>
<td>19.7</td>
</tr>
<tr>
<td>Skilled worker/</td>
<td>2779</td>
<td>20.5</td>
<td>16.7</td>
</tr>
<tr>
<td>technician</td>
<td>2779</td>
<td>20.5</td>
<td>16.7</td>
</tr>
<tr>
<td>Unskilled worker</td>
<td>8735</td>
<td>64.4</td>
<td>22.3</td>
</tr>
<tr>
<td>Working experience (years)</td>
<td>3197</td>
<td>23.3</td>
<td>19.8</td>
</tr>
<tr>
<td>1 or less</td>
<td>6350</td>
<td>46.3</td>
<td>19.7</td>
</tr>
<tr>
<td>2-5</td>
<td>1982</td>
<td>14.5</td>
<td>23.1</td>
</tr>
<tr>
<td>6-10</td>
<td>1179</td>
<td>8.6</td>
<td>22.8</td>
</tr>
<tr>
<td>11-20</td>
<td>964</td>
<td>7</td>
<td>24.1</td>
</tr>
<tr>
<td>21-30</td>
<td>39</td>
<td>0.3</td>
<td>30.8</td>
</tr>
</tbody>
</table>

Table 7- Association of job type with physical factors in employees, 2003

<table>
<thead>
<tr>
<th>Heavy lifting %pos</th>
<th>P</th>
<th>Repetitive work %pos</th>
<th>P</th>
<th>Sitting position %pos</th>
<th>P</th>
<th>Awkward positions %pos</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager</td>
<td>4.6</td>
<td>&lt;0.001</td>
<td>8.9</td>
<td>&lt;0.001</td>
<td>56.3</td>
<td>&lt;0.001</td>
<td>12.7</td>
</tr>
<tr>
<td>Office worker</td>
<td>9.7</td>
<td>13.2</td>
<td>66.9</td>
<td>26.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skilled worker/ technician</td>
<td>21.3</td>
<td>25.3</td>
<td>33.7</td>
<td>33.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled worker</td>
<td>58.6</td>
<td>65.3</td>
<td>22.2</td>
<td>70.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 8 - Lifestyle, physical and psychosocial factors at work and their association with low back pain in employees, 2003 (n=13776)

<table>
<thead>
<tr>
<th>Lifestyle factors</th>
<th>Study population</th>
<th>LBP in past 12 months</th>
<th>LBP-related absence in last year</th>
<th>LBP in past 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCT</td>
<td>%</td>
<td>% pos</td>
<td>p-value</td>
<td>% pos</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20</td>
<td>990</td>
<td>7.3</td>
<td>0.34</td>
<td>4.7</td>
</tr>
<tr>
<td>20-24.99</td>
<td>7046</td>
<td>52</td>
<td>21.1</td>
<td>5.1</td>
</tr>
<tr>
<td>25-29.99</td>
<td>4688</td>
<td>34.6</td>
<td>20.6</td>
<td>5.2</td>
</tr>
<tr>
<td>≥ 30</td>
<td>817</td>
<td>6</td>
<td>22.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Regular exercise</td>
<td>6782</td>
<td>49.7</td>
<td>19.3 &lt;0.001</td>
<td>4.7 &lt;0.001</td>
</tr>
<tr>
<td>Smoker</td>
<td>1278</td>
<td>11.1</td>
<td>23.2 &lt;0.05</td>
<td>6.4 &lt;0.05</td>
</tr>
<tr>
<td><strong>PHYSICAL FACTORS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy lifting</td>
<td>5785</td>
<td>44.4</td>
<td>22.7 &lt;0.001</td>
<td>6.3 &lt;0.001</td>
</tr>
<tr>
<td>Repetitive work</td>
<td>6478</td>
<td>49.8</td>
<td>22.9 &lt;0.001</td>
<td>6.1 &lt;0.001</td>
</tr>
<tr>
<td>Sitting position</td>
<td>3952</td>
<td>30.5</td>
<td>22.1 &lt;0.01</td>
<td>5.5 0.29</td>
</tr>
<tr>
<td>Awkward working position</td>
<td>7442</td>
<td>56.8</td>
<td>22.3 &lt;0.001</td>
<td>6.0 &lt;0.001</td>
</tr>
<tr>
<td><strong>PSYCHOSOCIAL FACTORS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninteresting work</td>
<td>3387</td>
<td>24.6</td>
<td>22.9 &lt;0.001</td>
<td>6.4 &lt;0.001</td>
</tr>
<tr>
<td>Monotonous work</td>
<td>5698</td>
<td>41.4</td>
<td>23.4 &lt;0.001</td>
<td>6.3 &lt;0.001</td>
</tr>
<tr>
<td>Non-encouraging organizational culture</td>
<td>7362</td>
<td>53.5</td>
<td>22.5 &lt;0.001</td>
<td>5.9 &lt;0.001</td>
</tr>
<tr>
<td>No support from superior</td>
<td>3131</td>
<td>22.8</td>
<td>21.7 &lt;0.136</td>
<td>5.9 &lt;0.03</td>
</tr>
<tr>
<td>No support from fellow workers</td>
<td>1190</td>
<td>8.6</td>
<td>16.1 &lt;0.001</td>
<td>3.6 &lt;0.01</td>
</tr>
<tr>
<td>No support if trouble at work</td>
<td>3788</td>
<td>27.5</td>
<td>22.2 &lt;0.01</td>
<td>5.8 &lt;0.03</td>
</tr>
<tr>
<td>No control at work</td>
<td>6772</td>
<td>49.2</td>
<td>22.1 &lt;0.001</td>
<td>5.8 &lt;0.002</td>
</tr>
<tr>
<td>High quantitative demands</td>
<td>7895</td>
<td>57.4</td>
<td>21.5 &lt;0.028</td>
<td>5.3 0.40</td>
</tr>
<tr>
<td>High qualitative demands</td>
<td>6773</td>
<td>49.2</td>
<td>21.7 &lt;0.01</td>
<td>5.5 &lt;0.1</td>
</tr>
<tr>
<td>Anxiety of change</td>
<td>5914</td>
<td>43</td>
<td>21.5 &lt;0.08</td>
<td>5.3 0.49</td>
</tr>
</tbody>
</table>

In the bivariate analyses of risk indicators for reporting any history of LBP, increasing age and working experience (years), female sex, no regular exercise, heavy lifting, repetitive work, sitting position at work, awkward working positions, uninteresting
work, monotonous work, no encouragement in organizational culture, no control at work, were all associated with an increased likelihood of reporting LBP and only no support from fellow workers was associated with a decreased likelihood of reporting LBP. Results from unadjusted OR with 95% CI for the outcome absence due to LBP in the previous 12 months showed the same pattern (table 9).

In the multiple logistic regressions model the following factors remained risk indicators: increasing age, no regular exercise, heavy lifting, repetitive work, monotonous work, no encouragement in organizational culture and no support from fellow workers. For the outcome absence due to LBP the pattern is similar (table 9).

Table 9- Unadjusted odds ratio and multiple logistic regression with 95% CI for factors associated with low back pain and Absence due to LBP in the previous 12 months, 2003

<table>
<thead>
<tr>
<th></th>
<th>LBP in last 12 months</th>
<th>Absence due to LBP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted OR</td>
<td>Adjusted OR</td>
</tr>
<tr>
<td>Age groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>31-50</td>
<td>1.15(1.06-1.28)</td>
<td>1.10(0.96-1.26)</td>
</tr>
<tr>
<td>&gt;51</td>
<td>1.37(1.15-1.62)</td>
<td>1.28(1.04-1.57)</td>
</tr>
<tr>
<td>Working experience(yr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;=1&lt;6</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>&gt;=6</td>
<td>1.24(1.13-1.37)</td>
<td>1.11(0.97-1.27)</td>
</tr>
<tr>
<td>No regular exercise</td>
<td>1.21(1.11-1.33)</td>
<td>1.11(0.97-1.27)</td>
</tr>
<tr>
<td>Heavy lifting work</td>
<td>1.28(1.16-1.40)</td>
<td>1.12(1.01-1.24)</td>
</tr>
<tr>
<td>Repetitive work</td>
<td>1.38(1.30-1.52)</td>
<td>1.20(1.07-1.36)</td>
</tr>
<tr>
<td>Sitting position</td>
<td>1.38(1.30-1.56)</td>
<td>1.11(1.00-1.24)</td>
</tr>
<tr>
<td>Awkward position</td>
<td>1.31(1.19-1.44)</td>
<td>1.02(0.89-1.16)</td>
</tr>
<tr>
<td>Uninteresting work</td>
<td>1.19(1.08-1.32)</td>
<td>1.02(0.89-1.16)</td>
</tr>
<tr>
<td>Monotonous work</td>
<td>1.33(1.21-1.47)</td>
<td>1.22(1.08-1.37)</td>
</tr>
<tr>
<td>Non-encouraging</td>
<td>1.28(1.17-1.41)</td>
<td>1.11(0.99-1.24)</td>
</tr>
<tr>
<td>organizational</td>
<td></td>
<td></td>
</tr>
<tr>
<td>culture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No support from fellow workers</td>
<td>0.73(0.62-0.87)</td>
<td>0.68(0.56-0.82)</td>
</tr>
<tr>
<td>No control at work</td>
<td>1.09(1.06-1.27)</td>
<td>1.02(0.91-1.36)</td>
</tr>
</tbody>
</table>
7-3 Incidence and recurrence of disabling LBP (Paper II)

During the one-year follow-up, 314 respondents (n=13,769) were registered as having new episodes of disabling LBP. According to the official company statistics among non-respondents (n=3647), 144 new episodes of disabling LBP were reported. During the one-year follow-up, the incidence of disabling LBP was 2.1 % and the recurrence of disabling LBP was 2.9 %. Cumulative recurrence of LBP was 0.3 % and 97 % of people with LBP at baseline recovered during the one-year follow-up. The incidence rate of disabling LBP among employees who rejected our invitation to participate at baseline was 3.9 %, and significantly higher than in the other group. Although the prevalence of LBP in females was higher than in males, the incidence and recurrence of disabling LBP was higher in males. Both prevalence and incidence of disabling low back pain were high in unskilled workers. LBP prevalence increased with increasing work experience, but in employees with more than 10 years of work experience both incidence and recurrence decreased. The highest incidence and recurrence rates were related to employees with 6-10 years of work experience. In different age groups of our study cohort, the highest prevalence rate of LBP was found in older (aged 46-55 years) employees but the highest incidence and recurrence was found in young and middle-aged (31-40 years) employees.

Table 10- Characteristics of gender, job type and working experience and their association with one-year Cumulative Incidence, and Recurrence of low back pain, during a one-year follow-up of employees.

<table>
<thead>
<tr>
<th></th>
<th>Incidence</th>
<th></th>
<th>Recurrence</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>P=0.56</td>
<td>P=0.84</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>224</td>
<td>2.1</td>
<td>79</td>
<td>2.9</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>1.7</td>
<td>4</td>
<td>2.6</td>
</tr>
<tr>
<td>Job type</td>
<td></td>
<td>P&lt;0.001</td>
<td>P=0.68</td>
<td></td>
</tr>
<tr>
<td>Managers</td>
<td>3</td>
<td>1.3</td>
<td>2</td>
<td>3.4</td>
</tr>
<tr>
<td>Office workers</td>
<td>10</td>
<td>0.9</td>
<td>5</td>
<td>1.8</td>
</tr>
<tr>
<td>Skilled&amp;technical</td>
<td>36</td>
<td>1.6</td>
<td>13</td>
<td>2.8</td>
</tr>
<tr>
<td>workers</td>
<td></td>
<td>P&lt;0.002</td>
<td>P=0.09</td>
<td></td>
</tr>
<tr>
<td>Unskilled workers</td>
<td>174</td>
<td>2.6</td>
<td>62</td>
<td>3.2</td>
</tr>
<tr>
<td>Working experience (yr)</td>
<td></td>
<td></td>
<td>P&lt;0.002</td>
<td></td>
</tr>
<tr>
<td>1 or less</td>
<td>45</td>
<td>1.8</td>
<td>16</td>
<td>2.5</td>
</tr>
<tr>
<td>2-5</td>
<td>114</td>
<td>2.2</td>
<td>42</td>
<td>3.4</td>
</tr>
<tr>
<td>6-10</td>
<td>49</td>
<td>3.2</td>
<td>19</td>
<td>4.2</td>
</tr>
<tr>
<td>11-20</td>
<td>14</td>
<td>1.5</td>
<td>4</td>
<td>1.5</td>
</tr>
<tr>
<td>21-30</td>
<td>6</td>
<td>0.8</td>
<td>2</td>
<td>0.9</td>
</tr>
</tbody>
</table>
7-4 Psychosocial working conditions and risk of LBP (Paper III)

A total of 3838 completed baseline questionnaires were collected. From this cohort 664 subjects who had a history of war participation were excluded from analysis in this paper. Among the 3174 employees eligible for participation in the study, a total of 744 subjects reported current LBP (point prevalence cases). A total of 52 (less than 2%) new episodes of disabling LBP were observed during the one-year follow-up (incident cases). In this study, male employees reported higher demands, lower control and lower support than female employees. Therefore the number suffering from strain is higher for men than for women.

Table 1 - Unadjusted odds ratio and multiple logistic regression with 95% CI for psychosocial factors associated with point prevalence of low back pain

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted OR</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>High Demands</td>
<td>2.3(1.8-3.0)</td>
<td>0.8(0.4-1.3)</td>
<td>2.5(2-3.1)</td>
<td>0.7(0.4-1.2)</td>
</tr>
<tr>
<td>Low Control</td>
<td>2.3(1.9-2.9)</td>
<td>0.8(0.5-1.2)</td>
<td>2.5(2-3.1)</td>
<td>0.6(0.4-1.1)</td>
</tr>
<tr>
<td>Low Support</td>
<td>0.4(0.3-0.4)</td>
<td>0.7(0.5-1.2)</td>
<td>0.3(0.3-0.4)</td>
<td>0.7(0.4-1.2)</td>
</tr>
<tr>
<td>Strain</td>
<td>2.5(2.1-3.0)</td>
<td>0.6(0.3-1.0)</td>
<td>2.3(2.3-3.4)</td>
<td>0.5(0.3-0.9)</td>
</tr>
<tr>
<td>IsoStrain</td>
<td>0.9(0.7-1.0)</td>
<td>0.4(0.1-0.9)</td>
<td>1.0(0.8-1.3)</td>
<td>0.3(0.1-0.9)</td>
</tr>
<tr>
<td>Low Job Satisfaction</td>
<td>2.5(2.0-3.1)</td>
<td>1.2(0.7-2.2)</td>
<td>2.6(2.1-3.2)</td>
<td>1.0(0.5-1.9)</td>
</tr>
<tr>
<td>Low Job Appreciation</td>
<td>1.2(1.0-1.5)</td>
<td>1.1(0.6-1.9)</td>
<td>1.1(0.9-1.4)</td>
<td>1.1(0.6-2.0)</td>
</tr>
</tbody>
</table>

*Model 1 controlled for age
*Model 2 controlled for age and physical exposures
*Model 3 controlled for age, physical exposure and psychosocial factors (jobstrain, low job satisfaction and low job appreciation)
GHAFFARI M.

In a multiple logistic regression model for psychosocial factors associated with point prevalence of LBP, increased odds ratios for men were found for high demands (OR=1.9, CI=1.4-2.5), low control (OR=1.9, CI=1.5-2.4) and job strain (OR=2.1, CI=1.7-2.6). The results were controlled for age and physical exposures (sitting position, awkward working position, work with hands above shoulders or under knee level and carrying heavy objects). Also among men, low job satisfaction and low job appreciation showed an increased odds ratio of 2.2 (95% CI=1.7-2.8) and 1.1 (95% CI=0.9-1.4) in LBP point prevalence respectively. The results for women were not conclusive, due to the fact that there were few cases (table 11).

In a multiple logistic regression model for psychosocial factors associated with one-year incidence of disabling LBP, increased odds ratios for men were found for high demand (OR=1.8, CI=0.7-4.9), low control (OR=1.3, CI=0.7-2.5) and job strain (OR=1.8, CI=0.9-3.4), but these results were not statistically significant (table 12).

| Table 12- Unadjusted odds ratio and multiple logistic regression with 95% CI for psychosocial factors associated with one-year incidence of disabling low back pain in employees 2005 (n=3174) Male= 2795 & Females=379 |
|--------------------------------------------------|------------------|------------------|------------------|
|                                                  | Unadjusted OR    | Model 1          | Model 2          | Model 3          |
|                                                  | Men              | Men              | Men              | Men              |
| High Demands                                     | 1.9(0.8-4.2)     | 2.3(1.0-5.4)     | 1.8(0.7-4.9)     |
| Low Control                                      | 1.3(0.7-2.4)     | 1.5(0.8-2.8)     | 1.3(0.7-2.7)     |
| Low Support                                      | 0.6(0.3-1.1)     | 0.5(0.3-1.0)     | 0.5(0.3-0.9)     |
| Job Strain                                       | 2.0(1.1-3.5)     | 2.2(1.2-4.1)     | 1.8(0.9-3.4)     | 1.7(0.7-3.9)     |
| Iso-Strain                                       | 1.7(0.9-3.2)     | 1.7(0.9-3.3)     | 1.5(0.7-3.0)     |
| Low Job Satisfaction                             | 1.9(1.0-3.5)     | 2.1(1.1-3.9)     | 1.8(1.0-3.5)     | 2.9(1.3-6.3)     |
| Low Job Appreciation                             | 1.1(0.5-2.2)     | 1.1(0.6-2.3)     | 1.3(0.6-2.7)     | 1.1(0.9-1.2)     |

* Model 1 controlled for age
* Model 2 controlled for age and physical exposures
* Model 3 controlled for age, physical exposure and psychosocial factors (job strain, job satisfaction and job appreciation)
The results were controlled for age and physical exposures (sitting position, awkward working position, work with hands above shoulder or under knee level and carrying heavy objects). Also among men low job satisfaction and low job appreciation showed an increased odds ratio of 1.8 (95% CI= 1.0-3.6) and 1.3 (95% CI= 0.6-2.7) in disabling LBP incidence respectively. The results for women were not conclusive due to that fact that there were few cases.

7-5 Cigarette smoking and risk of LBP (Paper IV)

All cases of sick leave are compulsorily registered at the occupational health clinic. Among 3838 employees eligible for follow-up study, a total of 983 subjects reported current LBP (point prevalence cases). A total of 67 new episode of disabling LBP were observed during one-year follow-up (incident cases). Unskilled workers displayed the highest prevalence and incidence rate. With increasing age and work experience the number of employees who smoked increased. Higher pain intensity and a higher rate of surgery due to LBP were found in smokers. Sleep problems and negative impact of LBP were higher in smokers than non-smokers.

Current smoking increased both LBP prevalence and incidence of disabling LBP. Smokers suffered three times as many new episodes of disabling LBP as non-smokers. Ex-smokers showed a lower incidence of disabling LBP. In a multiple logistic regression model for smoking habits associated with point prevalence of LBP, increased odds ratios were found for smokers (OR=1.3, 95% CI= 1.0-1.6). The results were controlled for age, sex, psychosocial factors, physical exposures, and war participation. Among ex-smokers there was no significant association with LBP prevalence.

Table 13- Unadjusted odds ratio and multiple logistic regression with 95% CI for smoking habits associated with point prevalence of low back pain in employees of an Iranian car manufacturing company, 2005 (n=3838)

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted OR(95% CI)</th>
<th>Regression Model 1</th>
<th>Regression Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smokers (n= 2734)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ex-smokers (n= 145)</td>
<td>1.1 (0.7-1.6)</td>
<td>0.9 (0.6-1.4)</td>
<td>0.7 (0.4-1.2)</td>
</tr>
<tr>
<td>Smokers (n= 657)</td>
<td>1.6 (1.3-1.9)</td>
<td>1.3 (1.1-1.6)</td>
<td>1.3 (1.0-1.6)</td>
</tr>
</tbody>
</table>

* Model 1 controlled for age, sex, and war participation

* Model 2 controlled for age, sex, psychosocial factors, physical workload, and war participation
In a multiple logistic regression model for smoking habits associated with one-year incidence of disabling LBP, increased odds ratios were found for smokers (OR=3.1, 95% CI= 1.6-6.2). The results were controlled for age, sex, psychosocial factors, physical exposures, and war participation. The association between smoking habits and disabling LBP incidence is stronger than LBP prevalence.

Table 14- Unadjusted odds ratio and multiple logistic regression with 95% CI for smoking habits associated with one-year incidence of disabling low back pain in employees of an Iranian car manufacturing company, 2005 (n=3838)

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted OR(95% CI)</th>
<th>Regression Model 1</th>
<th>Regression Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smokers (n= 2734)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ex-smokers (n= 145)</td>
<td>0.5 (0.1-3.7)</td>
<td>0.4 (0.1-3.5)</td>
<td>0.9 (0.1-7.4)</td>
</tr>
<tr>
<td>Smokers (n= 657)</td>
<td>2.8 (1.7-4.8)</td>
<td>2.5 (1.4-4.3)</td>
<td>3.1 (1.6-6.2)</td>
</tr>
</tbody>
</table>

* Model 1 controlled for age, sex, and war participation
* Model 2 controlled for age, sex, psychosocial factors and physical workload, and war participation
8 DISCUSSION

8-1 METHODOLOGICAL ISSUES

Epidemiology is defined as the distribution and determinants of disease in human populations (Rothman KJ 2002). Based on the theory, after randomized trials, one of the best types of epidemiological studies regarding disease causation is observational study. Observational studies can be defined as descriptive or analytical. Analytical studies address aetiological hypotheses. The purpose of the analytical study is to assess exposure and disease outcome in individuals, with the objective of ascertaining whether the particular exposure and the particular disease are associated or not. The relative risk is most often used as a measure of association in analytical studies. In studies with less common or rare outcome, relative risk and odds ratio will be the same. However, an association does not necessarily indicate causation, as association can be generated by chance, confounding and bias (Rothman KJ 2002).

8-1-1 Study design

One of the two main types of epidemiological analytical studies is the cohort study. A cohort study is defined as a group of designated individuals who are followed over time with regard to disease occurrence. In a prospective cohort study, present exposure is documented before the start of follow-up and potential occurrence of disease. Cohort members must be at risk for the disease under study, alive and free of this disease at the outset of follow-up (Rothman KJ 2002).

Major strengths of the studies included in this thesis are their prospective designs (studies II, III, and IV) that allow us to draw some conclusions about causes and effects, the rather large cohort with a wide range of different job titles represented and good quality of outcome measures. The study sample was chosen from one of the biggest industrial groups in Iran with more than 100 different job titles that were aggregated in four main job titles. The fact that there was an extremely large number of study subjects with different job titles suggests that our results can be generalized, and may be of interest to similar occupational populations in developing as well as developed countries. The response rates in study I (78 %) and study III (85 %) are considered to be very good.

8-1-2 Bias

Systematic errors, or bias, can be defined as a process at any stage of inference producing results that depart systematically from the true values. A study can be biased because of the way the study persons have been selected, the way the study variables are measured or some confounding factors. Selection bias, information bias and confounding are three main categories of bias.
Selection bias
According to definition, selection bias is a systemic error originating from the procedures used to select study population, and from factors influencing study participation (Rothman KJ 2002). Selection bias is present when the association between exposure and outcome differs for those who participate and those who do not participate in a study. A high participation rate will reduce this problem. Also, separate analysis for examining the possibility of selection bias will be helpful. In our studies not participating persons were similar to the participants with regard to age, job title, and working history.

The “healthy worker effect” is a special form of selection bias in the field of occupational health epidemiology. The “healthy worker effect” is defined as a self-selection process that allows relatively healthy people to remain in certain jobs, whereas those who change jobs are, as a group, less healthy (McMickel AJ 1974). Most employees at IKCO are young and only those who are absolutely fit are employed. The low incidence and prevalence rate in our studies compared with industrialized countries may be related to the healthy worker effect and the young age of the workforce.

Information bias
Information bias represents systematic errors in the measurement of information on exposure or outcome. Recall bias is one type of information bias. Recall bias may potentially have contributed to the observed result in paper I.

Controlling for potential confounders
Confounding may be regarded as a mixing of effects. A confounder has three properties:
- a) it must be associated with the outcome
- b) it must associated with the exposure
- c) it must not be an effect of the exposure

In papers I, III and IV we were able to adjust for a number of potential confounders in the multivariable regression models. While there appears to be some evidence that psychosocial variables are related to LBP, the interpretation of the results may depend upon whether other potential confounding variables were controlled for in the analyses. When evaluating the association between psychosocial factors and LBP it is important to take two types of variables into account: demographic variables and biomechanical factors. Biomechanical factors have also been shown to be related to both psychosocial work factors and LBP. Several studies have found that jobs with high biomechanical demands are likely to be associated with poor psychosocial work factors such as high demands, and low control (Leino PI 1995, Toomingas A 1997, Burton AK 1997). Methods to assess the effect of independent risk factors on the presence of LBP did not pay sufficient attention to the importance of interrelations between risk factors. Physical, psychosocial, and individual risk factors coexist, are interrelated, and can potentially interact with each other. In the literature there are few
studies that have considered simultaneously physical and psychosocial workload in
the same occupational group (Vinagard E 2000, Burdof A 1999). In paper III, in
order to show the association between psychosocial factors and LBP, we controlled
for the effect of physical load.

8-1-3 Quality of the exposure measurement
Both questionnaires used in studies I, III, and IV tested for reliability and validity.
Results provided evidence that the Persian version of the NMQ and MUSIC inventory
is a reliable and valid instrument to measure musculoskeletal pain and disorders, and
work-related physical and psychosocial exposures as well as non-work-related factors.
The absence of individual observer-based measurements of physical workload may be
considered a weakness in the assessment of potential confounders. This is a typical
limitation of large-scale epidemiological studies, because of the high costs associated
with individual standardized measurements.
Most prospective studies are limited by measuring the predictor variables only once, at
the beginning of the study. Repeated measurement during the follow-up period would
have allowed us to adjust for changes in the predictor variables and therefore to
measure exposure more accurately. The one-time measurement might have biased the
results towards an underestimation or overestimation of the true size of the effect
(Rothman KJ 1998). Fortunately in the IKCO study most of the employees stayed at
their workplace during the follow-up period, and carried out the same job task as
before.

8-1-4 Quality of the outcome measurement
A complicating factor in low back pain research is the fact that onset and duration of
LBP episodes are difficult to measure (Elders LA 2004). If the onset of LBP is not
clearly defined, it is very difficult to distinguish between incidence and recurrence. Few
studies have assessed two outcome measures at the same time within the same
population (Elders LA 2004, Croft P 1998). In study I, we defined people free of LBP
in the last year and then followed them for one year, using a clear definition of
prevalence, incidence, recurrence and cumulative recurrence. For this reason, our paper
II, is one of the few studies that distinguishes between incidence and recurrence.
An important strength in paper II is our system for collecting new cases. All episodes of
LBP that lead to sick leave require a medical certificate from a physician inside or
outside the factory, and are registered at the IKCO occupational health clinic. After a
period of medically certified sick leave the employee needs to obtain permission to
return to work from the occupational health clinic at the factory. Therefore, the
accuracy of detecting new episodes of LBP, which leads to sick leave in this study, was
very high.

In papers III and IV, whereas psychosocial work conditions and smoking habits were
measured by self-report, the outcome was assessed not only by self-report but also
objectively through physicians’ diagnoses made in the course of an accepted sickness
absence certificate. By doing this, we avoided bias through common method variance, or the tendency to find spurious associations in studies measuring both predictors and outcome by self-report.

8-2 INTERPRETATIONS OF THE FINDINGS

Low back pain prevalence

To our knowledge, this study on more than 18,000 workers is one of the first longitudinal studies in which prevalence, incidence, and recurrence of LBP were studied simultaneously, and with this number of participants in a developing country. Paper I showed that LBP is a common problem in the working population even in a developing country. In this cross-sectional study, age and gender as well as certain work-related physical and psychosocial factors influenced the prevalence of LBP.

This study, which is based on a large study population with a high participation rate from top management to unskilled workers, is one of the very few that are able to provide a reliable estimation of the prevalence of LBP in the working population in a developing country. The physical and psychosocial exposures at work differed between these groups but LBP prevalence was similar. This indicates that LBP is a common burden in the society and cannot be completely attributed to work factors. However, this population, like most working populations in developing countries is young, and we do not know what will happen after a long period of heavy exposure to adverse working conditions. In addition, initial employment is based on health status among other things. In a country with a high unemployment rate such selection mechanisms are probably common and result in a workforce in attractive industries that is healthier than the general working population.

The one-year prevalence of LBP observed in our study (21 %) was far from that reported by Elders for scaffolders in the Netherlands (60 %), by Schibye for Danish sewing machine operators (45%), and by Jin, for different occupational groups in Shanghai (74 %). However, caution must be exercised when comparing these studies, due to differences in LBP definitions and study methods. In two different studies among automotive assembly workers in the UK and Sweden, the one-year prevalence of LBP has been reported as 65 % and 46 % respectively. Like our study, both of them used the Nordic Musculoskeletal Questionnaire. Differences in social security systems, workers’ compensation systems and benefits during sickness absence, as well as the healthy worker effect, may explain the difference.

Low back pain incidence

Paper II showed that the incidence of disabling LBP in Iran is much lower than in developed countries. One reason for this considerable difference is related to how the outcome is defined. We calculated the incidences of disabling low back pain leading to
sickness absence. Other studies use self-reporting of new episodes of low back, a less severe outcome with less importance for the employees and employer. Differences between social security systems, workers’ compensation systems and benefits during sickness absence may be another reason for the difference.

For example, in Sweden employees can have one week of sickness absence without a medical certificate, but in Iran sickness absence is only permitted with a medical certificate. According to insurance legislation in Iran, sickness benefit is payable in cases of disease, or injuries, that reduce work capacity. For seven days or less, a general medical certificate may be accepted. In cases of sickness absence lasting more than seven days, physicians who are approved by the insurance system must confirm medical certificates. For long-term sickness absence (more than 60 days), sickness benefit is payable based on a confirmation of diagnosis by the expert medical board at the insurance organization. Sickness benefit is payable from the first day of accident and fourth day of disease by insurance organization. In case of disease, the employer will cover the first three days of sickness benefit. According to insurance legislation in Iran there is no time limit for sickness benefit payment, and it will continue until such time that the insurance organization expert committee approve it; however, in most cases employees will return to work, or in severe cases where they have lost their workability partially or completely, this committee will give them partial or complete disability pension.

According to insurance organization legislation, complete disability pension will be awarded to employees with more than 66% reduction in workability, and partial disability pension will awarded to employees with more than 33% and less than 66% reduction in workability. In both cases their income will be less than their usual income and pension.

There is no part-time sickness absence and benefit in Iran. In cases where a sickness certificate is approved, the benefit covers only 75% of salary for married employees and 66% of salary for unmarried employees. In Iran, working extra hours is rather common and this accounts for a considerable part of the employee’s income. In these cases, employees will lose this part of their income.

In study II, non-respondent employees in the baseline survey had a higher incidence and recurrence rate of low back pain than employees who responded to the baseline survey. One reason for this may be that people had low back pain but did not want to report their health problems, and subsequently did not participate in the baseline survey. For this reason there is a possibility that the prevalence result at the baseline (21%) has been underestimated, and this supports the hypothesis that the healthy worker bias might have been present, an effect that is not as easily detectable in other studies with a less restrictive reporting system.
Physical working conditions
In accordance with other studies (Vingard E 2000, Burdorf A 1997), we found weak but significant association between heavy lifting, sitting position and repetitive work and LBP in our cross-sectional study that was reported in paper I. In our prospective study, crude odds ratio showed slightly increased risk for carrying heavy things, bending and twisting, sitting position, and vibration, but in the multiple logistic regression model only sitting position and bending remained significant. In a review, Vingard (Vingard E 2000) found that most published investigations report an association between some types of WBV for prolonged periods, frequent bending and twisting of the trunk, and frequent heavy lifting. For persons in extreme working environments, such as helicopter pilots and firefighters, the risk estimates are the highest. In population-based studies in workers with low exposures in general and few heavily exposed workers, the risk estimates are much lower (Vingard 2000).

In our study, these employees work in a rather modern factory and most of them are young. Therefore, more time is needed to reveal any effects of physical exposures.

Psychosocial working conditions
Paper III is one of few studies of psychosocial factors and LBP that controlled for physical work characteristics. Previous reviews (Bongers PM 1993, Burdorf A 1997, Burton AK 1997, Davis KG 2000, Vingard E 2000) have concluded that certain psychosocial work characteristics are associated with LBP. In study III, male employees reported higher demands, lower control and lower support than female employees. Therefore the number of employees with strain is higher in men than women. Our study showed that job strain would lead to twofold increase in the risk of getting LBP. High demands, low control and low job satisfaction also led to a twofold increase in the risk of getting LBP. While the literature reviews suggest some association between psychosocial work characteristics and LBP, with our results we suggest that there are some causal inferences.

Lifestyle factors
The result in paper IV showed that there is a significant association between cigarette smoking and LBP prevalence and incidence of disabling LBP. The association was consistent and significant across a variety of statistical models. Different mechanisms are suggested that could link smoking with LBP. Aortic atherosclerosis may cause LBP, and chronic bronchitis may induce LBP because of the repeated increase of spinal pressure from coughing (Gyntelberg F 1974, Leboeuf Yde C 1999).

Our study population was young and most of them were under 35 years old. It could be argued that a pathological process may not have had enough time to develop in the younger smokers. On the other hand, there is a transient physiological construction of blood vessels in response to smoking that can occur at all ages. Smoking could
therefore have an effect on smaller blood vessels in the spinal region also in younger adults.

Many studies from western and industrialized countries have reported on a possible link between smoking cigarettes and non-specific low back pain (Goldberg MS 2000). Our study IV is one of the first studies to include this number of participants with different job titles from a developing country that confirms this relationship.
9 CONCLUSIONS

The studies in this thesis have described the prevalence and incidence of LBP among industrial workers in Iran. In conclusion, incidence of LBP differs considerably between developed countries and developing countries.

Several factors in working life as well as lifestyle factors acted as risk factors for LBP. This thesis showed that, psychosocial risk factors at the workplace are associated with LBP. Lifestyle factors such as cigarette smoking will increase the risk of getting LBP.

This study is one of the first longitudinal studies to include this number of participants from a developing country that has attempted to test the suggested link between different physical, psychosocial and lifestyle factors and LBP. A better understanding of such key issues as the exposure panorama, causal pathway and dimension of the selected health problem is paramount for health promotion and interventional programmes in the workplace. Our study results generate knowledge and open up possibilities for evidence-based intervention programmes. The fact that there were a huge number of study subjects with different job titles suggests that our results can be generalized, and may be of interest to similar occupational populations in developing and developed countries.

Where do we go from here?
In order to reach a better understanding of the relationship between lifestyle factors, physical factors and psychosocial work characteristics and low back pain, future research needs to address some of the methodological issues.
Future studies should to:
- Conduct prospective studies with multiple measurements of exposures and outcome.
- Utilize high quality and objective measures of occupational exposures (both physical and psychosocial)
- Conduct intervention research to test the hypothesis and assess the effectiveness of modifying physical and psychosocial work characteristics for reducing LBP.
- Conduct health promotion intervention programmes for promoting a healthy lifestyle.

Fortunately at IKCO with our research results people are motivated to conduct the intervention programme in order to reduce the burden of LBP and other musculoskeletal disorders. One of the important impacts of our five-year project in this industrial group was the capacity-building and system development for screening the workers’ health and computerizing the disease and sickness absence registration system.
Now we are trying to conduct multi-disciplinary evidence-based intervention programmes for reducing LBP and other musculoskeletal problems in this industrial group, as a model for other industries in Iran.
ACKNOWLEDGEMENTS

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LOW BACK PAIN AMONG INDUSTRIAL WORKERS

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REFERENCES


LOW BACK PAIN AMONG INDUSTRIAL WORKERS


Frank A. Low back pain. BMJ 1993;306-901


GHAFFARI M.


Hansson EK, Hansson TH. The costs for persons sick-listed more than one month because of low back or neck problems. A two-year prospective study of Swedish patients. Eur Spine J 2005;14:337-345.


LOW BACK PAIN AMONG INDUSTRIAL WORKERS


LOW BACK PAIN AMONG INDUSTRIAL WORKERS


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